On-line Fault Diagnosis of Produced Water Treatment with Multilevel Flow Modeling

Making sense of alarms can be difficult on oil and gas platforms. Multilevel Flow Modeling provides a structure for modelling plant functionality and inferring causes for alarms and predicting consequences. Currently, Multilevel Flow Modeling has limited application for on-line fault diagnosis. Based on a fault emulated on a pilot plant for offshore produced water treatment, Multilevel Flow Modeling is used for reasoning about causes for triggered alarms. The inferred causes are analysed to investigate the current maturity of Multilevel Flow Modeling for on-line diagnosis.
Adaptive Observer for Nonlinearly Parameterised Hammerstein System with Sensor Delay – Applied to Ship Emissions Reduction

Taking offspring in a problem of ship emission reduction by exhaust gas recirculation control for large diesel engines, an underlying generic estimation challenge is formulated as a problem of joint state and parameter estimation for a class of multiple-input single-output Hammerstein systems with first order dynamics, sensor delay and a bounded time-varying parameter in the nonlinear part. The paper suggests a novel scheme for this estimation problem that guarantees exponential convergence to an interval that depends on the sensitivity of the system. The system is allowed to be nonlinear parameterized and time dependent, which are characteristics of the industrial problem we study. The approach requires the input nonlinearity to be a sector nonlinearity in the time-varying parameter. Salient features of the approach include simplicity of design and implementation. The efficacy of the adaptive observer is shown on simulated cases, on tests with a large diesel engine on test bed and on tests with a container vessel.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, MAN Diesel & Turbo, Linköping University
Authors: Nielsen, K. V. (Ekstern), Blanke, M. (Intern), Eriksson, L. (Ekstern)
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.966 SNIP 2.798 CiteScore 4.72
Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 1.786 SNIP 3.006 CiteScore 4.34
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
An Architecture for Controller Parameterization
The focus in this paper is on the YJBK (after Youla, Jabr, Bongiorno and Kucera) parameterization of all stabilizing feedback controllers for a given system. A new formulation of YJBK controller architecture is presented and the relation with the double Bezout equation is described. In the standard formulation, a full order model of the system is required for an implementation of the YJBK controller architecture. Here, implementation of the YJBK parameterization will be based on reduced order model, obtained by e.g. model reduction of the full order models or by using identification methods. The controller architecture based on reduced order models will be analyzed with respect to closed-loop stability.

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Organisations: Department of Electrical Engineering, Automation and Control
Authors: Niemann, H. H. (Intern)
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Autonomous 3d model generation of unknown objects for dual-manipulator humanoid robots
This paper proposes a novel approach for the autonomous 3D model generation of unknown objects. A humanoid robot
(or any setup with two manipulators) holds the object to model in one hand, views it from different perspectives and
registers the depth information using a RGB-D sensor. The occlusions due to limited movement of the manipulator and the
gripper itself covering the object are avoided by switching the object from one hand to the other. This allows for additional
viewpoints leading to the registration of more depth information of the object. The contributions of this paper are as
follows: 1. A humanoid robot that manipulates objects and obtains depth information 2. Tracing the hand movements with
the robots head to be able to see the object at every moment 3. Filtering the point clouds to remove parts of the robot from
them 4. Utilizing the Normal Iterative Closest Point algorithm (depth points, surface normals and curvature information) to
register point clouds over time. This method will be applied to those pointclouds that include the robots gripper for optimal
convergence; the resultant transform is then applied to those point clouds that describe only the segmented object 5.
Changing the object from one hand to another 6. Merging the resulting objects’ partial point clouds from both the left
and right hands 7. Generating a mesh of the object based on the triangulation of final points of the object’s surface.
No prior knowledge of the objects is necessary. No human intervention nor external help (i.e visual markers, turntables..)
is required either.

A Water Treatment Case Study for Quantifying Model Performance with Multilevel Flow Modeling
Decision support systems are a key focus of research on developing control rooms to aid operators in making reliable
decisions, and reducing incidents caused by human errors. For this purpose, models of complex systems can be
developed to diagnose causes or consequences for specific alarms. Models applied in safety systems of complex and
safety-critical systems require rigorous and reliable model building and testing. Multilevel Flow Modelling is a qualitative
and discrete method for diagnosing faults and has previously only been validated by subjective and qualitative means. To
ensure reliability during operation, this work aims to synthesize a procedure to measure model performance according to
diagnostic requirements. A simple procedure is proposed for validating and evaluating the concept of Multilevel Flow
Modelling. For this purpose, expert statements, dynamic process simulations, and pilot plant experiments are used for
validation of simple Multilevel Flow Modelling models of a hydrocyclone unit for oil removal from produced water.

General information
State: Published
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Technology (KAIST)
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3D model creation, Humanoid robot, Point cloud processing
DOIs: 10.1007/978-3-319-78452-6_41
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Closed loop identification of a piezoelectrically controlled radial gas bearing: Theory and experiment

Gas bearing systems have extremely small damping properties. Feedback control is thus employed to increase the damping of gas bearings. Such a feedback loop correlates the input with the measurement noise which in turn makes the assumptions for direct identification invalid. The originality of this article lies in the investigation of the impact of using different identification methods to identify a rotor-bearing systems’ dynamic model when a feedback loop is active. Two different identification methods are employed. The first method is open loop Prediction Error Method, while the other method is the modified Hansen scheme. Identification based on the modified Hansen scheme is conducted by identifying the Youla deviation system using subspace identification. Identification of the Youla deviation system is based on the Youla–Jabr–Bongiorno–Kucera parametrisation of plant and controller. By using the modified Hansen scheme, identification based on standard subspace identification methods can be used to identify the Youla deviation system of the gas bearing. This procedure ensures the input to the Youla deviation system, and the noise is uncorrelated even though the system is subject to feedback control. The effect of identifying the Youla deviation system compared to direct subspace identification of the gas bearing is further investigated through a simulation example. Experiments are conducted on the piezoelectrically controlled radial gas bearing. A dynamic model is identified using the modified Hansen scheme as well as using Prediction Error Method identification. The resulting models are compared for different imperfect nominal models, to examine under which conditions each method should be used.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Applied Mathematics and Computer Science, Dynamical Systems, Department of Mechanical Engineering, Solid Mechanics
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Number of pages: 11
Publication date: 2018
Main Research Area: Technical/natural sciences
Condition monitoring of spar-type floating wind turbine drivetrain using statistical fault diagnosis

Operation and maintenance costs are significant for large-scale wind turbines, and particularly so for offshore. A well-organized operation and maintenance strategy is vital to ensure the reliability, availability, and cost-effectiveness of a system. The ability to detect, isolate, estimate and perform prognoses on component degradation could become essential to reduce unplanned maintenance and downtime. Failures in gearbox components are in focus since they account for a large share of wind turbine (WT) downtime. This study considers detection and estimation of wear in the downwind main shaft bearing of a 5 MW spar-type floating turbine. Using a high-fidelity gearbox model, we show how the downwind main bearing and nacelle axial accelerations can be used to evaluate the condition of the bearing. The paper shows how relative acceleration can be evaluated using statistical change detection methods to perform a reliable estimation of wear of the bearing. It is shown in the paper that the amplitude distribution of the residual accelerations follows a t-distribution and a change detection test is designed for the specific changes we observe when the main bearing becomes worn. The generalized likelihood ratio (GLR) test is extended to fit the particular distribution encountered in this problem, and closedform expressions are derived for shape and scale parameter estimation, which are indicators for wear and extent of wear in the bearing. The results in this paper show how the proposed approach can detect and estimate wear in the bearing.
according to desired probabilities of detection and false alarm
Constrained Multi-Body Dynamics for Modular Underwater Robots — Theory and Experiments
This paper investigates the problem of modelling a system of interconnected underwater robots with highly coupled dynamics. The objective is to develop a mathematical description of the system that captures its most significant dynamics. The proposed modelling method is based on active constraint enforcement by utilising the Udwadia-Kalaba Formulation for multi-body dynamics. The required description of a rigid constraint is defined, derived and implemented into a system of interconnected sub-models. An exhaustive experimental validation is conducted on a two-vehicle system, including towing tank tests on a BlueROV vehicle to determine the model parameters. The applicability of the modelling approach is assessed by comparing experimental data to simulations of an equivalent model synthesised using the proposed theory.

General information
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Organisations: Department of Electrical Engineering, Automation and Control, Norwegian University of Science and Technology
Authors: Nielsen, M. C. (Intern), Eidsvik, O. A. (Ekstern), Blanke, M. (Intern), Schjølberg, I. (Ekstern)
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BFI (2015): BFI-level 1
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Web of Science (2015): Indexed yes
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Web of Science (2014): Indexed yes
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Cooperative Rendezvous and Docking for Underwater Robots Using Model Predictive Control and Dual Decomposition

This paper considers the problem of rendezvous and docking with visual constraints in the context of underwater robots with camera-based navigation. The objective is the convergence of the vehicles to a common point while maintaining visual contact. The proposed solution includes the design of a distributed model predictive controller based on dual decomposition, which allows for optimization in a decentralized fashion. The proposed distributed controller enables rendezvous and docking between vehicles while maintaining visual contact.

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Organisations: Department of Electrical Engineering, Automation and Control, Norwegian University of Science and Technology
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Demand response with residential and commercial loads for phase balancing in secondary distribution networks

Current demand response (DR) programs are designed for wholesale markets and utility level issues, neglecting the local challenges that distribution network operators face during daily operations. On the other hand, deployment of DR in specific parts of a distribution network can enable additional services and benefits. Phase balancing, as a distribution system management requirement, is among them. This study is one of the first efforts on field testing of phase balancing through load management in residential and commercial buildings. Tests were conducted in an experimental facility to quantify the impact of corrective management actions on phase loadings.

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Organisations: Department of Electrical Engineering, Center for Applied Electric Power and Energy, Energy System Management, Automation and Control, Western Macedonia University of Applied Sciences, Istanbul Technical University, National Technical University of Athens
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2018

Detector design for active fault diagnosis in closed-loop systems

Fault diagnosis of closed-loop systems is extremely relevant for high-precision equipment and safety critical systems. Fault diagnosis is usually divided into 2 schemes: active and passive fault diagnosis. Recent studies have highlighted some advantages of active fault diagnosis based on dual Youla-Jabr-Bongiorno-Kucera parameters. In this paper, a method for closed-loop active fault diagnosis based on statistical detectors is given using dual Youla-Jabr-Bongiorno-Kucera parameters. The goal of this paper is 2-fold. First, the authors introduce a method for measuring a residual signal subject to white noise. Second, an optimal detector design is presented for single and multiple faults using the amplitude and phase shift of the residual signal to conduct diagnosis. Here, both the optimal case of a perfect model and the suboptimal case of a model with uncertainties are discussed. The method is successfully tested on a simulated system with parametric faults.

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Organisations: Department of Electrical Engineering, Automation and Control, Department of Applied Mathematics and Computer Science, Dynamical Systems
Authors: Sekunda, A. K. (Intern), Niemann, H. H. (Intern), Poulsen, N. K. (Intern)
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Estimating the Density of Fluid in a Pipeline System with an Electropump

To transfer petroleum products, a common pipeline is often used to continuously transfer various products in batches. Separating the different products requires detecting the interface between the batches at the storage facilities or pump stations along the pipelines. The conventional technique to detect the product in the pipeline is to sample the fluid in a laboratory and perform an offline measurement of its physical characteristics. The measurement requires sophisticated laboratory equipment and can be time-consuming and susceptible to human error. In this paper, for performing the online detection and separation of the batches, two methods are suggested that do not need extra equipment and are more practical. Because different petroleum products have different densities, the goal of both methods was to estimate the density of each product to detect its type. To estimate the fluid density, the first method used a recursive Kalman filtering
algorithm and a model that defined the relationship among the pump's differential pressure, the volume flow rate, and the rotational speed. The second method was suggested for the cases when the measurement of pressure and flow rate are not possible but the motor current and rotational speed are directly measurable. For that purpose, first the load torque was estimated. Then, by using a model that has parameters that depend on the density and that defines the relationship between the required pump torque and its rotational speed, the parameters of this model and consequently the density of the fluid were estimated. (C) 2018 American Society of Civil Engineers.

Fault Diagnosis and Identification of Electro Mechanical Systems - Methods for Closed Loop Systems.

We are on the verge of the fourth industrial revolution also known as industry 4.0[1]. The goal of industry 4.0 is to increase the incorporation of sensor information into decision making for machinery. This in turn increases the popularity of feedback control, and by extension, closed loop schemes. With the increasing popularity of closed loop control it is important that the impact of the feedback loop is handled appropriately. Because of the feedback loop, signals that might normally be uncorrelated are suddenly not and assumptions often used for identification and fault diagnosis schemes are no longer realistic to achieve.

The thesis aims at introducing the reader to design methods with proper handling of noise for closed loop systems. In order to achieve this goal, it is investigated how to transform a closed loop identification problem into an open loop identification problem. Such a transformation is already well known, however the excitation signal design is not intuitive when applying such a transformation. The shape of the excitation signal is of paramount importance for the quality of the identified model. By making the design of the excitation signal more intuitive, it should be possible to increase the quality of identified models.

Another interesting closed loop application is fault diagnosis. More and more systems will be part of a closed loop scheme in the future in accordance with industry 4.0. Often, systems are designed without sensor redundancy, and with disturbance rejecting controllers. Methods which are not limited in isolability due to sensor redundancy, and which decouple the effect of the disturbance rejecting controller, are therefore of huge interest. Active fault diagnosis obtains the required information through a known excitation signal instead of the sensor redundancy. Design of detectors based on active fault diagnosis can therefore make fault diagnosis possible for systems where installation of extra sensors are too cost demanding.

The methods were developed with a piezoelectric rotor-bearing application in mind. The bearing is using air as the lubricant between the bearing and the shaft and is therefore referred to as a gas bearing. Gas bearings have relative low damping compared to high friction bearings such as ball bearings. Feedback control is therefore employed to increase the damping of the Gas Bearing. This makes Gas Bearings a prime example of technology following with the industry 4.0 standard.
Fault Diagnosis for Satellite Sensors and Actuators using Nonlinear Geometric Approach and Adaptive Observers

This paper presents a novel scheme for diagnosis of faults affecting sensors that measure the satellite attitude, body angular velocity, flywheel spin rates, and defects in control torques from reaction wheel motors. The proposed methodology uses adaptive observers to provide fault estimates that aid detection, isolation and estimation of possible actuator and sensor faults. The adaptive observers do not need a-priori information about fault internal models. A nonlinear geometric approach is used to avoid that aerodynamic disturbance torques have unwanted influence on the fault estimates. An augmented high fidelity spacecraft model is exploited during design and validation to replicate faults. This simulation model includes disturbance torques as experienced in low Earth orbits. The paper includes an analysis to assess robustness properties of the method with respect to parameter uncertainties and disturbances. The results document the efficacy of the suggested methodology.
Fault Tolerant Position-mooring Control for Offshore Vessels

Fault-tolerance is crucial to maintain safety in offshore operations. The objective of this paper is to show how systematic analysis and design of fault-tolerance is conducted for a complex automation system, exemplified by thruster assisted Position-mooring. Using redundancy as required by classification societies' class notations for offshore position controlled vessels, the paper shows how violations of normal behaviour of main components can be detected and isolated. Using a functional service philosophy, diagnosis procedures are auto-generated based on provable correct graph analysis methods. Functional faults that are only detectable, are rendered isolable through an active isolation approach. Once functional faults are isolated, they are handled by fault accommodation techniques to meet overall control objectives specified by class requirements. The paper illustrates the generic methodology by a system to handle faults in mooring lines, sensors or thrusters. Simulations and model basin experiments are carried out to validate the concept for scenarios with single or multiple faults. The results demonstrate that enhanced availability and safety are obtainable with this design approach. While methods are introduced at a tutorial level, the paper is original by providing a total Position-mooring system design that ensures resilience to any single fault and to selected multiple faults.

General information
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Friction-resilient position control for machine tools—Adaptive and sliding-mode methods compared

Robust trajectory tracking and increasing demand for high-accuracy tool positioning have motivated research in advanced control design for machine tools. State-of-the-art industry solutions employ cascades of Proportional (P) and Proportional-
Integral (PI) controllers for closed-loop servo control of position and velocity of the machine axes. Although these schemes provide the required positioning accuracy in nominal conditions, performance deteriorates with increased friction and wear of the machine. With conventional control, re-tuning is necessary during the lifetime if specified accuracy shall be maintained. This paper investigates whether nonlinear and adaptive controllers can cope with typical levels of friction increase without loss of performance. It evaluates the performance of a state-of-art industry solution with that obtainable with adaptive and sliding mode positioning controls. The main finding is that an adaptive backstepping control is resilient to unknown and increasing friction at realistic levels of wear, where the P-PI control fall short with respect to accuracy. A single-axis test rig with adjustable friction is used to assess the performance of different controllers.

General information
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.205 SNIP 2.502 CiteScore 3.26
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.339 SNIP 3.154 CiteScore 3.5
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.164 SNIP 3.054 CiteScore 3.02
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.405 SNIP 2.865 CiteScore 2.96
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.24 SNIP 2.647
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.4 SNIP 2.947
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.391 SNIP 2.817
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.086 SNIP 2.14
Scopus rating (2006): SJR 0.912 SNIP 1.898
Scopus rating (2005): SJR 0.538 SNIP 1.598
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.435 SNIP 1.292
Functional Modeling for Monitoring of Robotic System

With the expansion of robotic applications in the industrial domain, it is important that the robots can execute their tasks in a safe and reliable way. A monitoring system can be implemented to ensure the detection of abnormal situations of the robots and report the abnormality to their human supervisors or cooperators. In this work, we focus on developing a modeling framework for monitoring robotic system based on means-end analysis and the concept of action phases from action theory. A circular cascaded action phase structure is proposed for building the model of cyclical robotic events. This functional model provide a formal way of decompose robotic tasks and analyze each level of conditions for an action to be executed successfully. It can be used for monitoring robotic systems by checking the preconditions in the action phases and identifying the failure modes. The proposed method is demonstrated by using a simulated robotic manipulation system. The simulation results demonstrate the feasibility of the developed functional model in finding errors during the execution monitoring.

General information
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Organisations: Department of Electrical Engineering, Automation and Control, Technical University of Denmark
Authors: Wu, H. (Intern), Bateman, R. R. (Ekstern), Zhang, X. (Intern), Lind, M. (Intern)
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BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 0.81 SJR 0.27 SNIP 0.543
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.245 SNIP 0.558 CiteScore 0.77
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.419 SNIP 0.822 CiteScore 1
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.412 SNIP 1.039 CiteScore 1
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.26 SNIP 0.882 CiteScore 0.92
BFI (2011): BFI-level 2
Marine Diesel Engine Control to meet Emission Requirements and Maintain Maneuverability

International shipping has been reported to account for 13% of global NOx emissions and 2.1% of global greenhouse gas emissions. Recent restrictions of NOx emissions from marine vessels have led to the development of exhaust gas recirculation (EGR) for large two-stroke diesel engines. Meanwhile, the same engines have been downsized and derated to optimize fuel efficiency. The smaller engines reduce the possible vessel acceleration, and to counteract this, the engine controller must be improved to fully utilize the physical potential of the engine. A fuel index limiter based on air/fuel ratio was recently developed [1], but as it does not account for EGR, accelerations lead to excessive exhaust smoke formation which could damage the engine when recirculated. This paper presents two methods for extending a fuel index limiter function to EGR engines. The methods are validated through simulations with a mean-value engine model and on a vessel operating at sea. Validation tests compare combinations of the two index limiter methods, using either traditional PI control for the EGR loop or the recently developed fast adaptive feedforward EGR control [2]. The experiments show that the extended limiters reduce exhaust smoke formation during acceleration to a minimum, and that the suggested limiter, combined with adaptive feedforward EGR control, is able to maintain full engine acceleration capability. Sea tests with engine speed steps from 35 to 50 RPM, made peak exhaust opacity increase by only 5 percentage points when using the proposed limiter, whereas it increased 70 percentage points without the limiter.
On the joint distribution of excursion duration and amplitude of a narrow-band Gaussian process

The probability density of crest amplitude and of duration of exceeding a given level are used in many theoretical and practical problems in engineering. The joint density is essential for design of constructions that are subjected to waves and wind. The presently available joint distributions of amplitude and period are limited to excursion through a mean-level or to describe the asymptotic behavior of high level excursions. This paper extends the knowledge by presenting a theoretical derivation of probability of wave exceedance amplitude and duration, for a narrow-band Gaussian process. The suggested density function has the following properties: (1) it only depends on the three lowest spectral moments m0, m1, m2 and desired level of exceedance, H. It does not require any condition on the autocorrelation function; (2) by increasing H, correlation between excursion periods and amplitudes increases; (3) for a spectrum describing a physical phenomenon such as a sea state spectrum, the accuracy of the proposed approximation, for a given spectral width parameter ν, increases for higher level H. The paper shows that the marginal distribution of amplitude is compatible with the Rayleigh distribution, as expected, and that the marginal distribution of excursion duration works both for asymptotic and non-
asymptotic cases. The suggested model is found to be a good replacement for the empirical distributions that are widely used. Results from simulations of narrow-band Gaussian processes, real sea states at three European sites—in the Atlantic ocean and in North sea—are found to agree well with the established distribution.

**General information**

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Organisations: Department of Electrical Engineering, Automation and Control, Norwegian University of Science and Technology
Authors: Ghane, M. (Ekstern), Gao, Z. (Ekstern), Blanke, M. (Intern), Moan, T. (Ekstern)
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Scopus rating (2016): CiteScore 5.13
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**Optimisation of Combine Harvesters using Model-based Control**

The world population is expected to grow by over one third between 2009 and 2050 according to the Food and Agriculture Organization of the United Nations. The arable areas are expected to decrease in the developed countries requiring an increase in yield on the available land meanwhile it gets increasingly harder to find qualified operators for combine harvesters.

The performance of the combine harvester is affected by a number of uncontrollable biological variables comprising both temporal and spatial field variations. The threshing, separation and cleaning processes can be optimised by adjusting a number of actuators, however this is not straightforward as the material flows are tightly coupled and the optimisation parameters are even conflicting. Integration of a closed-loop control system is highly challenging as most state of the art process sensors only offer a relative reading of the actual material flows in the combine.

The aim of the project is to design a closed-loop control system than can optimise the performance of the threshing, separation and cleaning processes in a combine harvester. Model development will be required to analyse, optimise and obtain transparency to the system states. The methods acknowledge that a high degree of model accuracy is not achievable as well as the complexity of observer and controller design is kept at a minimum.

Material flow models are generated for the threshing, separation and cleaning systems using acquired material samples from laboratory test stands and field test experiments. Material samples and sensor data are used to generate a virtual combine, which is utilised for initial testing of all controllers, greatly reducing the scarce field test time required for test and verification.

The material flow analysis revealed that the rotor speed had a dominating effect on both separation grain losses as well as grain damage compared to the concave clearance, hence sole control of the rotor speed in the threshing and separation system is chosen.

A Luenberger observer was designed to estimate grain damage from a grain quality sensor, which has a long settling time compared to impact loss sensors. This facilitate a fast response to changes in the separation grain loss in varying conditions.

A closed-loop rotor speed controller was designed to balance rotor separation loss and grain damage using the grain
damage observer. The controller was verified by means of simulation as well as during field test experiments. The material flow analysis for the cleaning system showed degradation of cleaning performance is dominated by the MOG load and inclination angles as well as the effect from the fan speed and sieve actuators to material flows were tightly coupled, similar to the results from previous literature. It was shown that the fluidised phase characterising low grain losses could be identified using the tailings grain and MOG throughputs. The upper sieve primarily affected cleaning losses and tailings MOG throughout, and the lower sieve the cleanliness of the clean grain throughput and tailings grain throughput, hence these should be controlled using a distributed control scheme for optimisation, where each individual controller primarily will consider two balance parameters. An estimate of the tailings MOG throughput and tailings grain composition was obtained with reasonable good accuracy using sensor fusion of the tailings grain sensor and the non-linear tailings volume sensor. An on-line estimate of the tailings grain composition set-point characterising the fluidised phase was obtained, which facilitates a novel closed-loop fan speed control design. The fan speed controller was validated using a virtual combine, the cleaning system laboratory environment and during full scale field test. Implementation and verification of upper and lower sieve controllers is not addressed. The average harvest grain loss in the industrialised countries is 4% corresponding to the total cereal consumption of Germany. Hence reducing the grain loss by a fraction results in millions of tonnes of food as well as it can be the key to maintain a profitable business for the farmer, which is characterised by high revenues and small profit margins. The contributions of this project enables integration of a control system for rotor speed, fan speed and sieve openings on the AGCO IDEAL series of combine harvesters. The developed controllers are planned to be included in the automation system and will be commercially available in 2019. The dissertation is a summary of Ph.D. project and the methods developed during the project period. The results are disseminated in four conference articles, two submitted journal articles and one patent application.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Hermann, D. (Intern)
Number of pages: 229
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Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
thesis_180625.pdf

Relations
Projects:
Optimisation of Combine Harvesters using Model-based Control
Publication: Research › Ph.D. thesis – Annual report year: 2018

Robust Backlash Estimation for Industrial Drive-Train Systems—Theory and Validation
Backlash compensation is used in modern machinetool controls to ensure high-accuracy positioning. When wear of a machine causes deadzone width to increase, high-accuracy control may be maintained if the deadzone is accurately estimated. Deadzone estimation is also an important parameter to indicate the level of wear in a machine transmission, and tracking its development is essential for condition-based maintenance. This paper addresses the backlash estimation problem using sliding-mode and adaptive estimation principles and shows that prognosis of the development of wear is possible in both theory and practice. This paper provides the proof of asymptotic convergence of the suggested estimator, and it shows how position offset between motor and load is efficiently utilized in the design of a very efficient estimator. The algorithm is experimentally tested on a drive-train system with the state-of-the-art Siemens equipment. The experiments validate the theory and show that expected performance and robustness to parameter uncertainties are both achieved.

General information
State: Accepted/In press
Organisations: Department of Electrical Engineering, Automation and Control, Department of Applied Mathematics and Computer Science, Siemens
Authors: Papageorgiou, D. (Intern), Blanke, M. (Intern), Niemann, H. H. (Intern), Richter, J. H. (Ekstern)
Number of pages: 15
Publication date: 2018
Main Research Area: Technical/natural sciences
Publication information
A set of robotic building elements

A set of building elements (900), comprising one or more building elements (101;701;901..907) with a housing (119) which is selected from a group of straight, bend, L-shaped, and T-shaped bodies with one or more end-portions (121); wherein the building elements are configured with at least one connector (103) configured as a plug integrated with or installed in at least some of the end-portions (121). The connectors (103) comprise: an abutment face (201) with a centre portion (202); a diagonally magnetized magnet arranged behind the abutment face (201); and a pair of a female engagement
member (504) extending radially from the centre portion (202) and a male engagement member (503) extending from the
centre portion (202); wherein a depth (D) of the female engagement member and a height (H) of the corresponding male
engagement member is greater than a width (Wm) of the male engagement member or greater than a width (Wf) of the
female engagement member. At least a first building element among the building elements (101,701) comprises at least a
first one of the connectors (103); wherein the at least first one of the connectors (103) is rotatable mounted in a bearing
(108) fixed to the first building element. A drive unit (114) is coupled to turn the first one of connectors (103) in response to
a control signal and an energy storage unit (117) is coupled to supply operating power the drive unit. Preferably, the body
members (119) are tubular or tubular with one or more branches.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware
Authors: Christensen, D. J. (Intern), Pacheco, M. (Intern)
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Publication information
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Priority number: EP20160157134
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Main Research Area: Technical/natural sciences
Source: espacenet
Source-ID: WO2017144505
Publication: Research › Patent – Annual report year: 2017

Condition monitoring of a rotor arrangement in particular a wind turbine
The present invention relates to a method of determining the condition of a device comprising a rotor arrangement. The
rotor arrangement comprising a rotational shaft and a number rotor blades each connected at the root to the rotational
shaft and extending radially from the rotational shaft. Sensors are arranged to measure for each rotor blade corresponding
values of one or more of the following parameters: azimuth angle (Φ) (or a parameter related to the azimuth angle), root
bending moment(s) (q), such as the edgewise and/or flapwise root bending moments. The method comprises, while the
rotor arrangement rotates, recording corresponding values of azimuth angle and edgewise and flap wise root bending
moments for a plurality of rotations of rotor arrangement, transforming by use of e.g. a multi blade coordinate
transformation, a Park's transformation or similar transformation the recorded edgewise and flap wise root bending
moments (q) into a coordinate system rotating with the rotational shaft, thereby obtaining transformed root bending
moments (qf). The method further comprising identifying periodicity in each of the transformed root bending moments,
determining the condition of the rotor arrangement to be faulty, in case the one or more periodicities are identified in the
transformed root bending moments.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Applied Mathematics and
Computer Science, Dynamical Systems, Department of Wind Energy, Wind turbine loads & control
Authors: Niemann, H. H. (Intern), Poulsen, N. K. (Intern), Mirzaei, M. (Intern), Henriksen, L. C. (Ekstern)
Publication date: 8 Jun 2017

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Main Research Area: Technical/natural sciences
Source: espacenet
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Publication: Research › Patent – Annual report year: 2017
A Combination of Machine Learning and Cerebellar-like Neural Networks for the Motor Control and Motor Learning of the Fable Modular Robot
We scaled up a bio-inspired control architecture for the motor control and motor learning of a real modular robot. In our approach, the Locally Weighted Projection Regression algorithm (LWPR) and a cerebellar microcircuit coexist, in the form of a Unit Learning Machine. The LWPR algorithm optimizes the input space and learns the internal model of a single robot module to command the robot to follow a desired trajectory with its end-effector. The cerebellar-like microcircuit refines the LWPR output delivering corrective commands. We contrasted distinct cerebellar-like circuits including analytical models and spiking models implemented on the SpiNNaker platform, showing promising performance and robustness results.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, Copenhagen Center for Health Technology
Authors: Baira Ojeda, I. (Intern), Tolu, S. (Intern), Pacheco, M. (Intern), Christensen, D. J. (Intern), Lund, H. H. (Intern)
Pages: 62–66
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
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A Combination of Machine Learning and Cerebellar Models for the Motor Control and Learning of a Modular Robot
We scaled up a bio-inspired control architecture for the motor control and motor learning of a real modular robot. In our approach, the Locally Weighted Projection Regression algorithm (LWPR) and a cerebellar microcircuit coexist, forming a Unit Learning Machine. The LWPR optimizes the input space and learns the internal model of a single robot module to command the robot to follow a desired trajectory with its end-effector. The cerebellar microcircuit refines the LWPR output delivering corrective commands. We contrasted distinct cerebellar circuits including analytical models and spiking models implemented on the SpiNNaker platform, showing promising performance and robustness results.

General information
State: Published
Organisations: Department of Electrical Engineering, Centre for Playware, Automation and Control, Copenhagen Center for Health Technology
Authors: Baira Ojeda, I. (Intern), Tolu, S. (Intern), Pacheco, M. (Intern), Christensen, D. J. (Intern), Lund, H. H. (Intern)
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Source: PublicationPreSubmission
Source-ID: 128902220
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A comprehensive gaze stabilization controller based on cerebellar internal models

Gaze stabilization is essential for clear vision; it is the combined effect of two reflexes relying on vestibular inputs: the vestibulocollic reflex (VCR), which stabilizes the head in space and the vestibulo-ocular reflex (VOR), which stabilizes the visual axis to minimize retinal image motion. The VOR works in conjunction with the opto-kinetic reflex (OKR), which is a visual feedback mechanism that allows to move the eye at the same speed as the observed scene. Together they keep the image stationary on the retina. In this work we implement on a humanoid robot a model of gaze stabilization based on the coordination of VCR and VOR and OKR. The model, inspired by neuroscientific cerebellar theories, is provided with learning and adaptation capabilities based on internal models. We present the results for the gaze stabilization model on three sets of experiments conducted on the SABIAN robot and on the iCub simulator, validating the robustness of the proposed control method. The first set of experiments focused on the controller response to a set of disturbance frequencies along the vertical plane. The second shows the performances of the system under three-dimensional disturbances. The last set of experiments was carried out to test the capability of the proposed model to stabilize the gaze in locomotion tasks. The results confirm that the proposed model is beneficial in all cases reducing the retinal slip (velocity of the image on the retina) and keeping the orientation of the head stable.

General information
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Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, Scuola Superiore Sant'Anna
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BFI (2018): BFI-level 1
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BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.219 SJR 0.764 CiteScore 2.83
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.6 SJR 0.909 SNIP 1.232
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.281 SNIP 1.97 CiteScore 3.29
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.077 SNIP 1.679 CiteScore 2.87
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.954 SNIP 1.868 CiteScore 3.04
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.751 SNIP 1.73 CiteScore 2.47
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.691 SNIP 1.448 CiteScore 2.18
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.548 SNIP 1.154
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.806 SNIP 1.477
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.635 SNIP 1.354
Scopus rating (2007): SJR 0.427 SNIP 1.228
Adaptive feedforward control of exhaust recirculation in large diesel engines

Environmental concern has led the International Maritime Organization to restrict NOₓ emissions from marine diesel engines. Exhaust gas recirculation (EGR) systems have been introduced in order to comply to the new standards. Traditional fixed-gain feedback methods are not able to control the EGR system adequately in engine loading transients so alternative methods are needed. This paper presents the design, convergence proofs and experimental validation of an adaptive feedforward controller that significantly improves the performance in loading transients. First the control concept is generalized to a class of first order Hammerstein systems with sensor delay and exponentially converging bounds of the control error are proven analytically. It is then shown how to apply the method to the EGR system of a two-stroke crosshead diesel engine. The controller is validated by closed loop simulation with a mean-value engine model, on an engine test bed and on a vessel operating at sea. A significant reduction of smoke formation during loading transients is observed both visually and with an opacity sensor.
A Decision Support Tool for Transient Stability Preventive Control
The paper presents a decision support tool for transient stability preventive control contributing to increased situation awareness of control room operators by providing additional information about the state of the power system in terms of transient stability. A time-domain approach is used to assess the transient stability for potentially critical faults. Potential critical fault locations are identified by a critical bus screening through analysis of pre-disturbance steady-state conditions. The identified buses are subject to a fast critical contingency screening determining the actual critical contingencies/buses. These two screenings aim at reducing the computational burden of the assessment, since only contingencies considered as critical are taken into account. The critical clearing times for the critical contingencies are determined. A preventive re-dispatch of generators to ensure a predefined minimum critical clearing time for faults at all buses is proposed, while costs are minimized. The results of the assessment are presented to the control room operator, who decides to accept the suggested dispatch or to repeat the assessment considering additional user-specific constraints. The effectiveness of the proposed method is demonstrated on a standard nine-bus and the New England test system.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy System Management, Automation and Control, Distributed Energy Resources, University of Liege
Authors: Pertl, M. (Intern), Weckesser, J. T. G. (Intern), Rezkalla, M. M. (Intern), Heussen, K. (Intern), Marinelli, M. (Intern)
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Main Research Area: Technical/natural sciences

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  Scopus rating (2017): SNIP 1.412 SJR 1.048 CiteScore 3.31
  Web of Science (2017): Indexed yes
  BFI (2016): BFI-level 2
An experimentally validated simulation model for a four-stage spray dryer

In this paper, we develop a dynamic model of an industrial type medium size four-stage spray dryer. The purpose of the model is to enable simulations of the spray dryer at different operating points, such that the model facilitates development and comparison of control strategies. The dryer is divided into four consecutive stages: a primary spray drying stage, two heated fluid bed stages, and a cooling fluid bed stage. Each of these stages in the model is assumed ideally mixed and the dynamics are described by mass- and energy balances. These balance equations are coupled with constitutive equations such as a thermodynamic model, the water evaporation rate, the heat transfer rates, and an equation for the stickiness of the powder (glass transition temperature). Laboratory data is used to model the equilibrium moisture content and the glass transition temperature of the powder. The resulting mathematical model is an index-1 differential algebraic equation (DAE) model with 12 states, 9 inputs, 8 disturbances, and 30 parameters. The parameters in the model are identified from well-excited experimental data obtained from the industrial type spray dryer. The simulated outputs of the model are validated using independent well-excited experimental data from the same spray dryer. The simulated temperatures, humidities, and residual moistures in the spray dryer compare well to the validation data. The model also provides the profit of operation, the production rate, the energy consumption, and the energy efficiency. In addition, it computes stickiness of the powder in different stages of the spray dryer. These facilities make the model well suited as a simulation model for comparison of the process economics associated to different control strategies.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Dynamical Systems, Department of Electrical Engineering, Automation and Control, Scientific Computing, GEA Process Engineering A/S
Authors: Petersen, L. N. (Intern), Poulsen, N. K. (Intern), Niemann, H. H. (Intern), Utzen, C. (Ekstern), Jørgensen, J. B. (Intern)
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Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.41 SJR 1.037 SNIP 2.138
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.346 SNIP 2.028 CiteScore 3.35
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.397 SNIP 2.642 CiteScore 3.92
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.421 SNIP 2.537 CiteScore 3.47
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.435 SNIP 2.883 CiteScore 3.39
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.236 SNIP 2.535 CiteScore 2.9
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
An Integrated Research Infrastructure for Validating Cyber-Physical Energy Systems

Renewables are key enablers in the plight to reduce greenhouse gas emissions and cope with anthropogenic global warming. The intermittent nature and limited storage capabilities of renewables culminate in new challenges that power system operators have to deal with in order to regulate power quality and ensure security of supply. At the same time, the increased availability of advanced automation and communication technologies provides new opportunities for the derivation of intelligent solutions to tackle the challenges. Previous work has shown various new methods of operating highly interconnected power grids, and their corresponding components, in a more effective way. As a consequence of these developments, the traditional power system is being transformed into a cyber-physical energy system, a smart grid. Previous and ongoing research have tended to mainly focus on how specific aspects of smart grids can be validated, but until there exists no integrated approach for the analysis and evaluation of complex cyber-physical systems configurations. This paper introduces integrated research infrastructure that provides methods and tools for validating smart grid systems in a holistic, cyber-physical manner. The corresponding concepts are currently being developed further in the European project ERIGrid.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management, Austrian Institute of Technology, Ricerca sul Sistema Energetico, European Distributed Energy Resources Laboratories (DERLab) e.V, DNV-GL Oil & Gas, Hamburg University of Applied Sciences, VTT - Technical Research Centre of Finland, Fraunhofer Gesellschaft, University of Strathclyde, National Technical University of Athens, OFFIS - Institute for Information Technology, Delft University of Technology, TECNALIA Research and Innovation, Tecnalia, Parque Científico y Tecnológico de Bizkaia
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Application of visual servoing for grasping and placing operation in slaughterhouse

In food industry due to the high variety of the object including the shape, size and structure the involvement of real time robotic system is limited compared to the applications of robotic systems in automotive industry. For completing operations within food industry it is generally necessary to contain dynamical adjustment to each target in the control loop. This work focuses on using visual feedback to capture information of each piece of work for robotic control. A grasping and placing operation is selected as a case study of using visual servoing in slaughterhouse. For detecting the location of the target the color information provided by a visual sensor is utilized. The control command for the robot is generated based on the real time visual feedback. An industrial robot arm UR10 is applied to complete the operation. A lab-scale experimental setup is constructed for system validation. The experimental results show that the proposed visual servoing system works well for the grasping and placing task in slaughterhouse. The system is implemented in ROS and can be easily extended to similar operation tasks using different hardware.

A Scalable Neuro-inspired Robot Controller Integrating a Machine Learning Algorithm and a Spiking Cerebellar-like Network

Combining Fable robot, a modular robot, with a neuroinspired controller, we present the proof of principle of a system that can scale to several neurally controlled compliant modules. The motor control and learning of a robot module are carried out by a Unit Learning Machine (ULM) that embeds the Locally Weighted Projection Regression algorithm (LWPR) and a spiking cerebellar-like microcircuit. The LWPR guarantees both an optimized representation of the input space and the learning of the dynamic internal model (IM) of the robot. However, the cerebellar-like sub-circuit integrates LWPR input-driven contributions to deliver accurate corrective commands to the global IM. This article extends the earlier work by including the Deep Cerebellar Nuclei (DCN) and by reproducing the Purkinje and the DCN layers using a spiking neural network (SNN) implemented on the neuromorphic SpiNNaker platform. The performance and robustness outcomes from the real robot tests are promising for neural control scalability.
Backlash Estimation for Industrial Drive-Train Systems

Backlash in gearing and other transmission components is a common positioning-degrading phenomenon that develops over time in industrial machines. High-performance machine tool controls use backlash compensation algorithms to maintain accurate positioning of the tool to cope with such deadzone phenomena. As such, estimation of the magnitude of deadzones is essential. This paper addresses the generic problem of accurately estimating the width of the deadzone in a single-axis mechanical drive train. The paper suggests a scheme to estimate backlash between motor and load, employing a sliding mode observer and a nonlinear adaptive estimator. The efficacy of the approach is illustrated via simulations.
Choreographies, a formal model for the development of failure-aware distributed systems, and discuss how quality choreographies respond to the needs presented by DCS. We demonstrate their applicability by modelling the Bully Algorithm, one of the de-facto election algorithms used in coordination of DCS.

**General information**

**State:** Published

**Organisations:** Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management, Department of Applied Mathematics and Computer Science, Formal Methods

**Authors:** López-Acosta, H. (Intern), Heussen, K. (Intern)

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**Comparison of three control strategies for optimization of spray dryer operation**

Spray drying is the preferred process to reduce the water content of many chemicals, pharmaceuticals, and foodstuffs. A significant amount of energy is used in spray drying to remove water and produce a free flowing powder product. In this paper, we present and compare the performance of three controllers for operation of a four-stage spray dryer. The three controllers are a proportional-integral (PI) controller that is used in industrial practice for spray dryer operation, a linear model predictive controller with real-time optimization (MPC with RTO, MPC-RTO), and an economically optimizing nonlinear model predictive controller (E-NMPC). The MPC with RTO is based on the same linear state space model in the MPC and the RTO layer. The E-NMPC consists of a single optimization layer that uses a nonlinear system of ordinary differential equations for its predictions. The PI control strategy has a fixed target that is independent of the disturbances, while the MPC-RTO and the E-NMPC adapt the operating point to the disturbances. The goal of spray dryer operation is to optimize the profit of operation in the presence of composition and ambient air humidity variations; i.e. to maximize the production rate, while minimizing the energy consumption, keeping the residual moisture content of the powder below a maximum limit, and avoiding that the powder sticks to the chamber walls. We use an industrially recorded disturbance scenario in order to produce realistic simulations and conclusions. The key performance indicators such as the profit of operation, the product flow rate, the specific energy consumption, the energy efficiency, and the residual moisture content of the produced powder are computed and compared for the three controllers. In this simulation study, we find that the economic performance of the MPC with RTO as well as the E-NMPC is considerably improved compared to the PI control strategy used in industrial practice. The MPC with RTO improves the profit of operation by 8.61%, and the E-NMPC improve.

**General information**

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**Organisations:** Scientific Computing, Department of Applied Mathematics and Computer Science, Dynamical Systems, Department of Electrical Engineering, Automation and Control, GEA Process Engineering A/S

**Authors:** Petersen, L. N. (Intern), Poulsen, N. K. (Intern), Niemann, H. H. (Intern), Utzen, C. (Ekstern), Jørgensen, J. B. (Intern)

**Pages:** 1-14

**Publication date:** 2017

**Main Research Area:** Technical/natural sciences

**Publication information**

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The gradual deployment of intelligent and coordinated devices in the electrical power system needs careful investigation of the interactions between the various domains involved. Especially due to the coupling between ICT and power systems a holistic approach for testing and validating is required. Taking existing (quasi-) standardised smart grid system and test specification methods as a starting point, we are developing a holistic testing and validation approach that allows a very flexible way of assessing the system level aspects by various types of experiments (including virtual, real, and mixed lab settings). This paper describes the formal holistic test case specification method and applies it to a particular co-simulation experimental setup. The various building blocks of such a simulation (i.e., FMI, mosaiik, domain-specific simulation federates) are covered in more detail. The presented method addresses most modeling and specification challenges in cyber-physical energy systems and is extensible for future additions such as uncertainty quantification.
Description of the detailed Functional Architecture of the Frequency and Voltage control solution (functional and information layer)

This D4.2 document provides the description of the detailed functional architecture of the selected solutions that will be implemented and tested. This is documented by combining a function-based IEC 62559 Use Case description with an SGAM mapping of these functions and the interactions among these functions on the Function and Information layer.

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Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy System Management, Automation and Control, Distributed Energy Resources, Flemish Institute for Technological Research, University of Strathclyde, Tecnalia, Parque Científico y Tecnologico de Bizkaia, Instytut Energetyki, TUBITAK, Ricerca sul Sistema Energetico, Centre for Renewable Energy Sources, Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, OFFIS - Institute for Information Technology
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Publication date: 2017

Designing a Tool System for Lowering Friction during the Ejection of In-Die Sintered Micro Gears

The continuous improvements in micro-forging technologies generally involve process, material, and tool design. The field assisted sintering technique (FAST) is a process that makes possible the manufacture of near-net-shape components in a closed-die setup. However, the final part quality is affected by the influence of friction during the ejection phase, caused by radial expansion of the compacted and sintered powder. This paper presents the development of a pre-stressed tool system for the manufacture of micro gears made of aluminum. By using the hot isostatic pressing (HIP) sintering process and different combinations of process parameters, the designed tool system was compared to a similar tool system designed without a pre-stressing strategy. The comparison between the two tool systems was based on the ejection force and part fidelity. The ejection force was measured during the tests, while the part fidelity was documented using an optical microscope and computed tomography in order to obtain a multi-scale characterization. The results showed that the use of pre-stress reduced the porosity in the gear by 40% and improved the dimensional fidelity by more than 75% compared to gears produced without pre-stress.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Electrical Engineering, Automation and Control
Authors: Cannella, E. (Intern), Nielsen, E. K. (Intern), Stolfi, A. (Intern)
Number of pages: 15
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Micromachines
Diagnostic monitoring of drivetrain in a 5 MW spar-type floating wind turbine using Hilbert spectral analysis

The objective of this paper is to investigate the frequency-based fault detection of a 5MW spar-type floating wind turbine (WT) gearbox using measurements of the global responses. It is extremely costly to seed managed defects in a real WT gearbox to investigate different fault detection and condition monitoring approaches; using analytical tools, therefore, is one of the promising approaches in this regard. In this study, forces and moments on the main shaft are obtained from the global response analysis using an aero-hydro-servo-elastic code, SIMO-RIFLEX-AeroDyn. Then, they are utilized as inputs to a high-fidelity gearbox model developed using a multi-body simulation software (SIMPACK). The main shaft bearing is one of the critical components since it protects gearbox from axial and radial loads. Six different fault cases with different severity in this bearing are investigated using power spectral density (PSD) of relative axial acceleration of the bearing and nacelle. It is shown that in severe degradation of this bearing the first stage dynamic of the gearbox is dominant in the main shaft vibration signal. Inside the gearbox, the bearings on the high speed side are those often with high probability of failure, thus, one fault case in IMS-B bearing was also considered. Based on the earlier studies, the angular velocity error function is considered as residual for this fault. The Hilbert transform is used to determine the envelope of this residual. Information on the amplitude of this residual properly indicates damage in this bearing.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Norwegian University of Science and Technology
Authors: Ghane, M. (Ekstern), Nejad, A. R. (Ekstern), Blanke, M. (Intern), Gao, Z. (Ekstern), Moan, T. (Ekstern)
Pages: 204–213
Publication date: 2017
Conference: 14th Deep Sea Offshore Wind R&D Conference, Trondheim, Norway, 18/01/2017 - 18/01/2017
Main Research Area: Technical/natural sciences

Publication information
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Volume: 137
ISSN (Print): 1876-6102
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.44 SJR 0.495 SNIP 0.799
Door and cabinet recognition using convolutional neural nets and real-time method fusion for handle detection and grasping

In this paper we present a new method that robustly identifies doors, cabinets and their respective handles, with special emphasis on extracting useful features from handles to be then manipulated. The novelty of this system relies on the combination of a Convolutional Neural Net (CNN), as a form of reducing the search space, several methods to extract point cloud data and a mobile robot to interact with the objects. The framework consists of the following components: The implementation of a CNN to extract a Region of Interest (ROI) from an image corresponding to a door or cabinet. Several vision based techniques to detect handles inside the ROI and its 3D positioning. A complementary plane segmentation method to differentiate door/cabinet from the handle. An algorithm to fuse both approaches robustly and extract essential information from the handle for robotic grasping (i.e. handle point cloud, door plane model, grasping locations, turning orientation, orthogonal vector to door). A mobile robot for grasping the handle. The system assumes no prior knowledge of the environment.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Maurin, A. L. (Intern), Ravn, O. (Intern), Andersen, N. A. (Intern)
Pages: 144-9
Publication date: 2017

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ISBN (Print): 9781509060863
Series: 2017 3rd International Conference on Control, Automation and Robotics (iccar)
Main Research Area: Technical/natural sciences
Conference: 2017 3rd International Conference on Control, Automation and Robotics, Nagoya, Japan, 24/04/2017 - 24/04/2017
Dynamic pricing for demand response considering market price uncertainty

Retail energy providers (REPs) can employ different strategies such as offering demand response (DR) programs, participating in bilateral contracts, and employing self-generation distributed generation (DG) units to avoid financial losses in the volatile electricity markets. In this paper, the problem of setting dynamic retail sales price by a REP is addressed with a robust optimization technique. In the proposed model, the REP offers price-based DR programs while it faces uncertainties in the wholesale market price. The main contribution of this paper is using a robust optimization approach for setting the short-term dynamic retail rates for an asset-light REP. With this approach, the REP can decide how to participate in forward contracts and call options. They can also determine the optimal operation of the self-generation DG units. Several case studies have been carried out for a REP with 10,679 residential consumers. The deterministic approach and its robust counterpart are used to solve the problem. The results show that, with a slight decrease in the expected payoff, the REP can effectively protect itself against price variations. Offering time-variable retail rates also can increase the expected profit of the REPs.

General information

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Polytechnic Institute of Porto, University of Lisbon
Authors: Ghazvini, M. A. F. (Ekstern), Soares, J. (Ekstern), Morais, H. (Intern), Castro, R. (Ekstern), Vale, Z. (Ekstern)
Number of pages: 20
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information

Journal: Energies
Volume: 10
Issue number: 9
Article number: 1245
ISSN (Print): 1996-1073
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.11 SJR 0.67 SNIP 1.34
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.5 SJR 0.662 SNIP 1.106
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.785 SNIP 1.399 CiteScore 2.87
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.844 SNIP 1.565 CiteScore 2.66
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.613 SNIP 1.331 CiteScore 2.29
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.852 SNIP 1.53 CiteScore 2.46
ISI indexed (2012): ISI indexed yes
Enhancing damping of gas bearings using linear parameter-varying control

Journal bearings can be lubricated through controllable injectors using pressurised fluids, whose viscosity highly determines the dynamic responses of the rotating machine. The use of fluids with low viscosity is attracting a growing interest due to the reduced friction forces and consequent losses when the machine is in operation. However, low viscosity also entails poor damping properties, which may lead to degraded performance or even instability when the rotating machine operates at or near one of the modal frequencies. This issue can be properly addressed by employing active feedback control systems to regulate the injection pressure of the fluid. Due to the strong dependencies of system performance on system parameters, the sought controller should be robust over a large range of operational conditions. Through an extensive experimental campaign, the paper evaluates two robust controllers: a linear parameter-varying (LPV) controller and a controller, on their capability to guarantee stability and performance of a gas bearing across the large operational envelopes in rotational speed and injection pressure. The control systems are designed applying state-of-the-art methods in the respective areas. The experimental results clearly demonstrate the feasibility of enhancing the damping properties of a gas bearing by means of robust control methods.
Fault diagnosis and condition monitoring of wind turbines

This paper describes a model-free method for the fault diagnosis and condition monitoring of rotor systems in wind turbines. Both fault diagnosis and monitoring can be achieved without using a model for the wind turbine, applied controller, or wind profiles. The method is based on measurements from standard sensors on modern wind turbines, including moment sensors and rotor angle sensors. This approach will allow the method to be applied to existing wind turbines without any modifications. The method is based on the detection of asymmetries in the rotor system caused by changes or faults in the rotor system. A multiblade coordinate transformation is used directly on the measured flap-wise and edge-wise moments followed by signal modulation. Changes or faults in the rotor system will result in unique signatures in the set of modulation signals. These signatures are described through the amplitudes and phase information of the modulation signals. It is possible to detect and isolate which blade is faulty or has been changed based on these signatures. Furthermore, the faulty component can be isolated, i.e., the actuator, sensor or blade, and the type of fault can...
be determined. The method can be used both on- and off-line.

**General information**

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Applied Mathematics and Computer Science, Dynamical Systems, Department of Wind Energy, Wind turbine loads & control, AF Consult
Authors: Niemann, H. H. (Intern), Poulsen, N. K. (Intern), Mirzaei, M. (Intern), Henriksen, L. C. (Ekstern)
Pages: 586-613
Publication date: 2017
Main Research Area: Technical/natural sciences

**Publication information**

Volume: 32
Issue number: 4
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.162 SJR 0.915 CiteScore 2.48
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.04 SJR 0.749 SNIP 1.046
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.015 SNIP 1.06 CiteScore 1.69
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.157 SNIP 1.328 CiteScore 1.98
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.9 SNIP 1.204 CiteScore 2.07
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.779 SNIP 1.249 CiteScore 1.84
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.834 SNIP 0.962 CiteScore 1.45
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.836 SNIP 1.214
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.299 SNIP 1.555
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.31 SNIP 1.76
Scopus rating (2007): SJR 1.012 SNIP 1.623
Scopus rating (2006): SJR 0.691 SNIP 1.087
Scopus rating (2005): SJR 0.569 SNIP 1.173
Scopus rating (2004): SJR 0.641 SNIP 1.034
Scopus rating (2003): SJR 1.148 SNIP 1.369
Scopus rating (2002): SJR 1.258 SNIP 1.094
Scopus rating (2001): SJR 0.351 SNIP 0.495
Scopus rating (2000): SJR 0.587 SNIP 1.064
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.577 SNIP 0.949
Original language: English

Blade faults, Model-free fault diagnosis, Multiblade coordinate transformation, System monitoring, Signal modulation, Wind turbines
Generalized framework for the parallel semantic segmentation of multiple objects and posterior manipulation

The end-to-end approach presented in this paper deals with the recognition, detection, segmentation and grasping of objects, assuming no prior knowledge of the environment nor objects. The proposed pipeline is as follows: 1) Usage of a trained Convolutional Neural Net (CNN) that recognizes up to 80 different classes of objects in real time and generates bounding boxes around them. 2) An algorithm to derive in parallel the pointclouds of said regions of interest (ROI). 3) Eight different segmentation methods to remove background data and noise from the pointclouds and obtain a precise result of the semantically segmented objects. 4) Registration of the object's pointclouds over time to generate the best possible model. 5) Utilization of an algorithm to detect an array of grasping positions and orientations based mainly on the geometry of the object's model. 6) Implementation of the system on the humanoid robot MyBot, developed in the RIT Lab at KAIST. 7) An algorithm to find the bounding box of the object's model in 3D to then create a collision object and add it to the octomap. The collision checking between robot's hand and the object is removed to allow grasping using the MoveIt libraries. 8) Selection of the best grasping pose for a certain object, plus execution of the grasping movement. 9) Retrieval of the object and moving it to a desired final position.

High Accuracy Nonlinear Control and Estimation for Machine Tool Systems

Component mass production has been the backbone of industry since the second industrial revolution, and machine tools are producing parts of widely varying size and design complexity. The ever-increasing level of automation in modern manufacturing processes necessitates the use of more sophisticated machine tool systems that are adaptable to different workspace conditions, while at the same time being able to maintain very narrow workpiece tolerances. The main topic of this thesis is to suggest control methods that can maintain required manufacturing tolerances, despite moderate wear and tear. The purpose is to ensure that full accuracy is maintained between service intervals and to advice when overhaul is needed. The thesis argues that quality of manufactured components is directly related to the positioning accuracy of the machine tool axes, and it shows which low level control architectures are used to position the machining tool relatively to the material being processed. While existing algorithms provide sufficient accuracy after commissioning of the machine by experts, the thesis shows how they fail short in keeping required tolerances in the presence of equipment wear, unless they are re-tuned by experts. The goal of this research has therefore been investigation and development of advanced control and estimation algorithms, which facilitate high-accuracy machinetool axis positioning, and are robust to equipment degradation and wear. This thesis presents the findings of the research conducted during the three years of the PhD program at the Technical University of Denmark. The research has been carried out in close collaboration with Siemens AG in Nuremberg, who sponsored the research. Siemens also provided state-of-the-art industrial equipment to facilitate experimental testing and validation. DTU added mechanical components to test the development of friction and backlash. The scientific-technical contributions of the research fall into three parts, which also constitute the structure of the thesis. The first part concerns the development of
an efficient description of a generic machine-tool axis system. A detailed mathematical model is derived that captures the most important axis dynamics. Positioning degrading phenomena, such as friction and backlash, are expressed as nonlinear axis torques. Identification of the test rig parameters and sensitivity analysis is carried out, to highlight the significance of individual model parameters. The second contribution of this research pertains to the investigation of different nonlinear control strategies and architectures for the positioning of the axis. Eight position controllers based on sliding-mode and adaptive principles are designed, implemented and tested on the experimental setup. A set of quantitative and qualitative criteria is used for the systematic comparison of the methods. The evaluation results show that four out of the eight designs provide superior positioning accuracy and resilience to unknown and varying friction, in comparison to the state-of-the-art proportional-integral control solutions. The third part of the research relates to the development of online backlash estimation algorithms for machine-tools. The proposed method utilizes position and velocity measurements in a cascaded scheme consisting of a sliding-mode velocity observer and an adaptive deadzone angle estimator. A series of experiments is conducted for testing the algorithm in various operation scenarios under different levels of uncertainty. The results show that the estimator identifies the unknown deadzone angle and changes in it with sufficient accuracy and can, therefore, facilitate backlash compensation, as well as equipment wear assessment and prognosis. The scientific results of this research have been summarized in three journal articles, which have been submitted, and an article presented at the IFAC World Congress 2017 that has been published.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Siemens
Authors: Papageorgiou, D. (Intern), Blanke, M. (Intern), Niemann, H. H. (Intern), Richter, J. H. (Ekstern)
Number of pages: 282
Publication date: 2017

Publication information
Publisher: Technical University of Denmark, Department of Electrical Engineering
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
Dimitrios_Papageorgiou_phd_thesis.pdf

Relations
Projects:
- High Accuracy Nonlinear Control and Estimation for Machine Tool Systems
Source: PublicationPreSubmission
Source-ID: 137914542
Publication: Research › Ph.D. thesis – Annual report year: 2017

Identifying Causality from Alarm Observations
The complexity of modern industrial plants poses significant challenges for the design of effective alarm systems. Rigorous alarm management is recommended to ensure that the operators get useful information from the alarm system, rather than being overloaded with irrelevant state information. Alarm management practices have been shown to significantly reduce the frequency of alarms in industrial process plants. These practices help focusing the operators’ attention on actually critical situations. However, they cannot resolve the cascades of critical situations frequently occurring during emergency situations. Multilevel flow modelling (MFM) has been proposed as a way of representing knowledge about the industrial process and infer causes and consequences of deviations throughout the system. The method enables the identification of causes and consequences of alarm situations based on an abstracted model of the mass and energy flows in the system. The application of MFM for root cause analysis based alarm grouping has been demonstrated and can be extended to reason about the direction of causality considering the entirety of the alarms present in the system for more comprehensive decision support. This contribution presents the foundation for combining the cause and consequence propagation of multiple observations from the system based on an MFM model. The proposed logical reasoning matches actually observed alarms to the propagation analysis in MFM to distinguish plausible causes and consequences. This extended analysis results in causal paths from likely root causes to tentative consequences, providing the operator with a comprehensive tool to not only identify but also rank the criticality of a large number of concurrent alarms in the system.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Kirchhübel, D. (Intern), Zhang, X. (Intern), Lind, M. (Intern), Ravn, O. (Intern)
Number of pages: 6
Publication date: 2017
Low-complexity Behavioral Model for Predictive Maintenance of Railway Turnouts

Maintenance of railway infrastructures represents a major cost driver for any infrastructure manager since reliability and dependability must be guaranteed at all times. Implementation of predictive maintenance policies relies on the availability of condition monitoring systems able to assess the infrastructure health state. The core of any condition monitoring system is the a-priori knowledge about the process to be monitored, in the form of either mathematical models of different complexity or signal features characterizing the healthy/faulty behavior. This study investigates the identification of a low-complexity behavioral model of a railway turnout capable of capturing the dominant dynamics due to the ballast and railpad components. Measured rail accelerations, acquired through a receptance test carried out on the switch panel of a turnout of the Danish railway network, have been utilized together with the Eigensystem Realization Algorithm – a type of subspace identification – to identify a fourth order model of the infrastructure. The robustness and predictive capability of the low-complexity behavioral model to reproduce track responses under different types of train excitations have been successfully validated. It is anticipated that the identified model will be instrumental for the development of methods for diagnosis and prognosis of faults and degradation process in switches and crossings.

Model-based plant-wide optimization of large-scale lignocellulosic bioethanol plants.

Second generation biorefineries transform lignocellulosic biomass into chemicals with higher added value following a conversion mechanism that consists of: pretreatment, enzymatic hydrolysis, fermentation and purification. The objective of this study is to identify the optimal operational point with respect to maximum economic profit of a large scale biorefinery plant using a systematic model-based plantwide optimization methodology. The following key process parameters are identified as decision variables: pretreatment temperature, enzyme dosage in enzymatic hydrolysis, and yeast loading per batch in fermentation. The plant is treated in an integrated manner taking into account the interactions and trade-offs between the conversion steps. A sensitivity and uncertainty analysis follows at the optimal solution considering both model and feed parameters. It is found that the optimal point is more sensitive to feedstock composition than to model parameters, and that the optimization supervisory layer as part of a plantwide automation system has the following benefits: (1) increases the economical profit, (2) flattens the objective function allowing a wider range of operation without negative impact on profit, and (3) reduces considerably the uncertainty on profit.
Second generation bioethanol plant, Nonlinear model-based optimization, Uncertainty and sensitivity analysis, Steam pretreatment, Enzymatic hydrolysis, C5 and C6 co-fermentation
Modelling and Validating a Deoiling Hydrocyclone for Fault Diagnosis using Multilevel Flow Modeling

Decision support systems are a key focus in research on developing control rooms to aid operators in making reliable decisions, and reducing incidents caused by human errors. For this purpose, models of complex systems can be developed to diagnose causes or consequences for specific alarms. Models applied in safety systems of complex and safety critical systems, require rigorous and reliable model building and testing. Multilevel Flow Modeling is a qualitative method for diagnosing faults, and has previously only been validated by subjective and qualitative means. This work aims to synthesize a procedure to measure model performance, according to diagnostic requirements, to ensure reliability during operation. A simple procedure is proposed for validating and evaluating Multilevel Flow Modeling models. For this purpose, expert statements, a dynamic process simulation in K-spice, and pilot plant experiments are used for validation of two simple Multilevel Flow Modeling models of a deoiling hydrocyclone, used for water and oil separation.

On-the-go throughput prediction in a combine harvester using sensor fusion

The paper addresses design of a clean grain throughput observer for a combine harvester, i.e., delay free yield sensing. The aim is to predict grain throughput changes using the forward speed and a throughput sensor in the feederhouse. By utilising a grain flow model and sensor fusion an estimate of the current grain throughput is obtained, hence the effect from the lag in the momentary yield sensor reading due to material transport delays can be reduced. Statistical change detection is used to detect feederhouse load condition as well as sensor discrepancies using the observer innovation signal. The system is able to predict changes originating from forward speed and local crop density variations. Also temporary sensor discrepancies are detected and compensated in the grain flow estimate.
Performance Comparison of Controllers with Fault-Dependent Control Allocation for UAVs
This paper combines fault-dependent control allocation with three different control schemes to obtain fault tolerance in the longitudinal control of unmanned aerial vehicles. The paper shows that fault-dependent control allocation is able to accommodate actuator faults that would otherwise be critical and it makes a performance assessment for the different control algorithms: an L1 adaptive backstepping controller; a robust sliding mode controller; and a standard PID controller. The actuator faults considered are the partial to total loss of the elevator, which is a critical component for the safe operation of unmanned aerial vehicles. During nominal operation, only the main actuator, namely the elevator, is active for pitch control. In the event of a partial or total loss of the elevator, fault-dependent control allocation is used to redistribute control to available healthy actuators. Using simulations of a Cessna 182 aircraft model, controller performance and robustness are evaluated by metrics that assess control accuracy and energy use. System uncertainties are investigated over an envelope of pertinent variation, showing that sliding mode and L1 adaptive backstepping provide robustness, where PID control falls short. Additionally, a key finding is that the fault-dependent control allocation is instrumental when handling actuator faults.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Norwegian University of Science and Technology
Authors: Nørgaard Sørensen, M. E. (Ekstern), Hansen, S. (Intern), Breivik, M. (Ekstern), Blanke, M. (Intern)
Pages: 187–207
Publication date: 2017
Main Research Area: Technical/natural sciences

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Journal: Journal of Intelligent and Robotic Systems
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Issue number: 1
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.534 SJR 0.537 CiteScore 2.36
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.27 SJR 0.635 SNIP 1.59
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.624 SNIP 1.432 CiteScore 1.79
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.682 SNIP 1.701 CiteScore 1.91
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.469 SNIP 1.69 CiteScore 1.74
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.619 SNIP 1.887 CiteScore 1.7
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.523 SNIP 1.858 CiteScore 1.44
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.467 SNIP 1.65
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.357 SNIP 1.235
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.301 SNIP 1.109
Scopus rating (2007): SJR 0.309 SNIP 1.065
Scopus rating (2006): SJR 0.294 SNIP 0.803
Scopus rating (2005): SJR 0.223 SNIP 0.649
Scopus rating (2004): SJR 0.233 SNIP 0.61
Scopus rating (2003): SJR 0.487 SNIP 0.679
Piezoelectric transformers: Control

General information
State: Published
Organisations: Department of Electrical Engineering, Electronics, Automation and Control
Authors: Zsurzsan, T. (Intern), Andersen, M. A. E. (Intern), Andersen, N. A. (Intern), Zhang, Z. (Intern)
Number of pages: 20
Publication date: 2017

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Media of output: PowerPoint
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
Gabriel_ZSURZSAN_ICAT2017.pdf
Source: PublicationPreSubmission
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Publication: Research - peer-review › Sound/Visual production (digital) – Annual report year: 2017

Playware ABC 2: a Disruptive Technology for Global Development
The Playware ABC concept is used to create solutions that are usable by all kinds of users and contexts in our globalized society. In this paper, the Playware ABC can be exemplified with the development of the modular interactive tiles for health prevention and rehabilitation of anybody, anywhere, anytime. The paper gives examples of how playware becomes a disruptive technology for global development, for instance in the health sector. For instance, in Tanzania doctors and community-based rehabilitation workers are constructing and combining modular playware tiles to easily create the right kind of intervention for their patients in both urban and deep rural areas in Tanzania.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware
Authors: Lund, H. H. (Intern)
Number of pages: 4
Pages: 25-28
Publication date: 2017
Conference: 2016 International Conference on Artificial Life and Robotics, Ginowan, Japan, 29/01/2016 - 29/01/2016
Main Research Area: Technical/natural sciences

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Journal: Journal of Robotics Networks and Artificial Life
Volume: 3
Issue number: 4
ISSN (Print): 2352-6386
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Web of Science (2018): Indexed yes
Web of Science (2017): Indexed yes
Original language: English
Playware, User-friendly, Modularity, Development, Playful robotics and intelligent systems
DOIs:
Playware ABC: Engineering Play for Everybody

This paper describes the Playware ABC concept, and how it allows anybody, anywhere, anytime to be building bodies and brains, which facilitates users to construct, combine and create. The Playware ABC concept focuses engineering and IT system development on creating solutions that are usable by all kinds of users and contexts. The result becomes solutions, often based on modular technologies that are highly flexible and adaptable to different contexts, users, and applications.

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State: Published
Organisations: Copenhagen Center for Health Technology, Department of Electrical Engineering, Automation and Control, Centre for Playware
Authors: Lund, H. H. (Intern)
Pages: P21-P24
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DOIs: 10.2991/jrnal.2017.3.4.16

Positioning the laparoscopic camera with industrial robot arm

This paper introduces a solution for the movement control of the laparoscopic camera employing a teleoperated robotic assistant. The project propose an autonomous robotic solution based on an industrial manipulator, provided with a modular software which is applicable to large scale. The robot arm is envisioned to orient and move the optic device in direction of a fixed point, the incision on the wall of the abdominal cavity, accordingly to the surgeon's request. To manage the movements of the laparoscope around the fulcrum point a Cartesian control strategy is exploited. A six degrees of freedom industrial robot arm is designated to accomplish this manipulation task. The software is implemented in ROS in order to facilitate future extensions. The experimental results shows a manipulator capable of moving fast and smoothly the surgical tool around a remote center of motion.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Capolei, M. C. (Intern), Wu, H. (Intern), Andersen, N. A. (Intern), Ravn, O. (Intern)
Pre-treatment of Biomass By Rolling - A Combined Experimental and Numerical Analysis
Pre-treatment of bulk straw material by rolling is studied as a possible method to prepare for subsequent biogas production. A combined experimental and theoretical study is presented. A pilot rolling mill with a double screw feeder is designed and constructed for crushing of bulk straw. Experiments show that the roll speed and the roll reduction should be chosen within a specific range depending on the injection screw speed to avoid blocking or insufficient compaction. A mechanical testing procedure of the bulk straw material including closed die compaction testing as well as simple upsetting of pre-compacted billets of straw is carried out based on which a mathematical model for the yield surface is determined fitting to a geological cap model for porous material similar to the Drucker-Prager spherical cap model. An experimental test campaign is carried out to determine the feasible process window for pre-treatment of wheat straw by roll pressing varying the feed, the roll gap, the roll speed and the moisture content of the bulk straw.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Mechanical Engineering, Manufacturing Engineering, TK Energi AS
Authors: Hansen, K. S. (Intern), Ravn, C. (Intern), Nielsen, E. K. (Intern), Koch, T. (Ekstern), Porte, C. (Ekstern), Christiansen, P. (Intern), Rasmussen, A. A. (Intern), Bay, N. O. (Intern)
Pages: 492 - 499
Publication date: 2017

Remote Off-Grid Solutions for Greenland and Denmark
Renewable off-grid solutions are steadily growing in both developed and developing countries (R. Kempener et al. 2015). With the decreasing cost and improving performance of small hydro installations, solar power, wind power, and energy storage systems, renewable energy is expected to supplement or replace existing diesel grids on islands and in remote areas.

General information
State: Published
Authors: Wu, Q. (Intern), Larsen, E. (Intern), Heussen, K. (Intern), Bindner, H. W. (Intern), Douglass, P. J. (Ekstern)
Pages: 64-73
Representing Operational Modes for Situation Awareness

Operating complex plants is an increasingly demanding task for human operators. Diagnosis of and reaction to on-line events requires the interpretation of real time data. Vast amounts of sensor data as well as operational knowledge about the state and design of the plant are necessary to deduct reasonable reactions to abnormal situations. Intelligent computational support tools can make the operator's task easier, but they require knowledge about the overall system in form of some model. While tools used for fault-tolerant control design based on physical principles and relations are valuable tools for designing robust systems, the models become too complex when considering the interactions on a plant-wide level. The alarm systems meant to support human operators in the diagnosis of the plant-wide situation on the other hand fail regularly in situations where these interactions of systems lead to many related alarms overloading the operator with alarm floods. Functional modelling can provide a middle way to reduce the complexity of plant-wide models by abstracting from physical details to more general functions and behaviours. Based on functional models the propagation of failures through the interconnected systems can be inferred and alarm floods can potentially be reduced to their root-cause. However, the desired behaviour of a complex system changes due to operating procedures that require more than one physical and functional configuration. In this paper a consistent representation of possible configurations is deduced from the analysis of an exemplary start-up procedure by functional models. The proposed interpretation of the modelling concepts simplifies the functional modelling of distinct modes. The analysis further reveals relevant links between the quantitative sensor data and the qualitative perspective of the diagnostics tool based on functional models. This will form the basis for the ongoing development of a novel real-time diagnostics system based on the on-line adaptation of the underlying MFM model.
This paper investigates self-reconfiguration of a modular robotic system, which consists of a cluster of modular vehicles that can attach to each other by a connection mechanism. Thereby, they can form a desired morphology to meet task specific requirements. Reconfiguration can be needed due to limitations from dimensions of passable corridors for an underwater maintenance task, for supplemental instrumentation that is available on a particular robot, or as remedial action if one robot in a cluster suffers from malfunction. Being crucial for autonomous underwater vehicles, energy consumed is employed as a heuristic. The paper shows how the Basic Theta* algorithm can be guided by an energy criterion to calculate a transition from start- to goal morphology. Individual robots are guided while minimizing the overall energy for propulsion and for balancing restoring forces and moments in morphologies. The properties of the proposed self-reconfiguration algorithm are evaluated through simulations and preliminary model tank experiments. The energy based heuristic for reconfiguration is compared to a traditional solution that minimizes the Euclidean distance.
Stability Boundaries for Offshore Wind Park Distributed Voltage Control

In order to identify mechanisms causing slow reactive power oscillations observed in an existing offshore wind power plant, and be able to avoid similar events in the future, voltage control is studied in this paper for a plant with a static synchronous compensator, type-4 wind turbines and a park pilot control. Using data from the actual wind power plant, all stabilizing subsystem voltage proportional-integral controller parameters are first characterized based on their Hurwitz signature. Inner loop current control is then designed using Internal Mode Control principles, and guidelines for feed forward filter design are given to obtain required disturbance rejection properties. The paper contributes by providing analytical relations between power plant control, droop, sampling time, electrical parameters and voltage control characteristics, and by assessing frequencies and damping of reactive power modes over a realistic envelope of electrical impedances and control parameters.
Study protocol: effect of playful training on functional abilities of older adults - a randomized controlled trial

Background: Loss of functional capabilities due to inactivity is one of the most common reasons for fall accidents, and it has been well established that loss of capabilities can be effectively reduced by physical activity. Pilot studies indicate a possible improvement in functional abilities of community dwelling elderly as a result of short-term playing with an exergame system in the form of interactive modular tiles. Such playful training may be motivational to perform and viewed by the subjects to offer life-fulfilling quality, while providing improvement in physical abilities, e.g. related to prevent fall accidents. The RCT will test for a variety of health parameters of community-dwelling elderly playing on interactive modular tiles.

Methods: The study will be a single blinded, randomized controlled trial with 60 community-dwelling adults ≥70 years. The trial will consist an intervention group of 30 participants training with the interactive modular tiles, and a control group of 30 participants that will receive the usual care provided to non-patient elderly. The intervention period will be 12 weeks. The intervention group will perform group training (4-5 individuals for 1 h training session with each participant receiving 13 min training) on the interactive tiles twice a week. Follow-up tests include 6-min Walk Test (6MWT), the 8-ft Timed Up & Go Test (TUG), and the Chair-Stand Test (CS) from the Senior Fitness Test, along with balancing tests (static test on Wii Board and Line Walk test). Secondary outcomes related to adherence, motivation and acceptability will be investigated through semi-structured interviews. Data will be collected from pre-and post-tests. Data will be analyzed for statistically significant differences by checking that there is a Gaussian distribution and then using paired t-test, otherwise using Wilcoxon signed-rank test. *Intention to treat* analysis will be done.

Discussion: The trial tests for increased mobility, agility, balancing and general fitness of community-dwelling elderly as a result of playing, in this case on modular interactive tiles. A positive outcome may help preventing loss of functional capabilities due to inactivity.
Supporting Control Room Operators in Highly Automated Future Power Networks

Operating power systems is an extremely challenging task, not least because power systems have become highly interconnected, as well as the range of network issues that can occur. It is therefore a necessity to develop decision support systems and visualisation that can effectively support the human operators for decision making in the complex and dynamic environment of future highly automated power system. This paper aims to investigate the decision support functions associated with frequency deviation events for the proposed Web of Cells concept.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Distributed Energy Resources, Energy System Management, Automation and Control, Strathclyde University, University of Strathclyde
Authors: Chen, M. (Ekstern), Catterson, V. (Ekstern), Syed, M. (Ekstern), MCarthur, S. (Ekstern), Burt, G. M. (Ekstern), Marinelli, M. (Intern), Prostejovsky, A. (Intern), Heussen, K. (Intern)
Pages: 1492-5
Publication date: 2017
Conference: 24th International Conference on Electricity Distribution, Glasgow, United Kingdom, 12/06/2017 - 12/06/2017
Main Research Area: Technical/natural sciences

Taxonomy for Evaluation of Distributed Control Strategies for Distributed Energy Resources

Distributed control strategies applied to power distribution control problems are meant to offer robust and scalable integration of distributed energy resources (DER). However, the term “distributed control” is often loosely applied to a variety of very different control strategies. In particular there is a lack of discrimination between aspects related to communication topology, physical distribution of components and associated control objectives. This has lead to a lack of objective criteria for performance comparison and general quality assessment of state of the art distributed control solutions. For such comparison, a classification is required that is consistent across the different aspects mentioned above. This paper develops systematic categories of control strategies that accounts for communication, control and physical distribution aspects of the problem, and provides a set of criteria that can be assessed for these categories. The proposed taxonomy is applied to the state of the art as part of a review of existing work on distributed control of DER. Finally, we demonstrate the applicability and usefulness of the proposed classification to researchers and system designers.

General information
State: Accepted/In press
Authors: Han, X. (Intern), Heussen, K. (Intern), Gehrke, O. (Intern), Bindner, H. W. (Intern), Kroposki, B. (Ekstern)
Number of pages: 11
Publication date: 2017
The future of Robotics Technology

In the last decade the robotics industry has created millions of additional jobs led by consumer electronics and the electric vehicle industry, and by 2020, robotics will be a $100 billion worth industry, as big as the tourism industry. For example, the rehabilitation robot market has grown 10 times between 2010 and 2016, thanks to advancements in rehab/therapy robots, active prostheses, exoskeletons, and wearable robotics. In short, the very next decade robotics will become vital components in a number of applications and robots paired with AI will be able to perform complex actions that are capable of learning from humans, driving the intelligent automation phenomenon. Therefore, in this paper we try to depict the direction and the fields of application of such important sector of future markets, and scientific research.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, Academy of Fine Arts of Macerata
Authors: Pagliarini, L. (Ekstern), Lund, H. H. (Intern)
Using MFM methodology to generate and define major accident scenarios for quantitative risk assessment studies

Generating and defining Major Accident Scenarios (MAS) are commonly agreed as the key step for quantitative risk assessment (QRA). The aim of the study is to explore the feasibility of using Multilevel Flow Modeling (MFM) methodology to formulating MAS. Traditionally this is usually done based on historical incidents or the outcome of HAZOP/HAZID. This paper suggests using MFM to model the plant, and then performs systematic reasoning based on the model to produce casual paths of plant failure scenarios. The cause trees generated by MFM are transformed into fault trees, which are then used to calculate likelihood of each MAS. Combining the likelihood of each scenario with a qualitative risk matrix, each major accident scenario is thereby ranked for consideration for detailed consequence analysis. The methodology is successfully highlighted using part of BMA-process for production of hydrogen cyanide as case study.

Active Fault Detection Based on a Statistical Test

In this paper active fault detection of closed loop systems using dual Youla-Jabr-Bongiorno-Kucera(YJBK) parameters is presented. Until now all detector design for active fault detection using the dual YJBK parameters has been based on CUSUM detectors. Here a method for design of a matched filter detector is proposed instead, based upon the NeymanPearson criterion for optimal detector design. Furthermore alternative ways to design the excitation signal which relates to indirect identification methods are presented. Examples are given on detection of actuator faults using a simulated gas bearing for both one and multiple possible parametric faults.
Adaptive FTC based on Control Allocation and Fault Accommodation for Satellite Reaction Wheels
This paper proposes an active fault tolerant control scheme to cope with faults or failures affecting the flywheel spin rate sensors or satellite reaction wheel motors. The active fault tolerant control system consists of a fault detection and diagnosis module along with a control allocation and fault accommodation module directly exploiting the on-line fault estimates. The use of the nonlinear geometric approach and radial basis function neural networks allows to obtain a precise fault isolation, independently from the knowledge of aerodynamic disturbance parameters, and to design generalised estimation filters, which do not need a priori information about the internal model of the signal to be estimated. The adaptive control allocation and sensor fault accommodation can handle both temporal faults and failures. Simulation results illustrate the convincing fault correction and attitude control performances of the proposed system.

Adaptive gaze stabilization through cerebellar internal models in a humanoid robot
Two main classes of reflexes relying on the vestibular system are involved in the stabilization of the human gaze: The vestibulocollic reflex (VCR), which stabilizes the head in space and the vestibulo-ocular reflex (VOR), which stabilizes the visual axis to minimize retinal image motion. The VOR works in conjunction with the opto-kinetic reflex (OKR), which is a visual feedback mechanism for moving the eye at the same speed as the observed scene. Together they keep the image stationary on the retina. In this work we present the first complete model of gaze stabilization based on the coordination of VCR and VOR and OKR. The model, inspired on neuroscientific cerebellar theories, is provided with learning and adaptation capabilities based on internal models. Tests on a simulated humanoid platform confirm the effectiveness of our approach.
Adaptive Portfolio Optimization for Multiple Electricity Markets Participation

The increase of distributed energy resources, mainly based on renewable sources, requires new solutions that are able to deal with this type of resources’ particular characteristics (namely, the renewable energy sources intermittent nature). The smart grid concept is increasing its consensus as the most suitable solution to facilitate the small players’ participation in electric power negotiations while improving energy efficiency. The opportunity for players’ participation in multiple energy negotiation environments (smart grid negotiation in addition to the already implemented market types, such as day-ahead spot markets, balancing markets, intraday negotiations, bilateral contracts, forward and futures negotiations, and among other) requires players to take suitable decisions on whether to, and how to participate in each market type. This paper proposes a portfolio optimization methodology, which provides the best investment profile for a market player, considering different market opportunities. The amount of power that each supported player should negotiate in each available market type in order to maximize its profits, considers the prices that are expected to be achieved in each market, in different contexts. The price forecasts are performed using artificial neural networks, providing a specific database with the expected prices in the different market types, at each time. This database is then used as input by an evolutionary particle swarm optimization process, which originates the most advantage participation portfolio for the market player. The proposed approach is tested and validated with simulations performed in multiagent simulator of competitive electricity markets, using real electricity markets data from the Iberian operator-MIBEL.
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 3.231 SJR 3.406 CiteScore 8.96
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 2.564 SNIP 2.741 CiteScore 6.48
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.605 SNIP 2.923 CiteScore 6.34
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.41 SNIP 3.283 CiteScore 5.73
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.33 SNIP 3.612 CiteScore 5.5
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.017 SNIP 3.012
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.872 SNIP 2.642
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.222 SNIP 2.086
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.357 SNIP 3.021
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.85 SNIP 3.264
Web of Science (2008): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.745 SNIP 4.06
Scopus rating (2004): SJR 1.103 SNIP 3.935
Scopus rating (2003): SJR 1.494 SNIP 2.979
Scopus rating (2002): SJR 1.422 SNIP 2.94
Scopus rating (2001): SJR 1.814 SNIP 2.532
Scopus rating (2000): SJR 0.982 SNIP 2.013
Scopus rating (1999): SJR 0.986 SNIP 2.255

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Artificial Intelligence, Computer Networks and Communications, Computer Science Applications, Software, Adaptive learning, artificial neural network (NN), electricity markets, multiagent simulation, portfolio optimization, swarm intelligence, Commerce, Costs, Electric power transmission networks, Energy efficiency, Energy resources, Financial data processing, Financial markets, Investments, Neural networks, Particle swarm optimization (PSO), Renewable energy resources, Smart power grids, Bilateral contracts, Competitive electricity markets, Distributed Energy Resources, Electricity market, Evolutionary particle swarm optimizations, Market opportunities, Portfolio optimization, Renewable energy source, Power markets, smart power grids, optimisation, power markets, evolutionary particle swarm optimization process, adaptive portfolio optimization, multiple electricity markets participation, distributed energy resources, smart grid concept, energy efficiency, day-ahead spot markets, balancing markets, intraday negotiations, bilateral contracts, artificial neural networks, Electricity supply industry, Optimization, Artificial neural networks, Context, Databases, Portfolios, Adaptation models, Power system management, operation and economics

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**Advanced Control of Active Bearings - Modelling, Design and Experiments**
In all rotating machines relative movements between the stationary parts and the rotating parts imply energy loss and, in many critical cases, vibration problems. This energy loss leads to higher overall energy consumption of the system. Research activities towards the reduction of friction, the enhancement of damping, the extension of operating range and the minimisation of critical vibrations in machine elements are of fundamental importance. The main component to tackle the energy-loss-related problems is the bearing. The area of design of active bearings, while very promising, is still in its early development mainly because of its high complexity and its multiphysics nature. The state-of-the-art models derived from first principles and axioms of mechanics are complex and often subject to significant parameter uncertainties. They are challenging to develop and not easily used for feedback control design. One example is the controllable radial gas bearing, where the lubricant air is injected through controllable injectors to levitate the rotor on an air film. Feedback control of the injection can improve upon the poor damping to reduce the disturbance sensitivity and vibrations near the critical speeds. The feedback control law is preferably designed from a simple model, which captures the dominant dynamics of the machine in the frequency range of interest. This thesis offers two main original contributions in the field of active bearings. First, an experimental technique is proposed for "in situ" identification of low complexity models of the entire rotor-bearing-actuator-sensor system. The approach employs grey-box identification techniques and is easily applied to industrial rotating machinery with controllable bearings. The approach is applied for identification of a linear parameter-varying model of a rotor supported by an active gas bearing. Second, is the application of model-based control techniques for controllable gas bearings. The parameter-varying model is shown to suit the design of classical and modern control including observer and state-feedback, H1, LPV and gain-scheduled H2 control designs to improve upon the dynamic properties of the gas bearing test rig. Experimental results using the control designs show that the controllers can increase the damping significantly. The damping enhancing controllers are shown to extend the range of safe operation by a 70% increase in shaft angular velocity, thereby allowing safe operation in and above the regions of the first and second critical speeds.

**General information**
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Theisen, L. R. S. (Intern), Niemann, H. H. (Intern), Galeazzi, R. (Intern)
Number of pages: 246
Publication date: 2016

**Publication information**
Publisher: Technical University of Denmark, Department of Electrical Engineering
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions: phdthesis.pdf

**Relations**
Projects:
Advanced Control of Active Bearings - Modelling, Design and Experiments
Publication: Research - peer-review › Journal article – Annual report year: 2016

**Advances in Piezoelectric Systems: An Application-Based Approach.**
Piezoelectricity is a fascinating research topic with wide-branching applications due to the unique property of bidirectional energy transfer. Piezoceramics can be used as both actuators and sensors without imposing any constraints on their supporting circuitry. This property, coupled with their low manufacturing costs and high robustness has enabled widespread usage in applications ranging from simple spark lighters or pressure sensors to much more complicated energy harvesting systems and piezoelectric transformers. One governing property of piezoelectric devices is the existence of a mechanical frequency of resonance, or the natural frequency of the device paired with an antiresonance, which are material and size-dependent. From an electrical standpoint, the equivalent behavior of a piezoelectric device depends on how close or far from its natural resonance the device is excited in terms of frequency. Based on this classification, three distinct, useful electrical behaviors can be identified: a capacitive behavior prominent at frequencies far from resonance, a resistive behavior encountered at resonance and antiresonance peaks and an inductive behavior, encountered at frequencies between the two. These three distinct behaviors encountered in any piezoelectric device represents the basis of discussion in the thesis. Therefore the present PhD dissertation is an application-based approach to researching all three behaviors individually, while dealing solutions to the challenges encountered along the way. First, the capacitive behavior is studied, with the Piezoelectric Actuator Drive motor as a direct application. At low frequencies, piezoelectric devices are ideal as micro-and nanoscale positioning actuators but they are plagued by high levels of hysteretic nonlinearities. A model is developed to estimate this behavior, followed by a low-cost forward compensation method which achieves a positioning error reduction by a factor 20. Next, the characteristics of the PAD motor are researched and a method of extracting mechanical quality information and predict overload through feedback signal analysis is
demonstrated. The next behavior studied is the inductive behavior, specifically dealing with a bidirectional dc-dc power converter employing a piezoelectric transformer as major component. The main contribution here is achieving optimum tracking, hard-switching minimization and power ow control during bidirectional operation of a self-oscillating converter. Feasibility of using the converter in an MRI scanner is demonstrated. The third and nal behavior researched is the resistive behavior. This is widely encountered since most piezoelectric motors, ultrasonic baths and some energy harvesting systems operate at resonance. Friction control through squeeze- lm application is achieved in an electrostatic surface actuator for the rst time ever. This enables system functionality without glass gap material and concomitantly reduces minimum electrostatic operating voltage by 70%.

General information
State: Published
Organisations: Department of Electrical Engineering, Electronics, Automation and Control
Authors: Zsurzsan, T. (Intern), Andersen, M. A. E. (Intern), Zhang, Z. (Intern), Andersen, N. A. (Intern)
Number of pages: 284
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Main Research Area: Technical/natural sciences

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Projects:
Advances in Piezoelectric Systems: An Application-Based Approach.
Publication: Research › Ph.D. thesis – Annual report year: 2016

A Framework for Semi-Automated Generation of a Virtual Combine Harvester
This paper describes a generic data-driven model of the threshing, separation and cleaning process in a combine harvester. The aim is a model that describes the actual material ow and sensor values for relevant actuator configurations and measured environmental disturbances in order to facilitate Hardware In the Loop (HIL) simulation and sensor based material ow estimation. A modular data-driven model structure is chosen as it maintains the actual steady-state values and facilitates verication and debugging using laboratory and eld data. The overall model structure, model generation procedure, and estimation of parameters from eld data are described, as well as simulation results are presented.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, AGCO A/S
Authors: Hermann, D. (Intern), Bilde, M. (Ekstern), Andersen, N. A. (Intern), Ravn, O. (Intern)
Pages: 55–60
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Scopus rating (2016): CiteScore 0.45 SJR 0.234 SNIP 0.328
Scopus rating (2015): SJR 0.298 SNIP 0.39
Scopus rating (2014): SJR 0.298 SNIP 0.383
Scopus rating (2013): SJR 0.326 SNIP 0.41
Scopus rating (2012): SJR 0.265 SNIP 0.331
Scopus rating (2011): SJR 0.257 SNIP 0.324
Scopus rating (2010): SJR 0.197 SNIP 0.276
Scopus rating (2009): SJR 0.211 SNIP 0.29
Scopus rating (2008): SJR 0.172 SNIP 0.239
An application of gain-scheduled control using state-space interpolation to hydroactive gas bearings

Sinusoidal disturbances are common, especially in rotordynamics where mass imbalance causes undesirable vibrations. When the frequency of the disturbance is constant and known, it can be rejected using robust control techniques by including notches in the weights. For a known time-varying frequency, it is possible to design a gain-scheduled controller using multiple controllers optimised for a single frequency. Gain-scheduling strategies using the Youla parametrisation can guarantee stability at the cost of increased controller order and performance loss in the interpolation region. This paper contributes with a gain-scheduling strategy using state-space interpolation, which avoids both the performance loss and the increase of controller order associated to the Youla parametrisation. The proposed state-space interpolation for gain-scheduling is applied for mass imbalance rejection for a controllable gas bearing scheduled in two parameters. Comparisons against the Youla-based scheduling demonstrate the superiority of the state-space interpolation.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Automation, University of Campinas
Authors: Theisen, L. R. S. (Intern), Camino, J. F. (Ekstern), Niemann, H. H. (Intern)
Pages: 1117-22
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Mechanical variables control, Interpolation and function approximation (numerical analysis), Control system analysis and synthesis methods, Stability in control theory, Time-varying control systems, Mechanical components, Numerical analysis, Control technology and theory, interpolation, machine bearings, mechanical variables control, robust control, state-space methods, time-varying systems, rotordynamics, disturbance frequency, notches, time-varying frequency, gain-scheduled controller, Youla parametrisation, controller order, performance loss, gain-scheduling strategy, state-space interpolation region, mass imbalance rejection, controllable gas bearing, Youla-based scheduling, sinusoidal disturbances
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Class-D amplifier design and performance for driving a Piezo Actuator Drive servomotor.
This paper investigates the behavior of piezoelectric stacks in a Piezoelectric Actuator Drive (PAD) motor, which shows non-linear equivalent impedance and has a dramatic impact on the overall system performance. Therefore, in this paper, the piezo stack's model is discussed and an improved large signal model is proposed and verified by measurement. Finally, a Class-D amplifier as a power driver and its associated closed-loop control are implemented and tested to control PAD drive effectively.

General information
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Organisations: Department of Electrical Engineering, Electronics, Automation and Control
Authors: Zsurzsan, T. (Intern), Zhang, Z. (Intern), Andersen, M. A. E. (Intern), Andersen, N. A. (Intern)
Pages: 1068-1072
Publication date: 2016

Host publication information
This paper presents a novel scheme for diagnosis of faults affecting the sensors measuring the satellite attitude, body angular velocity and flywheel spin rates as well as defects related to the control torques provided by satellite reaction wheels. A nonlinear geometric design is used to avoid that aerodynamic disturbance torques have unwanted influence on the residuals exploited for fault detection and isolation. Radial basis function neural networks are used to obtain fault estimation filters that do not need a priori information about the fault internal models. Simulation results are based on a detailed nonlinear satellite model with embedded disturbance description. The results document the efficacy of the proposed diagnosis scheme.
Control-Oriented Model of Molar Scavenge Oxygen Fraction for Exhaust Recirculation in Large Diesel Engines

Exhaust gas recirculation (EGR) systems have been introduced to large marine engines in order to reduce NOx formation. Adequate modelling for control design is one of the bottlenecks to design EGR control that also meets emission requirements during transient loading conditions. This paper therefore focus on deriving and validating a mean-value model of a large two-stroke crosshead diesel engines with EGR. The model introduces a number of amendments and extensions to previous, complex models and shows in theory and practice that a simplified nonlinear model captures all essential dynamics that is needed for EGR control. Our approach is to isolate and reduce the gas composition part of the more complex models using nonlinear model reduction techniques. The result is a control-oriented model (COM) of the oxygen fraction in the scavenge manifold with three molar flows being inputs to the COM, and it is shown how these flows are estimated from signals that are commonly available. The COM is validated by first comparing the output to a simulation of the full model, then by comparing with measurement series from two engines. The control oriented nonlinear model is shown to be able to replicate the behavior of the scavenge oxygen fraction well over the entire envelope of load and blower speed range that are relevant for EGR. The simplicity of the new model makes it suitable for observer and control design, which are essential steps to meet the emission requirements for marine diesel engines that take effect from 2016.

General information

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Linköping University, MAN B&W Diesel A/S
Authors: Nielsen, K. V. (Intern), Blanke, M. (Intern), Eriksson, L. (Ekstern), Vejgaard-Laursen, M. (Ekstern)
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Publication date: 2016
Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.29 SJR 0.526 SNIP 0.88
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.664 SNIP 1.059 CiteScore 1.36
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.663 SNIP 1.291 CiteScore 1.38
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.741 SNIP 1.344 CiteScore 1.4
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.579 SNIP 1.182 CiteScore 1.09
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.584 SNIP 1.053 CiteScore 0.96
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.833 SNIP 1.721
Diagnosis for Control and Decision Support for Autonomous Vehicles

Diagnosis and, when possible, prognosis of faults are essential for safe and reliable operation. The area of fault diagnosis has emerged over three decades. The majority of studies are related to linear systems but real-life systems are complex and nonlinear. The development of methodologies coping with complex and nonlinear systems have matured and even though there are many unsolved problems, methodology and associated tools have become available in the form of theory and software for design. Genuine industrial cases have also become available. Analysis of system topology, referred to as structural analysis, has proven to be unique and simple in use and a recent extension to active structural techniques have made fault isolation possible in a wide range of systems.

Following residual generation using these topology-based methods, deterministic and statistical change detection has proven very useful for online prognosis and diagnosis. For complex systems, results from nonGaussian detection theory have been employed with convincing results. The chapter presents the theoretical foundation for design methodologies that now appear as enabling technology for a new area of design of systems that are reliable in practise. Yet they are also affordable due to the use of fault-tolerant philosophies and tools that make engineering efforts minimal for their implementation. The chapter includes examples for an autonomous aircraft and a baling system for agriculture to illustrate the generic design procedures and real life results.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, CLAAS Agrosystems
Authors: Blanke, M. (Intern), Hansen, S. (Intern), Rufus Blas, M. (Ekstern)
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Publication date: 2016

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Editor: Dimirovski, G. M.
ISBN (Print): 978-3-319-28858-1
Series: Studies in Systems, Decision and Control
Volume: 55
Main Research Area: Technical/natural sciences
Fault diagnosis, Fault-tolerant control, Change detection, Complex systems

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DOIs: 10.1007/978-3-319-28860-4_1
Source: PublicationPreSubmission
Source-ID: 123901177
Publication: Research - peer-review › Book chapter – Annual report year: 2016
**Diagnosis of wind turbine rotor system**

This paper describes a model free method for monitoring and fault diagnosis of the elements in a rotor system for a wind turbine. The diagnosis as well as the monitoring is done without using any model of the wind turbine and the applied controller or a description of the wind profile. The method is based on available standard sensors on wind turbines. The method can be used both on-line as well as off-line. Faults or changes in the rotor system will result in asymmetries, which can be monitored and diagnosed. This can be done by using the multi-blade coordinate transformation. Changes in the rotor system that can be diagnosed and monitored are: actuator faults, sensor faults and internal blade changes as e.g. change in mass of a blade.

**General information**
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Applied Mathematics and Computer Science, Department of Wind Energy, Wind turbine loads & control, Dynamical Systems, AF Consult
Authors: Niemann, H. H. (Intern), Mirzaei, M. (Intern), Henriksen, L. C. (Ekstern), Poulsen, N. K. (Intern)
Pages: 3170-3175
Publication date: 2016

**Host publication information**
Title of host publication: Proceedings of the American Control Conference (ACC 2016)
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Main Research Area: Technical/natural sciences
Conference: American Control Conference (ACC 2016), Boston, United States, 06/07/2016 - 06/07/2016
DOIs:
10.1109/ACC.2016.7525405
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

**Disrupting the Industry with Play**

Decades of research into intelligent, playful technology and user-friendly man-machine interfaces has provided important insight into the creation of robotic systems and intelligent interactive systems which are much more user-friendly, safer and cheaper than what appeared possible merely a decade or two ago. This is significantly disrupting the industry in several market sectors. This paper describes the components of the playware and embodied artificial intelligence research that has led to disruption in the industrial robotics sector, and which points to the next disruption of the health care sector. This includes playful robotics, LEGO robots for kids, minimal robot systems, user-friendly, behavior-based, biomimetic, modular robotics and intelligent systems. The insight into these components and the use in synthesis for designing robots and intelligent systems allows anybody, anywhere, anytime to use these systems, providing an unforeseen flexibility into the sectors, which become disrupted with these systems.

**General information**
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware
Authors: Lund, H. H. (Intern)
Number of pages: 4
Pages: 28-31
Publication date: 2016
Conference: 2016 International Conference on Artificial Life and Robotics, Ginowan, Japan, 29/01/2016 - 29/01/2016
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Journal of Robotics Networks and Artificial Life
Volume: 3
Issue number: 1
ISSN (Print): 2352-6386
Ratings:
Web of Science (2018): Indexed yes
Web of Science (2017): Indexed yes
Original language: English
Playware, User-friendly, Modular robots, Playful robotics and intelligent systems
DOIs:
10.2991/jrnal.2016.3.1.4
Source: FindIt
Source-ID: 2306114282
Publication: Research - peer-review › Conference article – Annual report year: 2017
Efficient Modelling Methodology for Reconfigurable Underwater Robots

This paper considers the challenge of applying reconfigurable robots in an underwater environment. The main result presented is the development of a model for a system comprised of \( N \), possibly heterogeneous, robots dynamically connected to each other and moving with 6 Degrees of Freedom (DOF). This paper presents an application of the Udwadia-Kalaba Equation for modelling the Reconfigurable Underwater Robots. The constraints developed to enforce the rigid connection between robots in the system is derived through restrictions on relative distances and orientations. To avoid singularities in the orientation and, thereby, allow the robots to undertake any relative configuration the attitude is represented in Euler parameters.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Norwegian University of Science and Technology
Authors: Nielsen, M. C. (Intern), Blanke, M. (Intern), Schjølberg, I. (Ekstern)
Pages: 74-80
Publication date: 2016
Conference: 10th IFAC Conference on Control Applications in Marine Systems, Trondheim, Norway, 13/09/2016 - 13/09/2016
Main Research Area: Technical/natural sciences

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Journal: IFAC-PapersOnLine
Volume: 49
Issue number: 23
ISSN (Print): 2405-8963
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Scopus rating (2016): CiteScore 0.45 SJR 0.234 SNIP 0.328
Scopus rating (2015): SJR 0.298 SNIP 0.39
Scopus rating (2014): SJR 0.298 SNIP 0.383
Scopus rating (2013): SJR 0.326 SNIP 0.41
Scopus rating (2012): SJR 0.265 SNIP 0.331
Scopus rating (2011): SJR 0.257 SNIP 0.324
Scopus rating (2010): SJR 0.197 SNIP 0.276
Scopus rating (2009): SJR 0.211 SNIP 0.29
Scopus rating (2008): SJR 0.172 SNIP 0.239
Scopus rating (2007): SJR 0.195 SNIP 0.271
Scopus rating (2006): SJR 0.21 SNIP 0.284
Scopus rating (2005): SJR 0.192 SNIP 0.445
Scopus rating (2004): SJR 0.245 SNIP 0.419
Scopus rating (2003): SJR 0.26 SNIP 0.403
Original language: English
Udwadia-Kalaba, Multi-body Dynamics, Quaternion, Autonomous Underwater Vehicles, Reconfigurable Robots

Electronic versions:
CAMS2016_mcn_mb.pdf
1_s2.0_S2405896316319115_main.pdf

DOI's:
10.1016/j.ifacol.2016.10.324

Source: PublicationPreSubmission
Source-ID: 125022493
Publication: Research - peer-review › Conference article – Annual report year: 2016

Electricity Markets Ontology to Support MASCEM's Simulations

Power systems worldwide are complex and challenging environments. The increasing necessity for an adequate integration of renewable energy sources is resulting in a rising complexity in power systems operation. Multi-agent based simulation platforms have proven to be a good option to study the several issues related to these systems, including the involved players that act in this domain. To take better advantage of these systems, their integration is mandatory. The main contribution of this paper is the development of the Electricity Markets Ontology, which integrates the essential concepts necessary to interpret all the available information related to electricity markets, while enabling an easier cooperation and adequate communication between related systems. Additionally, the concepts and rules defined by this
ontology can be extended and complemented according to the needs of other simulation and real systems in this area. Each system's particular ontology must import the proposed ontology, thus enabling the effective interoperability between independent systems.

**General information**

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Polytechnic Institute of Porto
Authors: Santos, G. (Ekstern), Pinto, T. (Ekstern), Vale, Z. (Ekstern), Praca, I. (Ekstern), Morais, H. (Intern)
Number of pages: 12
Pages: 393-404
Publication date: 2016

**Host publication information**

Title of host publication: Highlights of Practical Applications of Scalable Multi-Agent Systems. The PAAMS Collection: International Workshops of PAAMS 2016
Volume: 616
Publisher: Springer
Editor: Bajo, J.
ISBN (Electronic): 978-3-319-39387-2

Series: Communications in Computer and Information Science
Volume: 616
ISSN: 1865-0929
Main Research Area: Technical/natural sciences
Conference: 14th International Conference on Practical Applications of Agents and Multiagent Systems, Seville, Spain, 01/06/2016 - 01/06/2016

Computer Science (all), Electricity markets, Multi-agent simulation, Ontologies, Commerce, Interoperability, Ontology, Power markets, Renewable energy resources, Independent systems, Integration of renewable energies, Multi agent based simulations, Multi agent simulation, Power systems operation, Real systems, Related systems, Multi agent systems, COMPUTER

DOIs:
10.1007/978-3-319-39387-2_33
Source: FindIt
Source-ID: 2306658990
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

**Electric vehicle fleet management in smart grids: A review of services, optimization and control aspects**

Electric vehicles can become integral parts of a smart grid, since they are capable of providing valuable services to power systems other than just consuming power. On the transmission system level, electric vehicles are regarded as an important means of balancing the intermittent renewable energy resources such as wind power. This is because electric vehicles can be used to absorb the energy during the period of high electricity penetration and feed the electricity back into the grid when the demand is high or in situations of insufficient electricity generation. However, on the distribution system level, the extra loads created by the increasing number of electric vehicles may have adverse impacts on grid. These factors bring new challenges to the power system operators. To coordinate the interests and solve the conflicts, electric vehicle fleet operators are proposed both by academics and industries. This paper presents a review and classification of methods for smart charging (including power to vehicle and vehicle-to-grid) of electric vehicles for fleet operators. The study firstly presents service relationships between fleet operators and other four actors in smart grids; then, modeling of battery dynamics and driving patterns of electric vehicles, charging and communications standards are introduced; after that, three control strategies and their commonly used algorithms are described; finally, conclusion and recommendations are made.

**General information**

State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy System Management, Automation and Control, EDF Lab Clamart, Instituto Politécnico do Porto
Authors: Hu, J. (Intern), Morais, H. (Ekstern), Sousa, T. (Ekstern), Lind, M. (Intern)
Pages: 1207–1226
Publication date: 2016
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Renewable & Sustainable Energy Reviews
Volume: 56
ISSN (Print): 1364-0321
Ratings:
Electric vehicles, Fleet operator, Optimization and control strategies, Smart charging, Vehicle-to-grid

Electronic versions:
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DOIs:
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Source: PublicationPreSubmission
Source-ID: 119290100
Publication: Research - peer-review › Journal article – Annual report year: 2016
Energy Optimization for Distributed Energy Resources Scheduling with Enhancements in Voltage Stability Margin

The need for developing new methodologies in order to improve power system stability has increased due to the recent growth of distributed energy resources. In this paper, the inclusion of a voltage stability index in distributed energy resources scheduling is proposed. Two techniques were used to evaluate the resulting multiobjective optimization problem: the sum-weighted Pareto front and an adapted goal programming methodology. With this new methodology, the system operators can consider both the costs and voltage stability. Priority can be assigned to one objective function according to the operating scenario. Additionally, it is possible to evaluate the impact of the distributed generation and the electric vehicles in the management of voltage stability in the future electric networks. One detailed case study considering a distribution network with high penetration of distributed energy resources is presented to analyse the proposed methodology. Additionally, the methodology is tested in a real distribution network.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Electric Power Systems, Polytechnic Institute of Porto
Number of pages: 20
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Mathematical Problems in Engineering
Volume: 2016
Article number: 6379253
ISSN (Print): 1024-123X
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.503 SJR 0.268 CiteScore 0.83
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.279 SNIP 0.5 CiteScore 0.77
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.285 SNIP 0.564 CiteScore 0.74
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.287 SNIP 0.606 CiteScore 0.79
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.289 SNIP 0.886 CiteScore 1.14
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.363 SNIP 0.947 CiteScore 1.22
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.417 SNIP 0.749 CiteScore 0.92
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.233 SNIP 0.565
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.258 SNIP 0.44
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.313 SNIP 0.553
Scopus rating (2007): SJR 0.275 SNIP 0.492
Scopus rating (2006): SJR 0.237 SNIP 0.732
Scopus rating (2005): SJR 0.297 SNIP 0.702
Scopus rating (2004): SJR 0.263 SNIP 0.463
understand how play tools work. Developing on these findings, the thesis then presents the notion of "play dynamics" that the goal of bringing them into the state of play. This brings a new perspective on games and gives a framework to developed in the thesis by applying the Actor Network Theory (ANT) as a framework for analysis, by which the author research, that in order to get into the state of play we use "play tools", such as games, toys etc. This finding is further investigated when we are in what we call the "state of play". Further, the thesis gives an account of an important finding in playware enjoyment it brings, or, as it is formulated: The purpose of play is play itself. From this understanding, the thesis goes on to present the point of department, the thesis further investigates how the MOTO tiles as an example of playware and exergames created play among the users. This study begins with a presentation of the results of two different pilot trials done with the MOTO tiles technology which showed remarkable development among the elderly, particularly regarding balance. It further contextualizes MOTO tiles in the research area of "games for health" by an account of research done in this area, including the sub-area of "exergames", which are games that require the user to be physically active in order to play. This account points out that the research hitherto completed is inadequate with regards to scientific validity. The review of randomized controlled trials (RCT) done in the area of exergames shows that there is a need for more studies, and for studies with a higher methodological quality. Based on the knowledge gained in the pilot studies and the review of the area of exergames, the author of this thesis analyzes and presents how RCTs are done, as well as exploring how to secure studies of high methodological quality. The knowledge gained from this analysis is then used to plan and conduct an RCT on the MOTO tiles with elderly people in the age range from 70 years and above. The findings from the RCT show that it is possible to do a study of high methodological quality, but it also points out problems that are partly to do with the age group, including the problem of missing data due to, for example, sudden illness, which is more common among elderly. None the less, the findings of the study showed one primary outcome that was significant (an increase of 22% in score in the test "Chair Stand") and another that had indications that there could be an important clinical finding (a decrease of 12% in score in the test "Timed Up & Go"), while one was unaffected (no difference in the test "6 Minutes Walking Test"). The author concludes that more studies are still needed and that higher power of the studies should be considered or meta-analysis on several trials combined. The trial additionally confirms the findings from the pilot tests and shows that the participants saw statistically significant improvements on the balance score ("Line Walk" or "Tandem Walk") with an impressive increase of 149% in score after adjusting for the outlier. Besides the physical tests, the participants answered a questionnaire, and here the findings showed that the vast majority of the participants enjoyed the training and wanted to continue using the MOTO tiles. Over half also indicated that they felt better and 75% indicated that they had improved physically. This shows that playware such as the MOTO tiles can promote health and, not least, that this can be done in a playful and thus, motivational manner. Taking these findings as the point of departure, the thesis further investigates how the MOTO tiles as an example of playware and exergames created play among the users. This investigation begins with a presentation of the concept of play, based on the philosophy of play that is the foundation of modern game research. Play is here understood as something we humans engage in for nothing else than the sake of the enjoyment it brings, or, as it is formulated: The purpose of play is play itself. From this understanding, the thesis goes on to present the definition of play we have in play we have a special attitude towards the world, and this frames our understanding of actions done when we are in what we call the "state of play". Further, the thesis gives an account of an important finding in playware research, that in order to get into the state of play we use "play tools", such as games, toys etc. This finding is further developed in the thesis by applying the Actor Network Theory (ANT) as a framework for analysis, by which the author reaches a new understanding of games as "actors" which encourage their players to act in certain prescribed ways, with the goal of bringing them into the state of play. This brings a new perspective on games and gives a framework to understand how play tools work. Developing on these findings, the thesis then presents the notion of "play dynamics" that
is, dynamics, which play tools make use of to bring players into the state of play. Examples of such dynamics are presented, and the thesis points to the need to further develop our understanding of play dynamics, the different types of dynamics and how they work together to create new dynamics and effects.

**General information**
- **State:** Published
- **Organisations:** Department of Electrical Engineering, Automation and Control, Centre for Playware, Copenhagen Center for Health Technology
- **Authors:** Jessen, J. D. (Intern), Lund, H. H. (Intern)
- **Number of pages:** 276
- **Publication date:** 2016

**Publication information**
- **Publisher:** Technical University of Denmark, Department of Electrical Engineering
- **ISBN (Print):** 978-87-92465-61-0
- **Original language:** English
- **Main Research Area:** Technical/natural sciences
- **Electronic versions:** Thesis_Final_20_september_2016.pdf

**Relations**
- **Projects:** Evaluation and understanding of Playware Technology – trials with playful balance training.
- **Publication:** Research › Ph.D. thesis – Annual report year: 2016

**Evaluation of different initial solution algorithms to be used in the heuristics optimization to solve the energy resource scheduling in smart grids**

Over the last years, an increasing number of distributed resources have been connected to the power system due to the ambitious environmental targets, which resulted into a more complex operation of the power system. In the future, an even larger number of resources is expected to be coupled which will turn the day-ahead optimal resource scheduling problem into an even more difficult optimization problem. Under these circumstances, metaheuristics can be used to address this optimization problem. An adequate algorithm for generating a good initial solution can improve the metaheuristic's performance of finding a final solution near to the optimal than using a random initial solution. This paper proposes two initial solution algorithms to be used by a metaheuristic technique (simulated annealing). These algorithms are tested and evaluated with other published algorithms that obtain initial solution. The proposed algorithms have been developed as modules to be more flexible their use by other metaheuristics than just simulated annealing. The simulated annealing with different initial solution algorithms has been tested in a 37-bus distribution network with distributed resources, especially electric vehicles. The proposed algorithms proved to present results very close to the optimal with a small difference between 0.1%. A deterministic technique is used as comparison and it took around 26 h to obtain the optimal one. On the other hand, the simulated annealing was able of obtaining results around 1 min.

**General information**
- **State:** Published
- **Organisations:** Department of Electrical Engineering, Automation and Control, Polytechnic Institute of Porto, University of Lisbon
- **Authors:** Sousa, T. (Ekstern), Morais, H. (Intern), Castro, R. (Ekstern), Vale, Z. (Ekstern)
- **Pages:** 491-506
- **Publication date:** 2016
- **Main Research Area:** Technical/natural sciences

**Publication information**
- **Journal:** Applied Soft Computing
- **Volume:** 48
- **ISSN (Print):** 1568-4946
- **Ratings:**
  - **BFI (2018):** BFI-level 1
  - **Web of Science (2018):** Indexed yes
  - **BFI (2017):** BFI-level 1
  - **Scopus rating (2017):** SNIP 2.006 SJR 1.199 CiteScore 4.81
  - **Web of Science (2017):** Indexed Yes
  - **BFI (2016):** BFI-level 1
  - **Scopus rating (2016):** CiteScore 4.29 SJR 1.262 SNIP 2.119
  - **Web of Science (2016):** Indexed yes
Evaluation of Shipboard Wave Estimation Techniques through Model-scale Experiments

The paper continues a study on the wave buoy analogy that uses shipboard measurements to estimate sea states. In the present study, the wave buoy analogy is formulated directly in the time domain and relies only partly on wave-vessel response amplitude operators (RAOs), which is in contrast to all previous works that either are formulated in the frequency domain and/or depend entirely on RAOs. Specifically, the paper evaluates a novel concept for wave estimation based on combined techniques using a wave frequency estimator, not dependent on RAOs, to detect wave frequency and, respectively, nonlinear least squares fitting to estimate wave amplitude and phase. The concept has been previously tested with only numerical simulations but in this study the techniques are applied to model-scale experiments. It is shown that the techniques successfully can be used to estimate the wave parameters of a regular wave train.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Mechanical Engineering, Fluid Mechanics, Coastal and Maritime Engineering, Norwegian University of Science and Technology
Authors: Nielsen, U. D. (Intern), Galeazzi, R. (Intern), H. Brodtkorb, A. (Ekstern)
Number of pages: 8
Publication date: 2016
Exhaust Recirculation Control for Reduction of NOx from Large Two-Stroke Diesel Engines

Increased awareness of the detrimental effects on climate, ecosystems and human health have led to numerous restrictions of the emissions from internal combustion engines. Recently the International Maritime Organization has introduced the Tier III standard, which includes a significantly stricter restriction on NOx emissions from large two-stroke diesel engines on vessels operating in certain NOx Emission Control Areas. Exhaust Gas Recirculation (EGR) is one of the three technologies on the market that are able to reduce the NOx emission adequately for Tier III operation. EGR is well known from the automotive industry, but have only recently been introduced commercially to large two-stroke diesel engines. Recirculation of exhaust gas to the cylinders lowers the oxygen availability and increases the heat capacity during combustion, which in turn leads to less formation of NOx. Experience shows, that while large two-stroke engines with EGR perform well in steady state, fast engine load transients cause smoke formation due to the decreased oxygen availability. The aim of this thesis is to design a control system that enables the large two-stroke engines with EGR to meet the emission limits of the Tier III standard, while still maintaining maneuverability performance without smoke formation. The design methods acknowledge that engine specific parameter tuning is a scarce resource in the industry and controller complexity is kept to a minimum. An existing dynamic model of the engine and EGR system is adapted and used for high-fidelity simulation. By isolating the gas composition part of the model and removing non-essential dynamics, a novel nonlinear reduced model of scavenge oxygen fraction is developed. Based on the reduced model, a novel nonlinear joint state and parameter observer for the scavenge oxygen fraction is designed. Based on the reduced model, a novel nonlinear joint state and parameter observer for the scavenge oxygen fraction is designed. This observer compensates for a significant delay in the oxygen sensor, and observer errors are proven to converge exponentially. By inverting part of the reduced model and using the parameter observer, a novel scavenge oxygen controller based on nonlinear adaptive feed forward is developed. The controller error is proven to converge exponentially. This controller requires only one tuning parameter in addition to a number of physical parameters of the engine system. It exploits the availability of fuel and EGR flow estimates and the turbocharger speed to provide fast adjustment of EGR flow. In addition to the scavenge oxygen controller, a novel fuel index limiter based on oxygen/fuel-ratio is introduced and investigated. The limiter ensures that the maximal fuel flow set by the engine speed governor does not exceed the amount that can be completely burned, by considering the oxygen contents of the scavenge gas. The reduced model, observer, controller and limiter designs are validated by simulation of the high-fidelity engine model, and by closed loop experiments on an engine at test bed and on a vessel operating at sea. Significant performance improvements promised by the simulations are verified in the experiments. Scavenge oxygen control during transients is improved, when compared to the reference controller. Formation of visible smoke is completely avoided, while acceleration performance is maintained. The contributions of this project enable the EGR technology on large two-stroke diesel engines to reduce NOx emissions by a factor of four without compromising vessel maneuverability. Project partner MAN Diesel & Turbo has applied for a patent covering the EGR controller design in Japan, China and South Korea. The controllers developed in this project are planned to be included as standard in commercially available EGR controller software by 2017. The thesis consists of a summary of the methods developed and validations performed during the project. The results are disseminated in a number of papers submitted to research journals and a conference.
Eye-head stabilization mechanism for a humanoid robot tested on human inertial data

Two main classes of reflexes relying on the vestibular system are involved in the stabilization of the human gaze: the vestibulocollic reflex (VCR), which stabilizes the head in space and the vestibulo-ocular reflex (VOR), which stabilizes the visual axis to minimize retinal image motion. Together they keep the image stationary on the retina. In this work we present the first complete model of eye-head stabilization based on the coordination of VCR and VOR. The model is provided with learning and adaptation capabilities based on internal models. Tests on a simulated humanoid platform replicating torso disturbance acquired on human subject performing various locomotion tasks confirm the effectiveness of our approach.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, Copenhagen Center for Health Technology, Scuola Superiore Sant'Anna
Authors: Vannucci, L. (Ekstern), Falotico, E. (Ekstern), Tolu, S. (Intern), Dario, P. (Ekstern), Lund, H. H. (Intern), Laschi, C. (Ekstern)
Pages: 341-352
Publication date: 2016
Conference: 5th International Conference on Biomimetic and Biohybrid Systems, Edinburgh, United Kingdom, 19/07/2016 - 19/07/2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Lecture Notes in Computer Science
Volume: 9793
ISSN (Print): 0302-9743
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.9 SJR 0.295 SNIP 0.655
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.67 SJR 0.339 SNIP 0.642
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.369 SNIP 0.684 CiteScore 0.37
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.354 SNIP 0.743 CiteScore 0.42
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.36 SNIP 0.761 CiteScore 0.49
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.346 SNIP 0.762 CiteScore 0.49
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.338 SNIP 0.765 CiteScore 0.49
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.322 SNIP 0.663
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.302 SNIP 0.576
Fault diagnosis of active magnetic bearings based on Gaussian GLRT detector

Active magnetic bearings are progressively replacing conventional bearings in many industrial applications, particularly in the energy sector. Magnetic bearings have many advantages such as contactless support and clean operation; however, their use also poses some challenges connected to their inherent open loop instability. Occurrence of faults in one or more components of an active magnetic bearing may lead to loss of control of the rotor. Timely detection and isolation of faults in an active magnetic bearing could prevent hazardous system behaviour by enabling proper reconfiguration of the control system. A structural model of the bearing-rotor system is presented and used to perform a detectability and isolability analysis of faults in the magnetic actuator. Structural detectability and group-wise isolability is concluded for single and multiple faults in the actuators. A Gaussian generalized likelihood ratio test is proposed for detecting faults striking the electromagnet. The detector is capable of detecting and isolating the occurrence of faults in e.g. the windings of bearing by tracking changes in the mean value of a Gaussian distribution. The statistical distribution of the residuals in non-faulty condition is characterized by experimental data of a full-scale bearing-rotor system. Verification of the detection performance is done through simulated data of a nonlinear model of the magnetic bearing calibrated against the real system.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Mechanical Engineering, Solid Mechanics, Technical University of Denmark
Authors: Nagel, L. (Ekstern), Galeazzi, R. (Intern), Voigt, A. J. (Intern), Santos, I. (Intern)
Pages: 540-547
Publication date: 2016
Fault Tolerant Emergency Control to Preserve Power System Stability

This paper introduces a method for fault-masking and system reconfiguration in power transmission systems. The paper demonstrates how faults are handled by reconfiguring remaining controls through utilisation of wide-area measurement in real time. It is shown how reconfiguration can be obtained using a virtual actuator concept, which covers Lure-type systems. The paper shows the steps needed to calculate a virtual actuator, which relies on the solution of a linear matrix inequality. The solution is shown to work with existing controls by adding a compensation signal. Simulation results of a benchmark system show ability of the reconfiguration to maintain stability.
In this paper, we present our first results from an industrial application of model predictive control (MPC) with real-time steady-state target optimization (RTO) for control of an industrial spray dryer that produces enriched milk powder. The MPC algorithm is based on a continuous-time transfer function model identified from data and states estimated by a time-varying Kalman filter. The RTO layer utilizes the same linear model and a nonlinear economic objective function for calculation of the economically optimized targets. We demonstrate, by industrial application of the MPC, that this method provides significantly better control of the residual moisture content, increases the throughput and decreases the energy consumption compared to conventional PI-control. The MPC operates the spray dryer closer to the residual moisture constraint of the powder product. Thus, the same amount of feed produces more powder product by increasing the average water content. The value of this is 186,000 €/year. In addition, the energy savings account to 6,900 €/year.
Key requirements for future control room functionality

This internal report provides the key requirements for the future control centres. R8.1 represents the starting point of WP8 activities and wants to achieve a double objective. On the one hand it collects general requirements on future control centres emerging from the general trends in power system operation as well as experiences and results from other European projects. On the other hand, it analyses what requirements for future control rooms arise from the ELECTRA proposed control solutions. Hence, different points of view are taken into account. The ELECTRA Use Cases (UCs) and the observability needs highlighted within WP5 led to the definition of the requirements with a Web of Cell (WoC) point of view. The main European Distribution System Operators (DSOs) provided a valuable contribution in the definition of the evolvDSO Use Cases. Their analysis lead to the definition of further requirements for the future control centres discussed within this report. The analysis of what happened before the European system disturbance occurred on 4th November 2006 and of the existing trends by vendors helped T8.1 in the definition of the requirements for the future control centres. Volunteer stakeholders led to the creation of a stakeholder group within T8.1.

A dedicated questionnaire (available on the website) related to the control centres and pointed towards the network operators found the answers of different European network operators (mainly DSOs) and enriched the requirements outlined in this document. In addition, during workshops organized by ELECTRA it was possible to analyse the experiences from DEMO projects of other relevant EU projects (e.g. GRID4EU). All together these suggestions and input helped T8.1 in reaching its goal. Finally, due to the presence of evolving concepts (e.g. the WoC) within ELECTRA this document will be updated during the project life.
Model Predictive Control of Sewer Networks

The developments in solutions for management of urban drainage are of vital importance, as the amount of sewer water from urban areas continues to increase due to the increase of the world’s population and the change in the climate conditions. How a sewer network is structured, monitored and controlled have thus become essential factors for efficient performance of waste water treatment plants. This paper examines methods for simplifying modelling and controlling a sewer network. A practical approach to the problem is used by analysing simplified design model, which is based on the Barcelona benchmark model. Due to the inherent constraints the applied approach is based on Model Predictive Control.

General information

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BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.288 SNIP 0.351
Web of Science (2010): Indexed yes
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Scopus rating (2009): SJR 0.259 SNIP 0.346
Modular Robotic Playware

There is an open debate on whether today’s consumer driven economy is constantly encouraging us to buy and not to build. Plagiarism and copyright policies can potentially serve as mental barricades that dry out our curiosity, creativity and collaboration [1, 2]. In this work we, at Center for Playware, seek to revitalize and quench our users thirst for knowledge within the domain of robotics. We believe that, given the right tools, anyone can become a robot designer. As a result we have developed Fable a modular robot designed for education that can help motivate users towards social interaction while building and playing with robots. Our approach uses easy to assemble units that allow users to build a robot in a matter of seconds. Fable’s design encloses topics in modular robotics within the Danish educational sector. Fable is a heterogeneous chain based user-reconfigurable robot, that is based on two types of modules: passive and active. Passive modules give the system shape and structure, while active modules are able to interact with the environment. Fable’s library of modules currently consists of a 2 DOF Joint Module, a Wheel Module a Sensor Module and a set of 11 different Passive Modules. The system also has a Dongle, used to enable PCs to communicate wirelessly with active modules. Users can choose the communication channel by pressing the button on the Dongle, where each radio channel is color coded. Fable uses scaffolding based progression by allowing unexperienced users to program through a graphical user interface based on Google’s ”Blockly” and later progress to Python programming. The system was tested with more than 500 students in various settings including: public schools, after-school clubs and research labs. We then used this knowledge to improve our design and built a robot that fits the requirements of the Danish educational system. In autumn 2016 Fable will be available to public schools in Denmark.

MPC control of water supply networks

This paper investigates the modelling and predictive control of a drinking water supply network with the aim of minimising the energy and economic cost. A model predictive controller, MPC, is applied to a nonlinear model of a drinking water network that follows certain constraints to maintain consumer pressure desire. A model predictive controller, MPC, is based on a simple model that models the main characteristics of a water distribution network, optimizes a desired cost minimisation, and keeps the system inside specified constraints. In comparison to a logic (on/off) control design, controlling the drinking water supply network with the MPC showed reduction of the energy and the economic cost of running the system. This has been achieved by minimising actuator control effort and by shifting the actuator use towards the night time, where energy prices are lower. Along with energy cost reduction the MPC also achieves reduction in the
amount of consumed water by keeping the pressure closer to the lower pressure constraint.

**Multi-agent based modeling for electric vehicle integration in a distribution network operation**

The purpose of this paper is to present a multi-agent based modeling technology for simulating and operating a hierarchical energy management of a power distribution system with focus on EVs integration. The proposed multi-agent system consists of four types of agents: i) Distribution system operator (DSO) technical agent and ii) DSO market agents that both belong to the top layer of the hierarchy and their roles are to manage the distribution network by avoiding grid congestions and using congestion prices to coordinate the energy scheduled; iii) Electric vehicle virtual power plant agents are in the middle level of the hierarchy and their roles are to manage the charge process of the electric vehicles; iv) Electric vehicle agents are placed at the bottom layer of the hierarchy and they represent electric vehicle owners with different users’ profiles. To demonstrate the coordination behavior of the proposed system, a multi-agent simulation platform is developed based on the co-simulation environment of JACK, Matlab and GAMS. The aim of the multi-agent system is to simulate the collaborative (all agents contribute to achieve an optimized global performance) but also competitive environment (each agent will try to increase its utilities or reduce its costs). [All rights reserved Elsevier].

**General information**

State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy System Management, Department of Automation, Risø National Laboratory for Sustainable Energy, Automation and Control
Authors: Hu, J. (Intern), Morais, H. (Intern), Lind, M. (Intern), Bindner, H. W. (Intern)
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Web of Science (2017): Indexed yes
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BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.962 SNIP 1.606 CiteScore 2.74
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
On-Line Generation and Arming of System Protection Schemes

This paper presents a new method to automatically generate system protection schemes in real-time, where contingencies are filtered using a method providing N-1 system snapshots. With future power systems consisting largely of renewable distributed generation with time-varying production, highly fluctuating conditions throughout the day will be the result. This makes off-line design of extensive defense plans for power systems infeasible, forming the motivation for the presented method. It relies on the real-time identification of which disturbances that threatens a power systems integrity. The method is based on a recently proposed method of calculating post-contingency Thevenin equivalents, which are used to assess the security of the post-contingency condition. The contingencies that violate the emergency limits are contained by pre-determining event-based remedial actions. The instability mechanisms threatening the system are individually treated, such that appropriate controls are allocated. The procedure is illustrated through a case study using the Nordic32 benchmark system.
Oscillation-Driven Spike-Timing Dependent Plasticity Allows Multiple Overlapping Pattern Recognition in Inhibitory Interneuron Networks

The majority of operations carried out by the brain require learning complex signal patterns for future recognition, retrieval and reuse. Although learning is thought to depend on multiple forms of long-term synaptic plasticity, the way this latter contributes to pattern recognition is still poorly understood. Here, we have used a simple model of afferent excitatory neurons and interneurons with lateral inhibition, reproducing a network topology found in many brain areas from the cerebellum to cortical columns. When endowed with spike-timing dependent plasticity (STDP) at the excitatory input synapses and at the inhibitory interneuron-interneuron synapses, the interneurons rapidly learned complex input patterns. Interestingly, induction of plasticity required that the network be entrained into theta-frequency band oscillations, setting the internal phase-reference required to drive STDP. Inhibitory plasticity effectively distributed multiple patterns among available interneurons, thus allowing the simultaneous detection of multiple overlapping patterns. The addition of plasticity in intrinsic excitability made the system more robust allowing self-adjustment and rescaling in response to a broad range of input patterns. The combination of plasticity in lateral inhibitory connections and homeostatic mechanisms in the inhibitory interneurons optimized mutual information (MI) transfer. The storage of multiple complex patterns in plastic interneuron networks could be critical for the generation of sparse representations of information in excitatory neuron populations falling under their control.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, University of Granada, University of Pavia
Authors: Garrido, J. A. (Ekstern), Luque, N. R. (Ekstern), Tolu, S. (Intern), D'Angelo, E. (Ekstern)
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Main Research Area: Technical/natural sciences

Publication information
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.157 SNIP 1.598 CiteScore 5.16
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.937 SNIP 1.806 CiteScore 4.85
BFI (2014): BFI-level 1
In this paper, a hierarchical management system is proposed to integrate electric vehicles (EVs) into a distribution grid. Three types of actors are included in the system: Distribution system operators (DSOs), Fleet operators (FOs) and EV owners. In contrast to a typical hierarchical control system where the upper level controller directly controls the lower level subordinated nodes, this study aims to integrate two common indirect control methods: market-based control and price-based control into the hierarchical electric vehicles management system. Specifically, on the lower level of the hierarchy, the FOs coordinate the charging behaviors of their EV users using a price-based control method. A parametric utility model is used on the lower level to characterize price elasticity of electric vehicles and thus used by the FO to coordinate the individual EV charging. On the upper level of the hierarchy, the distribution system operator uses the market-based control strategy to coordinate the limited power capacity of power transformer with fleet operators. To facilitate the application of the two indirect control methods into the system, a model describing decision tasks in control is used to specify the essential functions that are needed in the control system. The simulations illustrate the effectiveness of the proposed solutions.
Procedure for Validation of Aggregators Providing Demand Response
As aggregators become viable sources of ancillary services, they will be required to undergo a validation process similar
to the prequalification process of traditional generators. Aggregators are fundamentally different from traditional generators
in that they are formed of a large quantity of small heterogeneous resources that are geographically distributed. Therefore,
a new test procedure must be designed for the aggregator validation. This work proposes such a procedure and
exemplifies is with a study case. The validation of aggregators is essential if aggregators are to be integrated succesfully
into the power system.

Redefining robot based technologies for elderly people assistance: a survey
We analyse the state of the art of hi-tech and robot based technologies in terms of Assistive Technology for all patients
and, in particular, elderly people assistance and everyday activities aid. We focus on different aspects and characteristics
of these tools, such as playfulness, invasiveness, learning-speed, efficiency, short and long-term effect, active vs. passive,
etc. We do so by showing the most important existing examples, and by taking into account all the possible factors that
might help researchers when thinking of developing appropriate technologies for elderly care, as well as, for their relative
assistance personnel. Indeed, while in rehabilitation robotics, a major role is played by the human-machine interface (HMI)
used to gather the patient's intent from biological signals, and convert them into control signals for the robotic artefacts,
surprisingly, decades of research have not yet declared what the optimal HMI is in this context [1]. Further, there is an
urgent need to clarify how various technologies can be a goal or an approach for preventive, rehabilitative and assistive
interaction. Therefore, we try to make a first step towards a redefinition of Robotics Assistive Technology.

**Response Analysis and Comparison of a Spar-Type Floating Offshore Wind Turbine and an Onshore Wind Turbine under Blade Pitch Controller Faults**

This paper analyses the effects of three pitch controller faults on the responses of an onshore wind turbine and a spar-type offshore floating wind turbine. These faults include: a stuck blade pitch actuator, a fixed value fault and a bias fault of the blade pitch sensor. The faults are modeled in the controller dynamic link library and a short-term extreme response analysis is performed using the HAWC2 simulation tool. The main objectives of this paper are to investigate how different faults affect the performance of wind turbines for condition monitoring purposes and which differences exist in the structural responses between onshore and offshore floating wind turbines. Statistical analysis of the selected response parameters are conducted using the six 1-hour stochastic samples for each load case. For condition monitoring purposes, the effects of faults on the responses at different wind speeds and fault amplitudes are investigated by comparing the same response under normal operation. The severities of the individual faults are categorized by the extreme values of structural loads and the structural components are sorted based on the magnitude of the fault effects on the extreme values. The pitch sensor fixed value fault is determined as the most severe fault case and the shaft appears as the structural component that experiences the highest risk. The effects of fault conditions on the offshore floating and the onshore wind turbines are compared to investigate the potential differences. The results show that faults cause more damage to the tower and the yaw bearing for the onshore wind turbine and more damage to the shaft for the offshore floating wind turbine.
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Publication: Research - peer-review › Journal article – Annual report year: 2014
SALVAGE D2.2 Description of the developed algorithms for intrusion detection in smart grid components
This report presents developed model-based anomaly detection techniques used for intrusion detection in smart grid.

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State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy System Management, Automation and Control, Technical University of Denmark, KTH - Royal Institute of Technology
Authors: Kosek, A. M. (Intern), Korman, M. (Ekstern), Heussen, K. (Intern), Tyge, E. (Ekstern), Jonasdottir, A. H. (Ekstern)
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Statistical fault diagnosis of wind turbine drivetrain applied to a 5MW floating wind turbine
Deployment of large scale wind turbine parks, in particular offshore, requires well organized operation and maintenance strategies to make it as competitive as the classical electric power stations. It is important to ensure systems are safe, profitable, and cost-effective. In this regards, the ability to detect, isolate, estimate, and prognose faults plays an important role. One of the critical wind turbine components is the gearbox. Failures in the gearbox are costly both due to the cost of the gearbox itself and also due to high repair downtime. In order to detect faults as fast as possible to prevent them to develop into failure, statistical change detection is used in this paper. The Cumulative Sum Method (CUSUM) is employed to detect possible defects in the downwind main bearing. A high fidelity gearbox model on a 5-MW spar-type wind turbine is used to generate data for fault-free and faulty conditions of the bearing at the rated wind speed and the associated wave condition. Acceleration measurements are utilized to find residuals used to indirectly detect damages in the bearing. Residuals are found to be non-Gaussian, following a t-distribution with multivariable characteristic parameters. The results in this paper show how the diagnostic scheme can detect change with desired false alarm and detection probabilities.

General information
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Organisations: Department of Electrical Engineering, Automation and Control, Norwegian University of Science and Technology
Authors: Ghane, M. (Ekstern), Nejad, A. R. (Ekstern), Blanke, M. (Intern), Gao, Z. (Ekstern), Moan, T. (Ekstern)
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.45 SJR 0.24 SNIP 0.401
Web of Science (2016): Indexed yes
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Scopus rating (2015): SJR 0.252 SNIP 0.374 CiteScore 0.35
Toward Coordinated Robust Allocation of Reserve Policies for a Cell-based Power System

Conventional regulation reserves have fixed participation factors and are thus not well suited to utilize differentiated capabilities of ancillary service providers. This study applies linear decision rules-based (LDR) control policies, which effectively adapt the present participation factor in dependence of the imbalance signal of previous time steps. The LDR-policies are centrally computed using a robust optimization approach which takes into account both the covariances of historic imbalance signals and the operational flexibility of ancillary service providers. The concept is then extended to the cooperation of multiple cells. Two illustrating examples are presented to show the functioning of the proposed LDR method.

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Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management, Restore, Zhejiang University, Flemish Institute for Technological Research
Authors: Hu, J. (Intern), Heussen, K. (Intern), Claessens, B. (Ekstern), Sun, L. (Ekstern), D’Hulst, R. (Ekstern)
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Publisher: IEEE
Towards a foundation for holistic power system validation and testing

Renewable energy sources and further electrification of energy consumption are key enablers to decrease greenhouse gas emissions, but they also introduce increased complexity to the electric power system. The increased availability of automation, information and communication technology, and intelligent solutions for system operation have transformed the power system into a smart grid. To support the development process of smart grid solutions on system level they have to be tested in a holistic manner covering the multi-domain aspect of such complex systems. This paper introduces the concept of holistic power system testing and discusses first steps towards a corresponding methodology that is being developed in the European ERIGrid research infrastructure project.

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State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management, OFFIS - Institute for Information Technology, Austrian Institute of Technology
Authors: Blank, M. (Ekstern), Lehnhoff, S. (Ekstern), Heussen, K. (Intern), Bondy, D. E. M. (Intern), Moyo, C. (Ekstern), Strasser, T. (Ekstern)
Number of pages: 4
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Publisher: IEEE
ISBN (Print): 978-1-5090-1314-2
Main Research Area: Technical/natural sciences

Towards modeling future energy infrastructures - the ELECTRA system engineering approach

Within this contribution, we provide an overview based on previous work conducted in the ELECTRA project to come up with a consistent method for modeling the ELECTRA WoC approach according to the methods established with the M/490 mandate of the European Commission. We will motivate the use of the IEC 62559 use case template as well as needed changes to cope particularly with the aspects of controller conflicts and Greenfield technology modeling. From the original envisioned use of the standards, we show a possible transfer on how to properly deal with a Greenfield approach when modeling.
Trade-off Analysis of Virtual Inertia and Fast Primary Frequency Control During Frequency Transients in a Converter Dominated Network

Traditionally the electricity generation is based on rotating synchronous machines which provide inertia to the power system. The increasing share of converter connected energy sources reduces the available rotational inertia in the power system leading to faster frequency dynamics, which may cause more critical frequency excursions. Both, virtual inertia and fast primary control could serve as a solution to improve frequency stability, however, their respective impacts on the system have different consequences, so that the trade-off is not straightforward. This study presents a comparative analysis of virtual inertia and a fast primary control algorithm with respect to rate of change of frequency (ROCOF), frequency nadir and steady state value considering the effect of the dead time which is carried out by a sensitivity analysis. The investigation shows that the virtual inertia controller is effective in reducing the ROCOF compared to fast primary control. However, it is worsening frequency nadir and steady state value. Moreover, the sensitivity analysis shows the very limited effect of the two controllers on the voltage magnitude.
Ultrasonic lubrication: concept and application

General information
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Organisations: Department of Electrical Engineering, Electronics, Automation and Control, University of Tokyo
Authors: Zsurzsan, T. (Intern), Yamamoto, A. (Ekstern), Andersen, M. A. E. (Intern), Andersen, N. A. (Intern), Zhang, Z. (Intern)
Number of pages: 22
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Original language: English
Main Research Area: Technical/natural sciences
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Source: PublicationPreSubmission
Source-ID: 126991276

Validation of multi-body modelling methodology for reconfigurable underwater robots
This paper investigates the problem of employing reconfigurable robots in an underwater setting. The main results presented is the experimental validation of a modelling methodology for a system consisting of N dynamically connected robots with heterogeneous dynamics. Two distinct types of experiments are performed, a series of hydrostatic free-decay tests and a series of open-loop trajectory tests. The results are compared to a simulation based on the modelling methodology. The modelling methodology shows promising results for usage with systems composed of reconfigurable underwater modules. The purpose of the model is to enable design of control strategies for cooperative reconfigurable underwater systems.

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Authors: Nielsen, M. (Ekstern), Eidsvik, O. A. (Ekstern), Blanke, M. (Intern), Schjølberg, I. (Ekstern)
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Publication date: 2016

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oceans2016_mcn_mb_is.pdf
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Source-ID: 127843426

Vision-based robotic system for object agnostic placing operations
Industrial robots are part of almost all modern factories. Even though, industrial robots nowadays manipulate objects of a huge variety in different environments, exact knowledge about both of them is generally assumed. The aim of this work is to investigate the ability of a robotic system to operate within an unknown environment manipulating unknown objects. The developed system detects objects, finds matching compartments in a placing box, and ultimately grasps and places the objects there. The developed system exploits 3D sensing and visual feature extraction. No prior knowledge is provided to the system, neither for the objects nor for the placing box. The experimental evaluation of the developed robotic system
shows that a combination of seemingly simple modules and strategies can provide effective solution to the targeted problem.

**General information**
State: Published
Organisations: Department of Automation, Department of Electrical Engineering, Automation and Control, Aalborg University
Authors: Rofalis, N. (Ekstern), Nalpantidis, L. (Ekstern), Andersen, N. A. (Intern), Kriger, V. (Ekstern)
Pages: 467-75
Publication date: 2016

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**Main Research Area:** Technical/natural sciences

Image recognition, Control in industrial production systems, Computer vision and image processing techniques, Robotics, Manufacturing facilities, image matching, industrial robots, production facilities, robot vision, modern factories, visual feature extraction, 3D sensing, matching compartments, environment unknown object manipulation, object agnostic placing operations, vision-based robotic system

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**Source:** FindIt
Source-ID: 2306531874
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

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**Visual Servoing for Object Manipulation: A Case Study in Slaughterhouse**

Automation for slaughterhouse challenges the design of the control system due to the variety of the objects. Realtime sensing provides instantaneous information about each piece of work and thus, is useful for robotic system developed for slaughterhouse. In this work, a pick and place task which is a common task among tasks in slaughterhouse is selected as the scenario for the system demonstration. A vision system is utilized to grab the current information of the object, including position and orientation. The information about the object is then transferred to the robot side for path planning.

An online and offline combined path planning algorithm is proposed to generate the desired path for the robot control. An industrial robot arm is applied to execute the path. The system is implemented for a lab-scale experiment, and the results show a high success rate of object manipulation in the pick and place task. The approach is implemented in ROS which allows utilization of the developed algorithm on different platforms with little extra effort.

**General information**
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Wu, H. (Intern), Andersen, T. T. (Intern), Andersen, N. A. (Intern), Ravn, O. (Intern)
Number of pages: 6
Publication date: 2016

**Host publication information**
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Publisher: IEEE
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**Main Research Area:** Technical/natural sciences

Robot kinematics, Cameras, Robot vision systems, Service robots, Belts

**Electronic versions:**
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2017
Voltage Estimation in Active Distribution Grids Using Neural Networks

The power flow in distribution grids is becoming more complicated as reverse power flows and undesired voltage rises might occur under particular circumstances due to integration of renewable energy sources, increasing the occurrence of critical bus voltages. To identify these critical feeders the observability of distribution systems has to be improved. To increase the situational awareness of the power system operator data driven methods can be employed. These methods benefit from newly available data sources such as smart meters. This paper presents a voltage estimation method based on neural networks which is robust under complex load and in-feeder generation situations. A major advantage of the proposed method is that the power system does not have to be explicitly modeled.

Active Fault Diagnosis in Sampled-data Systems

The focus in this paper is on active fault diagnosis (AFD) in closed-loop sampled-data systems. Applying the same AFD architecture as for continuous-time systems does not directly result in the same set of closed-loop matrix transfer functions. For continuous-time systems, the LFT (linear fractional transformation) structure in the connection between the parametric faults and the matrix transfer function (also known as the fault signature matrix) applied for AFD is not directly preserved for sampled-data system. As a consequence of this, the AFD methods cannot directly be applied for sampled-data systems. Two methods are considered in this paper to handle the fault signature matrix for sampled-data systems such that standard AFD methods can be applied. The first method is based on a discretization of the system such that the LFT structure is preserved resulting in the same LFT structure in the fault signature matrix as obtained for continuous-time systems. The other method is an approximation method, where the same structure is obtained for small parametric faults.
This paper investigates the feasibility of operating a wind turbine with lightweight tower in the full load region exploiting an adaptive nonlinear controller that allows the turbine to dynamically lean against the wind while maintaining nominal power output. The use of lightweight structures for towers and foundations would greatly reduce the construction cost of the wind turbine, however extra features ought to be included in the control system architecture to avoid tower collapse. An adaptive backstepping collective pitch controller is proposed for tower point tracking control, i.e. to modify the angular deflection of the tower with respect to the vertical axis in response to variations in wind speed. The controller is shown to guarantee asymptotic tracking of the reference trajectory. The performance of the control system is evaluated through deterministic and stochastic simulations including an extreme wind gust event, and the feasibility of stabilizing the tower position while maintaining the rated power output is shown.

Adjustable broaching tool for tolerance compensation in precision manufacturing
Current manufacturing of precision tools for machining typically requires processes such as grinding, EDM or laser processing in order to comply with high requirements on tolerances. However even tools manufactured by these processes come short, when a new batch of workpieces are supplied, and their tolerances are not compliant. This approach presents a precision broaching tool for adjusting the inner diameter of an external broach. The tool compensates
for the manufacturing tolerance chain of tool and workpieces by up to 37 m. The approach is based on conventional shrink fitting of cold forging tools. A numerical and analytical model of the compression is compared with experimental results.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Nielsen, E. K. (Intern), Eriksen, R. S. (Intern), Paldan, N. A. (Intern), Arentoft, M. (Intern)
Number of pages: 7
Publication date: 2015

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Title of host publication: MATEC Web of Conferences
Volume: 21
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Conference: 4th International Conference on New Forming Technology, Glasgow, United Kingdom, 06/08/2015 - 06/08/2015
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Bibliographical note
This is an Open Access article distributed under the terms of the Creative Commons Attribution License 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.
Source: PublicationPreSubmission
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

A Functional Reference Architecture for Aggregators
Aggregators are considered to be a key enabling technology for harvesting power system services from distributed energy resources (DER). As a precondition for more widespread use of aggregators in power systems, methods for comparing and validating aggregator designs must be established. This paper proposes a functional reference architecture for aggregators to address this requirement.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management
Authors: Bondy, D. E. M. (Intern), Heussen, K. (Intern), Gehrke, O. (Intern), Thavlov, A. (Intern)
Number of pages: 4
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Publisher: IEEE
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Main Research Area: Technical/natural sciences

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"Work in progress" paper
Source: PublicationPreSubmission
Source-ID: 112407212
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Agent-Based Smart Grid Market Simulation with Connection to Real Infrastructures
The consensus behind Smart Grids (SG) as one of the most promising solutions for the massive integration of renewable energy sources in power systems has led to the practical implementation of several prototypes and pilots that aim at testing and validating SG methodologies. The urgent need to accommodate such resources of distributed and intermittent nature and the impact that a deficient management of energy sources has on the global population require that alternative solutions are experimented. This paper presents a multi-agent based SG simulation platform that is connected to physical
resources, so that realistic scenarios with palpable influence on real resources can be simulated. The SG simulator is also connected to the Multi-Agent Simulator of Competitive Electricity Markets (MASCEM), which provides a solid framework for the simulation of restructured electricity markets. Taking advantage on the complementarities between the simulators, a SG market is proposed, and a realistic simulation scenario, using two real buildings acting in a simulated SG is presented.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Polytechnic Institute of Porto
Authors: Santos, G. (Ekstern), Pinto, T. (Ekstern), Gomes, L. (Ekstern), Silva, M. (Ekstern), Morais, H. (Intern), Vale, Z. (Ekstern), Praca, I. (Ekstern)
Pages: 283-295
Publication date: 2015

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Title of host publication: Highlights of Practical Applications of Agents, Multi-Agent Systems, and Sustainability - The PAAMS Collection : International Workshops of PAAMS 2015, Salamanca, Spain, June 3-4, 2015. Proceedings
Publisher: Springer
ISBN (Print): 978-3-319-19032-7
ISBN (Electronic): 978-3-319-19033-4

A modern artificial intelligence Playware art tool for psychological testing of group dynamics
We describe an artistic method used for the psychological analysis of group dynamics. The design of the artistic system, which mediates group dynamics, emerges from our studies of modular Playware and remixing Playware. Inspired from remixing modular Playware, where users remix samples in the form of physical and functional modules, we created an artistic instantiation of such a concept with the Parallel Relational Universes, allowing arts alumni to remix artistic expressions. Here, we report the data emerged from a first pre-test, run with gymnasium's alumni. We then report both the artistic and the psychological findings. We describe the modern artificial intelligence implementation of this instrument. Between an art piece and a psychological test, at a first cognitive analysis, it seems to be a promising research tool. In the discussion we speculate about potential industrial applications, as well.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, Academy of Fine Arts of Macerata
Authors: Pagliarini, L. (Ekstern), Lund, H. H. (Intern)
Pages: 60-65
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Host publication information
Title of host publication: Proceedings of IEEE International Conference on Advanced Intelligent Mechatronics (AIM) 2015
Publisher: IEEE
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BFI conference series: IEEE/ASME International Conference on Advanced Intelligent Mechatronics (5020027)
Main Research Area: Technical/natural sciences
Conference: 2015 IEEE International Conference on Advanced Intelligent Mechatronics, Busan, Korea, Republic of, 07/07/2015 - 07/07/2015
DOIs: 10.1109/AIM.2015.7222509
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

A multi-agent system for distribution grid congestion management with electric vehicles
Electric vehicles (EVs) are widely regarded as valuable assets in the smart grid as distributed energy resources in addition to their primary transportation function. However, connecting EVs to the distribution network and recharging the EV batteries without any control may overload the transformers and cables during peak hours when the penetration of EVs is
relatively high. In this study, a two level hierarchical control method for integrating EVs into the distribution network is proposed to coordinate the self-interests and operational constraints of two actors, the EV owner and Distribution system operator (DSO), facilitated by the introduction of the fleet operator (FO) and the grid capacity market operator (CMO). Unlike the typical hierarchical control system where the upper level controller commands the low level unit to execute the actions, in this study, market based control are applied both in the upper and low level of the hierarchical system. Specifically, in the upper level of the hierarchy, distribution system operator uses market based control to coordinate the fleet operator's power schedule. In the low level of the hierarchy, the fleet operator use market based control to allocate the charging power to the individual EVs, by using market based control, the proposed method considers the flexibility of EVs through the presence of the response-weighting factor to the shadow price sent out by the FO. Furthermore, to fully demonstrate the coordination behavior of the proposed control strategy, we built a multi-agent system (MAS) that is based on the co-simulation environment of JACK, Matlab and Simulink. A use case of the MAS and the results of running the system are presented to intuitively illustrate the effectiveness of the proposed solutions.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Automation and Control, KTH - Royal Institute of Technology
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Pages: 45-58
Publication date: 2015
Main Research Area: Technical/natural sciences

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Journal: Engineering Applications of Artificial Intelligence
Volume: 38
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.677 SJR 0.874 CiteScore 3.75
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.74 SJR 0.999 SNIP 1.922
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.081 SNIP 2.151 CiteScore 3.51
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.12 SNIP 2.514 CiteScore 3.56
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.996 SNIP 2.324 CiteScore 3.19
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.021 SNIP 2.469 CiteScore 3
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.857 SNIP 2.284 CiteScore 2.81
ISI indexed (2011): ISI indexed yes
Scopus rating (2010): SJR 0.74 SNIP 2.068
Scopus rating (2009): SJR 0.606 SNIP 1.633
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.628 SNIP 1.687
Scopus rating (2007): SJR 0.559 SNIP 1.616
Scopus rating (2006): SJR 0.455 SNIP 1.656
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.305 SNIP 1.256
Scopus rating (2004): SJR 0.242 SNIP 0.93
A multi-objective optimization of the active and reactive resource scheduling at a distribution level in a smart grid context

In the traditional paradigm, the large power plants supply the reactive power required at a transmission level and the capacitors and transformer tap changer were also used at a distribution level. However, in a near future will be necessary to schedule both active and reactive power at a distribution level, due to the high number of resources connected in distribution levels. This paper proposes a new multi-objective methodology to deal with the optimal resource scheduling considering the distributed generation, electric vehicles and capacitor banks for the joint active and reactive power scheduling. The proposed methodology considers the minimization of the cost (economic perspective) of all distributed resources, and the minimization of the voltage magnitude difference (technical perspective) in all buses. The Pareto front is determined and a fuzzy-based mechanism is applied to present the best compromise solution. The proposed methodology has been tested in the 33-bus distribution network. The case study shows the results of three different scenarios for the economic, technical, and multi-objective perspectives, and the results demonstrated the importance of incorporating the reactive scheduling in the distribution network using the multi-objective perspective to obtain the best compromise solution for the economic and technical perspectives.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Polytechnic Institute of Porto
Authors: Sousa, T. (Ekstern), Morais, H. (Intern), Vale, Z. (Ekstern), Castro, R. (Ekstern)
Pages: 236-250
Publication date: 2015
Main Research Area: Technical/natural sciences

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Journal: Energy
Volume: 85
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Web of Science (2018): Indexed yes
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Scopus rating (2017): CiteScore 5.6 SJR 1.99 SNIP 1.923
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.17 SJR 1.974 SNIP 1.823
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.22 SNIP 2.037 CiteScore 5.03
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.575 SNIP 2.602 CiteScore 5.7
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.458 SNIP 2.556 CiteScore 5.02
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Analysis of Strategic Wind Power Participation in Energy Market using MASCEM simulator

In recent years the reassessment of remuneration schemes for renewable sources in several European countries has motivated the increase of wind power generation participation in electricity markets. Moreover, the continuous growth of wind power generation, as well as the evolution of wind turbines technology, suggests that wind power plants may participate in both energy and ancillary services markets with strategic behavior to improve their benefits. Thus, wind power generation with strategic behavior may have impact on market equilibrium and pricing. This paper evaluates the impact of a proportional offering strategy for wind power plants to participate in both energy and ancillary services markets. MASCEM (Multi-Agent System for Competitive Electricity Markets) is used to simulate and validate the impact of wind power plants in market equilibrium. A case study based on real and recent data for the Iberian market and its specific rules is simulated in MASCEM.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy Analytics and Markets, Automation and Control, Instituto Politécnico do Porto
Authors: Soares, T. (Intern), Santos, G. (Ekstern), Pinto, T. (Ekstern), Morais, H. (Intern), Pinson, P. (Intern), Vale, Z. (Ekstern)
Number of pages: 6
An Approach for a National eHealth Implementation – the Case of Modular Interactive Tiles for Rehabilitation

By the development of a mHealth tablet app together with modular interactive tiles for rehabilitation, we intend to facilitate the co-design, adaptation, demonstration and validation of modular ICT solutions for rehabilitation in deep rural sub-Saharan Africa. This results in highly mobile, modular and energy efficient technology which can be set up and used anywhere and anytime. We have formed a national partnership for sustainable implementation, comprising a governmental representative, national hospital, national health university department, regional hospitals, Living Labs and NGOs performing community-based rehabilitation. Thereby, we investigate the adaptation, contextualisation and implementation in different rehabilitation methods and centres, including hospitals both in a city centres and in a rural area, NGO's performing community based rehabilitation, and rehabilitation centres. Together, the partners contextualise the eHealth solution to fit the needs in urban, rural and deep rural areas.

A set-valued approach to FDI an FTC of wind turbines

A complete methodology to design robust Fault Detection and Isolation (FDI) filters and Fault Tolerant Control (FTC) schemes for Linear Parameter Varying (LPV) systems is proposed, with particular focus on its applicability to wind turbines. The paper takes advantage of the recent advances in model falsification using Set-Valued Observers (SVOs) that led to the development of FDI methods for uncertain linear time-varying systems, with promising results in terms of the time required to diagnose faults. An integration of such SVO-based FDI methods with robust control synthesis is described, in order to deploy new FTC algorithms that are able to stabilize the plant under faulty environments. The FDI and FTC algorithms are assessed by resorting to a publicly available wind turbine benchmark model, using Monte-Carlo simulation runs.
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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 5.89 SJR 1.832 SNIP 2.728
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.17 SJR 1.655 SNIP 2.643
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.966 SNIP 2.798 CiteScore 4.72
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.786 SNIP 3.006 CiteScore 4.34
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.707 SNIP 3.41 CiteScore 4.41
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.495 SNIP 3.011 CiteScore 3.7
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.585 SNIP 2.909 CiteScore 3.26
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.098 SNIP 2.391
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.587 SNIP 2.789
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.43 SNIP 2.736
Scopus rating (2007): SJR 1.082 SNIP 2.205
Scopus rating (2006): SJR 1.021 SNIP 2.306
Scopus rating (2005): SJR 0.968 SNIP 2.593
Scopus rating (2004): SJR 1.173 SNIP 2.183
Scopus rating (2003): SJR 1.537 SNIP 2.355
Scopus rating (2002): SJR 2.342 SNIP 2.886
Scopus rating (2001): SJR 2.073 SNIP 2.262
Scopus rating (2000): SJR 0.608 SNIP 2.15
Scopus rating (1999): SJR 0.619 SNIP 1.579
Original language: English
Fault Detection and Isolation, Fault Tolerant Control, Set-Valued observers, Wind Energy Conversion Systems
DOIs:
10.1109/TCST.2014.2322777
Assessing Operational Situations.

In spite of the high level of automation commonly applied to today’s engineering system, humans’ skill and knowledge still plays a central role in the systems’ daily operation, critical decision making, and accident management. The complexity of the engineered system poses great challenge for human operators to perceive and understand the operational situation. The research domain of situation awareness approaches the operational challenges from the human cognition perspective while the presented thesis aims at supporting situation assessment from the system perspective. The thesis has reviewed different perspectives on situation awareness in the human factor studies and uses the knowledge reflectively for system representation and analysis. The human cognitive activities during complex plant operation and how they perceive a situation and what kind of knowledge has to be established in the human mental model for the operators to be aware of the situations has motivated the utilization of functional representation in system level of situation assessment. The thesis has summarized the MFM syntax and provides detail instructions of how to model by using the modeling technique. A PWR primary system is used as a comprehensive modeling case to demonstrate the MFM modeling procedure. Then the thesis investigates the usability of functional modeling approaches to define and model a plant operational situation. MFM modeling is proposed because it is a formalization combining the means-end and part-whole dimensions of a system, so that the MFM models can therefore represent a complex system at several abstraction levels. MFM models also model cause-effect dependencies of functionalities and objectives of the system in different abstraction levels, so the model can be used for causal reasoning. This thesis extends the causal reasoning methods for MFM models and exploits the ability for MFM models to represent operational knowledge and operational modes. Both concepts are of great importance for situation assessment. By applying the extended MFM theory, situation assessment procedure is developed to assess the plant operational situation. The assessment procedure is demonstrated on the PWR model case.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management
Authors: Zhang, X. (Intern), Ravn, O. (Intern), Lind, M. (Intern)
Number of pages: 152
Publication date: 2015

Publication information
Publisher: Technical University of Denmark, Department of Electrical Engineering
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
phdthesis.pdf

Source: PublicationPreSubmission
Source-ID: 116475232
Publication: Research › Ph.D. thesis – Annual report year: 2015

A Use Case Methodology to Handle Conflicting Controller Requirements for Future Power Systems

This paper proposes a standards based requirements elicitation and analysis strategy tailored for smart grid control structure development. Control structures in electric power systems often span across several systems and stakeholders. Requirements elicitation for such control systems therefore requires coordination across many stakeholders and it is challenging to achieve a consistent design. To enable an iterative and distributed development we suggest a conflict management approach as a modular element of the design strategy, focusing on conflict identification and tracing. The idea is to describe a process starting from a tailored IEC 62559 template amended for recording controller conflicts and adapting the underlying use case management repository for collaborative work. Conflict identification is supported by Multilevel Flow Modeling providing abstracted conflict patterns.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management, OFFIS - Institute for Information Technology, Ricerca Sistema Energetico SpA
Authors: Heussen, K. (Intern), Uslar, M. (Ekstern), Tornelli, C. (Ekstern)
Pages: 582-587
Publication date: 2015

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Publisher: IEEE
ISBN (Print): 9781479977369
Centralised versus Decentralised Control Reconfiguration for Collaborating Underwater Robots.

The present paper introduces an approach to fault-tolerant reconfiguration for collaborating underwater robots. Fault-tolerant reconfiguration is obtained using the virtual actuator approach, Steen (2005). The paper investigates properties of a centralised versus a decentralised implementation and assesses the capabilities under communication constraints between the individual robots. In the centralised case, each robot sends information related to its own status to a unique virtual actuator that computes the necessary reconfiguration. In the decentralised case, each robot is equipped with its own virtual actuator that is able to accommodate both local faults and faults within a collaborating unit. The paper discusses how this is done through exploiting structural information (e.g. thruster configuration) for each participant in the cooperation. A test scenario is presented as a case in which an underwater drill needs to be transported and positioned by three collaborating robots as part of an underwater autonomous operation.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, Norwegian University of Science and Technology
Authors: Furno, L. (Intern), Nielsen, M. C. (Intern), Blanke, M. (Intern)
Pages: 732–739
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ISSN: 1474-6670
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Conference: IFAC Safeprocess'15, Paris, France, 02/09/2015 - 02/09/2015
Collaborating robots, Underwater robotics, Fault tolerance control, Actuator fault, Reconfiguration, Decentralised system
Electronic versions:
If_mcn_mb_SAFEPROCESS_2015.pdf
DOI: 10.1016/j.ifacol.2015.09.614
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Changing the Game: Tangible Energy Planning and Knowledge Sharing

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management, EnergyCrossroads Denmark, Climate KIC Nordic
Authors: Zeitouni, G. (Ekstern), Heussen, K. (Intern), Schröder, S. (Ekstern), Stern Dahl, P. L. (Ekstern)
Number of pages: 1
Publication date: 2015

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Title of host publication: Book of Abstracts. DTU's Sustain Conference 2015
Place of publication: Lyngby
Publisher: Technical University of Denmark (DTU)
Article number: C-7
Closed loop identification using a modified Hansen scheme: Paper

It is often not feasible or even impossible to identify a plant in open loop. This might be because the plant contains unstable poles, or it is simply too expensive to remove the plant from its intended operation, among other possibilities. There are several methods for identifying a plant in closed loop [4], and one such method is the Hansen scheme [1]. Standard identification using Hansen scheme demands generating the identification signals indirectly. In this paper it is instead proposed to use the relationship between the Youla factorization of a plant and its stabilizing controller to directly measure the signals used for identification. A simulation example and identification of a gas bearing is given to show the method in action. Rotors supported by controllable gas bearings are open loop stable systems. However as the rotational speed is increased feedback control is necessary in order to keep the system stable. Furthermore because the dynamics of such a system depends on the rotational speed it is needed to conduct an identification while the system is part of a closed loop scheme. The authors believe the paper able to contribute towards a simpler and more direct way of identifying closed loop plants using Hansen scheme.
Coalition of distributed generation units to virtual power players - a game theory approach

Smart Grids (SGs) have emerged as the new paradigm for power system operation and management, being designed to include large amounts of distributed energy resources. This new paradigm requires new Energy Resource Management (ERM) methodologies considering different operation strategies and the existence of new management players such as several types of aggregators. This paper proposes a methodology to facilitate the coalition between distributed generation units originating Virtual Power Players (VPP) considering a game theory approach. The proposed approach consists in the analysis of the classifications that were attributed by each VPP to the distributed generation units, as well as in the analysis of the previous established contracts by each player. The proposed classification model is based in fourteen parameters including technical, economical and behavioural ones. Depending of the VPP strategies, size and goals, each parameter has different importance. VPP can also manage other type of energy resources, like storage units, electric vehicles, demand response programs or even parts of the MV and LV distribution network. A case study with twelve VPPs with different characteristics and one hundred and fifty real distributed generation units is included in the paper.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Polytechnic Institute of Porto
Authors: Morais, H. (Intern), Sousa, T. M. (Ekstern), Santos, G. (Ekstern), Pinto, T. (Ekstern), Praca, I. (Ekstern), Vale, Z. (Ekstern)
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Collective Modular Underwater Robotic System for Long-Term Autonomous Operation
This paper provides a brief overview of an underwater robotic system for autonomous inspection in confined offshore underwater structures. The system, which is currently in development, consists of heterogeneous modular robots able to physically dock and communicate with other robots, transport tools and robots, and recharge their batteries while underwater. These properties will provide the system, when fully developed, with unique capabilities such as ability to adapt robotic morphology and function to the current task and tolerate failures leading to long-term autonomous operations.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware
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Main Research Area: Technical/natural sciences
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Combined Geometric and Neural Network Approach to Generic Fault Diagnosis in Satellite Reaction Wheels

This paper suggests a novel diagnosis scheme for detection, isolation and estimation of faults affecting satellite reaction wheels. Both spin rate measurements and actuation torque defects are dealt with. The proposed system consists of a fault detection and isolation module composed by a bank of residual filters organized in a generalized scheme, followed by a fault estimation module consisting of a bank of adaptive estimation filters. The residuals are decoupled from aerodynamic disturbances thanks to the Nonlinear Geometric Approach. The use of Radial Basis Function Neural Networks is shown to allow design of generalized fault estimation filters, which do not need a priori information about the faults internal model. Simulation results with a detailed nonlinear spacecraft model, which includes disturbances, show that the proposed diagnosis scheme can deal with faults affecting both reaction wheel torques and flywheel spin rate measurements, and obtain precise fault isolation as well as accurate fault estimates.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, University of Bologna, University of Ferrara
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Scopus rating (2010): SJR 0.121 SNIP 0.054
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Combining playware exergaming with a mobile fitness app

We propose a novel playware as a merge between exergames and mobile fitness apps to engage the users in physical exercises, not only as competitive play, but also in the form of cooperative play. The concept connects modular interactive tiles with radio communication to Android tablets and smart phones, which can connect to the Internet. This allows the players to monitor their playware exergaming performance on the smart device(s). A test was set up over 8 days allowing two school classes to compete with each other on which class was going to collect the most points playing on the modular tiles during the test. The test subjects were from 6th and 7th grade (12-13 years old children). As a social playware, we investigated how the playware mediated cooperative and competitive play amongst the users. It was found that the majority of game play involved social interaction between players, and that 8 out of 10 pupils on the top-10 were girls. The playware seemed to motivate the girls to become physically active.

Comparison of Linear and Nonlinear Model Predictive Control for Optimization of Spray Dryer Operation

In this paper, we compare the performance of an economically optimizing Nonlinear Model Predictive Controller (E-NMPC) to a linear tracking Model Predictive Controller (MPC) for a spray drying plant. We find in this simulation study, that the economic performance of the two controllers are almost equal. We evaluate the economic performance with an industrially recorded disturbance scenario, where unmeasured disturbances and model mismatch are present. The state of the spray dryer, used in the E-NMPC and MPC, is estimated using Kalman Filters with noise covariances estimated by a maximum likelihood (ML) method.
Configuration Selection for Reconfigurable Control of Piecewise Affine Systems

In this paper, the problem of configuration selection i.e. sensor/actuator placement for piecewise affine (PWA) systems subject to both sensor and actuator faults is considered. A method is proposed that provides a tool for the design phase to decide about the optimal placement of sensor/actuators where the reconfigurability of the system subject to sensor and actuator faults is also taken into account. Using a lattice of possible configurations (sensor/actuator placements), the reconfigurability of the system subject to faults for each configuration is evaluated and based on that one can draw conclusions about the reconfigurability of the system and the optimal configuration in the architecture design phase. A reconfigurable control must ensure stability of the reconfigured system and, if possible, a graceful degradation in the performance. Therefore, in the proposed reconfigurability analysis, we consider both stabilizability and performance of the system. The efficiency of the proposed method is demonstrated on several numerical examples.
Control and sensor techniques for PAD servo motor drive

The Piezoelectric Actuator Drive (PAD) is a new type of electrical motor that employs piezoelectric multilayer actuators coupled with a form-fitted micro-mechanical gearing to generate rotary motion. The PAD is precise, having a positioning error of less than 2 arc-seconds. Its typical output torque is 4 Nm, without any additional gearing. The whole motor is fully non-magnetic, enabling its use in applications where magnetic neutrality is of importance. The main challenges of the PAD are the hysteretic behavior of the ceramic actuators used and their highly capacitive nature. After compensating for the hysteretic behavior, the current waveforms of the motor can be used to extract all necessary parameters for sensorless operation. Moreover, these signals provide a qualitative information about the precision in motor centering and show any mismatch between the actuators used.

General information
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Organisations: Department of Electrical Engineering, Electronics, Automation and Control
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Convex Relaxation of Power Dispatch for Voltage Stability Improvement

A method for enhancing the voltage stability of a power system is presented in this paper. The method is based on a stability-constrained optimal power flow approach, where dispatch is done such that a maximum L-index is minimized for all load busses in a transmission grid. It is shown that optimal dispatch is obtainable with enhanced margins for voltage stability using a semidefinite relaxation of the optimal power flow problem, and that this problem can be formulated as a semidefinite program with a quasi-convex objective. Numerical tests are performed on the IEEE-30 bus and BPA systems. The feasibility of the method is demonstrated through demonstrating that improved voltage stability margins are obtained for both systems.

Cost allocation model for distribution networks considering high penetration of distributed energy resources

The high penetration of distributed energy resources (DER) in distribution networks and the competitive environment of electricity markets impose the use of new approaches in several domains. The network cost allocation, traditionally used in transmission networks, should be adapted and used in the distribution networks considering the specifications of the connected resources. The main goal is to develop a fairer methodology trying to distribute the distribution network use costs to all players which are using the network in each period. In this paper, a model considering different type of costs (fixed, losses, and congestion costs) is proposed comprising the use of a large set of DER, namely distributed generation (DG), demand response (DR) of direct load control type, energy storage systems (ESS), and electric vehicles with capability of discharging energy to the network, which is known as vehicle-to-grid (V2G). The proposed model includes three distinct phases of operation. The first phase of the model consists in an economic dispatch based on an AC optimal power flow (AC-OPF); in the second phase Kirschen's and Bialek's tracing algorithms are used and compared to evaluate the impact of each resource in the network. Finally, the MW-mile method is used in the third phase of the proposed model. A distribution network of 33 buses with large penetration of DER is used to illustrate the application of the proposed model. [All rights reserved Elsevier].

Cost allocation model for distribution networks considering high penetration of distributed energy resources

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Bialek's tracing method, Distributed energy resources, Kirschen's tracing method, MW-mile, Network tariffs allocation, Topological distribution factors
Day-ahead distributed energy resource scheduling using differential search algorithm

The number of dispersed energy resources is growing every day, such as the use of more distributed generators. This paper deals with energy resource scheduling model in future smart grids. The methodology can be used by virtual power players (VPPs) considering day-ahead time horizon. This method considers that energy resources are managed by a VPP which establishes contracts with their owners. The full AC power flow calculation included in the model takes into account network constraints. This paper presents an application of differential search algorithm (DSA) for solving the day-ahead scheduling. DSA method is used to minimize the operation costs for the VPP providing in satisfactory execution time. Two scenarios are presented using a 33-bus distribution network, large wind farm and several distributed energy resources to illustrate the proposed methodology. These scenarios consider a contingency on the large wind farm and different forecasts regarding load demand.
Diagnosis and Fault-tolerant Control, 3rd Edition
The book presents effective model-based analysis and design methods for fault diagnosis and fault-tolerant control. Architectural and structural models are used to analyse the propagation of the fault through the process, to test the fault detectability and to find the redundancies in the process that can be used to ensure fault tolerance. It also introduces design methods suitable for diagnostic systems and fault-tolerant controllers for continuous processes that are described by analytical models of discrete-event systems represented by automata.

General information
State: Published
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Diagnosis of CO Pollution in HTPEM Fuel Cell using Statistical Change Detection
The fuel cell technologies are advancing and maturing for commercial markets. However proper diagnostic tools needs to be developed in order to insure reliability and durability of fuel cell systems. This paper presents a design of a data driven method to detect CO content in the anode gas of a high temperature fuel cell. In this work the fuel cell characterization is based on an experimental equivalent electrical circuit, where model parameters are mapped as a function of the load current. The designed general likelihood ratio test detection scheme detects whether a equivalent electrical circuit parameter differ from the non-faulty operation. It is proven that the general likelihood ratio test detection scheme, with a very low probability of false alarm, can detect CO content in the anode gas of the fuel cell.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Aalborg University
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Diagnosis of Wing Icing Through Lift and Drag Coefficient Change Detection for Small Unmanned Aircraft

This paper addresses the issue of structural change, caused by ice accretion, on UAVs by utilizing a Neyman Pearson (NP) based statistical change detection approach, for the identification of structural changes of fixed wing UAV airfoils. A structural analysis is performed on the nonlinear aircraft system and residuals are generated, where a generalised likelihood ratio test is applied to detect faults. Numerical simulations demonstrate a robust detection with adequate balance between false alarm rate and sensitivity.
Drillstring Washout Diagnosis Using Friction Estimation and Statistical Change Detection

In oil and gas drilling, corrosion or tensile stress can give small holes in the drillstring, which can cause leakage and prevent sufficient flow of drilling fluid. If such washout remains undetected and develops, the consequence can be a complete twist-off of the drillstring. Aiming at early washout diagnosis, this paper employs an adaptive observer to estimate friction parameters in the nonlinear process. Non-Gaussian noise is a nuisance in the parameter estimates, and dedicated generalized likelihood tests are developed to make efficient washout detection with the multivariate t-distribution encountered in data. Change detection methods are developed using logged sensor data from a horizontal 1400 m managed pressure drilling test rig. Detection scheme design is conducted using probabilities for false alarm and detection to determine thresholds in hypothesis tests. A multivariate approach is demonstrated to have superior diagnostic properties and is able to diagnose a washout at very low levels. The paper demonstrates the feasibility of fault diagnosis technology in oil and gas drilling.
Dynamic Modeling and Validation of a Biomass Hydrothermal Pretreatment Process - A Demonstration Scale Study

Hydrothermal pretreatment of lignocellulosic biomass is a cost effective technology for second generation biorefineries. The process occurs in large horizontal and pressurized thermal reactors where the biomatrix is opened under the action of steam pressure and temperature to expose cellulose for the enzymatic hydrolysis process. Several by-products are also formed, which disturb and act as inhibitors downstream. The objective of this study is to formulate and validate a large scale hydrothermal pretreatment dynamic model based on mass and energy balances, together with a complex conversion mechanism and kinetics. The study includes a comprehensive sensitivity and uncertainty analysis, with parameter estimation from real-data in the 178-185°C range. To highlight the application utility of the model, a state estimator for biomass composition is developed. The predictions capture well the dynamic trends of the process, outlining the value of the model for simulation, control design, and optimization for full-scale applications.
Second generation biorefineries transform agricultural wastes into biochemicals with higher added value, e.g. bioethanol, which is thought to become a primary component in liquid fuels [1]. Extensive endeavors have been conducted to make the production process feasible on a large scale, and recently several commercial size biorefineries became operational: Beta Renewables (Italy, 2014), Abengoa Bioenergy (USA, 2014), POET-DSM (USA, 2014), GranBio (Brazil, 2014) [2], while others are under construction, e.g. the Måbjerg Energy Consortium in Denmark. This thesis presents the findings of a 3 years PhD project that was run by Technical University of Denmark (DTU) in collaboration with the largest Danish energy company DONG Energy A/S between 2012 and 2015. The company owns a demonstration scale second generation biorefinery in Kalundborg, Denmark, also known as the Inbicon demonstration plant [3]. The goal of the project is to utilize realtime data extracted from the large scale facility to formulate and validate first principle dynamic models of the plant. These models are then further exploited to derive model-based tools for process optimization, advanced control and real-time monitoring. The Inbicon biorefinery converts wheat straw into bioethanol utilizing steam, enzymes, and genetically modified yeast. The biomass is first pretreated in a steam pressurized and continuous thermal reactor where lignin is relocated, and hemicellulose partially hydrolyzed such that cellulose becomes more accessible to enzymes. The pretreated biomass is integrated with a nearby power plant following the Integrated Biomass Utilization System (IBUS) principle for reducing steam costs [4]. During the pretreatment, by-products are also created such as organic acids, furfural, and pseudo-lignin, which act as inhibitors in downstream processes. The pretreated fibers consist of cellulose and xylan, which are then liquified in the enzymatic hydrolysis process with the help of enzymes. High glucose and xylose yields are thus obtained for co-fermentation. Ethanol is recovered in distillation columns followed by molecular sieves for achieving a high concentration ethanol. Lignin is separated in the first column and recovered as bio-pellets in an evaporation unit. The bio-pellets are then burnt in the nearby power plant for steam generation. The first part of this research presents a large scale dynamic model of the plant, separated in modules for pretreatment, enzymatic hydrolysis, and fermentation. The pretreatment and enzymatic hydrolysis models have been validated and analyzed in this study together with a comprehensive sensitivity and uncertainty analysis [5, 6]. The models embed mass and energy balances with a complex conversion route. Computational fluid dynamics is used to model transport phenomena in large reactors capturing tank profiles, and delays due to plug flows. This work publishes for the first time demonstration scale real data for validation showing that the model library is suitable for optimization, control and monitoring purposes. As an application, the pretreatment dynamic model is used to construct a realtime observer that acts both as a measurement filter, and soft sensor for biomass components that are not measured, e.g. pretreatment inhibitors [5]. The next part of this study deals with building a plantwide model-based optimization layer, which searches for optimal values regarding the pretreatment temperature, enzyme dosage in liquefaction, and yeast seed in fermentation such that profit is maximized [7]. When biomass is pretreated, by-products are also created that affect the downstream processes acting as inhibitors in enzymatic hydrolysis and fermentation. Therefore, the biorefinery is treated in an integrated manner capturing the trade-offs between the conversion steps. Sensitivity and uncertainty analysis is also performed in order to identify the modeling bottlenecks and which feedstock components need to be determined for an accurate prediction. This analysis is achieved with Monte Carlo simulations and Latin Hypercube Sampling (LHS) on feedstock composition and kinetic parameters following the methodology from [5, 6, 8, 9]. In the last part of this work, two applications of the L1 adaptive output feedback controller [10] are developed: one for biomass pretreatment temperature [11] and another one for pH in enzymatic hydrolysis [12]. Biomass conversion is highly sensitive to these process parameters, which exhibit nonlinear behavior and can change nominal values. The adaptive controllers are found to perform better across multiple operational points without the
Early Detection and Localization of Downhole Incidents in Managed Pressure Drilling

Downhole incidents such as kick, lost circulation, pack-off, and hole cleaning issues are important contributors to downtime in drilling. In managed pressure drilling (MPD), operations margins are typically narrower, implying more frequent incidents and more severe consequences. Detection and handling of symptoms of downhole drilling contingencies at an early stage are therefore crucial for the reliability and safety of MPD operations. In this paper we describe a method for early detection and localization of such incidents, based on a fit for purpose model of the downhole pressure hydraulics, distributed pressure measurements from wired pipe, and statistical change detection methods. Using statistical change detection methods, it is possible to detect the incidents and their location at a very early stage when small changes in operating parameters are covered in measurement noise. The method has successfully been tested on experimental data from a medium-scale horizontal flow loop in Stavanger, Norway. The flow loop represents a 700 m borehole with emulation of the following downhole contingencies: drillstring washout, drill bit nozzle plugging, gas influx and fluid loss. In the tests, these incidents have been successfully detected at an early stage, when detection by a human operator observing the measured data is almost impossible. The developed detection and localization method can be included as a diagnosis tool in a drilling system with MPD or conventional drilling.

Early pack-off diagnosis in drilling using an adaptive observer and statistical change detection

Pack-off is a partially or complete blocking of the circulation flow in oil and gas drilling, which can lead to costly delays. Early detection and localization of a pack-off is crucial in order to take necessary actions avoiding downtime. This incident will affect physical friction parameters in the well. A model-based adaptive observer is used to estimate these friction parameters as well as flow rates. Detecting changes to these estimates can then be used for pack-off diagnosis, which due to measurement noise is done using statistical change detection. Isolation of incident type and location is done using a multivariate generalized likelihood ratio test, determining the change direction of the estimated mean values. The method is tested on simulated data from the commercial high-fidelity multi-phase simulator OLGA, where three different
pack-offs at different locations and with different magnitudes are successfully detected at an early stage and with low false alarms

**General information**
State: Published
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**Energy resource management under the influence of the weekend transition considering an intensive use of electric vehicles**

Energy resource scheduling is becoming increasingly important, as the use of distributed resources is intensified and of massive electric vehicle is envisaged. The present paper proposes a methodology for day-ahead energy resource scheduling for smart grids considering the intensive use of distributed generation and Vehicle-to-Grid (V2G). This method considers that the energy resources are managed by a Virtual Power Player (VPP) which established contracts with their owners. It takes into account these contracts, the users’ requirements subjected to the VPP, and several discharge price steps. The full AC power flow calculation included in the model takes into account network constraints. The influence of the successive day requirements on the day-ahead optimal solution is discussed and considered in the proposed model. A case study with a 33-bus distribution network and V2G is used to illustrate the good performance of the proposed method.

**General information**
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Estimation of Parametric Fault in Closed-loop Systems
The aim of this paper is to present a method for estimation of parametric faults in closed-loop systems. The key technology applied in this paper is coprime factorization of both the dynamic system as well as the feedback controller. Using the Youla-Jabr-Bongiorno-Kucera (YJBK) parameterization, it is shown that a certain matrix transfer function, the fault signature matrix, is an LFT (linear fractional transformation) of the parametric faults. Further, for limit parametric faults, the fault signature matrix transfer function can be approximated with a linear matrix function of the parametric faults.

General information
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Experiences from developing a new course in mechatronics
Experiences from a new course in mechatronics at Technical University of Denmark are conveyed in this paper. The course is supposed to teach students enrolled in the bachelor degree in electrical engineering some fundamental knowledge about electronics and to teach students enrolled in the bachelor degree in mechanical engineering fundamentals about electronics. Furthermore the course uses project work as a method to keep the students actively participating and in part have them teach each other the subjects. The general course plan is presented and the reasoning behind the course structure is discussed in the paper, together with a brief look at the student's reactions in form of data from the course evaluation.

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Experimental Investigations of Decentralised Control Design for The Stabilisation of Rotor-Gas Bearings

Rotor-gas bearings are attracting increasing interest because of their high speed capabilities, low friction and clean operation. However, hydrostatic rotor-gas bearings show reduced damping characteristics, which makes it challenging to operate the rotating machine at and about the resonance frequencies. Active lubrication of the journal during operations could enhance the damping and stabilisation characteristics of the systems, and this could be achieved by means of stabilising controllers. This paper investigates the feasibility of using reduced order models obtained through Grey-Box identification for the design of stabilising controllers, capable of enabling the active lubrication of the journal. The root locus analysis shows that two different control solutions are feasible for the dampening of the first two eigenfrequencies of the rotor-gas bearing in the horizontal and vertical directions. Hardening and softening P-lead controllers are designed based on the models experimentally identified, and salient features of both controllers are discussed. Both controllers are implemented and validated on the physical test rig. Experimental results confirm the validity of the proposed approach.

Experimental Verification of a Global Exponentially Stable Nonlinear Wave Encounter Frequency Estimator

This paper presents a global exponential stability (GES) proof for a signal-based nonlinear wave encounter frequency estimator. The estimator under consideration is a second-order nonlinear observer designed to estimate the frequency of a sinusoid with unknown frequency, amplitude, and phase. The GES proof extends previous results that only guarantee global K-exponential stability. Typical applications are control and decision-support systems for marine craft, where it is important to know the sea state and wave frequency. The theoretical results are verified experimentally by analyzing data from towing tank experiments using a container ship scale model. The estimates for both regular and irregular waves confirm the results. Finally, the estimator is applied to full-scale data gathered from a container ship operating in the Atlantic Ocean during a storm. Again, the theoretical results are confirmed.
Fable II: Design of a Modular Robot for Creative Learning

Robotic systems have a high potential for creative learning if they are flexible, accessible and engaging for the user in the experimental process of building and programming robots. In this paper we describe the Fable modular robotic system for creative learning which we develop to enable and motivate anyone to build and program their own robots. The Fable system consists of self-contained modules equipped with sensors and actuators, which users can use to easily assemble a wide range of robots in a matter of seconds. The robots are userprogrammable on several levels of abstraction ranging from a simple visual programming language to powerful conventional ones. This paper provides an overview of the design of Fable for different user groups and an evaluation of critical issues when we attempt to integrate the system into an everyday teaching context.

Fault diagnosis based on controller modification

Detection and isolation of parametric faults in closed-loop systems will be considered in this paper. A major problem is that a feedback controller will in general reduce the effects from variations in the systems including parametric faults on the controlled output from the system. Parametric faults can be detected and isolated using active methods, where an auxiliary input is applied. Using active methods for the diagnosis of parametric faults in closed-loop systems, the amplitude of the applied auxiliary input need to be increased to be able to detect and isolate the faults in a reasonable time. A negative effect of increasing the amplitude of the auxiliary input is that the disturbances in the external output will be increased and consequently reduce the closed-loop performance. This problem can be handled by using a modification of the feedback controller. Applying the YJBK-parameterization (after Youla, Jabr, Bongiorno and Kucera) for the controller, it is possible to modify the feedback controller with a minor effect on the closed-loop performance in the fault-free case and at the same time optimize the detection and isolation in a faulty case. Controller modification in connection with both fault detection and isolation will be discussed. Also passive fault diagnosis methods based on controller modification will be discussed.
Fault diagnosis of downhole drilling incidents using adaptive observers and statistical change detection

Downhole abnormal incidents during oil and gas drilling cause costly delays, and may also potentially lead to dangerous scenarios. Different incidents will cause changes to different parts of the physics of the process. Estimating the changes in physical parameters, and correlating these with changes expected from various defects, can be used to diagnose faults while in development. This paper shows how estimated friction parameters and flow rates can detect and isolate the type of incident, as well as isolating the position of a defect. Estimates are shown to be subjected to non-Gaussian, t-distributed noise, and a dedicated multivariate statistical change detection approach is used that detects and isolates faults by detecting simultaneous changes in estimated parameters and flow rates. The properties of the multivariate diagnosis method are analyzed, and it is shown how detection and false alarm probabilities are assessed and optimized using data-based learning to obtain thresholds for hypothesis testing. Data from a 1400 m horizontal flow loop is used to test the method, and successful diagnosis of the incidents drillstring washout (pipe leakage), lost circulation, gas in flow, and drill bit plugging are demonstrated.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Norwegian University of Science and Technology
Authors: Willersrud, A. (Ekstern), Blanke, M. (Intern), Imsland, L. (Ekstern), Pavlov, A. K. (Ekstern)
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Scopus rating (2016): CiteScore 3.41 SJR 1.037 SNIP 2.138
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BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.346 SNIP 2.028 CiteScore 3.35
Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 1.397 SNIP 2.642 CiteScore 3.92
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.421 SNIP 2.537 CiteScore 3.47
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Fault Tolerance for Industrial Actuators in Absence of Accurate Models and Hardware Redundancy

This paper investigates Fault-Tolerant Control for closed-loop systems where only coarse models are available and there is lack of actuator and sensor redundancies. The problem is approached in the form of a typical servomotor in closed-loop. A linear model is extracted from input/output data to describe the system over a frequency range. Two methods based on the Kalman Filter and Statistical Change Detection techniques are proposed for detecting degradation faults and component failures, respectively. Finally, a reference correction setup is used to compensate for degradation faults.

General information

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Siemens
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Main Research Area: Technical/natural sciences
Electronic versions: MSC2015.pdf
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Fault-tolerant Control of Discrete-time LPV systems using Virtual Actuators and Sensors

This paper proposes a new fault-tolerant control (FTC) method for discrete-time linear parameter varying (LPV) systems using a reconfiguration block. The basic idea of the method is to achieve the FTC goal without re-designing the nominal controller by inserting a reconfiguration block between the plant and the nominal controller. The reconfiguration block is realized by an LPV virtual actuator and an LPV virtual sensor. Its goal is to transform the signals from the faulty system such that its behavior is similar to that of the nominal system from the viewpoint of the controller. Furthermore, it transforms the output of the controller for the faulty system such that the stability and performance goals are preserved. Input-to-state stabilizing LPV gains of the virtual actuator and sensor are obtained by solving linear matrix inequalities (LMIs). We show that separate design of these gains guarantees the input-to-state stability (ISS) of the closed-loop reconfigured system. Moreover, we obtain performances in terms of the ISS gains for the virtual actuator, the virtual sensor and their interconnection. Minimizing these performances is formulated as convex optimization problems subject to LMI constraints. Finally, the effectiveness of the method is demonstrated via a numerical example and stator current control of an induction motor.

General information
State: Published
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Scopus rating (2015): SJR 1.992 SNIP 1.698 CiteScore 3.12
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Scopus rating (2014): SJR 2.037 SNIP 1.911 CiteScore 3.51
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.86 SNIP 1.91 CiteScore 3.41
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.685 SNIP 1.791 CiteScore 2.83
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.77 SNIP 1.769 CiteScore 2.41
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.519 SNIP 1.486
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.061 SNIP 2.065
BFI (2008): BFI-level 1
Gas Bearing Control for Safe Operation in Critical Speed Regions - Experimental Verification: Paper

Gas bearings are popular for their high speed capabilities, low friction and clean operation, but require low clearances and suffer from poor damping properties. The poor damping properties cause high disturbance amplification near the natural frequencies. These become critical when the rotation speed coincides with a natural frequency. In these regions, even low mass unbalances can cause rub and damage the machine. To prevent rubbing, the variation of the rotation speed of machines supported by gas bearings has to be carefully conducted during run-ups and run-downs, by acceleration and deceleration patterns and avoidance of operation near the critical speeds, which is a limiting factor during operation, specially during run-downs. An approach for reducing the vibrations is by feedback controlled lubrication. This paper addresses the challenge of reducing vibrations in rotating machines supported by gas bearings to extend their operating range. Using H-infinity design methods, active lubrication techniques are proposed to enhance the damping, which in turn reduces the vibrations to a desired safe level. The control design is validated experimentally on a laboratory test rig, and shown to allow safe shaft rotation speeds up to, in and above the two first critical speeds, which significantly extends the operating range.
General model and control of an n rotor helicopter

The purpose of this study was to create a dynamic, nonlinear mathematical model of a multirotor that would be valid for different numbers of rotors. Furthermore, a set of Single Input Single Output (SISO) controllers were implemented for attitude control. Both model and controllers were tested experimentally on a quadcopter. Using the combined model and controllers, simple system simulation and control is possible, by replacing the physical values for the individual systems.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, FORCE Technology
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Number of pages: 12
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Main Research Area: Technical/natural sciences

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Journal: Journal of Physics: Conference Series (Online)
Identification of Requirements for Distribution Management Systems in the Smart Grid Context.

The integration of significant volumes of distributed and renewable energy resources directly connected to the distribution network raises new requirement to maintain and operate the power system in secure state. Thus the Distribution Management System (DMS) needs to be updated and integrated with new functionality to provide effective support for the operators. The DMS is a control center solution that provides the needed functionality for the management of medium and...
low voltage distribution networks. This paper aims to provide an overview of the main functions present in today’s DMS platforms and to identify the new requirements to better serve in a smart grid context.

**General information**

**State:** Published  
**Organisations:** Department of Electrical Engineering, Center for Electric Power and Energy, Energy System Management, Automation and Control, Distributed Energy Resources  
**Authors:** Rezkalla, M. M. (Intern), Heussen, K. (Intern), Marinelli, M. (Intern), Hu, J. (Intern), Bindner, H. W. (Intern)  
**Pages:** 6  
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**Identifying parameters in active magnetic bearing system using LFT formulation and Youla factorization**

In this paper, a method for identifying uncertain parameters in a rotordynamic system composed of a flexible rotating shaft, rigid discs and two radial active magnetic bearings is presented. Shaft and disc dynamics are mathematically described using a Finite Element (FE) model while magnetic bearing forces are represented by linear springs with negative stiffness. Bearing negative stiffness produces an unstable rotordynamic system, demanding implementation of feedback control to stabilize the rotordynamic system. Thus, to identify the system parameters, closed-loop system identification techniques are required. The main focus of the paper relies on how to effectively identify uncertain parameters, such as stiffness and damping force coefficients of bearings and seals in rotordynamic systems. Dynamic condensation method, i.e. pseudo-modal reduction, is used to obtain a reduced order model for model-based control design and fast identification. The paper elucidates how nodal parametric uncertainties, which are easily represented in the full FE coordinate system, can be represented in the new coordinate system of the reduced model. The uncertainty is described as a single column vector of the system matrix A of the full FE model while it is represented as several elements spread over multiple rows and columns of the system matrix of the reduced model. The parametric uncertainty, for both the full and reduced FE model, is represented using Linear Fractional Transformation (LFT). In this way the LFT matrices represent the mapping of the uncertainties in and out of the full and reduced FE system matrices. Scaling the LFT matrices easily leads to the amplitudes of the uncertainty parameters. Youla Parametrization method is applied to transform the identification problem into an open-loop stable problem, which can be solved using standard optimization methods. An example shows how to decouple and identify an uncertainty in the linear bearing stiffness of a reduced FE rotordynamic system.

**General information**

**State:** Published  
**Organisations:** Department of Mechanical Engineering, Solid Mechanics, Department of Electrical Engineering, Automation and Control  
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**Pages:** 430-435  
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**Electronic versions:**
Incentive-based demand response programs designed by asset-light retail electricity providers for the day-ahead market

Following the deregulation experience of retail electricity markets in most countries, the majority of the new entrants of the liberalized retail market were pure REP (retail electricity providers). These entities were subject to financial risks because of the unexpected price variations, price spikes, volatile loads and the potential for market power exertion by GENCO (generation companies). A REP can manage the market risks by employing the DR (demand response) programs and using its generation and storage assets at the distribution network to serve the customers. The proposed model suggests how a REP with light physical assets, such as DG (distributed generation) units and ESS (energy storage systems), can survive in a competitive retail market. The paper discusses the effective risk management strategies for the REPs to deal with the uncertainties of the DAM (day-ahead market) and how to hedge the financial losses in the market. A two-stage stochastic programming problem is formulated. It aims to establish the financial incentive-based DR programs and the optimal dispatch of the DG units and ESSs. The uncertainty of the forecasted day-ahead load demand and electricity price is also taken into account with a scenario-based approach. The principal advantage of this model for REPs is reducing the risk of financial losses in DAMs, and the main benefit for the whole system is market power mitigation by virtually increasing the price elasticity of demand and reducing the peak demand.
Incident detection and isolation in drilling using analytical redundancy relations

Early diagnosis of incidents that could delay or endanger a drilling operation for oil or gas is essential to limit field development costs. Warnings about downhole incidents should come early enough to allow intervention before it develops to a threat, but this is difficult, since false alarms must be avoided. This paper employs model-based diagnosis using analytical redundancy relations to obtain residuals which are affected differently by the different incidents. Residuals are found to be non-Gaussian - they follow a multivariate t-distribution - hence, a dedicated generalized likelihood ratio test is applied for change detection. Data from a 1400 meter horizontal flow loop test facility is used to assess the diagnosis method. Diagnosis properties of the method are investigated assuming either with available downhole pressure sensors through wired drill pipe or with only topside measurements available. In the latter case, isolation capability is shown to be reduced to group-wise isolation, but the method would still detect all serious events with the prescribed false alarm probability.
Integrating modular mechatronic systems for immersive performances

As a branch of mechatronic research in interactivity, and in robot art, we describe the concept of implementing Playware based tools inspired by modern AI robotic systems for audio-video performances. We develop immersive and personalizable tools that can allow any user to manipulate both audio and video output in a very easy manner, thanks to mechatronical wearable interfaces. In this light, we describe two of our systems that explore the concept of run-time composition of a variety of input and output modalities, e.g. both music and graphical expression. Indeed, we developed both hardware/software tools by which it is possible to allow any user to create new song versions of music (e.g. the MusicTiles app) and software that are able to translate the musical experience in to a visual one (e.g. the MAG software). By interfacing these technologies into mechatronic systems, it is now possible to create a run-time audio-video performance that is original and unique. This can further be combined with modular wearable – inspired by modular robotics – to interact and control the performance. This mechatronic wearable concept and its implementations exemplify how to convey a user-centered experience in playware technology.

General information
State: Published
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Line-of-Sight Path Following for Dubins Paths with Adaptive Sideslip Compensation of Drift Forces

We present a nonlinear adaptive path-following controller that compensates for drift forces through vehicle sideslip. Vehicle sideslip arises during path following when the vehicle is subject to drift forces caused by ocean currents, wind and waves. The proposed algorithm is motivated by a lineof-sight (LOS) guidance principle used by ancient navigators, which is here extended to path following of Dubins paths. The unknown sideslip angle is treated as a constant parameter, which is estimated using an adaptation law. The equilibrium points of the cross-track and parameter estimation errors are proven to be uniformly semiglobally exponentially stable (USGES). This guarantees that the estimated sideslip angle converges to its true value exponentially. The adaptive control law is in fact an integral LOS controller for path following since the parameter adaptation law provides integral action. The proposed guidance law is intended for maneuvering in the horizontal-plane at given speeds and typical applications are marine craft, autonomous underwater vehicles (AUVs), unmanned aerial vehicles (UAVs) as well as other vehicles and craft where the goal is to follow a predefined parametrized curve without time constraints. Two vehicle cases studies are included to verify the theoretical results.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Norwegian University of Science and Technology
Authors: Fossen, T. I. (Ekstern), Pettersen, K. Y. (Ekstern), Galeazzi, R. (Intern)
Number of pages: 8
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The energy sector restructuring process in industrialized countries had the aim of reducing electricity prices by increasing competitiveness, and facilitate the integration of distributed energy resources. However, the complexity in market players' interactions has increased, and new problems have emerged. Decision support tools that facilitate the study and comprehension of these markets became extremely useful, providing players with competitive advantage. MASCEM (Multi-Agent Simulator of Competitive Electricity Markets) arises in this context, modeling and simulating real electricity markets. It is crucial to MASCEM to have the ability to simulate as many market models and player types as possible, thus enhancing the ability to recreate the electricity markets reality in its maximum possible extent. This paper presents the EPEX Spot Day-Ahead market integration in MASCEM. EPEX Spot SE's mission is to lead European markets coupling in...
Measuring and Modelling Delays in Robot Manipulators for Temporally Precise Control using Machine Learning.

Latencies and delays play an important role in temporally precise robot control. During dynamic tasks in particular, a robot has to account for inherent delays to reach manipulated objects in time. The different types of occurring delays are typically convoluted and thereby hard to measure and separate. In this paper, we present a data-driven methodology for separating and modelling inherent delays during robot control. We show how both actuation and response delays can be modelled using modern machine learning methods. The resulting models can be used to predict the delays as well as the uncertainty of the prediction. Experiments on two widely used robot platforms show significant actuation and response delays in standard control loops. Predictive models can, therefore, be used to reason about expected delays and improve temporal accuracy during control. The approach can easily be used on different robot platforms.

Modelling and Identification for Control of Gas Bearings

Gas bearings are popular for their high speed capabilities, low friction and clean operation, but suffer from poor damping, which poses challenges for safe operation in presence of disturbances. Enhanced damping can be achieved through active lubrication techniques using feedback control laws. Such control design requires models with low complexity, able to describe the dominant dynamics from actuator input to sensor output over the relevant range of operation. The mathematical models based on first principles are not easy to obtain, and in many cases, they cannot be directly used for control design due to their complexity and parameter uncertainties. As an alternative, this paper presents an experimental technique for “in situ” identification of low complexity models of the entire rotor-bearing-actuator system. Using grey-box identification techniques, the approach is shown to be easily applied to industrial rotating machinery with gas bearings and to allow for subsequent control design. The paper shows how piezoelectric actuators in a gas bearing are efficiently used to perturb the gas film for identification over relevant ranges of rotational speed and gas injection pressure. Parameter-varying linear models are found to capture the dominant dynamics of the system over the range of operation. Based on
the identified models, decentralised proportional control is designed and is shown to obtain the required damping in theory as well as in a laboratory test rig.
Early diagnosis and fault-tolerant control are essential for safe operation of floating platforms where mooring systems maintain vessel position and must withstand environmental loads. This paper considers two critical faults, line breakage and loss of a buoyancy element and employs vector statistical change detection for timely diagnosis of faults. Diagnosis design is scrutinized and a procedure is proposed based on specified false alarm probability and estimation of the distribution of the test statistics on which change detection is based. A structural reliability index is applied for monitoring the safety level of each mooring line and, a set-point chasing algorithm accommodates the effects of line failure, as an integral part of the reliability-based set-point chasing control algorithm. The feasibility of the diagnosis and of the fault-tolerant control strategy is verified in model basin tests.
New Concepts for Shipboard Sea State Estimation

The wave buoy analogy is a tested means for shipboard sea state estimation. Basically, the estimation principle resembles that of a traditional wave rider buoy which relies, fundamentally, on transfer functions used to relate measured wave-induced responses and the unknown wave excitation. This paper addresses however a newly developed concept of the wave buoy analogy but the approach presented herein is, on the contrary, not relying exclusively on transfer functions. Instead, the method combines a signal-based part, estimating wave frequency, and a model-based part, estimating wave amplitude and phase, where only the model-based part depends on transfer functions whereas the signal-based part relies on the measured vessel response alone. Case studies in terms of hypothetical examples show that the method is capable to reconstruct fully the wave elevation process of a sinusoidal regular wave; which include estimation of the wave's frequency, amplitude and phase. At this stage, the method is far from being a useful means in practical, real-situation applications but the method provides, indeed, a valuable step towards developing new approaches for shipboard sea state estimation.

General information
State: Published
Organisations: Department of Mechanical Engineering, Fluid Mechanics, Coastal and Maritime Engineering, Department of Electrical Engineering, Automation and Control, Technical University of Denmark, Norwegian University of Science and Technology
Authors: Nielsen, U. D. (Intern), Bjerregård, M. (Ekstern), Galeazzi, R. (Intern), Fossen, T. I. (Ekstern)
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Nonlinear Adaptive Control of Exhaust Gas Recirculation for Large Diesel Engines

A nonlinear adaptive controller is proposed for the exhaust gas recirculation system on large two-stroke diesel engines. The control design is based on a control oriented model of the nonlinear dynamics at hand that incorporates load and engine speed changes as known disturbances to the exhaust gas recirculation. The paper provides proof of exponential stability for closed loop control of the model given. Difficulties in the system include that certain disturbance levels will make a desired setpoint in O2 unreachable, for reasons of the physics of the system, and it is proven that the proposed control will make the system converge exponentially to the best achievable state. Simulation examples confirm convergence and good disturbance rejection over relevant operational ranges of the engine.

General information

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, MAN B&W Diesel A/S
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BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.252 SNIP 0.242 CiteScore 0.26
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Scopus rating (2013): SJR 0.249 SNIP 0.22 CiteScore 0.27
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.204 SNIP 0.165 CiteScore 0.17
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.142 SNIP 0.078 CiteScore 0.05
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.121 SNIP 0.054
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.111 SNIP 0.032
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Scopus rating (2007): SJR 0.107 SNIP 0.021
Scopus rating (2006): SJR 0.101 SNIP 0.004
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Scopus rating (2004): SJR 0.106 SNIP 0.017
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Exhaust gas recirculation, diesel engines, Nonlinear control, Adaptive control, Modelling for control, Parameter estimation

Electronic versions:
Offshore Wind Park Control Assessment Methodologies to Assure Robustness

The transition from fossil fuels to renewable energy is an expensive but necessary process to ensure a habitable world for future generations. Renewable energy sources such as hydro-, solar- and wind energy continues to increase their share of the total power production. With national goals set by the Renewable Energy Directive of the European Commission to decrease carbon dioxide emission, the demand for renewable energy is increasing. Wind energy has been harnessed since 1887 [1] and has seen a large growth since the first multi-megawatt turbine in 1978. Gradually the wind energy technology has matured to a point where turbines are reaching a production capability exceeding 6 megawatt and the turbines have moved offshore due to stronger wind, and to avoid proximity to populated areas. The placement of wind power plants (WPP) with a typical size of 60 large turbines in remote locations with a weak grid interconnection point, is a challenge with respect to power system stability. This dissertation considers the interaction between the offshore grid and the control of power electronic devices (PED), its effect on system stability and challenges with respect to unwanted interaction between controllers in the rather complex control hierarchy on an offshore WPP. The output waveform of modern turbines utilizing PEDs is distorted at high frequencies, and the stability of the control system is affected by resonances and harmonics present in the weak offshore grid. These phenomena pose a risk to drive the system to instability, as they exist within the bandwidth of the turbine controllers. The resonances and the number of turbines in operation are characteristics of the grid, which are partly unknown at the controller design stage. The uncertainty and the unwanted interaction in the grid are difficult challenges for control designers. This project deals with these challenges and provides insight in root causes to phenomena that have been issues during wind power plant commissioning in the past. This is done through development of design and validation methods for controllers, by analyzing turbine interaction with the grid and suggestion of design guidelines to ensure proper operation of stacked controllers. Two specific faults serve as basis for the analysis and development, a rotor blade deformation and an unwanted oscillation in the reactive power, both of which experienced at a WPP. The low frequency reactive power oscillations observed were suspected to be caused by the voltage control at the point of common coupling. The fault was thought to involve the interaction between the static synchronous compensator (STATCOM), the wind turbine voltage control and the power plant control (PPC). By establishing bounds on the sets of possible parameters of all involved controllers, the thesis replicates the phenomena by simulation and a method is proposed that analytically finds the set of control parameters, which ensure stable operation. The method enables DONG Energy to calculate bounds on controller parameters based on network parameters and the thesis contributes by ensuring proper operation before energization. The analysis of the voltage control philosophy related to the reactive power oscillations showed the need for proper handling of the resonances introduced by the offshore grid in the turbine control structure. The dissertation contributes to this area with the development of a robust H∞ converter employing notch filters in the performance specification to suppress harmonics of the grid frequency. This method combines attenuation of selected resonance frequencies with system stability and performance within the defined envelope of uncertainty of the grid. The controller is tested in a model of the WPP, and is shown to improve performance, control effort and output disturbance rejection compared to standard PI control. The second fault was that a turbine rotor blade was observed to deform in a WPP. This severe fault was suspected to have contributory causes from both mechanical and electrical systems. A preceding investigation was conducted which ruled out physical generator phenomena such as cogging torque, as well as network voltage disturbances and delays in the converter control system. The investigation indicated that the problem was an insufficient implementation of the rotor speed controller. The thesis addresses the problem by the development of control methods to limit the shaft stress, and thereby the rotor blade vibration. The contributions include a feedback linearization controller and an observer based backstepping controller for a wind turbine. The thesis consists of an introduction part that briefly describes the field, the investigations conducted in the study, the models developed and the controller designs suggested to deal with the challenges described above. The main results of the research are highlighted in the introduction and the detailed results are described in four papers, which are enclosed in the last part of the thesis.

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On Early Conflict Identification by Requirements Modeling of Energy System Control Structures

Control systems are purposeful systems involving goal-oriented information processing (cyber) and technical (physical) structures. Requirements modeling formalizes fundamental concepts and relations of a system architecture at a high-level design stage and can be used to identify potential design issues early. For requirements formulation of control structures, cyber and physical aspects need to be jointly represented to express interdependencies, check for consistency and discover potentially conflicting requirements. Early identification of potential conflicts may prevent larger problems at later design stages. However, languages employed for requirements modeling today do not offer the expressiveness necessary to represent control purposes in relation to domain level interactions and therefore miss several types of interdependencies. This paper introduces the idea of control structure modeling for early requirements checking using a suitable modeling language, and illustrates how this approach enables the identification of several classes of controller conflict.

On Quantification of Flexibility in Power Systems

Large scale integration of fluctuating and nondispatchable generation and variable transmission patterns induce high uncertainty in power system operation. In turn, transmission system operators (TSOs) need explicit information about available flexibility to maintain a desired reliability level at a reasonable cost. In this paper, locational flexibility is defined and a unified framework to compare it against forecast uncertainty is introduced. Both metrics are expressed in terms of ramping rate, power and energy and consider the network constraints. This framework is integrated into the operational practice of the TSO using a robust reserve procurement strategy which guarantees optimal system response in the worst-case realization of the uncertainty. An illustrative three-node system is used to investigate the procurement method. Finally, the locational flexibility for a larger test system is presented.
Optimizing the Universal Robots ROS driver.
In this report I will examine both the current and the possible performance of one of the most popular robotics platforms in research, the Universal Robot manipulator. I will solely focus on the ROS based approaches and show how the current driver can be improved. I will look at performance improvement both in terms of faster reaction as well as making it possible to control the robot using either ros_control or ordinary joint speed commands, which is required for many types of sensory based control like visual servoing. The developed driver is compared to the drivers already existing in the ROS framework to prove the improved performance.

Parallel Relational Universes – experiments in modularity
We here describe Parallel Relational Universes, an artistic method used for the psychological analysis of group dynamics. The design of the artistic system, which mediates group dynamics, emerges from our studies of modular playware and remixing playware. Inspired from remixing modular playware, where users remix samples in the form of physical and functional modules, we created an artistic instantiation of such a concept with the Parallel Relational Universes, allowing arts alumni to remix artistic expressions. Here, we report the data emerged from a first pre-test, run with gymnasium’s alumni. We then report both the artistic and the psychological findings. We discuss possible variations of such an instrument. Between an art piece and a psychological test, at a first cognitive analysis, it seems to be a promising research tool.
Parametric roll resonance monitoring using signal-based detection

Extreme roll motion of ships can be caused by several phenomena, one of which is parametric roll resonance. Several incidents occurred unexpectedly around the millennium and caused vast fiscal losses on large container vessels. The phenomenon is now well understood and some consider parametric roll a curiosity, others have concerns. This study employs novel signal-based detection algorithms to analyse logged motion data from a container vessel (2800 TEU) and a large car and truck carrier (LCTC) during one year at sea. The scope of the study is to assess the performance and robustness of the detection algorithms in real conditions, and to evaluate the frequency of parametric roll events on the selected vessels. Detection performance is scrutinised through the validation of the detected events using owners’ standard methods, and supported by available wave radar data. Further, a bivariate statistical analysis of the outcome of the signal-based detectors is performed to assess the real life false alarm probability. It is shown that detection robustness and very low false warning rates are obtained. The study concludes that small parametric roll events are occurring, and that the proposed signal-based monitoring system is a simple and effective mean to provide timely warning of resonance conditions.
Falling is a big issue among elderly, and prevention of falling is of big importance both for the individual and for society at large. In this paper we present a pilot study with fun exergaming equipment in private homes. The initial findings in the small pilot study suggests that this kind of training makes the elderly train more than they normally do, and they continue to find the training fun for up to 70 training times. Such motivation to train this much is important to understand, since studies of elderly people’s barriers to exercises indicate that motivation can be one of the very common barriers. Further, the paper describes how future research within the field will be structured.
Preisach model of hysteresis for the Piezoelectric Actuator Drive

The Piezoelectric Actuator Drive (PAD) is a precise piezoelectric motor generating high-torque rotary motion, which employs piezoelectric stack actuators in a wobblestyle actuation to generate rotation. The piezoelectric stacked ceramics used as the basis for motion in the motor suffer from hysteretic nonlinearities. In order to model these nonlinearities, the first-order hysteresis reversal curves of the actuators are measured and a discrete Preisach model is derived. This forms a basis that enables the study of different compensation methods. The results show matching between measured and estimated responses within 95.8%.

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Reconfigurable Control of Input Affine Nonlinear Systems under Actuator Fault

This paper proposes a fault tolerant control method for input-affine nonlinear systems using a nonlinear reconfiguration block (RB). The basic idea of the method is to insert the RB between the plant and the nominal controller such that fault tolerance is achieved without re-designing the nominal controller. The role of the RB is twofold: on one hand it transforms the output of the faulty system such that its behaviour is similar to that of the nominal one from the controller’s viewpoint; on the other hand it modifies the control input to the faulty system such that the stability of the reconfigured loop is preserved. The RB is realized by a virtual actuator and a reference model. Using notions of incremental and input-to-state stability (ISS), it is shown that ISS of the closed-loop reconfigured system can be achieved by the separate design of the virtual actuator. The proposed method does not need any knowledge of the nominal controller and only assumes that the nominal closed-loop system is ISS. The method is demonstrated on a dynamic positioning system for an offshore supply vessel, where the virtual actuator is designed using backstepping.

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SALVAGE Report D2.1 Description of existing and extended smart grid component models for use in the intrusion detection system
The purpose of the SALVAGE project is to develop better support for managing and designing a secure future smart grid. This approach includes cyber security technologies dedicated to power grid operation as well as support for the migration to the future smart grid solutions, including the legacy of ICT that necessarily will be part of it. The objective is further to develop cyber security technology and methodology optimized with the particular needs and context of the power industry, something that is to a large extent lacking in general cyber security best practices and technologies today. In particular the focus of the project will be on smart grid with many small distributed energy resources, in particular LV substation automation systems and LV distribution system.
Sensor based real-time control of robots
As robots are becoming more and more widespread in manufacturing, the desire and need for more advanced robotic solutions are increasingly expressed. This is especially the case in Denmark where products with natural variances like agricultural products takes up a large share of the produced goods. For such production lines, it is often not possible to use primitive preprogrammed industrial robots to handle the otherwise repetitive tasks due to the uniqueness of each product. To handle such products it is necessary to use sensors to determine the size, shape, and position of the product before a proper trajectory can be calculated in real-time for the robot to execute. This introduces a multitude of different challenges, some of which this project seeks to find the answer to. The production environment of agricultural products is not very well suited for advanced machinery. Handling crops often releases a lot of dust, livestock releases bodily fluids, and all naturally grown products plays host to different kinds of bacterial flora. To ensure food safety it is thus necessary to clean the production facilities daily. This is often done with high-pressure water which can easily cause small changes in the position or orientation of sensors and robots if hit, which in turn corrupts their internal relative calibration. And if the entire robot motion is based on a miscalibrated sensor measurement, the end result could easily be suboptimal or destroyed products, or even destroyed machinery. To avoid such outcomes and thus make sensor based control more reliable, an accurate calibration method has been developed as part of this project. After initial placement of a calibration target mounted on the robot end effector under a laser range scanner, the method can autonomously control the robot to determine the transformation between the laser scanner and the robot. And once the robot has a rough idea of the position of the scanner, the method can be used complete autonomously to correct for small misalignment after the daily cleaning cycle. Furthermore, the method makes it possible to calculate the worst case error of the calibration. This can help in guaranteeing end product uniformity, i.e. as part of a ISO9000 certification. Once the robot knows the pose of the product that needs manipulation, it needs to do a real-time calculation of an appropriate trajectory. The trajectory does not only need to be accurate with respect to the end pose of the robot, it also needs to be temporally accurate so the robot can manipulate the product without stopping the conveyor belt and thus possibly the entire production. To achieve temporal accuracy, it is necessary to know the delay throughout the entire system from acquisition delays in the sensor to actuation delays in the robot. To that end a method for measuring the actuation and response delay of an industrial robot manipulator, relative to the joint configuration of the robot, is presented. It is also shown how modern machine learning algorithms can be trained to build model based on the measurements. Once a model of the delay is constructed, it is furthermore shown how the model can be used for both forward and inverse predictions as well as current state corrections and thus improve on the temporal accuracy of an industrial robot manipulator. When using predefined trajectories for the robot, it is possible to simulate every motion and through prediction minimize the number of issues to ensure high uptime. With real-time generated trajectories and varying product shapes, this is not possible to the same extend. The robot could end up in singular configurations, the risk of a grasp failing when a product is lifted is increased, a sensor could malfunction or foreign objects could end up on the conveyor. A production system needs to be able to handle all these issues to ensure robustness and high uptime of the production facility. To accomplish this it is shown how an expert system can be used to monitor a robot executing a task and ensure that the system can either handle issues or at least degradein the least obstructive way. This is ensured through rules that defines the boundaries for solving the given task, and how the system must react if the boundary is crossed. Due to the generality of the methods presented in this project they constitutes a significant contribution towards using sensors for real-time control of robots, both in conjunction with industrial robots as well as in other robotic contexts.
Short-Range Sensor for Underwater Robot Navigation using Line-lasers and Vision
This paper investigates a minimalistic laser-based range sensor, used for underwater inspection by Autonomous Underwater Vehicles (AUV). This range detection system comprise two lasers projecting vertical lines, parallel to a camera’s viewing axis, into the environment. Using both lasers for distance estimation, the sensor offers three dimensional interpretation of the environment. This is obtained by triangulation of points extracted from the image using the Hough Transform. We evaluate the system in simulation and by physical proof-of-concept experiments on an OpenROV platform.
This paper describes an obstacle detection system for a high-speed and agile unmanned surface vehicle (USV), running at speeds up to 30 m/s. The aim is a real-time and high performance obstacle detection system using both radar and vision technologies to detect obstacles within a range of 175 m. A computer vision horizon detector enables a highly accurate attitude estimation despite large and sudden vehicle accelerations. This further facilitates the reduction of sea clutter by utilizing a attitude based statistical measure. Full scale sea trials show a significant increase in obstacle tracking performance using sensor fusion of radar and computer vision.
System Frequency as Information Carrier in AC Power Systems

Power generators contain control systems able to regulate system frequency, but the frequency setpoint values are only rarely modified from nominal values. This paper describes design considerations for a communication system from generators to frequency sensitive distributed energy resources (FS-DER) using changes to frequency setpoint values of generators. Signaling discrete system states by generating off-nominal system frequency values can be used as a novel narrowband unidirectional broadcast communications channel. This paper describes two protocols for utilizing off-nominal frequencies to carry information: First, a protocol for dispatching blocks of FS-DER that is suitable for systems restricted to relatively slow rates of change of frequency (ROCOF). Second, for systems that allow higher ROCOF values, the feasibility of using power generation resources as a power line communication transmitter is shown. Data from an operating islanded power system with diesel generators is analyzed to demonstrate the feasibility of the proposed communication system in systems fed by rotating machines. The feasibility of the proposed communication system in systems fed by voltage source inverters is shown with laboratory tests of a 20 kVA inverter. The inverter was found to have a maximum ROCOF of 2.2 Hz/s, sufficient to enable its use as a power line communication transmitter.
The continued development of the MFM suite and its practical application on a PWR system

This paper reports on the results from the practical application of the Shape Shifter framework on the continued development of a graphical editing suite, the MFM Suite, for MFM and process model design and analysis. The primary use of the MFM Suite is diagnosis and prognosis of anomalies in physical processes. One of the Halden Reactor Project’s advanced NPP simulators based on a PWR is used to demonstrate the applicability of the suite in realistic situations. The paper presents a summary and suggests some plans for future research and development.

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Two-stage stochastic day-ahead optimal resource scheduling in a distribution network with intensive use of distributed energy resources

The integration of renewable sources and electric vehicles will introduce new uncertainties to the optimal resource scheduling, namely at the distribution level. These uncertainties are mainly originated by the power generated by renewables sources and by the electric vehicles charge requirements. This paper proposes a two-state stochastic programming approach to solve the day-ahead optimal resource scheduling problem. The case study considers a 33-bus distribution network with 66 distributed generation units and 1000 electric vehicles.
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Using squeeze-film effect to reduce surface friction in electrostatic actuators
This paper presents a method of reducing load friction in two degrees-of-freedom (2-DOF) transparent electrostatic induction actuator by using vibration-induced squeeze film effect. An experimental set-up was built to prove the concept. An overall 70% reduction in required driving voltage was obtained when the squeeze film is present.

Validation of a functional model for integration of safety into process system design
Qualitative modeling paradigm offers process systems engineering a potential for developing effective tools for handling issues related to Process Safety. A qualitative functional modeling environment can accommodate different levels of abstraction for capturing knowledge associated with the process system functionalities as required for the intended safety applications. To provide the scientific rigor and facilitate the acceptance of qualitative modelling, this contribution focuses on developing a scientifically based validation method for functional models. The Multilevel Flow Modeling (MFM) methodology is adopted in the paper as a formalized qualitative functional modeling methodology for dynamic process systems. A functional model validation procedure is proposed to assess whether the intended modeling purpose indeed represents a relevant proposal and whether the model represents the system behavior sufficiently well. With the reasoning capability provided by the MFM syntax and semantics, the validation procedure is illustrated on a three-phase separator system of an MFM model. The MFM model reasoning results successfully compares against analysis results from API RP. 14-C.
In this paper a high level functional architecture for frequency and voltage control for the future (2030+) power system is presented. The proposal suggests a decomposition of the present organization of power system operation into a "web of cells". Each cell in this web is managed by a single system operator who assumes responsibility for real-time balance and voltage control of the cell, minimizing the dependency on inter-cell communication for secure system operation. The web-of-cells architecture ensures overall system stability by a combination of decentralized and distributed control patterns for frequency and voltage control. In each control cell, the operator maintains an accurate view on the overall cell state, based on adequate monitoring capabilities, and ensures secure operation by allocating and dispatching reserves located in the cell. Intercell coordination provides for efficient system-wide management and economic optimization.
Wide-Area Emergency Control in Power Transmission

This thesis concerns the development of new emergency control algorithms for electric power transmission systems. Diminishing global resources and climate concerns forces operators to change production away from fossil fuels and towards distributed renewable energy sources. Along with the change on production side measures must be taken on the demand side to maintain power balance. Due to these changes, the operating point of the power system will be less predictable. Traditionally, emergency controls are designed off-line by extensive simulations. The future power system is expected to fluctuate more, thus making the behaviour less predictable, suggesting the need for new intelligent wide-area emergency control algorithms. The fluctuating nature of the future power system calls for new methods of calculating remedial actions that are able to adapt to changing conditions. As part of this thesis convex relaxations are used to compute remedial actions when an emergency condition is detected, and the method is assessed using a set of benchmark systems. An optimal power flow approach is suggested to reconfigure a power system, and methods are introduced to be able to recover from an emergency condition and reach a secure stable equilibrium. In order to contain fast instability mechanisms, event-based emergency controls can be necessary, and this thesis also presents a contribution to real-time generation of event-based emergency control. By the use of contingency stability-margin information, system protection schemes are automatically generated and armed, and it is shown that, by examination of the physical phenomena behind the security threat, emergency controls can be properly allocated. Power systems can exhibit low-frequency oscillations due to the inertia of synchronous machines affecting each-other through electric power transfers. Today, dedicated controllers are applied to cope with such oscillations. However, faults can affect the behaviour of these controllers, or even separate them. The thesis presents a novel method that – without particular knowledge on existing controllers – reconfigures the close-loop system to guarantee stability in the case of faults. This is achieved through a stability-preserving reconfiguration design using absolute stability results for Lure type nonlinear power systems. It is implemented using a wide-area virtual actuator approach, and relies on the solution of a linear matrix inequality. The developed methods enables emergency control for real-time stabilization that adapts to changing conditions in the future power system. The results contribute to the development of a self-healing power system, where the power system automatically responds to system disturbances.

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Wind turbine inverter robust loop-shaping control subject to grid interaction effects

An \( H_\infty \) robust control of wind turbine inverters employing an LCL filter is proposed in this paper. The controller dynamics are designed for selective harmonic filtering in an offshore transmission network subject to parameter perturbations. Parameter uncertainty in the network originates from the grid and the number of wind turbines connected. Power converter based turbines inject harmonic currents, which are attenuated by passive filters. A robust high order active filter controller is proposed to complement the passive filtering. The \( H_\infty \) design of the control loop enables desired tracking with integral effect while bounding the induced change. The design was tested in an aggregated model of the London Array offshore wind power plant and compared with traditional PI controller designs. Robust stability and performance and a reduction of control effort by 25% are obtained over the full envelope of operation.

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A Communication and Resources Management Scheme to Support the Smart Grid Integration of Multiplayers Access to Resources Information

The increasing and intensive integration of distributed energy resources into distribution systems requires adequate methodologies to ensure a secure operation according to the smart grid paradigm. In this context, SCADA (Supervisory Control and Data Acquisition) systems are an essential infrastructure. This paper presents a conceptual design of a communication and resources management scheme based on an intelligent SCADA with a decentralized, flexible, and intelligent approach, adaptive to the context (context awareness). The methodology is used to support the energy resource management considering all the involved costs, power flows, and electricity prices leading to the network reconfiguration. The methodology also addresses the definition of the information access permissions of each player to each resource. The paper includes a 33-bus network used in a case study that considers an intensive use of distributed energy resources in five distinct implemented operation contexts.
Active fault detection in MIMO systems
The focus in this paper is on active fault detection (AFD) for MIMO systems with parametric faults. The problem of design of auxiliary inputs with respect to detection of parametric faults is investigated. An analysis of the design of auxiliary inputs is given based on analytic transfer functions from auxiliary input to residual outputs. The analysis is based on a singular value decomposition of these transfer functions. Based on this analysis, it is possible to design auxiliary input as well as design of the associated residual vector with respect to every single parametric fault in the system such that it is possible to detect these faults.

Active Fault Isolation in MIMO Systems
Active fault isolation of parametric faults in closed-loop MIMO systems are considered in this paper. The fault isolation consists of two steps. The first step is group-wise fault isolation. Here, a group of faults is isolated from other possible faults in the system. The group-wise fault isolation is based directly on the input/output signals applied for the fault detection. It is guaranteed that the fault group includes the fault that had occurred in the system. The second step is individual fault isolation in the fault group. Both types of isolation are obtained by applying dedicated auxiliary inputs and the associated residual outputs.

Active Fault Isolation in MIMO Systems
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Electricity markets are complex environments, involving a large number of different entities, playing in a dynamic scene to obtain the best advantages and profits. MASCEM (Multi-Agent System for Competitive Electricity Markets) is a multi-agent electricity market simulator that models market players and simulates their operation in the market. Market players are entities with specific characteristics and objectives, making their decisions and interacting with other players. This paper presents a methodology to provide decision support to electricity market negotiating players. This model allows integrating different strategic approaches for electricity market negotiations, and choosing the most appropriate one at each time, for each different negotiation context. This methodology is integrated in ALBidS (Adaptive Learning strategic Bidding System) – a multiagent system that provides decision support to MASCEM's negotiating agents so that they can properly achieve their goals. ALBidS uses artificial intelligence methodologies and data analysis algorithms to provide effective adaptive learning capabilities to such negotiating entities. The main contribution is provided by a methodology that combines several distinct strategies to build actions proposals, so that the best can be chosen at each time, depending on the context and simulation circumstances. The choosing process includes reinforcement learning algorithms, a mechanism for negotiating contexts analysis, a mechanism for the management of the efficiency/effectiveness balance of the system, and a mechanism for competitor players' profiles definition.
Adaptive Passivity Based Individual Pitch Control for Wind Turbines in the Full Load Region

This paper tackles the problem of power regulation for wind turbines operating in the top region by an adaptive passivity based individual pitch control strategy. An adaptive nonlinear controller that ensures passivity of the mapping aerodynamic torque-regulation error is proposed, where the inclusion of gradient based adaptation laws allows for the on-line compensation of variations in the aerodynamic torque. The closed-loop equilibrium point of the regulation error dynamics is shown to be UGAS (uniformly globally asymptotically stable). Numerical simulations show that the proposed control strategy succeeds in regulating the power output of the wind turbine despite fluctuations of the wind field due to wake and turbulence, without overloading the pitch actuators.

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Advanced Control and Automation Support – The Continued Development of the MFM Suite
Multilevel Flow Modelling (MFM) is a methodology for graphical modelling of industrial processes by representing the goals and functions of industrial plants. The purpose is to model the combined functions of any number of physical process components, which together provide the means to achieve one or more goals. The model may then be used for
diagnostic and prognostic purposes to determine the possible causes and potential consequences of unwanted process events. Previously, the design of MFM models was done using Microsoft Visio, while the model analysis was done using the MFM Workbench, developed at the Technical University of Denmark (DTU). However, a dedicated tool that combines these functionalities was considered essential to provide rapid design and analysis of MFM models. This report describes the continued development of the MFM Suite (formerly referred to as the MFM Editor), a tool for the design and analysis of MFM models. The tool was briefly introduced in HWR - 993 in connection with the development of the 2nd generation of the ShapeShifter framework. The background for and initial development of the tool was described in more detail in HWR - 1061. While the report describes a number of new features of the MFM Suite, additional attention has been given to describing the association between MFM functions and process components, by the introduction of process sensors where individual alarm limits are used to affect the states of associated MFM functions.

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**A Framework for Diagnosis of Critical Faults in Unmanned Aerial Vehicles**
Unmanned Aerial Vehicles (UAVs) need a large degree of tolerance towards faults. If not diagnosed and handled in time, many types of faults can have catastrophic consequences if they occur during flight. Prognosis of faults is also valuable and so is the ability to distinguish the severity of the different faults in terms of both consequences and the frequency with which they appear. In this paper flight data from a fleet of UAVs is analysed with respect to certain faults and their frequency of appearance. Data is taken from a group of UAVs of the same type but with small differences in weight and handling due to different types of payloads and engines used. Categories of critical faults, that could and have caused UAV crashes are analysed and requirements to diagnosis are formulated. Faults in air system sensors and in control surfaces are given special attention. In a stochastic framework, and based on a large number of data logged during flights, diagnostic methods are employed to diagnose faults and the performance of these fault detectors are evaluated against light data. The paper demonstrates a significant potential for reducing the risk of unplanned loss of remotely piloted vehicles used by the Danish Navy for target practice.

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A hybrid simulated annealing approach to handle energy resource management considering an intensive use of electric vehicles

The massification of electric vehicles (EVs) can have a significant impact on the power system, requiring a new approach for the energy resource management. The energy resource management has the objective to obtain the optimal scheduling of the available resources considering distributed generators, storage units, demand response and EVs. The large number of resources causes more complexity in the energy resource management, taking several hours to reach the optimal solution which requires a quick solution for the next day. Therefore, it is necessary to use adequate optimization techniques to determine the best solution in a reasonable amount of time. This paper presents a hybrid artificial intelligence technique to solve a complex energy resource management problem with a large number of resources, including EVs, connected to the electric network. The hybrid approach combines simulated annealing (SA) and ant colony optimization (ACO) techniques. The case study concerns different EVs penetration levels. Comparisons with a previous SA approach and a deterministic technique are also presented. For 2000 EVs scenario, the proposed hybrid approach found a solution better than the previous SA version, resulting in a cost reduction of 1.94%. For this scenario, the proposed approach is approximately 94 times faster than the deterministic approach.

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Authors: Sousa, T. (Ekstern), Vale, Z. (Ekstern), Carvalho, J. P. (Ekstern), Pinto, T. (Ekstern), Morais, H. (Intern)
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BFI (2009): BFI-level 2
**MAG** (an Italian acronym which stands for Musical Genetic Algorithms) is an electronic art piece in which a multifaceted software attempts to “translate” musical expression into a corresponding static or animated graphical expressions. The mechanism at the base of such “translation” consists in a quite complex and articulated algorithm that, in short, is based on artificial learning. Indeed, MAG implements different learning techniques to allow artificial agents to learn about music flow by developing an adaptive behaviour. In our specific case, such a technique consists of a population of neural networks – one dimensional artificial agents that populate their two dimensional artificial world, and which are served by a simple input output control system – that can use both genetic and reinforcement learning algorithms to evolve appropriate behavioural answers to an impressively large shapes of inputs, through both a fitness formula based genetic pressure, and, eventually, a user-machine based feedbacks. More closely, in the first version of MAG algorithm the agents’ control system is a perceptron; the world of the agents is a two dimensional grid that changes its dimensions accordingly to the host-screen; the most important input artificial agents get (i.e. not necessarily the only one) is the musical wave that any given musical file produces, run-time; the output is the behavioural answer that agents produce by moving, and thereby drawing on to a computer screen, therefore graphical. The combination of artificial evolution and the flows of a repeated song or different musical tunes make it possible for the software to obtain a special relationship between sound waves and the aesthetics of consequent graphical results. Further, we started to explore the concept of run-time creation of both musical expression and graphical expression. Recently, we developed a software by which it is possible to allow any user to create new song versions of popular music with the MusicTiles app simply by connecting musical building blocks. This creation of musical expression can happen as a performance (i.e. run-time). When connecting the MusicTiles app to the MAG software, we provide the connection and the possibility to melt both musical expression and graphical expression in parallel and at run-time, and therefore creating an audio-video performance that is always unique.

**General information**

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, Technical University of Denmark
Authors: Pagliarini, L. (Ekstern), Lund, H. H. (Intern)
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Volume: 1
Analysis of the Impact of Wind Power Participating in Both Energy and Ancillary Services Markets – The Danish Case

The impact of a high penetration of wind power generation in power systems motivates need for an assessment of its interaction with electricity markets. With the continuous evolution of wind turbines technology, wind farms have today the ability to provide certain ancillary services with appropriate levels of security and reliability. The participation of wind farms in ancillary service markets ought to rely on market designs and offering strategies that satisfy power system needs, as well as their operating characteristics. Here we evaluate the system impact of different offering strategies that wind farms employ on energy and ancillary service markets. A readily proposed Proportional Wind Reserve Strategy (PWRS) and a Continuous Wind Reserve Strategy (CWRS) are used to determine the amount of available power for ancillary services. A case study based on real and recent data for Denmark allows evaluating impact on market prices, wind farms’ revenue, as well as impact on power system reliability.

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State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Automation and Control, Department of Applied Mathematics and Computer Science
Authors: Soares, T. (Intern), Morais, H. (Intern), Pinson, P. (Intern)
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A New Heuristic Providing an Effective Initial Solution for a Simulated Annealing approach to Energy Resource Scheduling in Smart Grids

An intensive use of dispersed energy resources is expected for future power systems, including distributed generation, especially based on renewable sources, and electric vehicles. The system operation methods and tools must be adapted to the increased complexity, especially the optimal resource scheduling problem. Therefore, the use of metaheuristics is required to obtain good solutions in a reasonable amount of time. This paper proposes two new heuristics, called naive electric vehicles charge and discharge allocation and generation tournament based on cost, developed to obtain an initial solution to be used in the energy resource scheduling methodology based on simulated annealing previously developed by the authors. The case study considers two scenarios with 1000 and 2000 electric vehicles connected in a distribution network. The proposed heuristics are compared with a deterministic approach and presenting a very small error concerning the objective function with a low execution time for the scenario with 2000 vehicles.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, University of Lisbon, Polytechnic Institute of Porto, Instituto Politécnico do Porto
Authors: Sousa, T. M. (Ekstern), Morais, H. (Intern), Castro, R. (Ekstern), Vale, Z. (Ekstern)
An integrated qualitative and quantitative modeling framework for computer-assisted HAZOP studies

The article proposes a novel practical framework for computer-assisted hazard and operability (HAZOP) that integrates qualitative reasoning about system function with quantitative dynamic simulation in order to facilitate detailed specific HAZOP analysis. The practical framework is demonstrated and validated on a case study concerning a three-phase separation process. The multilevel flow modeling (MFM) methodology is used to represent the plant goals and functions. First, means-end analysis is used to identify and formulate the intention of the process design in terms of components, functions, objectives, and goals on different abstraction levels. Based on this abstraction, qualitative functional models are constructed for the process. Next MFM-specified causal rules are extended with systems specific features to enable proper reasoning. Finally, systematic HAZOP analysis is performed to identify safety critical operations, its causes and consequences. The outcome is a qualitative hazard analysis of selected process deviations from normal operations and their consequences as input to a traditional HAZOP table. The list of unacceptable high risk deviations identified by the qualitative HAZOP analysis is used as input for rigorous analysis and evaluation by the quantitative analysis part of the framework. To this end, dynamic first-principles modeling is used to simulate the system behavior and thereby complement the results of the qualitative analysis part. The practical framework for computer-assisted HAZOP studies introduced in this article allows the HAZOP team to devote more attention to high consequence hazards. © 2014 American Institute of Chemical Engineers AIChE J 60: 4150–4173, 2014
Application of Constrained Linear MPC to a Spray Dryer

In this paper we develop a linear model predictive control (MPC) algorithm for control of a two stage spray dryer. The states are estimated by a stationary Kalman filter. A non-linear first-principle engineering model is developed to simulate the spray drying process. The model is validated against experimental data and able to precisely predict the temperatures, the air humidity and the residual moisture in the dryer. The MPC controls these variables to the target and reject disturbances. Spray drying is a cost-effective method to evaporate water from liquid foods and produces a free flowing powder. The main challenge of spray drying is to meet the residual moisture specification and prevent powder from sticking to the chamber walls. By simulation we compare the performance of the MPC against the conventional PID control strategy. During an industrially recorded disturbance scenario, the MPC increases the production rate by 7.9%, profit of production by 8.2% and the energy efficiency by 4.1% on average.
Applying Functional Modeling for Accident Management of Nuclear Power Plant

The paper investigates applications of functional modeling for accident management in complex industrial plant with special reference to nuclear power production. Main applications for information sharing among decision makers and decision support are identified. An overview of Multilevel Flow Modeling is given and a detailed presentation of the foundational means-end concepts is presented and the conditions for proper use in modelling accidents are identified. It is shown that Multilevel Flow Modeling can be used for modelling and reasoning about design basis accidents. Its possible role for information sharing and decision support in accidents beyond design basis is also indicated. A modelling example demonstrating the application of Multilevel Flow Modelling and reasoning for a PWR LOCA is presented.
A Simple Method for Estimation of Parameters in First Order Systems

A simple method for estimation of parameters in first order systems with time delays is presented in this paper. The parameter estimation approach is based on a step response for the open loop system. It is shown that the estimation method does not require a complete step response, only a part of the response and the steady state value of the system before the step is applied. Further, for calculation of the time delay, it is also required that the time for the step is known.

General information

State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Niemann, H. H. (Intern), Miklos, R. (Intern)
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Automatic electricity markets data extraction for realistic multi-agent simulations

This paper presents the development of a tool that provides a database with available information from real electricity markets, ensuring the required updating mechanisms. Some important characteristics of this tool are: capability of collecting, analyzing, processing and storing real electricity markets data available on-line; capability of dealing with different file formats and types, some of them inserted by the user, resulting from information obtained not on-line but based on the possible collaboration with market entities; definition and implementation of database gathering information from different market sources, even including different market types; machine learning approach for automatic definition of downloads periodicity of new information available on-line. This is a crucial tool to go a step forward in electricity markets simulation, since the integration of this database with a scenarios generation tool, based on knowledge discovery techniques, provides a framework to study real market scenarios allowing simulators improvement and validation.

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Organisations: Department of Electrical Engineering, Automation and Control, Technical University of Denmark, Politechnic of Porto
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Calculation of critical fault recovery time for nonlinear systems based on region of attraction analysis

In safety critical systems, the control system is composed of a core control system with a fault detection and isolation scheme together with a repair or a recovery strategy. The time that it takes to detect, isolate, and recover from the fault (fault recovery time) is a critical factor in safety of a system. It must be guaranteed that the trajectory of a system subject to fault remains in the region of attraction (ROA) of the post-fault system during this time. This paper proposes a new algorithm to compute the critical fault recovery time for nonlinear systems with polynomial vector fields using sum of squares programming. The proposed algorithm is based on computation of ROA of the recovered system and finite-time stability of the faulty system.

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Authors: Tabatabaeipour, M. (Intern), Blanke, M. (Intern)
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Calibration between a Laser Range Scanner and an Industrial Robot Manipulator

In this paper we present a method for finding the transformation between a laser scanner and a robot manipulator. We present the design of a flat calibration target that can easily fit between a laser scanner and a conveyor belt, making the method easily implementable in a manufacturing line. We prove that the method works by simulating a range of different orientations of the target, and performs an extensive numerical evaluation of the targets design parameters to establish the optimal values as well as the worst-case accuracy of the method.

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Organisations: Department of Electrical Engineering, Automation and Control
Authors: Andersen, T. T. (Intern), Andersen, N. A. (Intern), Ravn, O. (Intern)
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Compositional Finite-Time Stability analysis of nonlinear systems

This paper investigates finite-time stability and finite-time boundedness for nonlinear systems with polynomial vector fields. Finite-time stability requires the states of the system to remain a given bounded set in a finite-time interval and finite-time boundedness considers the same problem for the system but with bounded disturbance. Sufficient conditions for finite-time stability and finite-time boundedness of nonlinear systems as well as a computational method based on sum of squares programming to check the conditions are given. The problem of finite-time stability for a system that consists of an interconnection of subsystems is also considered and we show how to decompose the problem into subproblems for each subsystem with coupling constraints. A solution to the problem using sum of squares programming and dual decomposition is presented. The method is demonstrated through
Controller modification applied for active fault detection

This paper is focusing on active fault detection (AFD) for parametric faults in closed-loop systems. This auxiliary input applied for the fault detection will also disturb the external output and consequently reduce the performance of the controller. Therefore, only small auxiliary inputs are used with the result that the detection and isolation time can be long. In this paper it will be shown, that this problem can be handled by using a modification of the feedback controller. By applying the YJBK-parameterization (after Youla, Jabr, Bongiorno and Kucera) for the controller, it is possible to modify the feedback controller with a minor effect on the external output in the fault free case. Further, in the faulty case, the signature of the auxiliary input can be optimized. This is obtained by using a band-pass filter for the YJBK parameter that is only effective in a small frequency range where the frequency for the auxiliary input is selected. This gives that it is possible to apply an auxiliary input with a reduced amplitude. An example is included to show the results.

Control strategies for power distribution networks with electric vehicles integration.

Demand side resources, like electric vehicles (EVs), can become integral parts of a smart grids because instead of just consuming power they are capable of providing valuable services to power systems. EVs can be used to balance the intermittent renewable energy resources such as wind and solar. EVs can absorb energy during periods of high electricity production and feed the electricity back into the grid when the demand is high or in situations of insufficent electricity generation. However, extra loads created by the increasing number of EVs may have adverse impacts on the distribution network such as congestion. These factors will bring new challenges to the distribution system operator. Typically, the
challenges are solved by expanding the grid to the size and the pattern of the demand. As an alternative, the capacity problem can also be solved smartly using advanced control strategies supported by an increased use of information and communication technology. This is the idea of the smart grid. The smart grid is a next-generation electrical power system that is typified by the increased use of communications and information technology in the generation, delivery and consumption of electrical energy. A smart grid can also be dened as an electricity network that can intelligently integrate the actions of all users connected to it - generators, consumers and those that do both - in order to eiently deliver sustainable, economic and secure electricity supplies. This thesis focuses on designing control strategies for congestion control in distribution network with multiple actors, such as the distribution system operator (DSO), eet operators (FO), and electric vehicle owners (or prosumers), considering their self-interests and operational constraints. Note that the control problem investigated here deals with 'higher level' control, e.g., optimization strategy algorithms related scheduling instead of 'lower level' direct process control. The thesis starts with reviewing innovative control strategies for large scale management of EVs in the power systems including centralized direct control, market based control, and price control. The thesis investigates new approaches for distribution networks congestion management. The general equilibrium market mechanism is utilized in the operation of the ii market. To build a complete solution for integration of EVs into the distribution network, a price coordinated hierarchical scheduling system is proposed which can well characterize the involved actors in the smart grid. With this system, we demonstrate that it is possible to schedule the charging scheme of EVs according to the users’ energy driving requirements and the forecasted day-ahead electricity market price. Several electric vehicle eet operators are specied to manage the electric vehicle eets. The method of market based control can then be used by the DSO to interact with the electric vehicle eet operators to eliminate the grid congestion problem. Note that the electric vehicle eet operator can manage the EVs based on the three aforementioned control strategies. To test and evaluate the proposed control strategies, multi-agent concepts is used to model the price coordinated hierarchical scheduling system. To implement and demonstrate the multi-agent systems, a novel simulation platform has been developed based on the integration of JACK (a Java based agent-oriented development environment) and Matlab/Simulink software.

General information
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Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy System Management, Automation and Control
Authors: Hu, J. (Intern), Østergaard, J. (Intern), Lind, M. (Intern)
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Coordinated Charging of Electric Vehicles for Congestion Prevention in the Distribution Grid
Distributed energy resources (DERs), like electric vehicles (EVs), can offer valuable services to power systems, such as enabling renewable energy to the electricity producer and providing ancillary services to the system operator. However, these new DERs may challenge the distribution grid due to insufficient capacity in peak hours. This paper aims to coordinate the valuable services and operation constraints of three actors: the EV owner, the Fleet operator (FO) and the Distribution system operator (DSO), considering the individual EV owner’s driving requirement, the charging cost of EV and thermal limits of cables and transformers in a distribution grid capacity market framework. Firstly, a theoretical market framework is described. Within this framework, FOs who represent their customer’s (EV owners) interests will centrally guarantee the EV owners’ driving requirements and procure the energy for their vehicles with lower cost. The congestion problem will be solved by a coordination between DSO and FOs through a distribution grid capacity market scheme. Then, a mathematical formulation of the market scheme is presented. Further, some case studies are shown to illustrate the effectiveness of the proposed solutions.

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Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Automation and Control
Authors: Hu, J. (Intern), You, S. (Intern), Lind, M. (Intern), Østergaard, J. (Intern)
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Publication information
Data Extraction Tool to Analyse, Transform and Store Real Data from Electricity Markets
The study of electricity markets operation has been gaining an increasing importance in the last years, as result of the new challenges that the restructuring process produced. Currently, lots of information concerning electricity markets is available, as market operators provide, after a period of confidentiality, data regarding market proposals and transactions. These data can be used as source of knowledge to define realistic scenarios, which are essential for understanding and forecast electricity markets behavior. The development of tools able to extract, transform, store and dynamically update data, is of great importance to go a step further into the comprehension of electricity markets and of the behaviour of the involved entities. In this paper an adaptable tool capable of downloading, parsing and storing data from market operators’ websites is presented, assuring constant updating and reliability of the stored data.

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Organisations: Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto
Authors: Pereira, I. F. (Ekstern), Sousa, T. (Ekstern), Praca, I. (Ekstern), Freitas, A. R. (Ekstern), Pinto, T. (Ekstern), Vale, Z. (Ekstern), Morais, H. (Intern)
Pages: 387-395
Publication date: 2014
Day-ahead resource scheduling including demand response for electric vehicles

Summary form only given. The energy resource scheduling is becoming increasingly important, as the use of distributed resources is intensified and massive gridable vehicle (V2G) use is envisaged. This paper presents a methodology for day-ahead energy resource scheduling for smart grids considering the intensive use of distributed generation and V2G. The main focus is the comparison of different EV management approaches in the day-ahead energy resources management, namely uncontrolled charging, smart charging, V2G and Demand Response (DR) programs in the V2G approach. Three different DR programs are designed and tested (trip reduce, shifting reduce and reduce+shifting). Other important contribution of the paper is the comparison between deterministic and computational intelligence techniques to reduce the execution time. The proposed scheduling is solved with a modified particle swarm optimization. Mixed integer non-linear programming is also used for comparison purposes. Full ac power flow calculation is included to allow taking into account the network constraints. A case study with a 33-bus distribution network and 2000 V2G resources is used to illustrate the performance of the proposed method.
and 32 consumers with DR capacity

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Organisations: Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto  
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

**Demand Response Design and Use Based on Network Locational Marginal Prices**

Power systems have been experiencing huge changes mainly due to the substantial increase of distributed generation (DG) and the operation in competitive environments. Virtual Power Players (VPP) can aggregate several players, namely a diversity of energy resources, including distributed generation (DG) based on several technologies, electric storage systems (ESS) and demand response (DR). Energy resources management gains an increasing relevance in this competitive context. This makes the DR use more interesting and flexible, giving place to a wide range of new opportunities. This paper proposes a methodology to support VPPs in the DR programs’ management, considering all the existing energy resources (generation and storage units) and the distribution network. The proposed method is based on locational marginal prices (LMP) values. The evaluation of the impact of using DR specific programs in the LMP values supports the manager decision concerning the DR use. The proposed method has been computationally implemented and its application is illustrated in this paper using a 33-bus network with intensive use of DG.

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Authors: Morais, H. (Intern), Faria, P. (Ekstern), Vale, Z. (Ekstern)  
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BFI (2015): BFI-level 2  
Scopus rating (2015): SJR 1.441 SNIP 2.031 CiteScore 3.97  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 2  
Scopus rating (2014): SJR 1.328 SNIP 2.312 CiteScore 4.34  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 2  
Scopus rating (2013): SJR 1.231 SNIP 2.731 CiteScore 4.54  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes
Diagnosis of airspeed measurement faults for unmanned aerial vehicles

Airspeed sensor faults are common causes for incidents with unmanned aerial vehicles with pitot tube clogging or icing being the most common causes. Timely diagnosis of such faults or other artifacts in signals from airspeed sensing systems could potentially prevent crashes. This paper employs parameter adaptive estimators to provide analytical redundancies and a dedicated diagnosis scheme is designed. Robustness is investigated on sets of flight data to estimate distributions of test statistics. The result is robust diagnosis with adequate balance between false alarm rate and fault detectability.
Distributed energy resources scheduling considering real-time resources forecast

Energy resource scheduling is becoming increasingly important, such as the use of more distributed generators and electric vehicles connected to the distribution network. This paper proposes a methodology to be used by Virtual Power Players (VPPs), regarding the energy resource scheduling in smart grids and considering day-ahead, hour-ahead and real-time time horizons. This method considers that energy resources are managed by a VPP which establishes contracts with their owners. The full AC power flow calculation included in the model takes into account network constraints. In this paper, distribution function errors are used to simulate variations between time horizons, and to measure the performance of the proposed methodology. A 33-bus distribution network with large number of distributed resources is used.
Recent changes in the operation and planning of power systems have been motivated by the introduction of Distributed Generation (DG) and Demand Response (DR) in the competitive electricity markets' environment, with deep concerns at the efficiency level. In this context, grid operators, market operators, utilities and consumers must adopt strategies and methods to take full advantage of demand response and distributed generation. This requires that all the involved players consider all the market opportunities, as the case of energy and reserve components of electricity markets.

The present paper proposes a methodology which considers the joint dispatch of demand response and distributed generation in the context of a distribution network operated by a virtual power player. The resources' participation can be performed in both energy and reserve contexts. This methodology contemplates the probability of actually using the reserve and the distribution network constraints. Its application is illustrated in this paper using a 32-bus distribution network with 66 DG units and 218 consumers classified into 6 types of consumers.
Dynamic load management in a smart home to participate in demand response events

In future power systems, in the smart grid and microgrids operation paradigms, consumers can be seen as an energy resource with decentralized and autonomous decisions in the energy management. It is expected that each consumer will manage not only the loads, but also small generation units, heating systems, storage systems, and electric vehicles. Each consumer can participate in different demand response events promoted by system operators or aggregation entities. This paper proposes an innovative method to manage the appliances on a house during a demand response event. The main contribution of this work is to include time constraints in resources management, and the context evaluation in order to ensure the required comfort levels. The dynamic resources management methodology allows a better resources management in a demand response event, mainly the ones of long duration, by changing the priorities of loads during the event. A case study with two scenarios is presented considering a demand response with 30 min duration, and another with 240 min (4 h). In both simulations, the demand response event proposes the power consumption reduction during the event. A total of 18 loads are used, including real and virtual ones, controlled by the presented house management system.
Dynamic Simulation, Sensitivity and Uncertainty Analysis of a Demonstration Scale Lignocellulosic Enzymatic Hydrolysis Process

This study presents the uncertainty and sensitivity analysis of a lignocellulosic enzymatic hydrolysis model considering both model and feed parameters as sources of uncertainty. The dynamic model is parametrized for accommodating various types of biomass, and different enzymatic complexes, accounting a large number of parameters. The sensitivity analysis of model predictions with respect to model parameters is quantified by the delta mean square measure. By ranking the delta mean square, a reduced subset of parameters is found helping to identify the bottleneck of the model. The uncertainty analysis is carried for both model parameters and feed composition in order to assess the accuracy of the predictions. First, the model and feed parameters are sampled by Latin Hypercube Sampling (LHS) and then Monte Carlo simulations are run with the sampled values. Feed parameters are considered to be affected by non-zero mean noise because they are determined by a Near Infrared (NIR) instrument. LHS is performed on 2 parameters: the probability of the mean value and the probability of the standard deviation for each measurement. The Monte Carlo outputs are then analyzed by linear regression and the standardized regression coefficients (SRC) are computed for identifying the responsible parameters for model outputs precision. It is found that sugar yields are mostly sensitive to the composition of the enzymatic complex, and xylooligomers and glucose inhibition. pH is affected mostly by the amount of acetyl groups in the hemicellulose, while viscosity is sensitive to a few coefficients from its empirical equation.

General information
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Organisations: Department of Electrical Engineering, Automation and Control, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS
Authors: Prunescu, R. M. (Intern), Sin, G. (Intern)
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Dynamic Simulation, Sensitivity and Uncertainty Analysis of a Demonstration Scale Lignocellulosic Enzymatic Hydrolysis Process
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Economic Optimization of Spray Dryer Operation using Nonlinear Model Predictive Control
In this paper we investigate an economically optimizing Nonlinear Model Predictive Control (E-NMPC) for a spray drying process. By simulation we evaluate the economic potential of this E-NMPC compared to a conventional PID based control
strategy. Spray drying is the preferred process to reduce the water content for many liquid foodstuffs and produces a free
flowing powder. The main challenge in controlling the spray drying process is to meet the residual moisture specifications
and avoid that the powder sticks to the chamber walls of the spray dryer. We present a model for a spray dryer that has
been validated on experimental data from a pilot plant. We use this model for simulation as well as for prediction in the E-
NMPC. The E-NMPC is designed with hard input constraints and soft output constraints. The open-loop optimal control
problem in the E-NMPC is solved using the single-shooting method combined with a quasi-Newton Sequential Quadratic
Programming (SQP) algorithm and the adjoint method for computation of gradients. The E-NMPC improves the cost of
spray drying by 26.7% compared to conventional PI control in our simulations.

**General information**
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Scientific Computing, Dynamical Systems,
Department of Electrical Engineering, Automation and Control, Center for Energy Resources Engineering, GEA Process
Engineering A/S
Authors: Petersen, L. N. (Intern), Poulsen, N. K. (Intern), Niemann, H. H. (Intern), Utzen, C. (Ekstern), Jørgensen, J. B.
(Intern)
Number of pages: 7
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BFI conference series: IEEE Conference on Decision and Control (5010888)
Main Research Area: Technical/natural sciences
Conference: 53rd IEEE Conference on Decision and Control (CDC 2014), Los Angeles, United States, 15/12/2014 -
15/12/2014
DOIs: 10.1109/CDC.2014.7040456
Source: PublicationPreSubmission
Source-ID: 100853733
Publication: Research › peer-review › Article in proceedings – Annual report year: 2015

**Effects of Short-Term Training of Community-Dwelling Elderly with Modular Interactive Tiles**
Objective: The objective of this study is to test for the increased mobility, agility, balancing, and general fitness of
community-dwelling elderly individuals as a result of short-term training involving playing with modular interactive tiles
(Entertainment Robotics, Odense, Denmark) at two community activity centers for the elderly. Three different tests from
the Senior Fitness Test were used in order to test a variety of health parameters of the community-dwelling elderly,
including those parameters related to fall prevention. Materials and Methods: Eighteen community-dwelling elderly
individuals (63–95 years of age; mean, 83.2 years of age) were assessed in one intervention group without the use of a
control group. The intervention group performed nine group sessions (1–1.5 hours each) of playful training with the
modular interactive tiles over a 12-week period in two community activity centers for the elderly. Data were collected using
pre-tests and post-tests of the 6-Minute Walk Test (6MWT), the 8-foot Timed Up & Go Test (TUG), and the Chair-Stand
Test (CS). Data were analyzed for statistically significant differences and increases of means. Results: The 6MWT, TUG,
and CS measurements showed statistically significant differences and increases of means between the pre-tests and
post-tests with the 6MWT (P

**General information**
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware
Authors: Lund, H. H. (Intern), Jessen, J. D. (Intern)
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Main Research Area: Technical/natural sciences

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Journal: Games for Health
Volume: 3
Issue number: 5
ISSN (Print): 2161-783X
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
The energy sector in industrialized countries has been restructured in the last years, with the purpose of decreasing electricity prices through the increase in competition, and facilitating the integration of distributed energy resources. However, the restructuring process increased the complexity in market players' interactions and generated emerging problems and new issues to be addressed. In order to provide players with competitive advantage in the market, decision support tools that facilitate the study and understanding of these markets become extremely useful. In this context arises MASCEM (Multi-Agent Simulator of Competitive Electricity Markets), a multi-agent based simulator that models real electricity markets. To reinforce MASCEM with the capability of recreating the electricity markets reality in the fullest possible extent, it is crucial to make it able to simulate as many market models and player types as possible. This paper presents a new negotiation model implemented in MASCEM based on the negotiation model used in day-ahead market (Elspot) of Nord Pool. This is a key module to study competitive electricity markets, as it presents well defined and distinct characteristics from the already implemented markets, and it is a reference electricity market in Europe (the one with the larger amount of traded power).

Elspot: Nord Pool Spot Integration in MASCEM Electricity Market Simulator
The energy sector in industrialized countries has been restructured in the last years, with the purpose of decreasing electricity prices through the increase in competition, and facilitating the integration of distributed energy resources. However, the restructuring process increased the complexity in market players' interactions and generated emerging problems and new issues to be addressed. In order to provide players with competitive advantage in the market, decision support tools that facilitate the study and understanding of these markets become extremely useful. In this context arises MASCEM (Multi-Agent Simulator of Competitive Electricity Markets), a multi-agent based simulator that models real electricity markets. To reinforce MASCEM with the capability of recreating the electricity markets reality in the fullest possible extent, it is crucial to make it able to simulate as many market models and player types as possible. This paper presents a new negotiation model implemented in MASCEM based on the negotiation model used in day-ahead market (Elspot) of Nord Pool. This is a key module to study competitive electricity markets, as it presents well defined and distinct characteristics from the already implemented markets, and it is a reference electricity market in Europe (the one with the larger amount of traded power).

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto
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Editor: Corchado, J.
ISBN (Print): 978-3-319-07766-6
ISBN (Electronic): 978-3-319-07767-3
Series: Communications in Computer and Information Science
Volume: 430
Main Research Area: Technical/natural sciences
Conference: PAAMS 2014, Salamanca, Spain, 04/07/2014 - 04/07/2014
DOIs: 10.1007/978-3-319-07767-3_24
Publication: Research - peer-review › Book chapter – Annual report year: 2014
Evaluation of the Electric Vehicle Impact in the Power Demand Curve in a Smart Grid Environment

Smart grids with an intensive penetration of distributed energy resources will play an important role in future power system scenarios. The intermittent nature of renewable energy sources brings new challenges, requiring an efficient management of those sources. Additional storage resources can be beneficially used to address this problem; the massive use of electric vehicles, particularly of vehicle-to-grid (usually referred as gridable vehicles or V2G), becomes a very relevant issue. This paper addresses the impact of Electric Vehicles (EVs) in system operation costs and in power demand curve for a distribution network with large penetration of Distributed Generation (DG) units. An efficient management methodology for EVs charging and discharging is proposed, considering a multi-objective optimization problem. The main goals of the proposed methodology are: to minimize the system operation costs and to minimize the difference between the minimum and maximum system demand (leveling the power demand curve). The proposed methodology perform the day-ahead scheduling of distributed energy resources in a distribution network with high penetration of DG and a large number of electric vehicles. It is used a 32-bus distribution network in the case study section considering different scenarios of EVs penetration to analyze their impact in the network and in the other energy resources management

General information
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Organisations: Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto
Authors: Morais, H. (Intern), Sousa, T. (Ekstern), Vale, Z. (Ekstern), Faria, P. (Ekstern)
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 6.85 SJR 2.537 SNIP 2.233
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.04 SJR 2.232 SNIP 2.109
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.023 SNIP 2.079 CiteScore 5.24
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.789 SNIP 2.791 CiteScore 5.35
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.613 SNIP 2.534 CiteScore 4.49
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.674 SNIP 2.242 CiteScore 3.72
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.24 SNIP 1.82 CiteScore 3.03
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.35 SNIP 1.735
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Experimental Grey Box Model Identification of an Active Gas Bearing

Gas bearings have inherent dynamics that gives rise to low damping and potential instability at certain rotational speeds. Required damping and stabilization properties can be achieved by active flow control if bearing parameters are known. This paper deals with identification of parameters in a dynamic model of an active gas bearing and subsequent control loop design. A grey box model is determined based on experiments where piezo actuated valves are used to perturb the journal and hence excite the rotor-bearing system. Such modelling from actuator to output is shown to efficiently support controller design, in contrast to impact models that focus on resonance dynamics. The identified model is able to accurately reproduce the lateral dynamics of the rotor-bearing system in a desired operating range, in this case around the first two natural frequencies. The identified models are validated and used to design a model-based controller capable of improving the damping of the gas bearing. Experimental impact responses show an increase in damping by a factor nine for the investigated conditions.
**Fable: A Modular Robot for Students, Makers and Researchers**

The vision of the Fable modular robotic system is to transform the development of robots from a process performed mainly by experts, to an easily accessible and motivating activity that enables a large range of users to assemble and animate their own robotic ideas. To achieve this vision, the Fable system consists of a range of modules equipped with sensors and actuators, which users can easily assemble into a wide range of robots within seconds. The robots are user-programmable on several levels of abstraction ranging from a simple visual programming language to powerful conventional ones. This paper provides a brief overview of the concept, design and state of development for the second version of the Fable modular robotic system.

**Fair division of generation profile and fuel consumption in isolated micro-grids**

Islands and rural areas can decrease their cost of energy by exploiting renewable energy as compared to diesel-only generation. Operation of such isolated micro-grids requires allocation of units for grid stability. Depending on the control strategy employed, the fluctuating renewable production leads to more stressed loading conditions of diesel generators. We propose a control strategy employing fair division of generator allocation using a compensation procedure based on social choice methods. A co-simulation set up with separate power system and control strategy simulators is used to provide a proof-of-concept case study of an isolated micro-grid with two wind turbines and three diesel generators. In comparison with a simple master-slave allocation, the proposed coordination scheme improves the distribution of fuel allocation by 27.5%, reduces under-load time by 43.5% and decreases the standard deviation of the under-load distribution between individual diesels by 80.7%.
Fault Diagnosis for Electrical Distribution Systems using Structural Analysis

Fault-tolerance in electrical distribution relies on the ability to diagnose possible faults and determine which components or units cause a problem or are close to doing so. Faults include defects in instrumentation, power generation, transformation and transmission. The focus of this paper is the design of efficient diagnostic algorithms, which is a prerequisite for fault-tolerant control of power distribution. Diagnosis in a grid depend on available analytic redundancies, and hence on network topology. When topology changes, due to earlier fault(s) or caused by maintenance, analytic redundancy relations (ARR) are likely to change. The algorithms used for diagnosis may need to change accordingly, and finding efficient methods to ARR generation is essential to employ fault-tolerant methods in the grid. Structural analysis (SA) is based on graph-theoretical results, that offer to find analytic redundancies in large sets of equations only from the structure (topology) of the equations. A salient feature is automated generation of redundancy relations. The method is indeed feasible in electrical networks where circuit theory and network topology together formulate the constraints that define a structure graph. This paper shows how three-phase networks are modelled and analysed using structural methods, and it extends earlier results by showing how physical faults can be identified such that adequate remedial actions can be taken. The paper illustrates a feasible modelling technique for structural analysis of power systems, it demonstrates detection and isolation of failures in a network, and shows how typical faults are diagnosed. Nonlinear fault simulations illustrate the results.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy
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Scopus rating (2015): SJR 1.992 SNIP 1.698 CiteScore 3.12
Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 2.037 SNIP 1.911 CiteScore 3.51
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.86 SNIP 1.91 CiteScore 3.41
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.685 SNIP 1.791 CiteScore 2.83
ISI indexed (2012): ISI indexed yes
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Scopus rating (2011): SJR 1.77 SNIP 1.769 CiteScore 2.41
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.519 SNIP 1.486
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.061 SNIP 2.065
BFI (2008): BFI-level 1
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Functional Modeling of Complex Systems

General information
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Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management
Authors: Lind, M. (Intern)
Pages: 95-114
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Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 102963191
Publication: Research - peer-review › Book chapter – Annual report year: 2014

Functional Modelling for Fault Diagnosis and its application for NPP.
The paper presents functional modelling and its application for diagnosis in nuclear power plants. Functional modelling is defined and it is relevant for coping with the complexity of diagnosis in large scale systems like nuclear plants is explained. The diagnosis task is analyzed and it is demonstrated that the levels of abstraction in models for diagnosis must reflect plant knowledge about goals and functions which is represented in functional modelling. Multi level flow modeling (MFM), which is a method for functional modeling, is introduced briefly and illustrated with a cooling system example. The use of MFM for reasoning about causes and consequences is explained in detail and demonstrated using the reasoning tool the MFM Suite. MFM applications in nuclear power systems are described by two examples a PWR and a FBR reactor. The PWR example shows how MFM can be used to model and reason about operating modes. The FBR example illustrates how the modeling development effort can be managed by proper strategies including decomposition and reuse.

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Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management
Authors: Lind, M. (Intern), Zhang, X. (Intern)
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Main Research Area: Technical/natural sciences

Publication information
Journal: Nuclear Engineering and Technology
Games as Actors - Interaction, Play, Design, and Actor Network Theory

When interacting with computer games, users are forced to follow the rules of the game in return for the excitement, joy, fun, or other pursued experiences. In this paper, we investigate how games achieve these experiences in the perspective of Actor Network Theory (ANT). Based on a qualitative data from a study of board games, computer games, and exergames, we conclude that games are actors that produce experiences by exercising power over the user's abilities, for example their cognitive functions. Games are designed to take advantage of the characteristics of the human players, and by doing so they create in humans what in modern play theory is known as a "state of play".

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, Aarhus University
Authors: Jessen, J. D. (Intern), Jessen, C. (Ekstern)
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Main Research Area: Technical/natural sciences

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Generic trajectory representation and trajectory following for wheeled robots
This article presents the work towards a purely generic navigation solution for wheeled mobile robots motivated by the following goals: Generic: Works for different types of robots. Configurable: Parameters maps to geometric properties of the robot. Predictable: Well defined where the robot will drive. Safe: Avoid fatal collisions. Based on a survey of existing methods and algorithms the article presents a generic way to represent constraints for different types of robots, a generic way to represent trajectories using Bézier curves, a method to convert the trajectory so it can be driven in a smooth motion, a method to create a safe velocity profile for the robot, and a path following controller.
Hazard identification by extended multilevel flow modelling with function roles.

HAZOP studies are widely accepted in chemical and petroleum industries as the method for conducting process hazard analysis related to design, maintenance and operation of the systems. In this paper, a HAZOP reasoning method based on function-oriented modelling, multilevel flow modelling (MFM) is extended with function roles to complete HAZOP studies in principle. A graphical MFM editor, which is combined with the reasoning engine (MFM Workbench) developed by DTU is applied to automate HAZOP studies. The method is proposed to support the ‘brain-storming’ sessions in traditional HAZOP analysis. As a case study, the extended MFM-based HAZOP methodology is applied to an offshore three-phase separation process. The results show that the cause-consequence analysis in MFM can infer the cause and effect of a deviation used in HAZOP and used to fill HAZOP worksheet. This paper is the first paper discussing and demonstrating the potential of the roles concept in MFM to supplement the completeness of HAZOP analysis in theory.
developed system it is possible for the users to regulate the exercise intensity on their own with biofeedback, and also possible to analyze exercise activity using number of steps on the tiles and heart beat rate.

**General information**

State: Published  
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, University of Tsukuba  
Authors: Shimokakimoto, T. (Ekstern), Lund, H. H. (Intern), Suzuki, K. (Ekstern)  
Pages: 69-73  
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Main Research Area: Technical/natural sciences

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Original language: English  
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Electronic versions:  
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Source: PublicationPreSubmission  
Source-ID: 97131507  
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**Implementing Modular Interactive Tiles for Rehabilitation in Tanzania – a pilot study**

The pilot study in the Iringa region, Tanzania, indicates how the modular interactive tiles can be used for playful physical rehabilitation for many diverse patient groups (handicapped children, stroke, cardiac, diabetic patients, etc.) in both urban and rural areas, and how it motivates the users through play to perform the physical rehabilitative actions. The system can be easily used by rehabilitation workers, and through the modularity it is robust to failure (e.g. power failure) in remote areas. The analyses of the use by many different user groups was condensed to a higher abstraction level to provide insight on the generalisation over the different user groups, and to provide pointers of opportunities and the means to meet these opportunities through subsequent development in the next cycles in the iterative research method. The pilot study indicates that the system can be a flexible and adaptive playful technology for rehabilitation in sub-Saharan Africa.

**General information**

State: Published  
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, University of Iringa  
Authors: Lund, H. H. (Intern), Jensen, L. S. D. (Intern), Ssessanga, Y. (Ekstern), Abdalahman, R. (Ekstern)  
Number of pages: 10  
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Source: PublicationPreSubmission  
Source-ID: 97131557  
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

**Investigating the Electromechanical Coupling in Piezoelectric Actuator Drive Motor Under Heavy Load**

The Piezoelectric Actuator Drive (PAD) is an accurate, high-torque rotary piezoelectric motor that employs piezoelectric stack actuators and inverse hypocycloidal motion to generate rotation. Important factors that determine motor performance are the proper concentric alignment between the motor ring and shaft and the similarity of the stack actuators used. This paper investigates the electromechanical coupling of these factors into the motor current through experimental means.

**General information**

State: Published
L1 Adaptive Speed Control of a Small Wind Energy Conversion System for Maximum Power Point Tracking

This paper presents the design of an L1 adaptive controller for maximum power point tracking (MPPT) of a small variable speed Wind Energy Conversion System (WECS). The proposed controller generates the optimal torque command for the vector controlled generator side converter (GSC) based on the wind speed estimation. The proposed MPPT control algorithm has a generic structure and can be used for different generator types. In order to verify the efficacy of the proposed L1 adaptive controller for the MPPT of the WECS, a full converter wind turbine with a squirrel cage induction generator (SCIG) is used to carry out case studies using Matlab/Simulink. The case study results show that the designed L1 adaptive controller has good tracking performance even with unmodeled dynamics and in the presence of parameter uncertainties and unknown disturbances.
In recent decades there has been increasing interest in green energies, of which wind energy is one of the most important. Wind turbines are the most common wind energy conversion systems and are hoped to be able to compete with traditional power plants in near future. This demands better technology to increase competitiveness of the wind power plants. One way to increase competitiveness of wind power plants is to offer grid services (also called ancillary services) that are normally offered by traditional power plants. One of the ancillary services is called reserve power. There are instants in the electricity market that selling the reserve power is more profitable than producing with the full capacity. Therefore wind turbines can be down-regulated and sell the differential capacity as the reserve power. In this paper we suggest a model based approach to control wind turbines for active power reference tracking. We use model predictive control (MPC) as our control method. We compare three different control strategies, namely Max-Ω, Constant-Ω and Constant-λ and discuss their drawbacks and benefits by presenting analysis of the steady state operating points and simulations on a high fidelity wind turbine model.

Model based active power control of a wind turbine

In recent decades there has been increasing interest in green energies, of which wind energy is one of the most important. Wind turbines are the most common wind energy conversion systems and are hoped to be able to compete with traditional power plants in near future. This demands better technology to increase competitiveness of the wind power plants. One way to increase competitiveness of wind power plants is to offer grid services (also called ancillary services) that are normally offered by traditional power plants. One of the ancillary services is called reserve power. There are instants in the electricity market that selling the reserve power is more profitable than producing with the full capacity. Therefore wind turbines can be down-regulated and sell the differential capacity as the reserve power. In this paper we suggest a model based approach to control wind turbines for active power reference tracking. We use model predictive control (MPC) as our control method. We compare three different control strategies, namely Max-Ω, Constant-Ω and Constant-λ and discuss their drawbacks and benefits by presenting analysis of the steady state operating points and simulations on a high fidelity wind turbine model.
Modelling of Rotor-gas bearings for Feedback Controller Design

Controllable rotor-gas bearings are popular owing adaptability, high speed operation, low friction and clean operation. Rotor-gas bearings are however highly sensitive to disturbances due to the low friction of the injected gas. These undesirable damping properties call for controllers, which can be designed from suitable models describing the relation from actuator input to measured shaft position. Current state of the art models of controllable gas bearings however do not provide such relation, which calls for alternative strategies. The present contribution discusses the challenges for feedback controller design using the state of the art method, and an alternative data driven modelling approach is pursued based on Grey-Box system identification. The method allows development of models of the rotor-gas bearing suitable for controller design, which can be identified from data over the range of operation and are shown to accurately describe the dynamical behaviour of the rotor-gas bearing. Design of a controller using the identified models is treated and experiments verify the improvement of the damping properties of the rotor-gas bearing.
Electric vehicles (EV) can become integral part of a smart grid because instead of just consuming power they are capable of providing valuable services to power systems. To integrate EVs smoothly into the power systems, a multi-agents system (MAS) with hierarchical organization structure is proposed in this paper. The proposed MAS system consists of three types of agents: distribution system operator agent (DSO agent), electric vehicle fleet operator agent (EV FO agent or alternatively called virtual power plant agent) and EV agent. A DSO agent belongs to the top level of the hierarchy and its role is to manage the distribution network safely by avoiding grid congestions and using congestion prices to coordinate the energy schedule of VPPs. VPP agents belong to the middle level and their roles are to manage the charge periods of the EVs. EV agents sit in the bottom level and they represent EV owners and operate the charging behaviour of EVs. To simulate this collaborative (all agents contribute to achieving an optimized global performance) but also competitive environment (each agent will try to increase its utilities or reduce its costs), a multi-agent platform was developed to demonstrate the coordination between the interacting agents.
Navigation System Fault Diagnosis for Underwater Vehicle

This paper demonstrates fault diagnosis on unmanned underwater vehicles (UUV) based on analysis of structure of the nonlinear dynamics. Residuals are generated using different approaches in structural analysis followed by statistical change detection. Hypothesis testing thresholds are made signal based to cope with non-ideal properties seen in real data. Detection of both sensor and thruster failures are demonstrated. Isolation is performed using the residual signature of detected faults and the change detection algorithm is used to assess severity of faults by estimating their magnitude. Numerical simulations and sea trial data show results with very favourable balance between detection and false alarm probabilities.
Operational Strategies for Predictive Dispatch of Control Reserves in View of Stochastic Generation

In view of the predictability and stochasticity of wind power generation, transmission system operators (TSOs) can benefit from predictive dispatch of slow and manual control reserves in order to maintain reactive reserve levels for unpredictable events. While scenario-based approaches for stochastic optimization are well suited for this problem, it appears that TSOs are hesitant in adopting this method into their practice of predictive dispatch. Differences in the formulation of constraints and cost functions, the timing and reserve product constraints influence the dispatch result significantly and yield varying results with different practical implications. To support adoption, there is a need to study relevant parameters and trade-offs to be considered in introducing such methods to operation practice, enabling also the investigation of alternate reserve product constraints, e.g., to enable reserve contribution from storage-constrained units. This paper introduces a framework for comparison of operational strategies for system balancing, proposes criteria for performance assessment and exemplifies a systematic evaluation of several operation strategies.

General information
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Authors: Delikaraoglou, S. (Intern), Heussen, K. (Intern), Pinson, P. (Intern)
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Main Research Area: Technical/natural sciences
Electronic versions:
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Parametric Roll - Risk Reduction through Real-time Detection

PAROLL is an innovative condition-monitoring system for the timely detection of parametric roll on merchant vessels. It has been invented and developed by the Technical University of Denmark. DNV GL and Wallenius Marine have supported the development and full-scale validation of this monitoring system.

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Authors: Galeazzi, R. (Intern)
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Source-ID: 102534154
Particle Filter for Fault Diagnosis and Robust Navigation of Underwater Robot

A particle filter based robust navigation with fault diagnosis is designed for an underwater robot, where 10 failure modes of sensors and thrusters are considered. The nominal underwater robot and its anomaly are described by a switching-mode hidden Markov model. By extensively running a particle filter on the model, the fault diagnosis and robust navigation are achieved. Closed-loop full-scale experimental results show that the proposed method is robust, can diagnose faults effectively, and can provide good state estimation even in cases where multiple faults occur. Comparing with other methods, the proposed method can diagnose all faults within a single structure, it can diagnose simultaneous faults, and it is easily implemented.

General information
State: Published
Organisations: Department of Automation, Department of Electrical Engineering, Automation and Control, Norwegian University of Science and Technology
Authors: Zhao, B. (Ekstern), Skjetne, R. (Ekstern), Blanke, M. (Intern), Dukan, F. (Ekstern)
Pages: 2399 – 2407
Publication date: 2014
Main Research Area: Technical/natural sciences

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Journal: IEEE Transactions on Control Systems Technology
Volume: 22
Issue number: 6
ISSN (Print): 1063-6536
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 5.89 SJR 1.832 SNIP 2.728
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.17 SJR 1.655 SNIP 2.643
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.966 SNIP 2.798 CiteScore 4.72
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.786 SNIP 3.006 CiteScore 4.34
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.707 SNIP 3.41 CiteScore 4.41
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.495 SNIP 3.011 CiteScore 3.7
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.585 SNIP 2.909 CiteScore 3.26
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.098 SNIP 2.391
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.587 SNIP 2.789
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.43 SNIP 2.736
Particle Swarm Optimization of Electricity Market Negotiating Players Portfolio

Energy systems worldwide are complex and challenging environments. Multi-agent based simulation platforms are increasing at a high rate, as they show to be a good option to study many issues related to these systems, as well as the involved players at act in this domain. In this scope the authors’ research group has developed a multi-agent system: MASCEM (Multi-Agent System for Competitive Electricity Markets), which performs realistic simulations of the electricity markets. MASCEM is integrated with ALBidS (Adaptive Learning Strategic Bidding System) that works as a decision support system for market players. The ALBidS system allows MASCEM market negotiating players to take the best possible advantages from each market context. However, it is still necessary to adequately optimize the players’ portfolio investment. For this purpose, this paper proposes a market portfolio optimization method, based on particle swarm optimization, which provides the best investment profile for a market player, considering different market opportunities (bilateral negotiation, market sessions, and operation in different markets) and the negotiation context such as the peak and off-peak periods of the day, the type of day (business day, weekend, holiday, etc.) and most important, the renewable based distributed generation forecast. The proposed approach is tested and validated using real electricity markets data from the Iberian operator – MIBEL.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto
Authors: Pinto, T. (Ekstern), Vale, Z. (Ekstern), Sousa, T. (Ekstern), Morais, H. (Intern), Praca, I. (Ekstern)
Pages: 273-84
Publication date: 2014

Host publication information
Title of host publication: Highlights of Practical Applications of Heterogeneous Multi-Agent Systems. : The PAAMS Collection
Publisher: Springer
Editor: Corchado, J.
ISBN (Print): 978-3-319-07766-6
ISBN (Electronic): 978-3-319-07767-3
Chapter: 12
Main Research Area: Technical/natural sciences
Conference: PAAMS 2014, Salamanca, Spain, 04/07/2014 - 04/07/2014
DOIs:
10.1007/978-3-319-07767-3_25
Source: PublicationPreSubmission
Source-ID: 100631623
Publication: Research - peer-review › Book chapter – Annual report year: 2014

Performance Assessment of Aggregation Control Services for Demand Response
Aggregation algorithms that provide services to the grid via demand side management are moving from research ideas to the market. With the diversity of the technology delivering such services, it becomes essential to establish transparent
performance standards from a service delivery perspective. This paper formulates performance measures and an index to evaluate in hindsight the quality of service delivery by an aggregator, both with respect to ancillary service and asset management service. The index is based on requirements formulated in service contracts and provides an overall assessment of the quality of service provided by an aggregation control algorithm. By a detailed case study we present and an application of the index, comparing the performance of two different control architectures for demand side management delivering a distribution grid service.

**General information**

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Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy System Management, Automation and Control
Number of pages: 6
Publication date: 2014

**Host publication information**

Title of host publication: Proceedings of IEEE PES ISGT 2014 Europe
Publisher: IEEE
Main Research Area: Technical/natural sciences
Performance Assessmen, Ancillary Services, Control service, Demand Side Management
Electronic versions:
Bondy_ISGT2014_final.pdf
DOIs:
10.1109/ISGTEurope.2014.7028779
Source: PublicationPreSubmission
Source-ID: 102865109
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

**Physical computer games for motivating physical play among elderly**

**General information**

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware
Authors: Jessen, J. D. (Intern), Lund, H. H. (Intern), Jessen, C. (Intern)
Number of pages: 1
Pages: 220
Publication date: 2014
Conference: 9th World Conference of Gerontechnology , Taipei, Taiwan, Province of China, 18/06/2014 - 18/06/2014
Main Research Area: Technical/natural sciences

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Volume: 13
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ISSN (Print): 1569-1101
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BFI (2017): BFI-level 1
Scopus rating (2017): SJR 0.128 SNIP 0.085 CiteScore 0.19
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.29 SJR 0.177 SNIP 0.213
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.232 SNIP 0.161 CiteScore 0.26
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.409 SNIP 2.897 CiteScore 1.35
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.222 SNIP 0.408 CiteScore 0.86
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.184 SNIP 0.279 CiteScore 0.61
Piezoelectric stack actuator parameter extraction with hysteresis compensation

The Piezoelectric Actuator Drive (PAD) is a type of rotary motor that transforms the linear motion of piezoelectric stack actuators into a precise rotational motion. The very high stiffness of the actuators employed make this type of motor suited for open-loop control, but the inherent hysteresis exhibited by piezoelectric ceramics causes losses. Therefore, this paper presents a straightforward method to measure piezoelectric stack actuator equivalent parameters that includes nonlinearities. By folding the nonlinearities into a newly-defined coupling coefficient, the inherent hysteretic behavior of piezoelectric stack actuators can be greatly reduced through precompensation. Experimental results show a fitting accuracy of 98.8% between the model and measurements and a peak absolute error reduction by a factor of 10 compared to the manufacturer-provided parameter. This method improves both the static and dynamic performance of the Piezoelectric Actuator Drive (PAD) while still permitting open-loop control.
Playte, a tangible interface for engaging human-robot interaction

This paper describes a tangible interface, Playte, designed for children animating interactive robots. The system supports physical manipulation of behaviors represented by LEGO bricks and allows the user to record and train their own new behaviors. Our objective is to explore several modes of interaction, i.e. direct remote control, tangible programming, programming by demonstration, and programming by training, to learn the design principles for more accessible, engaging, and playful robots. We evaluate the system experimentally and report on key observations from play sessions. We conclude that Playte facilitates playful activities and is appropriate for the intended target group (age 6+). Further, we discuss lessons learned regarding pros and cons of the different supported interactions modes.

General information

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware
Authors: Christensen, D. J. (Intern), Fogh, R. (Intern), Lund, H. H. (Intern)
Pages: 56-62
Publication date: 2014

Host publication information

Title of host publication: Proceedings of the 23rd International Symposium on Robot and Human Interactive Communication
Publisher: IEEE
ISBN (Print): 9781479967650
BFI conference series: IEEE International Symposium on Robot and Human Interactive Communication (5010882)
Main Research Area: Technical/natural sciences
Robotics and Control Systems, Actuators, Microcontrollers, Programming, Robot sensing systems, Training
DOIs: 10.1109/ROMAN.2014.6926230
Playware Research – Methodological Considerations

Several sub-disciplines of engineering are driven by the researchers’ aim of providing positive change to the society through their engineering. These researchers are challenged by the traditional research method of experimental research with a waterfall model which demands clearly defined project definition and functional requirements, and impose a sequential processes leading to the final system evaluation, which may lead to solutions which work in the lab, but have little impact in the messy real world. Based on two decades research in developing engineering systems with a societal impact (e.g. in robotics, embodied AI, and playware), in this paper we suggest a cyclic research method based on a mix between participatory and experimental processes. In particular, inspiration from the action research method applied to interdisciplinary technology development becomes a participatory approach characterized by rapid prototyping cycles which allow iterative technology specification and development together with people in their real world environment.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware
Authors: Lund, H. H. (Intern)
Pages: 23-27
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Robotics Networks and Artificial Life
Volume: 1
Issue number: 1
Ratings:
Web of Science (2018): Indexed yes
Web of Science (2017): Indexed yes
Original language: English
Playware, Research Method, Synthesis, Rapid Prototyping, Modular Technology

Practical Application of the MFM Suite on a PWR System: Modelling and Reasoning on Causes and Consequences of Process Anomalies

Multilevel Flow Modelling (MFM) is a functional modelling methodology which applies means - end and parts - whole decomposition and aggregation techniques to handle the complexity of engineering systems. It has been adopted in several case studies to model the process goal and functions of PWR systems. Two of the modelling examples can be found in HWR - 990 and HWR - 1059. The inherent causal reasoning capability enabled the developed MFM models to be used for diagnostic and prognostic analysis. These MFM models have been used to develop the basis for implementing operator support tools, with the aim to facilitate the plant operators to evaluate and understand plant situations. The theoretical aspects have been established for the cooperative development of an MFM software tool, namely MFM Suite, by the Halden Reactor Project (HRP) and the Technical University of Denmark (DTU). The MFM Suite is equipped with an MFM Model Editing Interface to facilitate the modelling process and MFM model analysis modules to run diagnosis and prognosis analyses based on developed models. New features of the MFM Suite also include making corresponding process diagram for the plant being modelled with MFM and linking the MFM model to its process components. The purpose of this report is to make a comprehensive demonstration of how to use the MFM Suite to develop MFM models and run causal reasoning for abnormal situations. This report will explain the capability of representing process and operational knowledge by using the MFM methodology, and demonstrate how the model combined with the MFM reasoning can be used to evaluate the plant state, identify the current situation and support operational decisions. The report will provide a detailed explanation of MFM concepts by modelling the primary side system of the Ringhals Westinghouse PWR and demonstrate the MFM reasoning for accident situation.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS, OECD Halden Reactor Project, Safepark Consultancy
Authors: Zhang, X. (Intern), Thunem, H. P. - J. (Ekstern), Lind, M. (Intern), Jørgensen, S. B. (Intern), Jensen, N. (Ekstern)
Real-time Energy Resource Scheduling considering a Real Portuguese Scenario
The development in power systems and the introduction of decentralized generation and Electric Vehicles (EVs), both connected to distribution networks, represents a major challenge in the planning and operation issues. This new paradigm requires a new energy resources management approach which considers not only the generation, but also the management of loads through demand response programs, energy storage units, EVs and other players in a liberalized electricity markets environment. This paper proposes a methodology to be used by Virtual Power Players (VPPs), concerning the energy resource scheduling in smart grids, considering day-ahead, hour-ahead and real-time scheduling. The case study considers a 33-bus distribution network with high penetration of distributed energy resources. The wind generation profile is based on a real Portuguese wind farm. Four scenarios are presented taking into account 0, 1, 2, and 5 periods (hours or minutes) ahead of the scheduling period in the hour-ahead and real-time scheduling.

Reinforcement Learning Based on the Bayesian Theorem for Electricity Markets Decision Support
This paper presents the applicability of a reinforcement learning algorithm based on the application of the Bayesian theorem of probability. The proposed reinforcement learning algorithm is an advantageous and indispensable tool for ALBidS (Adaptive Learning strategic Bidding System), a multi-agent system that has the purpose of providing decision support to electricity market negotiating players. ALBidS uses a set of different strategies for providing decision support to market players. These strategies are used accordingly to their probability of success for each different context. The approach proposed in this paper uses a Bayesian network for deciding the most probably successful action at each time, depending on past events. The performance of the proposed methodology is tested using electricity market simulations in MASCEM (Multi-Agent Simulator of Competitive Electricity Markets). MASCEM provides the means for simulating a real electricity market environment, based on real data from real electricity market operators.
Remixing playware

In this paper, we describe the concept of remixing playware, which allows sampling and remixing of both physical and functional (e.g. music content) aspects of a system. Such remixing playware has a number of distinguished features which are explained in the paper: user-configurable modularity, which allows the user to interact and manipulate with samples; user-guided behavior-based system, which allows music compositions to emerge from the way performer interacts with the instruments that provide the primitive behaviours; intelligent sampling as the ability of creating samples that allow anybody to remix with the samples ensuring an engaging outcome. The paper exemplifies remixing playware with a variety of implementations in RoboMusic concerts, the virtual MusicTiles app, the physical MagicCubes, the physical dice in Peter Gabriel concerts, and the S'n'S system. These examples focus on music creation and performance, based upon the concept of RoboMusic, and it is argued that the concept of remixing playware extends to many other application areas of playware.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, University of Siena
Authors: Lund, H. H. (Intern), Marti, P. (Ekstern), Tittarelli, M. (Ekstern)
Pages: 49-55
Publication date: 2014

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Publisher: IEEE
ISBN (Print): 9781479967650
BFI conference series: IEEE International Symposium on Robot and Human Interactive Communication (5010882)
Main Research Area: Technical/natural sciences

human computer interaction, interactive systems, music, robots, Robotics and Control Systems, Instruments, intelligent sampling, Materials, Music, physical dices, physical MagicCubes, remixing playware, RoboMusic concerts, Robot kinematics, Sn'n'S system, Sensors, Software, sound and sensors system, user-configurable modularity, user-guided behavior-based system, virtual MusicTiles app
DOIs:
10.1109/ROMAN.2014.6926229
Source: FindIt
Source-ID: 272322539
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Representing Operational Knowledge of PWR Plant by Using Multilevel Flow Modelling

The aim of this paper is to explore the capability of representing operational knowledge by using Multilevel Flow Modelling (MFM) methodology. The paper demonstrates how the operational knowledge can be inserted into the MFM models and be used to evaluate the plant state, identify the current situation and support operational decisions. This paper will provide a general MFM model of the primary side in a standard Westinghouse Pressurized Water Reactor (PWR) system including sub-systems of Reactor Coolant System, Rod Control System, Chemical and Volume Control System, emergency heat removal systems. And the sub-systems’ functions will be decomposed into sub-models according to different operational situations. An operational model will be developed based on the operating procedure by using MFM symbols and this model can be used to implement coordination rules for organize the utilization of different MFM models in different situation. Combining the operational model and different process models, MFM can be used to identify plant situation.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management, Department of Chemical and Biochemical Engineering, CAPEC-PROCESS, Safepark Consultancy
Robust fault detection of linear systems using a computationally efficient set-membership method

In this paper, a computationally efficient set-membership method for robust fault detection of linear systems is proposed. The method computes an interval outer-approximation of the output of the system that is consistent with the model, the bounds on noise and disturbance, and the past measurements. If the output of the system does not belong to this interval, a fault is detected. To compute the output interval, we propose using support functions. Only two support functions for each output must be computed which results in a computationally efficient algorithm. Moreover, the method is trivially parallelizable. The method is demonstrated for fault detection of a hydraulic pitch actuator of a wind turbine. We show the effectiveness of the proposed method by comparing our results with two zonotope-based set-membership methods.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Aalborg University
Authors: Tabatabaeipour, M. (Intern), Bak, T. (Ekstern)
Pages: 358 - 363
Publication date: 2014

Host publication information
Title of host publication: Proceedings of 2014 IEEE Conference on Control Applications (CCA)
Publisher: IEEE
Main Research Area: Technical/natural sciences
Conference: 2014 IEEE International Conference on Control Applications (CCA), Antibes, France, 08/10/2014 - 08/10/2014
DOIs:
10.1109/CCA.2014.6981372
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

RTLabOS Dissemination Activities: RTLabOS D4.2

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy System Management, Automation and Control
Authors: Kosek, A. M. (Intern), Heussen, K. (Intern)
Number of pages: 35
Publication date: 2014

Publication information
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Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
D4.2DisseminationActivities.pdf

Bibliographical note
Cover illustration: Anna Magdalena Kosek

Relations
Projects:
RTLabOS Dissemination Activities
Simulation of static pressure reset control in comfort ventilation
Variable air volume (VAV) ventilation systems reduce fan power consumption compared to constant air volume (CAV) systems because they supply air according to the airflow demand. However VAV ventilation systems do not take fully into account the potential energy savings as the control strategy operates the terminal boxes and the air handling unit (AHU) independently without pressure integration. The pressure in the main duct is maintained at a constant static pressure (CSP) which corresponds to the pressure required under the design full load condition. Under part load conditions, the fan provides excessive static pressure which is dissipated via throttling at the terminal boxes. As a result significant fan power is wasted in mechanical energy losses. The development of sophisticated direct digital controls (DDC) creates possibilities
to integrate feedback from the dampers into the building management system. In this way the operation of central plant equipment is adjusted in real time according to the actual pressure demand; this control scheme can be implemented by the static pressure reset (SPR) method. The SPR control method ensures that at least one damper remains fully opened; thus the fan generates only enough pressure to satisfy the airflow demand in the most critical zone. Consequently the airflow resistance of the ductwork is maintained at a minimum and the fan operation is optimized. There are various approaches to implement the control scheme of the SPR method; the state of the art is represented by the method of trim and respond based on pressure alarms.

This study investigates the operation of the SPR control method of trim and respond based on pressure alarms in a CO₂ demand application where large air volumes are provided to three classrooms. The investigation was based on simulations performed with a fully dynamic model of a VAV ventilation system that was developed in the Simulink programming tool which is add-on software to MATLAB mathematical programming language. The Simulink model was developed in previous research work and was built based on the International Building Physics Toolbox (IBPT), which is a library of blocks constructed for the thermal analysis in building physics. For the purpose of the current investigation the IBPT toolbox was remodelled to integrate the calculation of the airflow demand based on the CO₂ concentration occurring in the zone. The performance of the Simulink model was in previous work evaluated based on the experimental setup of a ventilation system. The investigation of the SPR control algorithm of trim and respond based on pressure alarms disclosed some issues that need to be addressed and optimized before the algorithm can effectively establish the pressure conditions that satisfy the pressure demand under high airflows. In short the algorithm must be tuned to the application beforehand or, preferably, actively learn to perform from continuous feedback before it presents a real plug-and-play solution.

General information
State: Published
Organisations: Department of Civil Engineering, Section for Building Physics and Services, Department of Electrical Engineering, Automation and Control
Authors: Koulani, C. S. (Intern), Prunescu, R. M. (Intern), Hviid, C. A. (Intern), Terkildsen, S. (Intern)
Number of pages: 10
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 35th AIVC Conference
Publisher: Air Infiltration and Ventilation Centre
Main Research Area: Technical/natural sciences
Conference: 35th AIVC Conference, Poznan, Poland, 24/09/2014 - 24/09/2014
CO₂ demand control ventilation, Static pressure reset, Modelling, Simulink, Energy savings
Electronic versions:
Koulani_Simulation_of_static_pressure_reset_control_in_comfort_ventilation_2014.pdf
Source: PublicationPreSubmission
Source-ID: 102382321
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

New challenges are arising in managing power systems as these systems become more complex due to the use of high levels of distributed generation, mainly based on renewable energy sources, and due to the competitive environment within the power sector. At the same time, the use of Phasor Measurement Units (PMUs) provides more information and enables wide-area monitoring with accurate timing. One of the challenges in the near future is converting the high quantity and quality of information provided by PMUs into useful knowledge about operational state of a global system. The use of real-time simulation in closed-loop is essential to develop and validate new real-time applications of wide-area PMU data. This paper presents a simulation platform developed within the research project Secure Operation of Sustainable Power Systems (SOSPO). The SOSPO simulation platform (SOSPO-SP) functions in a closed-loop, integrating new real-time assessment methods to provide useful information to operators in power system control centers and to develop new control methodologies that handle emergency situations and avoid power system blackouts.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy
Number of pages: 12
Pages: 2318-2329
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: I E E E Transactions on Industrial Informatics
Stabiliser Fault Emergency Control using Reconfiguration to Preserve Power System Stability

Stabiliser faults in multi-machine power systems are examined in this paper where fault-masking and system reconguration of the nonlinear system is obtained using a virtual actuator approach. Phasor Measurement Units, which can be integrated in wide-area transmission grids to improve the performance of power system stabilisers, are utilised when reconguring remaining stabilisers after one has been inoperable by a local failure. A stabilitypreserving reconguration is designed using absolute stability results for Lure type systems: The calculation of the virtual actuator that relies on a solution of a linear matrix inequality (LMI) is detailed in the paper. Simulation results of a benchmark transmission system show the ability of the fault-tolerant reconguration strategy to maintain wide-area stability of a power system despite failure in a stabiliser.
General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Siemens
Authors: Pedersen, A. S. (Intern), Richter, J. H. (Ekstern), Tabatabaeipour, M. (Intern), Jóhannsson, H. (Intern), Blanke, M. (Intern)
Number of pages: 7
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 19th IFAC World Congress
Publisher: International Federation of Automatic Control
ISBN (Print): 978-3-902823-62-5
Series: IFAC Workshop Series
Volume: 19
Number: 1
ISSN: 1474-6670
Main Research Area: Technical/natural sciences
Power-system stabilisers, Fault-tolerant systems, System failure and recovery, Absolute stability
Electronic versions:
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Relations
Projects:
Stabiliser Fault Emergency Control using Reconfiguration to Preserve Power System Stability
Source: PublicationPreSubmission
Source-ID: 93043981
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

State of the Art Smart Grid Laboratories - A Survey about Software Use: RTLabOS D1.2

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management
Authors: Heussen, K. (Intern), Gehrke, O. (Intern)
Number of pages: 53
Publication date: 2014

Publication information
Publisher: Technical University of Denmark, Department of Electrical Engineering
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
D1.2_survey_evaluation_final.pdf

Bibliographical note
Cover illustration: Anna Magdalena Kosek

Relations
Projects:
State of the Art Smart Grid Laboratories - A Survey about Software Use
Source: PublicationPreSubmission
Source-ID: 103489850
Publication: Research - peer-review › Report – Annual report year: 2014

Strategic Bidding for Electricity Markets Negotiation Using Support Vector Machines
Energy systems worldwide are complex and challenging environments. Multi-agent based simulation platforms are increasing at a high rate, as they show to be a good option to study many issues related to these systems, as well as the involved players at act in this domain. In this scope the authors' research group has developed a multi-agent system: MASCEM (Multi-Agent System for Competitive Electricity Markets), which simulates the electricity markets environment. MASCEM is integrated with ALBiD (Adaptive Learning Strategic Bidding System) that works as a decision support...
system for market players. The ALBidS system allows MASCEM market negotiating players to take the best possible advantages from the market context. This paper presents the application of a Support Vector Machines (SVM) based approach to provide decision support to electricity market players. This strategy is tested and validated by being included in ALBidS and then compared with the application of an Artificial Neural Network, originating promising results. The proposed approach is tested and validated using real electricity markets data from MIBEL - Iberian market operator

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto
Authors: Pereira, R. (Ekstern), Sousa, T. (Ekstern), Pinto, T. (Ekstern), Praca, I. (Ekstern), Morais, H. (Intern)
Pages: 9-17
Publication date: 2014

Host publication information
Title of host publication: Trends in Practical Applications of Heterogeneous Multi-Agent Systems. : The PAAMS Collection
Publisher: Springer
Editor: Corchado, J.
ISBN (Print): 978-3-319-07475-7
ISBN (Electronic): 978-3-319-07476-4
Series: Advances in Intelligent Systems and Computing
Volume: 293
ISSN: 2194-5357
Main Research Area: Technical/natural sciences
DOIs: 10.1007/978-3-319-07476-4_2
Publication: Research - peer-review › Book chapter – Annual report year: 2014

Survey and Characterization of User Profiles and User Requirements: RTLabOS D2.2

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy System Management, Automation and Control
Authors: Hu, J. (Intern), Heussen, K. (Intern)
Number of pages: 56
Publication date: 2014

Publication information
Publisher: Technical University of Denmark, Department of Electrical Engineering
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions: RTLabOS_version_D2.2_User_Survey_v1.pdf

Bibliographical note
Cover illustration: Anna Magdalena Kosek

Relations
Projects:
Survey and Characterization of User Profiles and User Requirements
Source: PublicationPreSubmission
Source-ID: 103489879
Publication: Research - peer-review › Report – Annual report year: 2014

SW-platform for R&D in Applications of Synchrophasor Measurements for Wide-Area Assessment, Control and Visualization in Real-Time
The Danish research project “Secure Operation of Sustainable Power Systems (SOSPO)” is currently being conducted in a collaboration by a group of partners from academia and industry. The focus of the project is on how to achieve secure operation of the power grid as large scale thermal power plants, supplied by fossil fuel, are phased out in favor of non-controllable renewable energy sources like wind and solar energy. In particular, the SOSPO project aims to develop real-time stability and security assessment methods as well as wide-area control methods to re-establish stable and secure operation when a critical operation has been identified. An important part of the SOSPO project is the development of a SW-platform that enables testing and demonstrations of the various methods for wide-area assessment, control and visualization the project delivers. In order to test the methods under realistic conditions, the future system scenarios are
represented in a real time grid simulator that is an integrated part of the platform. The SW - platform provides structured
access to any model parameter as well as access to real - time phasor measurement unit (PMU) and remote terminal unit
(RTU) snapshots. Having such stru ctured access to relevant data greatly eases the implementation process of new
methods. The SW - platform is facilitated by PowerLabDK at the Technical University of Denmark, which is a new state -
of - the - art experimental laboratory for technology development, testing, training and demonstration of technologies
within electric power and energy. More specifically, the SW - platform exploits the Intelligent Control Lab facilities in
PowerLabDK, which provides access to a powerful Real - Time Digital Simulator, a SCAD A system, a full scale
experimental power system control room with a video wall and an IBM Blade center for the implementation of the SW -
platform and the wide - area methods developed in SOSPO. This paper provides insights into the details of the SOSPO
SW - platform including the technical infrastructure and the platform architecture

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Automation and Control,
RTDS Technology Inc
Authors: Jóhannsson, H. (Intern), Morais, H. (Intern), Pedersen, A. H. B. (Intern), Wu, Q. (Intern), Ouellette, D. (Ekstern)
Number of pages: 8
Publication date: 2014

Host publication information
Title of host publication: Grid of the Future
Main Research Area: Technical/natural sciences
Real - Time Stability and Security Assessment,, SW - Platform for Wide - Area Applications, Synchrophasors and
Applications,, Wide Area Monitoring and Control.
Electronic versions:

Bibliographical note
PowerPoint presentation

Relations
Projects:
SW-platform for R&D in Applications of Synchrophasor Measurements for Wide-Area Assessment, Control and
Visualization in Real-Time
Source: PublicationPreSubmission
Source-ID: 99895397
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Towards a unified European electricity market: The contribution of data-mining to support realistic simulation studies
Worldwide electricity markets have been evolving into regional and even continental scales. The aim at an efficient use of
renewable based generation in places where it exceeds the local needs is one of the main reasons. A reference case of
this evolution is the European Electricity Market, where countries are connected, and several regional markets were
created, each one grouping several countries, and supporting transactions of huge amounts of electrical energy. The
continuous transformations electricity markets have been experiencing over the years create the need to use simulation
platforms to support operators, regulators, and involved players for understanding and dealing with this complex
environment. This paper focuses on demonstrating the advantage that real electricity markets data has for the creation of
realistic simulation scenarios, which allow the study of the impacts and implications that electricity markets transformations
will bring to the participant countries. A case study using MASCEM (Multi-Agent System for Competitive Electricity
Markets) is presented, with a scenario based on real data, simulating the European Electricity Market environment, and
comparing its performance when using several different market mechanisms.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Instituto Superior de Engenharia do Porto
Authors: Pinto, T. (Ekstern), Santos, G. (Ekstern), Pereira, I. F. (Ekstern), Fernandes, R. (Ekstern), Sousa, T. M. (Ekstern)
, Praça, I. (Ekstern), Vale, Z. (Ekstern), Morais, H. (Intern)
Number of pages: 5
Publication date: 2014

Host publication information
Title of host publication: Proceedings of 2014 IEEE PES General Meeting, Conference & Exposition
Publisher: IEEE
Article number: 6939565
Main Research Area: Technical/natural sciences
UR10 Performance Analysis
While working with the UR-10 robot arm, it has become apparent that some commands have undesired behaviour when operating the robot arm through a socket connection, sending one command at a time. This report is a collection of the results obtained when testing the performance of the different commands available in URScript to control the robot. It will also describe the different time delays discovered when using the UR-10 robot arm.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Ravn, O. (Intern), Andersen, N. A. (Intern), Andersen, T. T. (Intern)
Number of pages: 30
Publication date: 2014

Use Cases for Laboratory Software Infrastructure: RTLabOS Phase I: D2.1

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Energy System Management
Authors: Heussen, K. (Intern), Thavlov, A. (Intern), Kosek, A. M. (Intern)
Number of pages: 53
Publication date: 2014

What games do
When interacting with computer games, users are forced to follow the rules of the game in return of the excitement, joy, fun, or other pursued experiences. In this paper, we investigate how games achieve these experiences in the perspective of Actor Network Theory (ANT). Based on a qualitative study we conclude that both board games and computer games are actors that produce experiences by exercising power over the user’s abilities, for example their cognitive functions. Games are designed to take advantage of the characteristics of the human players.
A Clearinghouse Concept for Distribution-Level Flexibility Services

Flexibility resources on the demand side are anticipated to become a valuable asset for balancing renewable energy fluctuation as well as for reducing investment needs in distribution grids. To harvest this flexibility for distribution grids, flexibility services need to be defined that can be integrated with distribution grid operation and that provide a benefit that can be traded off against other grid investments. Two key challenges are here that the identification of useful services is still ongoing and that the transaction cost for the individually small contributions from the demand side could be prohibitive.

This paper introduces a flexibility clearinghouse (FLECH) concept and isolates FLECH key functionality: to facilitate flexibility services in distribution grids by streamlining the relevant business interactions while keeping technical specifications open.

Active fault detection and isolation of discrete-time linear time-varying systems: a set-membership approach

Active fault detection and isolation (AFDI) is used for detection and isolation of faults that are hidden in the normal operation because of a low excitation signal or due to the regulatory actions of the controller. In this paper, a new AFDI method based on set-membership approaches is proposed. In set-membership approaches, instead of a point-wise estimation of the states, a set-valued estimation of them is computed. If this set becomes empty the given model of the system is not consistent with the measurements. Therefore, the model is falsified. When more than one model of the system remains un-falsified, the AFDI method is used to generate an auxiliary signal that is injected into the system for detection and isolation of faults that remain otherwise hidden or non-isolated using passive FDI (PFDI) methods. Having the set-valued estimation of the states for each model, the proposed AFDI method finds an optimal input signal that guarantees FDI in a finite time horizon. The input signal is updated at each iteration in a decreasing receding horizon manner based on the set-valued estimation of the current states and un-falsified models at the current sample time. The problem is solved by a number of linear and quadratic programming problems, which result in a computationally efficient approach.
algorithm. The method is tested on a numerical example as well as on the pitch actuator of a benchmark wind turbine.
A Deported View Concept for Touch Interaction
Following the paradigm shift where physical controls are replaced by touch-enabled surfaces, we report on an experimental evaluation of a user interface concept that allows touchscreen-based panels to be manipulated partially blindly (aircrafts, cars). The proposed multi-touch interaction strategy – involving visual front-view feedback to the user from a copy of the peripheral panel being manipulated – compares favourably against trackballs or head-down interactions.

General information
State: Published
Organisations: Department of Management Engineering, Production and Service Management, Department of Electrical Engineering, Automation and Control, Centre for Playware, Department of Mechanical Engineering, Engineering Design and Product Development
Authors: Alapetite, A. (Intern), Andersen, H. B. (Intern), Fogh, R. (Intern), Özkil, A. G. (Intern)
Pages: 22-27
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Host publication information
Title of host publication: ACHI 2013: The Sixth International Conference on Advances in Computer-Human Interactions
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Main Research Area: Technical/natural sciences
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Links:
http://www.iaria.org/conferences2013/ProgramACHI13.html

Relations
Projects:
A Deported View Concept for Touch Interaction
Press / Media items:
Dynamo: Fremtidens cockpit
Source: dtu
Source-ID: u::7100
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

A distributed and morphology-independent strategy for adaptive locomotion in self-reconfigurable modular robots
In this paper, we present a distributed reinforcement learning strategy for morphology-independent lifelong gait learning for modular robots. All modules run identical controllers that locally and independently optimize their action selection based on the robot’s velocity as a global, shared reward signal. We evaluate the strategy experimentally mainly on simulated, but also on physical, modular robots. We find that the strategy: (i) for six of seven configurations (3–12 modules) converge in 96% of the trials to the best known action-based gaits within 15 min, on average, (ii) can be transferred to physical robots with a comparable performance, (iii) can be applied to learn simple gait control tables for both M-TRAN and ATRON robots, (iv) enables an 8-module robot to adapt to faults and changes in its morphology, and (v) can learn gaits for up to 60 module robots but a divergence effect becomes substantial from 20–30 modules. These experiments demonstrate the advantages of a distributed learning strategy for modular robots, such as simplicity in implementation, low resource requirements, morphology independence, reconfigurability, and fault tolerance.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, University of Southern Denmark
Authors: Christensen, D. J. (Intern), Schultz, U. P. (Ekstern), Stoy, K. (Ekstern)
Pages: 1021–1035
Publication date: 2013
Main Research Area: Technical/natural sciences
A Grey-Box Model for Spray Drying Plants

Multi-stage spray drying is an important and widely used unit operation in the production of food powders. In this paper we develop and present a dynamic model of the complete drying process in a multi-stage spray dryer. The dryer is divided into three stages: The spray stage and two fluid bed stages. Each stage is assumed ideally mixed and described by mass- and energy balances. The model is able to predict the temperature, the residual moisture and the particle size in each
stage. Process constraints are also proposed to predict deposits due to stickiness of the powder. The model predictions are compared to datasets gathered at GEA Process Engineering’s test facility. The identified grey-box model parameters are identified from data and the resulting model fits the data well. The complexity of the model has been selected such that it is suitable for development of real-time optimization algorithms in an economic optimizing MPC framework.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Scientific Computing, Dynamical Systems, Department of Electrical Engineering, Automation and Control, Center for Energy Resources Engineering, GEA Process Engineering A/S
Authors: Petersen, L. N. (Intern), Poulsen, N. K. (Intern), Niemann, H. H. (Intern), Utzen, C. (Ekstern), Jørgensen, J. B. (Intern)
Pages: 559-564
Publication date: 2013

Host publication information
Title of host publication: Proceedings of the 10th IFAC International Symposium on Dynamics and Control of Process Systems
Publisher: Elsevier
Article number: FrM2T2.3
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Main Research Area: Technical/natural sciences
DOIs:
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

Analytical Framework for Market-oriented DSR Flexibility Integration and Management
Integration and management of the flexibility of Demand Side Resources (DSR) in today's energy systems plays a significant role in building up a sustainable society. However, the challenges of understanding, predicating and handling the uncertainties associated this subject to a great extent hamper its development. In this paper, an analytical framework based on a multi-portfolio setup in presence of a deregulated power market is proposed to address such challenges by adopting the thinking in modern portfolio theory (MPT). A Numerical example that targets on analyzing the risk and return for various flexibility pricing strategies are presented to illustrate some features of the framework.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Automation and Control
Authors: You, S. (Intern), Hu, J. (Intern), Heussen, K. (Intern), Zhang, C. (Intern)
Pages: 1367-1371
Publication date: 2013
Main Research Area: Technical/natural sciences

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Journal: Energy and Power Engineering
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Publication: Research - peer-review › Journal article – Annual report year: 2013
An MPC approach to individual pitch control of wind turbines using uncertain LIDAR measurements

Spatial distribution of the wind field exerts unbalanced loads on wind turbine structures and it is shown these loads could be mitigated by controlling each blade’s angle individually (individual pitch control). In this work the problem of individual pitch control of a variable-speed variable pitch wind turbine in the full load region is considered. Model predictive control (MPC) is used to solve the problem. A new approach is proposed to simplify the optimization problem of MPC. We linearize the obtained nonlinear model for different operating points which are determined by the effective wind speed on the rotor disc and take the wind speed as a scheduling variable. The wind speed is measurable ahead of the turbine using LIDARS, therefore the scheduling variable is known for the entire prediction horizon. We consider uncertainty in the wind propagation, which is the traveling time of wind from the LIDAR measurement point to the rotor. An algorithm based on wind speed estimation and measurements from the LIDAR is devised to find an estimate of the delay and compensate for it before it is used in the controller. Comparisons between the MPC with error compensation, without error compensation and a benchmark cyclic pitch PI controller are given. The results show that with appropriate signal processing techniques, LIDAR measurements improve the performance of the wind turbine controller.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Dynamical Systems, Department of Electrical Engineering, Automation and Control, Aalborg University
Authors: Mirzaei, M. (Intern), Soltani, M. (Ekstern), Poulsen, N. K. (Intern), Niemann, H. H. (Intern)
Pages: 490-495
Publication date: 2013

Host publication information
Title of host publication: 2013 European Control Conference (ECC)
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BFI conference series: European Control Conference (5010925)
Main Research Area: Technical/natural sciences
Conference: 12th European Control Conference (ECC 2013), Zurich, Switzerland, 17/07/2013 - 17/07/2013
Electronic versions:
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Source-ID: u::7467
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

A novel hypothesis splitting method implementation for multi-hypothesis filters
The paper presents a multi-hypothesis filter library featuring a novel method for splitting Gaussians into ones with smaller variances. The library is written in C++ for high performance and the source code is open and free1. The multi-hypothesis filters commonly approximate the distribution transformations better, if the covariances of the individual hypotheses are sufficiently small. We propose a look-up table based method to calculate a set of Gaussian hypotheses approximating a wider Gaussian in order to improve the filter approximation. Python bindings for the library are also provided for fast prototyping.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Bayramoglu, E. (Intern), Ravn, O. (Intern), Andersen, N. A. (Intern)
Pages: 574-579
Publication date: 2013

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Publisher: IEEE
ISBN (Print): 9781467347075
Main Research Area: Technical/natural sciences
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Approximation theory, C++ language, Filtering theory, Gaussian distribution, Mobile robots, Public domain software, Software libraries, Table lookup
DOIs:
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Source-ID: n::oai:DTIC-ART:iel/389836948::32382
Apply Functional Modeling to Consequence Analysis in Supervision Systems

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Zhang, X. (Intern)
Number of pages: 15
Publication date: 2013

Publication information
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Main Research Area: Technical/natural sciences
Electronic versions:
PPT_ROM_XZ.pdf

Relations
Activities:
8th HOLMUG meeting

Apply Functional Modelling to Consequence Analysis in Supervision Systems
This paper will first present the purpose and goals of applying functional modelling approach to consequence analysis by adopting Multilevel Flow Modelling (MFM). MFM Models describe a complex system in multiple abstraction levels in both means-end dimension and whole-part dimension. It contains causal relations between functions and goals. A rule base system can be developed to trace the causal relations and perform consequence propagations. This paper will illustrate how to use MFM for consequence reasoning by using rule base technology and describe the challenges for integrating functional consequence analysis to practical or online applications in supervision systems. It will also suggest a multiagent solution as the integration architecture for developing tools to facilitate the utilization results of functional consequence analysis. Finally a prototype of the multiagent reasoning system will be introduced.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Institute for Energy Technology
Authors: Zhang, X. (Intern), Lind, M. (Intern), Gola, G. (Ekstern), Ravn, O. (Intern)
Number of pages: 10
Publication date: 2013

Host publication information
Title of host publication: Proceedings of EHPG 2013
Main Research Area: Technical/natural sciences
Conference: 37th Enlarged Halden Programme Group Meeting, Storefjell, Norway, 10/03/2013 - 10/03/2013
Electronic versions:
FullP_EHPG_XZ.pdf
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

Call for Papers: 'Adaptive methods and signal processing for marine systems'

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, University of Plymouth
Authors: Blanke, M. (Intern), Sutton, R. (Ekstern)
Pages: 200
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Volume: 28
Cloud-based Networked Visual Servo Control

The performance of vision-based control systems, in particular of highly dynamic vision-based motion control systems, is often limited by the low sampling rate of the visual feedback caused by the long image processing time. In order to overcome this problem, the networked visual servo control, which integrates networked computational resources for cloud image processing, is considered in this article. The main contributions of this article are i) a real-time transport protocol for transmitting large volume image data on a cloud computing platform, which enables high sampling rate visual feedback, ii) a stabilizing control law for the networked visual servo control system with time-varying feedback time delay, and iii) a sending rate scheduling strategy aiming at reducing the communication network load. The performance of the networked visual servo control system with sending rate scheduling is validated in an object tracking scenario on a 14 degree-of-freedom dual-arm robot. Experimental results show the superior performance of our approach. In particular the
communication network load is substantially reduced by means of the scheduling strategy without performance degradation.

**General information**

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Technische Universität München
Authors: Wu, H. (Intern), Lu, L. (Ekstern), Chen, C. (Ekstern), Hirche, S. (Ekstern), Kühnlenz, K. (Ekstern)
Pages: 554 - 566
Publication date: 2013
Main Research Area: Technical/natural sciences

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Scopus rating (2017): SJR 2.192 SNIP 3.257 CiteScore 9.07
Web of Science (2017): Indexed Yes
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Scopus rating (2016): CiteScore 9.25 SJR 2.289 SNIP 3.669
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.476 SNIP 4.081 CiteScore 9.47
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.341 SNIP 4.647 CiteScore 9.19
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.21 SNIP 5.01 CiteScore 9.14
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.075 SNIP 4.304 CiteScore 8.27
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.954 SNIP 3.841 CiteScore 7.72
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.679 SNIP 3.179
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.722 SNIP 3.141
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.126 SNIP 3.57
Scopus rating (2007): SJR 2.029 SNIP 2.849
Scopus rating (2006): SJR 0.964 SNIP 2.586
Scopus rating (2005): SJR 1.815 SNIP 2.677
Scopus rating (2004): SJR 1.746 SNIP 2.778
Scopus rating (2003): SJR 2.125 SNIP 2.241
Scopus rating (2002): SJR 1.207 SNIP 1.641
Scopus rating (2001): SJR 1.685 SNIP 1.799
Consequence Reasoning in Multilevel Flow Modelling

Consequence reasoning is a major element for operation support system to assess the plant situations. The purpose of this paper is to elaborate how Multilevel Flow Models can be used to reason about consequences of disturbances in complex engineering systems. MFM is a modelling methodology for representing process knowledge for complex systems. It represents the system by using means-end and part-whole decompositions, and describes not only the purposes and functions of the system but also the causal relations between them. Thus MFM is a tool for causal reasoning. The paper introduces MFM modelling syntax and gives detailed reasoning formulas for consequence reasoning. The reasoning formulas offers basis for developing rule-based system to perform consequence reasoning based on MFM, which can be used for alarm design, risk monitoring, and supervision and operation support system design.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy
Authors: Zhang, X. (Intern), Lind, M. (Intern), Ravn, O. (Intern)
Number of pages: 8
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Host publication information
Title of host publication: Proceedings of the 12th IFAC/IFIP/IFORS/IEA Symposium on Analysis, Design, and Evaluation of Human - Machine Systems
Publisher: Elsevier
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Main Research Area: Technical/natural sciences
Multilevel Flow Modelling, Knowledge representation, Functional modelling, Consequence reasoning, Rule-based system, Decision support system
Electronic versions:
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DOIs:
10.3182/20130811-5-US-2037.00028
Source: dtu
Source-ID: u::8447
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

Contextual Intelligent Load Management Considering Real Time Pricing in a Smart Grid Environment

The use of demand response programs enables the adequate use of resources of small and medium players, bringing high benefits to the smart grid, and increasing its efficiency. One of the difficulties to proceed with this paradigm is the lack of intelligence in the management of small and medium size players. In order to make demand response programs a feasible solution, it is essential that small and medium players have an efficient energy management and a fair optimization mechanism to decrease the consumption without heavy loss of comfort, making it acceptable for the users. This paper addresses the application of real-time pricing in a house that uses an intelligent optimization module involving artificial neural networks.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto
Authors: Gomes, L. (Ekstern), Fernandes, F. (Ekstern), Faria, P. (Ekstern), Vale, Z. (Ekstern), Ramos, C. (Ekstern), Morais, H. (Intern)
Number of pages: 6
Publication date: 2013
Control Surface Fault Diagnosis with Specified Detection Probability - Real Event Experiences

Diagnosis of actuator faults is crucial for aircraft since loss of actuation can have catastrophic consequences. For autonomous aircraft the steps necessary to achieve fault tolerance is limited when only basic and non-redundant sensor and actuators suites are present. Through diagnosis that exploits analytical redundancies it is, nevertheless, possible to cheaply enhance the level of safety. This paper presents a method for diagnosing control surface faults by using basic sensors and hardware available on an autonomous aircraft. The capability of fault diagnosis is demonstrated obtaining desired levels of false alarms and detection probabilities. Self-tuning residual generators are employed for diagnosis and are combined with statistical change detection to form a setup for robust fault diagnosis. On-line estimation of test statistics is used to obtain a detection threshold and a desired false alarm probability. A data based method is used to determine the validity of the methods proposed. Verification is achieved using real data and shows that the presented diagnosis method is efficient and could have avoided incidents where faults led to loss of aircraft.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Hansen, S. (Intern), Blanke, M. (Intern)
Pages: 526-531
Publication date: 2013

DARC: Next generation decentralized control framework for robot applications

This paper presents DARC, a next generation control framework for robot applications. It is designed to be equally powerful in prototyping research projects and for building serious commercial robots running on low powered embedded hardware, thus closing the gap between research and industry. It incorporates several new techniques such as a decentralized peer-to-peer architecture, transparent network distribution of the control system, and automatic run-time supervision to guarantee robustness.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Kjærgaard, M. (Intern), Andersen, N. A. (Intern), Ravn, O. (Intern)
Pages: 1598-1602
Publication date: 2013
Decision support tool for Virtual Power Players: Hybrid Particle Swarm Optimization applied to Day-ahead Vehicle-To-Grid Scheduling

This paper presents a decision support Tool methodology to help virtual power players (VPPs) in the Smart Grid (SGs) context to solve the day-ahead energy resource scheduling considering the intensive use of Distributed Generation (DG) and Vehicle-To-Grid (V2G). The main focus is the application of a new hybrid method combining a particle swarm approach and a deterministic technique based on mixed-integer linear programming (MILP) to solve the day-ahead scheduling minimizing total operation costs from the aggregator point of view. A realistic mathematical formulation, considering the electric network constraints and V2G charging and discharging efficiencies is presented. Full AC power flow calculation is included in the hybrid method to allow taking into account the network constraints. A case study with a 33-bus distribution network and 1800 V2G resources is used to illustrate the performance of the proposed method.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto
Authors: Soares, J. (Ekstern), Valle, Z. (Ekstern), Morais, H. (Intern)
Number of pages: 6
Publication date: 2013

Dispatch of distributed energy resources to provide energy and reserve in smart grids using a particle swarm optimization approach

The smart grid concept is a key issue in the future power systems, namely at the distribution level, with deep concerns in the operation and planning of these systems. Several advantages and benefits for both technical and economic operation of the power system and of the electricity markets are recognized. The increasing integration of demand response and distributed generation resources, all of them mostly with small scale distributed characteristics, leads to the need of aggregating entities such as Virtual Power Players. The operation business models become more complex in the context of smart grid operation. Computational intelligence methods can be used to give a suitable solution for the resources scheduling problem considering the time constraints. This paper proposes a methodology for a joint dispatch of demand response and distributed generation to provide energy and reserve by a virtual power player that operates a distribution network. The optimal schedule minimizes the operation costs and it is obtained using a particle swarm optimization approach, which is compared with a deterministic approach used as reference methodology. The proposed method is applied to a 33-bus distribution network with 32 medium voltage consumers and 66 distributed generation units.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto, Instituto Superior de Engenharia do Porto
Authors: Faria, P. (Ekstern), Soares, T. (Ekstern), Pinto, T. (Ekstern), Sousa, T. M. (Ekstern), Soares, J. (Ekstern), Vale, Z. (Ekstern), Morais, H. (Intern)
Pages: 51-58
Publication date: 2013
Distribution Networks Management with High Penetration of Photovoltaic Panels

The photovoltaic solar panels penetration increases significantly in recent years in several European countries, mainly in the low voltage and medium voltage networks supported by governmental policies and incentives. Consequently, the acquisition and installation costs of PV panels decrease and the know-how increase significantly. Presently is important the use of new management methodologies in distribution networks to support the growing penetration of PV panels. In some countries, like in Germany and in Italy, the solar generation based in photovoltaic panels supply 40% of the demand in some periods of sunny days, mainly in the weekends. In the present work are technically analysed three different approaches to improve the number of PV systems in a distribution network, namely the use of inductors/capacitors, the use of storage systems and the control of reactive power injected by inverters of PV systems.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Morais, H. (Intern)
Pages: 4337-4341
Publication date: 2013

Dynamic modeling and validation of a lignocellulosic enzymatic hydrolysis process: A demonstration scale study

The enzymatic hydrolysis process is one of the key steps in second generation biofuel production. After being thermally pretreated, the lignocellulosic material is liquefied by enzymes prior to fermentation. The scope of this paper is to evaluate a dynamic model of the hydrolysis process on a demonstration scale reactor. The following novel features are included: the application of the Convection–Diffusion–Reaction equation to a hydrolysis reactor to assess transport and mixing effects; the extension of a competitive kinetic model with enzymatic pH dependency and hemicellulose hydrolysis; a comprehensive pH model; and viscosity estimations during the course of reaction. The model is evaluated against real data extracted from a demonstration scale biorefinery throughout several days of operation. All measurements are within predictions uncertainty and, therefore, the model constitutes a valuable tool to support process optimization, performance monitoring, diagnosis and process control at full-scale studies.
Early Detection of Parametric Roll Resonance on Container Ships

Parametric roll resonance on ships is a nonlinear phenomenon where waves encountered at twice the natural roll frequency can bring the vessel dynamics into a bifurcation mode and lead to extreme values of roll. Recent years have seen several incidents with dramatic damage to container vessels. The roll oscillation, which is subharmonic with respect to the wave excitation, may be completely unexpected and a system for detection of the onset of such resonance could warn the navigators before roll angles reach serious levels. Timely warning could make remedial actions possible, such as change the ship's speed and course, to escape from the bifurcation condition. This paper proposes nonparametric methods to detect the onset of roll resonance and demonstrates their performance. Theoretical conditions for parametric resonance are revisited and are used to develop efficient methods to detect its onset. Spectral and temporal correlations of the square of roll with pitch (or heave) are demonstrated to be of particular interest as indicators. Properties of the indicators are scrutinized, and a change detector is designed for the Weibull-type of distributions that were observed from a time-domain indicator for phase correlation. Hypothesis testing for resonance is developed using a combination of detectors to obtain robustness. Conditions of forced roll and disturbances in real weather conditions are analyzed and robust detection techniques are suggested. The efficacy of the methodology is shown on experimental data from model tests and on data from a container ship crossing the Atlantic during a storm.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Department of Informatics and Mathematical Modeling, Mathematical Statistics
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Scopus rating (2014): SJR 1.786 SNIP 3.006 CiteScore 4.34
Web of Science (2014): Indexed yes
Effect of Playful Balancing Training - A Pilot Randomized Controlled Trial

We used the modular playware in the form of modular interactive tiles for playful training of community-dwelling elderly with balancing problem. During short-term play on the modular interactive tiles, the elderly were playing physical, interactive games that were challenging their dynamic balance, agility, endurance, and sensor-motoric reaction. A population of 12 elderly (average age: 79) with balancing problems (DGI average score: 18.7) was randomly assigned to control group or tiles training group, and tested before and after intervention. The tiles training group had statistical significant increase in balancing performance (DGI score: 21.3) after short-term playful training with the modular interactive tiles, whereas the control group remained with a score indicating balancing problems and risk of falling (DGI score: 16.6). The small pilot randomized controlled trial suggests that the playful interaction with the modular interactive tiles has a significant effect even after a very short time of play. The average total training time to obtain the statistical significant effect amounted to just 2h45m.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware
Authors: Lund, H. H. (Intern), Jessen, J. D. (Intern)
Publication date: 2013
Exception detection and handling in mission control for mobile robots

This paper introduces a method for robust, rule-based mission control for mobile robots in a modular framework. Due to the modularity of the framework, it is possible to use both hierarchical control and reactive behavior seamlessly to find solutions to both planned and unplanned events in the mission execution. A demonstration example for office navigation is presented along with considerations for rules that should ensure robust solving of missions.

Exhaust Gas Recirculation Control for Large Diesel Engines - Achievable Performance with SISO Design

This paper investigates control possibilities for Exhaust Gas Recirculation (EGR) on large diesel engines. The goal is to reduce the amount of NOx in the exhaust gas by reducing the oxygen concentration available for combustion. Control limitations imposed by the system are assessed using linear analysis of the highly non-linear dynamics. Control architectures are investigated and performance in terms of disturbance rejection and reference tracking are investigated under model uncertainty. Classical feed-forward and feedback controller designs are investigated using classical and Quantitative Feedback Theory (QFT) designs. Validation of the controller is made on the model with focus on disturbance reduction ability.
Fable: Design of a Modular Robotic Playware Platform
We are developing the Fable modular robotic system as a playware platform that will enable non-expert users to develop robots ranging from advanced robotic toys to robotic solutions to problems encountered in their daily lives. This paper presents the mechanical design of Fable: a chain-based system composed of reconfigurable heterogeneous modules with a reliable and scalable connector. Furthermore, this paper describes tests where the connector design is tested with children, and presents examples of a moving snake and a quadruped robot, as well as an interactive upper humanoid torso.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, Playful Invention Company
Authors: Pacheco, M. (Intern), Moghadam, M. (Intern), Magnússon, A. (Intern), Silverman, B. (Ekstern), Lund, H. H. (Intern), Christensen, D. J. (Intern)
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Fable: Socially Interactive Modular Robot
Modular robots have a significant potential as user-reconfigurable robotic playware, but often lack sufficient sensing for social interaction. We address this issue with the Fable modular robotic system by exploring the use of smart sensor modules that has a better ability to sense the behavior of the user. In this paper we describe the development of a smart sensor module which includes a 3D depth camera, and a server-side software architecture featuring user tracking, posture detection and a near-real-time facial recognition. Further, we describe how the Fable system with the smart sensor module has been tested in educational and playful contexts and present experiments to document its functional performance.

General information
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Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware
Authors: Magnússon, A. (Intern), Pacheco, M. (Intern), Moghadam, M. (Intern), Lund, H. H. (Intern), Christensen, D. J. (Intern)
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Fault tolerant control of systems with saturations

This paper presents framework for fault tolerant controllers (FTC) that includes input saturation. The controller architecture known from FTC is based on the Youla-Jabr-Bongiorno-Kucera (YJBK) parameterization is extended to handle input saturation. Applying this controller architecture in connection with faulty systems including input saturation gives an additional YJBK transfer function related to the input saturation. In the fault free case, this additional YJBK transfer function can be applied directly for optimizing the feedback loop around the input saturation. In the faulty case, the design problem is a mixed design problem involved both parametric faults and input saturation.

Fault-tolerant gait learning and morphology optimization of a polymorphic walking robot

This paper presents experiments with a morphology-independent, life-long strategy for online learning of locomotion gaits. The experimental platform is a quadruped robot assembled from the LocoKit modular robotic construction kit. The learning strategy applies a stochastic optimization algorithm to optimize eight open parameters of a central pattern generator based gait implementation. We observe that the strategy converges in roughly ten minutes to gaits of similar or higher velocity than a manually designed gait and that the strategy readapts in the event of failed actuators. We also optimize offline the reachable space of a foot based on a reference design but finds that the reality gap hardens the successfully transference to the physical robot. To address this limitation, in future work we plan to study co-learning of morphological and control parameters directly on physical robots.
**Frequency weighted model predictive control of wind turbine**

This work is focused on applying frequency weighted model predictive control (FMPC) on three blade horizontal axis wind turbine (HAWT). A wind turbine is a very complex, non-linear system influenced by a stochastic wind speed variation. The reduced dynamics considered in this work are the rotational degree of freedom of the rotor and the tower for-aft movement. The MPC design is based on a receding horizon policy and a linearised model of the wind turbine. Due to the change of dynamics according to wind speed, several linearisation points must be considered and the control design adjusted accordingly. In practice is very hard to measure the effective wind speed, this quantity will be estimated using measurements from the turbine itself. For this purpose stationary predictive Kalman filter has been used. Stochastic simulations of the wind turbine behaviour with applied frequency weighted model predictive controller are presented. Statistical comparison between frequency weighted MPC, standard MPC and baseline PI controller is shown as well.

**Grid storage and flexibility**

This work is focused on applying frequency weighted model predictive control (FMPC) on three blade horizontal axis wind turbine (HAWT). A wind turbine is a very complex, non-linear system influenced by a stochastic wind speed variation. The reduced dynamics considered in this work are the rotational degree of freedom of the rotor and the tower for-aft movement. The MPC design is based on a receding horizon policy and a linearised model of the wind turbine. Due to the change of dynamics according to wind speed, several linearisation points must be considered and the control design adjusted accordingly. In practice is very hard to measure the effective wind speed, this quantity will be estimated using measurements from the turbine itself. For this purpose stationary predictive Kalman filter has been used. Stochastic simulations of the wind turbine behaviour with applied frequency weighted model predictive controller are presented. Statistical comparison between frequency weighted MPC, standard MPC and baseline PI controller is shown as well.
Hand-Eye Calibration and Inverse Kinematics of Robot Arm using Neural Network

Traditional technologies for solving hand-eye calibration and inverse kinematics are cumbersome and time consuming due to the high nonlinearity in the models. An alternative to the traditional approaches is the artificial neural network inspired by the remarkable abilities of the animals in different tasks. This paper describes the theory and implementation of neural networks for hand-eye calibration and inverse kinematics of a six degrees of freedom robot arm equipped with a stereo vision system. The feedforward neural network and the network training with error propagation algorithm are applied. The proposed approaches are validated in experiments. The results indicate that the hand-eye calibration with simple neural network outperforms the conventional method. Meanwhile, the neural network exhibits a promising performance in solving inverse kinematics.

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Hazard Identification of the Offshore Three-phase Separation Process Based on Multilevel Flow Modeling and HAZOP

HAZOP studies are widely accepted in chemical and petroleum industries as the method for conducting process hazard analysis related to design, maintenance and operation of the systems. Different tools have been developed to automate HAZOP studies. In this paper, a HAZOP reasoning method based on function-oriented modeling, Multilevel Flow Modeling (MFM), is extended with function roles. A graphical MFM editor, which is combined with the reasoning capabilities of the MFM Workbench developed by DTU is applied to automate HAZOP studies. The method is proposed to support the “brain-storming” sessions in traditional HAZOP analysis. As a case study, the extended MFM based HAZOP methodology is applied to an offshore three-phase separation process. The results show that the cause-consequence analysis in MFM can infer the cause and effect of a deviation used in HAZOP and used to fill HAZOP worksheet. This paper is the first paper discussing and demonstrate the potential of the roles concept in MFM to supplement the integrity of HAZOP analysis.

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Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy, Department of Chemical and Biochemical Engineering, Computer Aided Process Engineering Center, China University of Petroleum, Technical University of Denmark
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HVDC Connected Offshore Wind Power Plants: Review and Outlook of Current Research

This paper presents a state-of-the-art review on grid integration of large offshore wind power plants (OWPPs) using high voltage direct voltage (HVDC) for grid connection. The paper describes in detail selected challenges hereto and presents how DONG Energy Wind Power (DEWP) is addressing these challenges through three coordinated PhD projects in close collaboration with leading academia within the field. The overall goal of these projects is to acquire in-depth knowledge of relevant operating phenomena in the offshore OWPP grid, rich with power electronics devices (PEDs) such as the HVDC and the PED widely used in the wind turbine generators (WTGs). Challenges hereto include PED control system interaction (from a stability point of view), assessment of the quality of vendor supplied control systems and their robustness against e.g. short circuits and load rejection. Furthermore, the outcome of the projects will be developed and validated models of e.g. the HVDC system, methodologies for assessment of control system stability and fault identification in implemented control system.

General information
State: Published
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HVDC Connected Offshore Wind Power Plants: Review and Outlook of Current Research
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Lessons Learned in Designing User-configurable Modular Robotics

User-configurable robotics allows users to easily configure robotic systems to perform task-fulfilling behaviors as desired by the users. With a user configurable robotic system, the user can easily modify the physical and functional aspect in terms of hardware and software components of a robotic sys-tem, and by making such modifications the user becomes an integral part in the creation of an intelligence response to the challenges posed in a given environ-ment. I.e. the overall intelligent response in the environment becomes the inte-gration of the user’s construction and creation with the semi-autonomous com-ponents of the user-configurable robotic system in interaction with the given environment. Components constituting such a user-configurable robotic system can be characterized as modules in a modular robotic system. Several factors in the definition and implementation of these modules have consequences for the user-configurability of the system. These factors include the modules’ granular-ity, autonomy, connectivity, affordance, transparency, and interaction.

Load Control Timescales Simulation in a Multi-Agent Smart Grid Platform

Environmental concerns and the shortage in the fossil fuel reserves have been potentiating the growth and globalization of distributed generation. Another resource that has increasing its importance is the demand response, which is used to change consumers’ consumption profile, helping to reduce peak demand. Aiming to support small players' participation in demand response events, the Curtailment Service Provider emerged. This player works as an aggregator for demand response events. The control of small and medium players which act in smart grid and micro grid environments is enhanced with a multi-agent system with artificial intelligence techniques – the MASGriP (Multi-Agent Smart Grid Platform). Using strategic behaviours in each player, this system simulates the profile of real players by using software agents. This paper shows the importance of modeling these behaviours for studying this type of scenarios. A case study with three examples shows the differences between each player and the best behaviour in order to achieve the higher profit in each situation.
Maximizing the Social Welfare of Virtual Power Players Operation in Case of Excessive Wind Power
The integration of growing amounts of distributed generation in power systems, namely at distribution networks level, has been fostered by energy policies in several countries around the world, including in Europe. This intensive integration of distributed, non-dispatchable, and natural sources based generation (including wind power) has caused several changes in the operation and planning of power systems and of electricity markets. Sometimes the available non-dispatchable generation is higher than the demand. This generation must be used; otherwise it is wasted if not stored or used to supply additional demand. New policies and market rules, as well as new players, are needed in order to competitively integrate all the resources.

The methodology proposed in this paper aims at the maximization of the social welfare in a distribution network operated by a virtual power player that aggregates and manages the available energy resources. When facing a situation of excessive non-dispatchable generation, including wind power, real time pricing is applied in order to induce the increase of consumption so that wind curtailment is minimized. This method is especially useful when actual and day-ahead resources forecast differ significantly. The distribution network characteristics and concerns are addressed by including the network constraints in the optimization model. The proposed methodology has been implemented in GAMS optimization tool and its application is illustrated in this paper using a real 937-bus distribution network with 20.310 consumers and 548 distributed generators, some of them non-dispatchable and with must take contracts. The implemented scenario corresponds to a real day in Portuguese power system.

Modelling and L1 Adaptive Control of pH in Bioethanol Enzymatic Process
The enzymatic process is a key step in second generation bioethanol production. Pretreated biomass fibers are liquefied with the help of enzymes to facilitate fermentation. Enzymes are very sensitive to pH and temperature and the main control challenge in the nonlinear process is to ensure minimum deviations from the optimal pH level. This article develops a mathematical model for the pH, which has not been reported earlier for this particular process. The new model embeds flow dynamics and pH calculations and serves both for simulation and control design. Two control strategies are then formulated for pH level regulation: one is a classical PI controller; the other an L1 adaptive output feedback controller.
Model-based feed-forward terms are added to the controllers to enhance their performances. A new tuning method of the L1 adaptive controller is also proposed. Further, a new performance function is formulated and tailored to this type of processes and is used to monitor the performances of the process in closed loop. The L1 design is found to outperform the PI controller in all tests.

**Modelling and L1 Adaptive Control of Temperature in Biomass Pretreatment**

Biomass steam pretreatment is a key process in converting agricultural wastes to bioethanol. The pretreatment occurs in a large pressurized tank called a thermal reactor. Two key parameters influence the successfulness of the process: the reactor temperature, and the retention time. A particle pump pressurizes untreated biomass from atmospheric to reactor pressure with recycled steam from the reactor. This paper formulates a steam mathematical model both for the thermal reactor and the particle pump, which is then used to design an L1 adaptive output feedback controller for the reactor temperature. As steam is recycled from the reactor to pressurize the particle pump, pressure drops and the reactor temperature is disturbed. The main control challenge is to reject these disturbances and keep a steady temperature. The nonlinear process model embeds mass and energy balances, valve characteristics, and enthalpy-pressure and pressure-temperature dependencies. Nonlinear feed-forward terms are added in the control strategy. The process model, the control strategy, the application of the L1 adaptive controller and its tuning method based on minimizing a cost function represent novelties of this paper.
**Modelling for Control of Exhaust Gas Recirculation on Large Diesel Engines**

Exhaust Gas Recirculation (EGR) reduces NOx emissions by reducing O2 concentration for the combustion and is a preferred way to obtain emission regulations that will take effect from 2016. If not properly controlled, reduction of O2 has adverse side effects and proper control requires proper dynamic models. While literature is rich on four-stroke automotive engines, this paper considers two-stroke engines and develops a non-linear dynamic model of the exhaust gas system. Parameters are determined by system identification. The paper uses black-box nonlinear model identification and modelling from first principles followed by parameter identification and compares the results of these approaches. The paper performs a validation against experimental data from a test engine and presents a linearised model for EGR control design.

**General information**

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, MAN Diesel & Turbo SE, Technical University of Denmark
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**Model Predictive Control of Wind Turbines using Uncertain LIDAR Measurements**

The problem of Model predictive control (MPC) of wind turbines using uncertain LIDAR (LIght Detection And Ranging) measurements is considered. A nonlinear dynamical model of the wind turbine is obtained. We linearize the obtained nonlinear model for different operating points, which are determined by the effective wind speed on the rotor disc. We take the wind speed as a scheduling variable. The wind speed is measurable ahead of the turbine using LIDARs, therefore, the scheduling variable is known for the entire prediction horizon. By taking the advantage of having future values of the scheduling variable, we simplify state prediction for the MPC. Consequently, the control problem of the nonlinear system is simplified into a quadratic programming. We consider uncertainty in the wind propagation time, which is the traveling time of wind from the LIDAR measurement point to the rotor. An algorithm based on wind speed estimation and measurements from the LIDAR is devised to find an estimate of the delay and compensate for it before it is used in the controller. Comparisons between the MPC with error compensation, the MPC without error compensation and an MPC with re-linearization at each sample point based on wind speed estimation are given. It is shown that with appropriate signal processing techniques, LIDAR measurements improve the performance of the wind turbine controller.

**General information**

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**Modular Platform for Commercial Mobile Robots**

Despite a rapid development in computers and sensor technologies, surprisingly few autonomous robot systems have successfully made it to the consumer market and into people's homes. Robotics is a popular topic in research circles, but focus is often on ground-breaking technologies, and not on putting the robots on the commercial market. At the time when this research project was started in May 2010, the amount of successful commercial applications based on mobile robots was very limited. The most known applications were vacuum cleaners, lawn mowers, and few examples of specialized transport robots used in warehouses and hospitals. At the same time, despite attempting to solve the same tasks and applications, the resulting software and products of research groups was very fragmented. Even if being open source, the software was based on self-made frameworks and often only used internally by the individual groups and perhaps a few close industrial partners. This research project addresses the problem of increasing the potential for more commercial applications based on mobile wheeled robots. Therefore the main focus is not on inventing new ground-breaking robotics technology, but instead understanding why the existing technology and algorithms are not ready for production. One focus area of this project is an analysis of these existing Technologies and algorithms for mobile robots. The most fundamental task for a mobile robot is navigation, yet no generic and ready to use implementation for solving this exists. This project includes an effort towards such a generic navigation system. It should provide a stable and easy-to-setup experience for robotics researcher and industry integrators who needs navigation capability for a specific mobile robot. At the same time a common package for navigation will provide a base for many researchers to contribute to and mature over time. The second focus area was to close the gap between research and industry by providing the necessary tools and motivation for researchers to create more robust prototype applications. During the time of the project period, a significant research community was created around one specific robot control framework called ROS. From the very beginning, this research project acknowledged the value of such a community, and put a significant eort into influencing the ROS framework to become usable also for industry and commercial applications. Based on a requirement analysis for such a framework, a prototype implementation of an industry ready component based ROS compatible middleware was created.

The project also includes work towards a smart parameter framework, assisting in configuring the individual components in a component based control framework. The smart parameters adapt to the respective robot, and makes it possible to reuse advanced software components, without Expert knowledge about the underlying algorithms. The smart parameters also assists in building a robot system, that can autonomously calibrate and optimize itself.

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**Multi-agent approach for power system in a smart grid protection context**

With increasing penetration of electricity application in society and the need of majority of appliance to electricity, high level of reliability becomes more essential; in one hand with deregulation of electricity market in production, transmission and distribution and emerge of competitive electricity markets and in the other hand with increasing penetration of Distributed Generation (DG) because of environment issues and diminishing in fossil fuel reserves and its price growth, made microgrid more attractive. Micro grids are considers as partial of SmartGrid system to accommodate DGs as well as control, protection and operation systems for electrical equipment to connect generation to consumption in better and more reliable way to maintain adequate operation system in distribution level. A highly challenging issue in Microgrid is protection scheme, which needs to develop and modify. This paper proposes a new approach for protection in a Microgrid environment as a part of SmartGrid: Multi-agent system to Protections Coordination (MAS-ProteC) which integrated in MASGrIP (Multi-Agent Smart Grid Platform), providing protection services within network operation in SmartGrid in electricity market context.
Multilevel Coordination in Smart Grids for Congestion Management of Distribution Grid

The operation of the distribution network will change in the near future due to increasing size and number of distributed energy resources (DER) and demand side resources (DSR). An active distribution network is proposed to address the challenges. The normal operation of an active distribution network requires coordination of different values and operation constraints of various involved actors. This paper proposes a multilevel coordination strategy for congestion management of distribution network. Firstly, the scheme of an active distribution network is described. Then, the coordination strategies between various actors, i.e., distribution system operator (DSO), fleet operators (FO), and EV owners are discussed. Further, a mathematical formulation of the chosen coordination strategies between DSO and FOs are presented and some case studies are shown to illustrate the effectiveness of the proposed solutions. Finally, we give the argument and proposal of using multi-agent based platform to demonstrate the multilevel coordination solution.

Index Terms—Congestion management, Distribution grid, Multilevel coordination, Multiagent systems based platform

Multilevel Flow Modeling Based Decision Support System and Its Task Organization

For complex engineering systems, there is an increasing demand for safety and reliability. Decision support system (DSS) is designed to offer supervision and analysis about operational situations. A proper model representation is required for DSS to understand the process knowledge. Multilevel Flow Modeling (MFM) represents complex system in multiple levels of means-end and part-whole decompositions, which is considered suitable for plant supervision tasks. The aim of this paper is to explore the different possible functionalities by applying MFM to DSS, where both currently available techniques of MFM reasoning and less mature yet relevant MFM concepts are considered. It also offers an architecture design of task organization for MFM software tools by using the concept of agent and technology of multiagent software system.
Multi-objective parallel particle swarm optimization for day-ahead Vehicle-to-Grid scheduling

This paper presents a methodology for multi-objective day-ahead energy resource scheduling for smart grids considering intensive use of distributed generation and Vehicle-To-Grid (V2G). The main focus is the application of weighted Pareto to a multi-objective parallel particle swarm approach aiming to solve the dual-objective V2G scheduling: minimizing total operation costs and maximizing V2G income. A realistic mathematical formulation, considering the network constraints and V2G charging and discharging efficiencies is presented and parallel computing is applied to the Pareto weights. AC power flow calculation is included in the metaheuristics approach to allow taking into account the network constraints. A case study with a 33-bus distribution network and 1800 V2G resources is used to illustrate the performance of the proposed method.

Observer Backstepping Control for Variable Speed Wind Turbine

This paper presents an observer backstepping controller as feasible solution to variable speed control of wind turbines to maximize wind power capture when operating between cut-in and rated wind speeds. The wind turbine is modeled as a two-mass drive-train system controlled by the generator torque. The nonlinear controller aims at regulating the generator torque such that an optimal tip-speed ratio can be obtained. Simply relying on the measured rotor angular velocity the proposed observer backstepping controller guarantees global asymptotic tracking of the desired trajectory while maintaining a globally uniformly ultimately bounded torsional angle. The proposed controller shows convincing performance when simulated in closed loop within a stochastic environment.
Optimization and control method for smart charging of EVs facilitated by Fleet operator: Review and classification

Electric vehicles (EV) can become integral parts of a smart grid, since they are capable of providing valuable services to power systems other than just consuming power. As an important solution to balance the intermittent renewable energy re-sources, such as wind power and PVs, EVs can absorb the energy during the period of high electricity penetration and feed the electricity back into the grid when the demand is high or in situations of insufficient electricity generation. However, the extra loads created by increasing EVs may have adverse impacts on grid. These factors will bring new challenges to the utility system operator; accordingly, smart charging of EVs is needed. This paper presents a review and classification of methods for smart charging of EVs found in the literature. The study is mainly executed from the control theory perspectives. Firstly, service dependent aggregation and the facilitator EV fleet operator are introduced. Secondly, control architectures and their integrations in term of electricity market and distribution grid are discussed. Then, data analysis of EVs including a battery model and driving pattern is presented. Further discussion is given on mathematical modelling and control of smart charging of EVs. Finally, the paper discusses and proposes future research directions in the area.

Pattern-based Automatic Translation of Structured Power System Data to Functional Models for Decision Support Applications

Improved information and insight for decision support in operations and design are central promises of a smart grid. Well-structured information about the composition of power systems is increasingly becoming available in the domain, e.g. due to standard information models (e.g. CIM or IEC61850) or otherwise structured databases. More measurements and data do not automatically improve decisions, but there is an opportunity to capitalize on this information for decision support. With suitable reasoning strategies data can be contextualized and decision-relevant events can be promoted and identified. This paper presents an approach to link available structured power system data directly to a functional representation suitable for diagnostic reasoning. The translation method is applied to test cases also illustrating decision support.
General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Center for Electric Power and Energy
Authors: Heussen, K. (Intern), Weckesser, J. T. G. (Intern), Kullmann, D. (Intern)
Number of pages: 6
Publication date: 2013

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Publisher: IEEE
Main Research Area: Technical/natural sciences
Conference: IWIES 2013, Vienna, Austria, 14/11/2013 - 14/11/2013
Power system modeling, Knowledge-based methods, Functional modeling, Model translation, Decision support
Electronic versions:
OLD-to-MFM_IWIES_final.pdf
DOIs:
10.1109/IWIES.2013.6698579
Source: dtu
Source-ID: u:9509
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

Plant-wide dynamic and static optimisation of supermarket refrigeration systems
Optimising the operation of a supermarket refrigeration system under dynamic as well as steadystate conditions is addressed in this paper. For this purpose an appropriate performance function that encompasses food quality, system efficiency, and also component reliability is established. The choice of setup parameters, which are necessary for system performance optimisation, depends on whether the system operates under steady state or dynamic conditions. While operating under steady state conditions, the total system performance is shown to predominantly be influenced by the suction pressure. The dynamic optimisation requires use of dedicated excitation signals. A method for designing such signals under realistic operational conditions is proposed. A derivative free optimisation technique based on Invasive Weed Optimisation (IWO) is utilised to optimise the parameters of the controllers in the system. Simulation results is used to substantiate the suggested methodology.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Danfoss A/S
Authors: Green, T. (Ekstern), Izadi-Zamanabadi, R. (Ekstern), Razavi-Far, R. (Ekstern), Niemann, H. H. (Intern)
Number of pages: 12
Pages: 106-117
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Refrigeration
Volume: 38
ISSN (Print): 0140-7007
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.888 SJR 1.471 CiteScore 3.46
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.06 SJR 1.371 SNIP 1.607
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.349 SNIP 1.532 CiteScore 2.44
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.619 SNIP 2.086 CiteScore 2.6
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
This paper describes a voice sensor, suitable for modular robotic systems, which estimates the energy and fundamental frequency, F0, of the user’s voice. Through a number of example applications and tests with children, we observe how the voice sensor facilitates playful interaction between children and two different robot configurations. In future work, we will investigate if such a system can motivate children to improve voice control and explore how to extend the sensor to detect emotions in the user’s voice.

**Playful Interaction with Voice Sensing Modular Robots**

This paper describes a voice sensor, suitable for modular robotic systems, which estimates the energy and fundamental frequency, F0, of the user’s voice. Through a number of example applications and tests with children, we observe how the voice sensor facilitates playful interaction between children and two different robot configurations. In future work, we will investigate if such a system can motivate children to improve voice control and explore how to extend the sensor to detect emotions in the user’s voice.
Playware Explorations in Robot Art

We describe the upcoming art field termed robot art. Describing our group contribution to the world of robot art, a brief excursion on the importance of the underlying principles, of the context, of the message and its semiotic is also provided, case by case, together with few hints on the recent history of such a discipline, under the light of an artistic perspective. Therefore, the aim of the paper is to try to summarize the main characteristics that might classify robot art as a unique and innovative discipline, and to track down some of the principles by which a robotic artifact can be considered - or not - an art piece, in terms of social, cultural and strictly artistic interest.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, Academy of Fine Arts of Macerata
Authors: Lund, H. H. (Intern), Pagliarini, L. (Ekstern)
Number of pages: 10
Publication date: 2013

Host publication information
Title of host publication: Proceedings of 2nd International Conference on Robot Intelligence and Applications
Publisher: Springer
Main Research Area: Technical/natural sciences
Conference: 2nd International Conference on Robot Intelligence and Applications, Denver, Colorado, United States, 18/12/2013 - 18/12/2013
Robot, Art, Kinetic, Sculpture, Cyber, Cyberpunk, Embodiment, Evolution, Modular, Holography, Metamorphic, Alife, Polymorphic, Intelligence, Virtual, Alive
Electronic versions:
RobotArt-final.pdf
Source: dtu
Source-ID: u::9495
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

Position Mooring Control Based on a Structural Reliability Criterion

To prevent failure of mooring lines in modern position mooring (PM) systems, position moored vessels are kept within a small distance from a desired reference position. A safe position within such region is where stress in all mooring lines are kept well below tensile strength. To prevent several mooring lines simultaneously from exceeding a stress threshold, this paper suggests a new algorithm to determine the reference position and an associated control system. The safety of each line is assessed through a structural reliability index. A reference position where all mooring lines are safe is achieved using structural reliability indices in a cost function, where both the mean mooring-line tension and dynamic effects are considered. An optimal set-point is automatically produced without need for manual interaction. The parameters of the extreme value distribution are calculated on-line thereby adapting the set-point calculations to the prevailing environment. In contrast to earlier approaches, several mooring line are simultaneously accounted for by the algorithm, not only the most critical one. Detailed simulations illustrate the features of the new method and it is shown that the structural reliability criterion based algorithm ensures the safety of mooring lines in a variety of external environmental conditions and also in situations of failure of a single line.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Norwegian University of Science and Technology
Authors: Fang, S. (Ekstern), Leira, B. J. (Ekstern), Blanke, M. (Intern)
Pages: 97–106
Publication date: 2013
Main Research Area: Technical/natural sciences
Power Management for Energy Systems

In this thesis, we consider the control of two different industrial applications that belong at either end of the electricity grid; a power consumer in the form of a commercial refrigeration system, and wind turbines for power production. Our primary studies deal with economic model predictive control of a commercial multi-zone refrigeration system, consisting of several cooling units that share a common compressor, and is used to cool multiple areas or rooms, e.g., in supermarkets.

Substantial amounts of energy are consumed in refrigeration systems worldwide and there is a strong motivation for introducing more energy efficient as well as cost reducing control techniques. At the same time, the power grid is evolving from a centralized system with rather controllable production in the conventional power plants to a much more decentralized network of many independent power generators and a large penetration of renewable, fossil-free energy sources such as solar and wind power. To facilitate such intermittent power producers, we must not only control the production of electricity, but also the consumption, in an efficient and exible manner. By enabling the use of thermal energy storage in supermarkets, we open up for exible power consumption schemes with the possibility of reducing operational costs and we develop and demonstrate prototype control technology that creates completely new business opportunities for selling regulating power to the grid. Moreover, this enables a larger penetration of wind energy in the power production and increases the potential market size for wind power generators and other renewable energy sources. Thus, we aim at promoting the use of environmentally sustainable power production technologies while creating new business opportunities for both power consumers and producers of renewable energy.

The second application, wind turbines, takes us to the production side of the power grid. The key concern here is to improve the quality and integrability of power delivered to the grid from large parks of wind turbines. Our goal is to reduce the fluctuating nature of the power output and to meet tightened demands from the grid by enabling a more intelligent control at both the individual turbine level, at the park controller level, and in cooperation with exible power consumers or other means of energy storage. The possible interaction and synergies of the two applications are obvious reasons to consider both in this thesis, and as we will see, the similarities in our formulations of the different control problems allow us to apply almost identical techniques despite the lack of immediate similarity.

For control of the commercial refrigeration application as well as the wind turbine application, we propose an economic optimizing model predictive controller, economic MPC. MPC is a feedback control technique that is characterized by its explicit handling of constrained control problems in which a model is used to predict the future behavior of a system along with forecasts of future disturbances. At each time step the values of the control inputs are computed by solving an open-loop finite time optimal control problem over a defined prediction horizon. Only the rst step in this optimal open-loop sequence is implemented as a control command. Feedback is obtained by solving the open-loop problem repeatedly, in a receding horizon fashion, as new predictions become available.

Our investigations are primarily concerned with: 1) modeling of the applications to suit the chosen control framework; 2) formulating the MPC controller laws to overcome challenges introduced by the industrial applications, and defining economic objectives that reect the real physics of the systems as well as our control objectives; 3) solving the involved, non-trivial optimization problems eiciently in real-time; 4) demonstrating the feasibility and potential of the proposed methods by extensive simulation and comparison with existing control methods and evaluation of data from systems in actual operation.

We present contributions on:

Economic MPC for commercial refrigeration systems, including
- Linear economic MPC formulations that utilize the exibility in refrigeration systems to counteract fluctuations in the balance between power consumption and production.
- Economic MPC with probabilistic constraints, ensuring a robust performance and constraint satisfaction in spite of inaccurate system models and forecasts.
- Nonlinear economic MPC, relecting the nonconvexity in the realistic description of temperature dependent efficiencies in the refrigeration cycle.
- Nonlinear economic MPC with uncertain predictions and the implementation of very simple predictors that use entirely historical data of, e.g., electricity prices and outdoor temperatures.

Economic MPC for wind turbines, including
- Optimal steady-state calculation for wind farms.
- Nonlinear economic MPC for individual turbines.
- Change of variables and convex formulations of economic MPC for individual turbines.

Tractable optimization methods for the MPC problems, including
- Sequential convex programming (SCP) for specific nonconvex problems originating from our studies of commercial refrigeration as well as from our studies concerning wind power.
- Successful demonstration of the SCP approach on three different problems the commercial refrigeration system with linear dynamics and constraints and a nonconvex objective, the individual wind turbine with nonlinear dynamics and constraints, and the static optimization of the wind farm with a black-box model.

The major contribution is the formulation of these problems and the demonstrations to show that the SCP method can be used for their solution.

We demonstrate, i.a., substantial cost savings, on the order of 30 %, compared to a standard thermostat-based supermarket refrigeration system and show how our methods exhibit sophisticated demand response to real-time variations in electricity prices. Violations of the temperature ranges can be kept at a very low frequency of occurrence inspite of the presence of uncertainty. For the power output from wind turbines, ramp rates, as low a 3 % of the rated power per minute, can be effectively ensured with the use of energy storage and we show how the active use of rotor
inertia as an additional energy storage can reduce the needed storage capacity by up to 30 % without reducing the power output.
**Real-time simulation of energy management in a domestic consumer**

Recent and future changes in power systems, mainly in the smart grid operation context, are related to a high complexity of power networks operation. This leads to more complex communications and to higher network elements monitoring and control levels, both from network’s and consumers’ standpoint. The present work focuses on a real scenario of the LASIE laboratory, located at the Polytechnic of Porto. Laboratory systems are managed by the SCADA House Intelligent Management (SHIM), already developed by the authors based on a SCADA system. The SHIM capacities have been recently improved by including real-time simulation from Opal RT. This makes possible the integration of Matlab®/Simulink® real-time simulation models. The main goal of the present paper is to compare the advantages of the resulting improved system, while managing the energy consumption of a domestic consumer.

**General information**

**State:** Published  
**Organisations:** Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto  
**Authors:** Fernandes, F. (Ekstern), Silva, M. (Ekstern), Faria, P. (Ekstern), Vale, Z. (Ekstern), Ramos, C. (Ekstern), Morais, H. (Intern)  
**Number of pages:** 5  
**Publication date:** 2013

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**Title of host publication:** 2013 4th IEEE PES Innovative Smart Grid Technologies Europe (ISGT Europe)  
**Publisher:** IEEE  
**ISBN (Electronic):** 978-1-4799-2984-9  
**Main Research Area:** Technical/natural sciences  
**Conference:** 2013 4th IEEE PES Innovative Smart Grid Technologies Europe, Lyngby, Denmark, 06/10/2013 - 06/10/2013  
**Demand response, Domestic consumer, Energy management, RT-LAB simulation**  
**DOIs:** 10.1109/ISGTEurope.2013.6695319  
**Publication:** Research - peer-review › Article in proceedings – Annual report year: 2013

**Real-Time Tariffs for Electric Vehicles in Wind Power based Power Systems**

The use of Electric Vehicles (EVs) will change significantly the planning and management of power systems in a near future. This paper proposes a real-time tariff strategy for the charge process of the EVs. The main objective is to evaluate the influence of real-time tariffs in the EVs owners’ behaviour and also the impact in load diagram. The paper proposes the energy price variation according to the relation between wind generation and power consumption. The proposed strategy was tested in two different days in the Danish power system. January 31st and August 13th 2013 were selected because of the high quantities of wind generation. The main goal is to evaluate the changes in the EVs charging diagram with the energy price preventing wind curtailment.

**General information**

**State:** Published  
**Organisations:** Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto  
**Authors:** Morais, H. (Intern), Sousa, T. (Ekstern), Silva, M. (Ekstern), Faria, P. (Ekstern), Vale, Z. (Ekstern)  
**Number of pages:** 6  
**Publication date:** 2013

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**Title of host publication:** Proceedings of 12nd International Workshop on Large-Scale Integration of Wind Power into Power Systems,  
**Publisher:** Energynautics GmbH  
**ISBN (Print):** 978-3-9813870-7-0  
**Main Research Area:** Technical/natural sciences  
**Conference:** 12th International Workshop on Large-Scale Integration of Wind Power into Power Systems as well as on Transmission Networks for Offshore Wind Power Plants, London, United Kingdom, 22/10/2013 - 22/10/2013  
**Electric vehicle, Opportunity Cost, Real-time tariff, Wind generation**  
**Electronic versions:** Wind_Paper_V16.pdf  
**Source:** dtu  
**Source-ID:** u::9586  
**Publication:** Research - peer-review › Article in proceedings – Annual report year: 2013
Robots for Field Operations with Comprehensive Multilayer Control

Today research within agricultural technology focuses beside productivity and operation costs mainly on increasing the resource efficiency of crop production. Autonomous machines have the potential to significantly contribute to this by utilizing more multi-factorial real-time sensing and embedding artificial intelligence. A multilayer controller has successfully been implemented on two outdoor machines with various implements to conduct several agricultural applications in autonomous mode. Future work has to be conducted to achieve a more integrated and flexible implement control.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, University of Hohenheim
Authors: Jæger, C. L. D. (Intern), Griepentrog, H. W. (Ekstern), Paraforos, D. S. (Ekstern)
Pages: 325-333
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Kuenstliche Intelligenz
Volume: 27
Issue number: 4
ISSN (Print): 0933-1875
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Autonomous field operations, Controller software framework, Autonomous weed control
Electronic versions:
griepentrog2013.pdf
DOIs:
10.1007/s13218-013-0266-z
Source: dtu
Source-ID: u::8869
Publication: Research - peer-review › Journal article – Annual report year: 2013

Robust observer-based fault estimation and accommodation of discrete-time piecewise linear systems

In this paper a new integrated observer-based fault estimation and accommodation strategy for discrete-time piecewise linear (PWL) systems subject to actuator faults is proposed. A robust estimator is designed to simultaneously estimate the state of the system and the actuator fault. Then, the estimate of fault is used to compensate for the effect of the fault. By using the estimate of fault and the states, a fault tolerant controller using a PWL state feedback is designed. The observer-based fault-tolerant controller is obtained by the interconnection of the estimator and the state feedback controller. We show that separate design of the state feedback and the estimator results in the stability of the overall closed-loop system. In addition, the input-to-state stability (ISS) gain for the closed-loop system is obtained and a procedure for minimizing it is given. All of the design conditions are formulated in terms of linear matrix inequalities (LMI) which can be solved efficiently. Also, performance of the estimator and the state feedback controller are minimized by solving convex optimization problems. The efficiency of the method is demonstrated by means of a numerical example.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Aalborg University
Authors: Tabatabaeipour, M. (Intern), Bak, T. (Ekstern)
Pages: 277–295
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of the Franklin Institute
Volume: 351
Issue number: 1
ISSN (Print): 0016-0032
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
Sensor-coupled fractal gene regulatory networks for locomotion control of a modular snake robot

In this paper we study fractal gene regulatory network (FGRN) controllers based on sensory information. The FGRN controllers are evolved to control a snake robot consisting of seven simulated ATRON modules. Each module contains three tilt sensors which represent the direction of gravity in the coordination system of the module. The modules are controlled locally and there is no explicit communication between them. So, they can synchronize implicitly using their sensors, and coordination of their behavior takes place through the environment. In one of our experiments, all the three tilt sensors are available for the FGRNs and a simple controller is evolved. The controller is a linear mapping of one input sensor to the output. It is only based on one sensor input and ignores the other sensors as well as the regulatory part of the network. In another experiment, the controller's input uses one of the other sensors that carries less information. In this case, the evolved controller blends sensory information with the regulatory network capabilities to come up with a proper distributed controller. © 2013 Springer-Verlag.
Set-membership state estimation for discrete time piecewise affine systems using zonotopes

This paper presents a method for guaranteed state estimation of discrete time piecewise affine systems with unknown but bounded noise and disturbance. Using zonotopic set representations, the proposed method computes the set of states that are consistent with the model, observation, and bounds on the noise and disturbance such that the real state of the system is guaranteed to lie in this set. Because in piecewise affine systems, the state space is partitioned into a number of polyhedral sets, at each iteration the intersection of the zonotopes containing a set-valued estimation of the states with each of the polyhedral partitions must be computed. We use an analytic method to compute the intersection as a zonotope and minimize the size of the intersection. A numerical example is provided to illuminate the algorithm.


The aggregation and management of Distributed Energy Resources (DERs) by an Virtual Power Players (VPP) is an important task in a smart grid context. The Energy Resource Management (ERM) of thses DERs can become a hard and complex optimization problem. The large integration of several DERs, including Electric Vehicles (EVs), may lead to a scenario in which the VPP needs several hours to have a solution for the ERM problem. This is the reason why it is necessary to use metaheuristic methodologies to come up with a good solution with a reasonable amount of time. The presented paper proposes a Simulated Annealing (SA) approach to determine the ERM considering an intensive use of DERs, mainly EVs. In this paper, the possibility to apply Demand Response (DR) programs to the EVs is considered.
Moreover, a trip reduce DR program is implemented. The SA methodology is tested on a 32-bus distribution network with 2000 EVs, and the SA results are compared with a deterministic technique and particle swarm optimization results.

**General information**
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto, Instituto Superior de Engenharia do Porto
Authors: Sousa, T. (Ekstern), Vale, Z. (Ekstern), Morais, H. (Intern)
Number of pages: 6
Publication date: 2013

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Title of host publication: Proceedings of 7th International Conference on Intelligent System Applications to Power Systems
Publisher: IEEE
Main Research Area: Technical/natural sciences
Conference: 17th International Conference on Intelligent Systems Application to Power Systems, Tokyo, Japan, 01/07/2013 - 01/07/2013

Demand Response, Electric Vehicle, Energy Resource Management, Simulated annealing

Electronic versions:
ISAP2013_TAS.pdf
Source: dtu
Source-ID: u::9678
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

**Strategic bidding in electricity markets: An agent-based simulator with game theory for scenario analysis**

Electricity markets are complex environments, involving a large number of different entities, with specific characteristics and objectives, making their decisions and interacting in a dynamic scene. Game-theory has been widely used to support decisions in competitive environments; therefore its application in electricity markets can prove to be a high potential tool. This paper proposes a new scenario analysis algorithm, which includes the application of game-theory, to evaluate and preview different scenarios and provide players with the ability to strategically react in order to exhibit the behavior that better fits their objectives. This model includes forecasts of competitor players' actions, to build models of their behavior, in order to define the most probable expected scenarios. Once the scenarios are defined, game theory is applied to support the choice of the action to be performed. MASCEM (Multi-Agent System for Competitive Electricity Markets) is a multi-agent electricity market simulator that models market players and simulates their operation in the market. The scenario analysis algorithm has been tested within MASCEM and our experimental findings with a case study based on real data from the Iberian Market are presented and discussed.

**General information**
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Instituto Politécnico do Porto, Polytechnic Institute of Porto
Authors: Pinto, T. (Ekstern), Praca, I. (Ekstern), Morais, H. (Intern), Sousa, T. M. (Ekstern)
Pages: 335-346
Publication date: 2013
Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.263 SJR 0.665 CiteScore 3.66
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.02 SJR 1.271 SNIP 1.406
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.944 SNIP 1.377 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
The globalization of use of Distributed Generation (DG) and other distributed energy resources in recent years have strongly influenced the power systems operation changes. The growing use of new technologies such as Phasor Measurements Units (PMUs) increases the possibilities and the efficiency of power systems operation control. The use of PMUs allows more penetration of DG mainly, with technologies based on renewable resources with intermittent and unpredictable operation such a wind power. This paper introduces the Secure Operation of Sustainable Power Systems (SOSPO) project. The SOSPO project tries to respond to the question “How to ensure a secure operation of the future power system where the operating point is heavily is fluctuating?” focusing in the Supervision module architecture and in the power system operation states. The main goal of Supervision module is to determine the power system operation state based on new stability and security parameters derived from PMUs measurement and coordinate the use of automatic and manual control actions. The coordination of the control action is based not only in the static indicators but also in the performance evaluation of control actions. Based in the performance evaluation, the control allocation uses an adaptive mechanism to give more or less importance to the actions considering the existent operation context.

**Supervision functions - Secure operation of sustainable power systems**

The globalization of use of Distributed Generation (DG) and other distributed energy resources in recent years have strongly influenced the power systems operation changes. The growing use of new technologies such as Phasor Measurements Units (PMUs) increases the possibilities and the efficiency of power systems operation control. The use of PMUs allows more penetration of DG mainly, with technologies based on renewable resources with intermittent and unpredictable operation such a wind power. This paper introduces the Secure Operation of Sustainable Power Systems (SOSPO) project. The SOSPO project tries to respond to the question “How to ensure a secure operation of the future power system where the operating point is heavily is fluctuating?” focusing in the Supervision module architecture and in the power system operation states. The main goal of Supervision module is to determine the power system operation state based on new stability and security parameters derived from PMUs measurement and coordinate the use of automatic and manual control actions. The coordination of the control action is based not only in the static indicators but also in the performance evaluation of control actions. Based in the performance evaluation, the control allocation uses an adaptive mechanism to give more or less importance to the actions considering the existent operation context.
The Physical Effect of Exergames in Healthy Elderly—A Systematic Review

Exergames have been suggested as an innovative approach to enhance physical activity in the elderly. The objective of this review was to determine the effectiveness of exergames on validated quantitative physical outcomes in healthy elderly individuals. We used Centre for Review and Disseminations guidance to conduct systematic reviews. Four electronic databases were searched. We included randomized controlled trials (RCTs), the study participants were healthy elderly individuals, and the intervention of interest was exergaming. The title and abstract screening of the 1861 citations identified 36 studies as potentially eligible for this review, and an additional nine were identified from reference lists. The full text screening identified seven studies with a total of 311 participants, all reporting RCTs with low-to-moderate methodological quality. Six of the seven studies found a positive effect of exergaming on the health of the elderly. However, the variation of intervention approaches and outcome data collected limited the extent to which studies could be compared. This review demonstrates how exergames have a potential to improve physical health in the elderly. However, there is a need for additional and better-designed studies that assess the effectiveness and long-term adherence of exergames designed specifically for the elderly.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, University of Copenhagen
Authors: Larsen, L. H. (Ekstern), Schou, L. (Ekstern), Lund, H. H. (Intern), Langberg, H. (Ekstern)
Pages: 205-212
Publication date: 2013
Main Research Area: Technical/natural sciences

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- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 1
- Scopus rating (2017): SNIP 0.756 SJR 0.611 CiteScore 1.99
- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): SJR 0.632 SNIP 0.844 CiteScore 1.07
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 0.298 SNIP 0.597
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 0.255 SNIP 0.444
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 0.128 SNIP 0.274
- ISI indexed (2013): ISI indexed no
The play grid
In this paper we propose The Play Grid, a model for systemizing different play types. The approach is psychological by nature and the actual Play Grid is based, therefore, on two pairs of fundamental and widely acknowledged distinguishing characteristics of the ego, namely: extraversion vs. introversion and agency vs. communion. The former pair concerns a person's orientation towards either inner or outer reality, while the latter has to do with orientation towards autonomy vs. being a part of something. When placing these pairs of characteristics on different axes and combining them, we arrive at the Play Grid. Thus, the model has four quadrants, each of them describing one of four play types: the Assembler, the Director, the Explorer, and the Improviser. It is our hope that the Play Grid can be a useful design tool for making entertainment products for children.

The Potential of Economic Model Predictive Control for Spray Drying Plants
In 2015 the milk quota system in the European Union will be completely liberalized. As a result, analysts expect production of skimmed and whole milk powder to increase by 5-6% while its price will decline by about 6-7%. Multi-stage spray drying is the prime process for the production of food powders. The process is highly energy consuming and capacity depends among other factors on correct control of the dryer. Consequently efficient control and optimization of the spray drying process has become increasingly important to accommodate the future market challenges.

The goal of the presentation is to present our results regarding modeling of the process and how the efficiency and probability can be lifted by introducing an economic optimizing MPC scheme.

Firstly, we develop a first-principle engineering model that can be used to simulate spray drying processes with high accuracy. The model can be adjusted to describe drying of various products and describes the complete drying process of a multi-stage spray dryer. The dryer is divided into three stages, the spray stage and two uid bed stages. Each stage is assumed ideally mixed and described by mass- and energy balances. The model is able to predict outlet temperatures, the residual moisture and particle size of the product. We also give a novel approach to predict deposits due to stickiness of the powder. The model predictions are compared to datasets gathered at GEA Process Engineering’s test facility. The identified model parameters are identified from data and the resulting model is the data well.

Secondly, the effect of disturbances, ambient air humidity and solids content in the feed, is studied by simulation. We show that conventional control is insufficient at controlling the product quality as well as driving the plant to the most economic conditions. Furthermore, we show that the efficiency can be increased by correct adjustment of heat and inlet air ow at each stage.
The recent focus in research has shifted from reference tracking MPC to optimization of economic objective functions. We will discuss how this optimization can be performed by advanced process control techniques, such as Economic Model Predictive Control (E-MPC). We suggest adding an E-MPC based supervisory control layer on top of the contemporary PI-controllers. The strong interconnection between drying stages and process constraints are well suited for MPC.

General information
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Organisations: Department of Applied Mathematics and Computer Science, Scientific Computing, Dynamical Systems, Department of Electrical Engineering, Automation and Control, Center for Energy Resources Engineering, GEA Process Engineering A/S
Authors: Petersen, L. N. (Intern), Poulsen, N. K. (Intern), Niemann, H. H. (Intern), Utzen, C. (Ekstern), Jørgensen, J. B. (Intern)
Number of pages: 1
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Spray drying, Multi-Stage dryer, Grey-box model, First-principles model
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The Requirements Domain for Laboratory Software Infrastructure. RTLabOS: Phase I – Deliverable 1.1

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Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Automation and Control
Authors: Kosek, A. M. (Intern), Heussen, K. (Intern)
Number of pages: 15
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RTLabOS_D11_Domain_Study.pdf

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The Requirements Domain for Laboratory Software Infrastructure. RTLabOS: Phase I – Deliverable 1.1
Source: dtu
Source-ID: u::9433
Publication: Research › Report – Annual report year: 2013

Towards self-tuning residual generators for UAV control surface fault diagnosis
Control surface fault diagnosis is essential for timely detection of manoeuvring and stability risks for an unmanned aircraft. Timely detection is crucial since control surface related faults impact stability of flight and safety. Reliable diagnosis require well fitting dynamical models but with the high cost of detailed modelling and wind tunnel testing, it would be highly desirable if good diagnosis could be obtained with very generic models that are adapted to individual conditions of aircraft and of its operation. This paper presents an approach where a basic generic model is applied and necessary parameters in residual generators are identified on the fly. Initial estimates of parameters are known from off-line analysis of previous flights. The paper analyses how such self-tuning residual generators are combined with change detection to obtain timely fault diagnosis. The paper investigates the parameter convergence and detection properties for the suggested combination of identification and change detection techniques and shows design aspects and trade-offs to be made to make this scheme an effective and robust system for diagnosis or even prognosis. Results are verified using a number of test flights with different members of a population of UAVs that have inherent model uncertainty from one member to another and from one flight to another. Events with actual faults on control surfaces demonstrates the efficacy of the approach.

General information
Unmanned Water Craft Identification and Adaptive Control in Low-Speed and Reversing Regions
This paper treats L1 adaptive hovering control of an unmanned surface vehicle in a station-keeping mode where a region of zero control authority and under-actuation are main challenges. Low-speed and reversing dynamics are identified from full scale sea trials, and parameter uncertainty is estimated. With significant parameter variation, an L1 adaptive controller is employed for heading control. The L1 family of controllers allows for several topologies and an architecture is suggested that suits heading control of a vessel, the requirements of which differ from that of previous L1 literature. The control design is tackled directly in discrete time to allow a fast embedded implementation in the vehicle. Analysis of robustness, tracking performance and wave disturbance response are detailed in the paper.

Virtual Power Players Internal Negotiation and Management in MASCEM
Electricity Markets are not only a new reality but an evolving one as the involved players and rules change at a relatively high rate. Multi-agent simulation combined with Artificial Intelligence techniques may result in very helpful sophisticated tools. This paper presents a new methodology for the management of coalitions in electricity markets. This approach is tested using the multi-agent market simulator MASCEM (Multi-Agent Simulator of Competitive Electricity Markets), taking advantage of its ability to provide the means to model and simulate Virtual Power Players (VPP). VPPs are represented as coalitions of agents, with the capability of negotiating both in the market and internally, with their members in order to combine and manage their individual specific characteristics and goals, with the strategy and objectives of the VPP itself. A case study using real data from the Iberian Electricity Market is performed to validate and illustrate the proposed approach.
A Concept for a Flexible Rehabilitation Tool for sub-Saharan Africa

This concept paper explores a technological building block approach to the development of a flexible rehabilitation tool that may address some of the needs in sub-Saharan Africa. We briefly outline some of the health challenges that lead us to suggest a concept for physical rehabilitation solutions to address many diverse patient groups (e.g. disabled children, cardiac, and stroke patients), to be used in both urban and rural areas, to be easily used in community based rehabilitation (e.g. by community rehabilitation workers), to motivate the users, and to be robust to failure (e.g. power failure) in remote areas. The concept leads to the implementation of modular interactive tiles for rehabilitation, and suggestions for future use in sub-Saharan Africa.

Adapting Playware to Rehabilitation Practices

We describe how playware and games may become adaptive to the interaction of the individual user and how therapists use this adaptation property to apply modular interactive tiles in rehabilitation practices that demand highly individualized training. Therapists may use the interactive modular tiles to provide treatment for a large number of patients who receive hospital, municipality or home care, although the tiles can as well be used for prevention with elderly or for fitness with normal people. In this paper, we describe the extensive use of the modular tiles with cardiac patients, smoker’s lung (COLD) patients and stroke patients in hospitals and in the private homes of patients and elderly. Through a qualitative research methodology of the new practice with the tiles, we find that therapists are using the modular aspect of the tiles for personalized training of a vast variety of elderly patients modulating exercises and difficulty levels. We also find that in physical games there are individual differences in patient interaction capabilities and styles, and that modularity allows the therapist to adapt exercises to the individual patient's capabilities.
Adaptive Strategy for Online Gait Learning Evaluated on the Polymorphic Robotic LocoKit

This paper presents experiments with a morphology-independent, life-long strategy for online learning of locomotion gaits, performed on a quadruped robot constructed from the LocoKit modular robot. The learning strategy applies a stochastic optimization algorithm to optimize eight open parameters of a central pattern generator based gait implementation. We observe that the strategy converges in roughly ten minutes to gaits of similar or higher velocity than a manually designed gait and that the strategy readapts in the event of failed actuators. In future work we plan to study co-learning of morphological and control parameters directly on the physical robot.
Adaptivity to Age, Gender, and Gaming Platform Topology in Physical Multi-Player Games

In games where players are competing against each other, it can be of interest to ensure that all players are challenged according to their individual skills. In order to investigate such adaptivity to the individual player in physical multi-player games, we developed a game on modular interactive tiles which can be used in both single-player and multi-player mode. We implemented simple adaptivity methods and tested these with different user groups including children and adults of both genders. The results show statistically significant differences in the game interactions between children and adults, and between male and female players. Also, results show statistically significant differences in the game interactions between different physical set-ups of the modular interactive tiles, i.e. the interaction depended on the topology of the modular tiles set-up. Changing the physical set-up of the physical game platform changes the interaction and performance of the players.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Centre for Playware, Technical University of Denmark
Authors: Lund, H. H. (Intern), Friðriksson, R. V. (Ekstern), Björnsson, D. Þ. (Ekstern)
Number of pages: 6
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Conference: 2012 Seventeenth International Symposium on Artificial Life and Robotics, Beppu, Japan, 19/01/2012 - 19/01/2012
Electronic versions:
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

Addressing the security of a future sustainable power system: The Danish SOSPO project

Current power systems have been undergoing in depth changes by the increasing use of renewable generations. At one hand, the grid is progressively more interconnected in order to collect the renewable generation from geographically dispersed places meanwhile reduce the risks of intermittency; on the other, the power is increasingly generated at relative low voltage networks which in turn gives rise to new challenges in the conventional system design. The high governmental objective of greenhouse gas reduction provokes accelerating adoption of the renewables. The effect of this has to be carefully evaluated to secure the operation from both transmission and distribution levels. The Danish SOSPO project is launched from 2012 targeting at the system security assessment in the control room for the future scenarios. Methods will be developed in this project to counteract with the future challenges, and a testing platform will be developed in the laboratory for algorithm testing and demonstration.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Automation and Control
Authors: Yang, G. (Intern), Jóhannsson, H. (Intern), Lind, M. (Intern), Garcia-Valle, R. (Intern), Blanke, M. (Intern), Nielsen, A. H. (Intern), Østergaard, J. (Intern)
Number of pages: 5
Publication date: 2012

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Main Research Area: Technical/natural sciences
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Renewable energies, System security, Control room application, Visualisation
DOIs: 10.1049/cp.2012.2164
Agent Based Reasoning in Multilevel Flow Modeling

Multilevel Flow Modeling (MFM) is a modeling method used for modeling complex industrial plant. Currently, MFM is supported with a standalone software tool called MFM Workbench, which is equipped with causal-relation analysis and other functionalities. The aim of this paper is to offer a new design to launch the MFM Workbench into an agent based environment, which can complement disadvantages of the original software. The agent-based MFM Workbench is centered on a concept called “Blackboard System” and use an event based mechanism to arrange the reasoning tasks. This design will support the new development in MFM concept and its application in monitoring systems.

A model-based approach to fault-tolerant control

A model-based controller architecture for Fault-Tolerant Control (FTC) is presented in this paper. The controller architecture is based on a general controller parameterization. The FTC architecture consists of two main parts, a Fault Detection and Isolation (FDI) part and a controller reconfiguration part. The theoretical basis for the architecture is given followed by an investigation of the single parts in the architecture. It is shown that the general controller parameterization is central in connection with both fault diagnosis as well as controller reconfiguration. Especially in relation to the controller reconfiguration part, the application of controller parameterization results in a systematic technique for switching between different controllers. This also allows controller switching using different sets of actuators and sensors.
Analyzing Control Challenges for Thermal Energy Storage in Foodstuffs

We consider two important challenges that arise when thermal energy is to be stored in foodstuffs. We have previously introduced economic optimizing MPC schemes that both reduce operating costs and offer flexible power consumption in a future Smart Grid. The goal is to utilize the thermal capacity of refrigerated goods in a supermarket to shift the load of the system in time without deteriorating the quality of the foodstuffs. The analyses in this paper go before closing any control loops. In the first part, we introduce and validate a new model with which we can estimate the actual temperatures of refrigerated goods from available air temperature measurements. This is based on data obtained from a dedicated experiment. Since limits are specified for food temperatures, the estimate is essential for full exploitation of the thermal potential. Secondly, the thermal properties, shapes and sizes of different foodstuffs make them behave differently when exposed to changes in air temperature. We present a novel analysis based on Biot and Fourier numbers for the different foodstuffs. This provides a valuable tool for determining how different items can be utilized in load-shifting schemes on different timescales and for estimating maximum energy storage time. The results are shown for a large range of parameters, and with specific calculations for selected foodstuff items.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Scientific Computing, Department of Electrical Engineering, Automation and Control, Institute for Product Development, Center for Energy Resources Engineering, Vestas Technology R&D
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Pages: 956-961
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Series: IEEE International Conference on Control Applications. Proceedings
ISSN: 1085-1992
Main Research Area: Technical/natural sciences
Conference: IEEE International Conference on Control Applications (CCA 2012), Dubrovnik, Croatia, 03/10/2012 - 03/10/2012
An educational tool for interactive parallel and distributed processing

In this article we try to describe how the modular interactive tiles system (MITS) can be a valuable tool for introducing students to interactive parallel and distributed processing programming. This is done by providing a hands-on educational tool that allows a change in the representation of abstract problems related to designing interactive parallel and distributed systems. Indeed, the MITS seems to bring a series of goals into education, such as parallel programming, distributedness, communication protocols, master dependency, software behavioral models, adaptive interactivity, feedback, connectivity, topology, island modeling, and user and multi-user interaction which can rarely be found in other tools. Finally, we introduce the system of modular interactive tiles as a tool for easy, fast, and flexible hands-on exploration of these issues, and through examples we show how to implement interactive parallel and distributed processing with different behavioral software models such as open loop, randomness-based, rule-based, user interaction-based, and AI- and ALife-based software.
Artificial Neural Network Based State Estimators Integrated into Kalmtool

In this paper we present a toolbox enabling easy evaluation and comparison of different filtering algorithms. The toolbox is called Kalmtool and is a set of MATLAB tools for state estimation of nonlinear systems. The toolbox now contains functions for Artificial Neural Network Based State Estimation as well as for DD1 filter and the DD2 filter, as well as functions for Unscented Kalman filters and several versions of particle filters. The toolbox requires MATLAB version 7, but no additional toolboxes are required.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Bayramoglu, E. (Intern), Ravn, O. (Intern), Poulsen, N. K. (Intern)
Pages: 1547-1552
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Simulation, Software tools, State estimation, Kalman filtering, Neural networks, Nonlinear systems
DOIs: 10.3182/20120711-3-BE-2024.00303

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Autonomous Robot Supervision using Fault Diagnosis and Semantic Mapping in an Orchard

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Blanke, M. (Intern), Blas, M. R. (Intern), Hansen, S. (Intern), Andersen, J. C. (Intern), Caponetti, F. (Intern)
Number of pages: 22
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Chapter: 1
Main Research Area: Technical/natural sciences
Broadcast Communication by System Frequency Modulation

Load controllers available today can measure AC system frequency and react to frequency deviations. A system operator can communicate to frequency sensitive loads by changing the set-points of the system’s dispatchable frequency regulation resources. Explicitly signaling system state by generating off-nominal system frequency values is a novel narrowband broadcast communications channel between system operators and frequency sensitive distributed energy resources (FS-DER). The feasibility of the proposed system is evaluated on an existing island power system in Denmark. This study shows that within standard frequency quality constraints, 4 distinct symbols are feasible on the island. However, the overarching imperative of system stability prevents the symbols from having arbitrary meanings. Higher frequency values must translate into greater consumption from loads, and vice versa. Within these constraints, the proposed system would allow operators to dispatch FS-DER in a robust manner, without using an external digital control channel. By dispatching FS-DER, their well known role as a power balancing resource can be expanded to include energy balancing services.

Cascade Controller Including Back-stepping for Hydraulic-Mechanical Systems

Development of a cascade controller structure including adaptive backstepping for a nonlinear hydraulic-mechanical system is considered in this paper where a dynamic friction (LuGre) model is included to obtain the necessary accuracy. The paper compares the performance of two variants of an adaptive backstepping tracking controller with earlier results. The new control architecture is analysed and enhanced tracking performance is demonstrated when including the extended friction model. The complexity of the backstepping procedure is significantly reduced due to the cascade structure. Hence, the proposed control structure is better suited to real-time implementation. © 2012 IFAC.
Computational Methods for Model Predictive Control: New Opportunities for Computational Scientists

Power Point presentation.

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Organisations: Center for Energy Resources Engineering, Department of Informatics and Mathematical Modeling, Scientific Computing, Automation and Control, Computer Science and Engineering, Mathematical Statistics, Technical University of Denmark
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Computational Methods for Model Predictive Control.pdf
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Configuration of Risk Monitor System by PLant Defense-In.DeeP Monitor and Reliability Monitor
A new method of risk monitor system of a nuclear power plant has been proposed from the aspect by what degree of safety functions incorporated in the plant system is maintained by multiple barriers of defense-in-depth (DiD). Wherein, the central idea is plant DiD risk monitor and reliability monitor derived from the four aspects of (i) design principle of nuclear safety to realize DiD concept, (ii) definition of risk and risk to be monitored, (iii) severe accident phenomena as major risk, (iv) scheme of risk ranking, and (v) dynamic risk display. In this paper, the overall frame of the proposed frame on risk monitor system is summarized and the detailed discussion is made on the definitions of major terminologies of risk, risk ranking, anatomy of fault occurrence, two-layer configuration of risk monitor, how to configure individual elements of plant DiD risk monitor and its example application for PWR safety system.

General information
State: Published
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Number of pages: 12
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Risk monitor, Plant DiD risk monitor, Reliability monitor, Risk ranking, PWR safety system
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2012
Contingency Estimation of States for Unmanned Aerial Vehicle using a Spherical Simplex Unscented Filter

Aiming at survival from contingency situations for unmanned aerial vehicles, a square root spherical simplex unscented Kalman filter is applied for state and parameter estimation and a rough model is used for state prediction when essential measurements are lost. Processing real flight data, received by telemetry at quite low sampling rate, the paper shows that filter performance of reasonable quality can be achieved despite the low sampling rate and the result is a low order model that can be useful during contingency operation. It is shown that the filter-estimator approach can cope with the low rate measurements requiring very little system knowledge and very limited tuning efforts. A generic aircraft model is utilised as process model where the non dimensional coefficients are identified online with joint estimation of states. Numerical stability is guaranteed by mathematically efficient square root implementation of the filter algorithm. A case of loss of GPS signal demonstrates the use of the state estimates to obtain return of the UAV to close to it's home base where safe recovery is possible.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, University of Rostock
Authors: Hahn, T. (Ekstern), Hansen, S. (Intern), Blanke, M. (Intern)
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Controlling Parametric Resonance: Induction and Stabilization of Unstable Motions

Parametric resonance is a resonant phenomenon which takes place in systems characterized by periodic variations of some parameters. While seen as a threatening condition, whose onset can drive a system into instability, this chapter advocates that parametric resonance may become an advantage if the system undergoing it could transform the large amplitude motion into, for example, energy. Therefore the development of control strategies to induce parametric resonance into a system can be as valuable as those which aim at stabilizing the resonant oscillations. By means of a mechanical equivalent the authors review the conditions for the onset of parametric resonance, and propose a nonlinear control strategy in order to both induce the resonant oscillations and to stabilize the unstable motion. Lagrange’s theory is used to derive the dynamics of the system and input–output feedback linearization is applied to demonstrate the feasibility of the control method.

General information
State: Published
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ISBN (Electronic): 978-1-4614-1043-0
Coordination strategies for distribution grid congestion management in a Multi-Actor, Multi-Objective Setting

It is well understood that the electric vehicle as a distributed energy resource can provide valuable services to the power system. Such services, however, would have to co-exist with hard constraints imposed by EV user demands and distribution grid operation constraints. This paper aims to address the interactions between the stakeholders involved, mainly considering the distribution grid congestion problem, and conceptualize several approaches by which their diverse, potentially conflicting, objectives can be coordinated. A key aspect to be considered is the relationship between the operational planning and the handling of real-time events for reliable grid operation. This paper presents an analysis of key stakeholders in terms of their objectives and key operations. Three potential strategies for congestion management are presented and evaluated based on their complexity of implementation, the value and benefits they can offer as well as possible drawbacks and risks.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Electric Energy Systems
Authors: Andersen, P. B. (Intern), Hu, J. (Intern), Heussen, K. (Intern)
Number of pages: 8
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Main Research Area: Technical/natural sciences
Conference: 3rd IEEE PES Innovative Smart Grid Technologies (ISGT) Europe Conference (IEEE PES ISGT Europe 2012), Berlin, Germany, 14/10/2012 - 14/10/2012
Electric vehicle integration, Distribution grid, Congestion management, Smart charging
Electronic versions:
congestiomarkets.pdf
Source: dtu
Source-ID: u::4471
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

Designing competitions for education in robotics
The paper describes design considerations for making a robot competition. Topics as level of participants, learning objective, evaluation form, task design and competition rules are treated. It is shown that careful design considering these topics are necessary for a successful outcome of a competition. The conclusions are based on examples from more than 15 years of experience with robotic competitions.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Andersen, N. A. (Intern), Ravn, O. (Intern)
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Series: Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)
Volume: 7429
Main Research Area: Technical/natural sciences
Designing Trailing Edge Flaps of Wind Turbines using an Integrated Design Approach

In this paper designing a controller for trailing edge flaps (TEF) as well as optimizing its position on the wind turbine blade will be considered. An integrated design approach will be used to optimize both TEF placement and controller simultaneously. Youla parameterization will be used to parameterize the controller and the plant. The goal is to maximize blade root bending moments while minimizing actuator activity. An optimization with linear matrix inequalities (LMI) constraints will be used to optimize the H1 norm of the system.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Dynamical Systems, Department of Electrical Engineering, Automation and Control
Authors: Mirzaei, M. (Intern), Poulsen, N. K. (Intern), Niemann, H. H. (Intern)
Number of pages: 3
Publication date: 2012
Main Research Area: Technical/natural sciences
Wind turbines, Trailing edge aps, Integrated design, Youla parameterization

Detection of Parametric Roll on Ships

Recent years have shown several incidents with dramatic damage on container vessels caused by parametric resonance. When the resonance starts, the roll oscillation at a sub-harmonic frequency of the wave excitation may be completely unexpected. Timely warning about the onset of the resonance phenomenon could make the navigator change ship’s speed and heading, and these remedial actions could make the vessel escape the bifurcation. This chapter proposes non-parametric methods to detect the onset of parametric roll resonance. Theoretical conditions for parametric resonance are re-visited and signal-based methods are developed to detect its onset. Hypothesis testing is derived for the particular distribution of the indicators for resonance. Robustness is investigated by analyzing forced roll and disturbances in real weather conditions. The performance of the novel methods is demonstrated on experimental data from towing tank tests and data from a container ship passing an Atlantic storm.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Galeazzi, R. (Intern), Blanke, M. (Intern), Poulsen, N. K. (Intern)
Pages: 17-43
Publication date: 2012
Electric Agricultural Robot with Multi-Layer-Control

Research within agricultural technology focuses mainly on increasing the efficiency of crop production. Electric powered machines have several advantages. The machine control is much easier in terms of sensor integration, active navigation and task application compared with traditional machine types. Furthermore, low machine weights and the use of renewable energy to provide the necessary energy contribute to soil protection and low emission performance. The aim of the paper was to describe the design, the control and the renewable energy supply for a small electric powered robot for outdoor field monitoring and other operations. Furthermore the energy consumption for the different operations scenarios was determined based on power consumption measurements for the basic navigation modes. Additionally two different charging scenarios have been investigated. The investigation has shown that it is possible to power a robot using PV cells for an operation time of 11 to 13 hours. The PV charging solutions are expensive compared with using the public power grid. They are only viable when there is no access to the grid.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Transport, Danish Transport Research Institute, Universität Hohenheim
Authors: Griepentrog, H. W. (Ekstern), Jæger-Hansen, C. L. (Intern), Dühring, K. (Intern)
Publication date: 2012
Main Research Area: Technical/natural sciences
Energy consumption, Robotics, Weed control, Controller software, Renewable energy
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Publication: Research - peer-review › Paper – Annual report year: 2012

Evolutional development of controlling software for agricultural vehicles and robots

Agricultural vehicles and robots expand their controlling software in size and complexity for their increasing functions. Due to repeated, ad hoc addition and modification, software gets structurally corrupted and becomes low performing, resource consuming and unreliable. This paper presents an evolutional development process combining Software Product Line (SPL) and eXtreme Derivation Development Process (XDDP). While SPL is a promising paradigm for successful reuse of software artefacts, it requires understanding of the whole system, a global and future view of the system, and preparation of well managed core assets. By contrast, while XDDP is a less burden process which focuses only on the portion to be changed in the new system, it never prevents software structure from corrupting due to absence of the global view of the system. The paper describes an adoption process for SPL, with an example of the autonomous tractor, that applies XDDP initially for addition and modification of functions, accumulates core assets and cultivates a global view of the system through iterated development with XDDP, and finally shifts to SPL development.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Kyushu University, University of Hohenheim
Fault Diagnosis and Fault Handling for Autonomous Aircraft

Unmanned Aerial vehicles (UAVs) or drones are used increasingly for missions where piloted aircraft are unsuitable. The unmanned aircraft has a number of advantages with respect to size, weight and manoeuvrability that makes it possible for them to solve tasks that an aircraft previously has been unable to solve. The primary cause that UAVs has reached the current level of development is their military potential. Both for surveillance operations and direct strikes, UAVs has many benefits compared to manned aircraft, and the biggest of those are that no pilots are put in direct contact with enemy troops. Gradually UAV’s are also being introduced in civilian applications. In this setting they have reduced the difficulty of tasks such as photo inspections of large buildings and rescue missions at sea. All in all UAVs have shown their great potential within the recent years. The increasing use of UAVs causes them to coexist with manned aircraft and in areas where humans are present on ground. This of course carries demands to the safety and reliability of the aircraft. It is inevitable that components onboard a UAV will fail at some point in time. When this happens it is important that the fault is discovered in time such that appropriate actions can be taken. That could either be the aircraft controlling computer taking the fault into account or a human operator that intervenes. Detection of faults that occur during flight is exactly the subject of this thesis. Safety towards faults for manned aircraft is often achieved by making most of the systems onboard redundant. This is an easy way to obtain safety since no single system fault is catastrophic. The failed subsystem can be disconnected and the redundant systems can take over the tasks of the failed system. For smaller UAVs both price and weight of the aircraft is very important meaning that redundant hardware will not be an applicable safety solution. This is why focus of this thesis have been on methods where redundancies are obtained by models and knowledge about the aircraft behaviour. Based on telemetry data from a specific UAV, used by the Danish military, it is investigated how a number of critical faults can be detected and handled. One of the challenges using telemetry data for the fault diagnosis is the limited bandwidth in the radio link between the aircraft and the base-station on ground. This combined with noise on the signals makes it difficult to use precise models for the fault diagnosis. This is solved by using statistical distributions to describe the aircraft’s normal behaviour and deviations from this, indicating different faults. To increase the applicability of the models, used for fault diagnosis, these are adaptive to some extent. This makes small discrepancies between aircraft and wind conditions to have less influence on the performance of the fault diagnosis with respect to time to detect and false alarms. It also means that less adjustment is needed if the methods should be applied to another type of aircraft with different parameters. Amongst the main findings of this research project is a method to handle faults on the UAV’s pitot tube, which measures the aircraft speed. A set of software redundancies based on GPS velocity information and engine thrust are used to detect abnormal airspeed signals. Another contribution worth mentioning considers diagnosis of control surface faults. Here a set of low-complexity models between the aircraft’s turn rates and input deflections are used in the fault detection. Both methods has been verified against data from incidents where the respective faults occurs, and show good potential. The thesis consists of a summary of the different methods, investigations and results obtained during the project. Detailed descriptions are found in a number of papers submitted to research conferences and journals during the project. These have been enclosed in the last part of the thesis.
Fault diagnosis of a Wind Turbine Rotor using a Multi-blade Coordinate Framework
Fault diagnosis of a wind turbine rotor is considered. The faults considered are sensor faults and blades mounted with a pitch offset. A fault at a single blade will result in asymmetries in the rotor, which can be applied for fault diagnosis. The diagnosis is derived by using the multiblade coordinate (MBC) transformation also known as the Coleman transformation together with active fault diagnosis (AFD). This transforms the setup from rotating to fixed frame coordinates. The rotor speed acts as the auxiliary input for the active diagnosis. The applied method takes the varying rotor speed into account. Operation at different mean wind speeds is examined and it is discussed how to exploit the findings acquired by the investigation of the various faults.

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Organisations: Department of Wind Energy, Aeroelastic Design, Department of Electrical Engineering, Automation and Control, Department of Informatics and Mathematical Modeling, Mathematical Statistics
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Indirect Control for Demand Side Management – A Conceptual Introduction
The concept of “indirect control” has become a relevant discussion term in relation to activation distributed and small-scale demand and generation units to provide resources for power system balancing. The term and its association with price signals has, however caused some confusion as to its correct definition, either as a control or a market concept. This paper aims to provide a conceptual introduction to "indirect control" for management of small and distributed demand side resources. A review of control concepts and an analysis of "indirectness" features are provided to create a framework for systematic classification of indirect control strategies. The concepts developed then enable a discussion of control performance and valuation of direct- and indirect control strategies.

General information
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Demand side management, Demand side resources, Control, Indirect control
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In-Flight Fault Diagnosis for Autonomous Aircraft Via Low-Rate Telemetry Channel
An in-flight diagnosis system that is able to detect faults on an unmanned aircraft using real-time telemetry data could provide operator assistance to warn about imminent risks due to faults. However, limited bandwidth of the air-ground radio-link makes diagnosis difficult. Loss of information about rapid dynamic changes and high parameter uncertainty are the main difficulties. This paper explores time-domain relations in received telemetry signals and uses knowledge of aircraft dynamics and the mechanics behind physical faults to obtain a set of greybox models for diagnosis. Relating actuator fin deflections with angular rates of the aircraft, low order models are derived and parameters are estimated using system identification techniques. Change detection methods are applied to the prediction error of angular rate estimates and properties of the test statistics are determined. Techniques to overcome correlations in data and cope with non-Gaussian distributions are employed and threshold selection is obtained for the particular distributions of test statistics. Verification using real data showed that the diagnosis method is efficient and could have avoided incidents where faults led to loss of aircraft.

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Organisations: Department of Electrical Engineering, Automation and Control
Authors: Blanke, M. (Intern), Hansen, S. (Intern)
Pages: 576-581
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L1 Adaptive Maneuving Control of Unmanned High-speed Water Craft

This work addresses the issue of designing an adaptive robust control system to govern the steering of a high speed unmanned personal watercraft (PWC) maintaining equal performance across the craft’s envelope of operation. The maneuvering dynamics of a high speed PWC is presented and a strong variation over the envelope of operational conditions, including speed, is highlighted. The complexity of the nonlinear dynamics is overcome through identification of linear models at different speed regimes. A gray-box identification is conducted from full scale experiments and results in a four degrees-of-freedom surge-sway-yaw-roll model. An L1 adaptive autopilot is then designed, which allows to achieve fast adaptation to system parameters’ changes and robustness of the closed loop system.

Model-Based approaches to Human-Automation Systems Design

Human-automation interaction in complex systems is common, yet design for this interaction is often conducted without explicit consideration of the role of the human operator. Fortunately, there are a number of modeling frameworks proposed for supporting this design activity. However, the frameworks are often adapted from other purposes, usually applied to a limited range of problems, sometimes not fully described in the open literature, and rarely critically reviewed in a manner acceptable to proponents and critics alike. The present paper introduces a panel session wherein these proponents (and reportedly one or two critics) can engage one another on several agreed questions about such frameworks. The goal is to aid non-aligned practitioners in choosing between alternative frameworks for their human-automation interaction design challenges.
Modeling Operating Modes during Plant Life Cycle

Modelling process plants during normal operation requires a set a basic assumptions to define the desired functionalities which lead to fulfillment of the operational goal(-s) for the plant. However during during start-up and shut down as well as during batch operation an ensemble of interrelated modes are required to cover the whole operational window of a process plant including intermediary operating modes. Development of such an model ensemble for a plant would constitute a systematic way of defining the possible plant operating modes and thus provide a platform for also defining a set of candidate control structures. The present contribution focuses on development of a model ensemble for a plant with an illustrative example for a bioreactor.

Starting from a functional model a process plant may be conceptually designed and qualitative operating models may be developed to cover the different regions within the plant operating window, including transitions between operating regions. Subsequently qualitative functional models may be developed when the means for achieving the desired functionality are sufficiently specified during the design process. Quantitative mathematical models of plant physics can be used for detailed design and optimization. However the qualitative functional models already provide a systematic framework based on the notion of means-end abstraction hierarchies. Thereby functional modeling provides a scientific basis for managing complexity. A functional modelling framework has been implemented to facilitate model development and application in a computer environment. Defining means-end causal relations makes it possible to perform qualitative causal reasoning within a functional modelling framework. Thus such a framework renders it possible to develop potentially feasible control structures. This ability is based on goal reasoning and development of goal trees from causal relations. These capabilities of functional models extend the application potential of functional modelling significantly beyond that of conventional mathematical modeling representing quantitative physical phenomena. The example case is a continuously operating bioreactor for manufacturing single cell protein from methane where also the bioreactor start-up is illustrated with switching between operating modes and their associated control structures as seen in a multiloop control configuration.
Modeling OperatingModes for the Monju Nuclear Power Plant

The specification of supervision and control tasks in complex processes requires definition of plant states on variouslevels of abstraction related to plant operation in start-up, normal operation and shut-down. Modes of plant operation are often specified in relation to a plant decomposition into subsystems or components or defined in relation to phases of the plant process. Multilevel Flow Modeling (MFM) is a methodology for representing goals and functions of complex process plants on multiple levels of means-end abstraction and is based on conceptual distinctions between purposes or goals of the process plant, its function and its structural elements. The paper explains how the means-end concepts of MFM can be used to provide formalized definitions of plant operation modes. The paper will introduce the mode types defined by MFM and show how selected operation modes can be represented for the Japanese fast breeder reactor plant MONJU.

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Modeling Safety Barriers and Defense in Depth with Multilevel Flow Modeling

The barrier concept plays a central role in design and operation of safety critical processes. In plant design, barriers are provided as means of prevention to avoid critical process conditions which may be harmful to the environment. In plant operations, barriers may be established and maintained through control actions in order to limit the consequences of critical plant events.

The barrier concept has had a significant practical value for industry by guiding the design thinking of safety engineers. The provision of material barriers preventing the release of radioactive materials from the reactor core to the environment is accordingly a basic principle of nuclear safety design. The application of barriers is furthermore an integral part of the defense in depth principle applied by nuclear industry. Here, several barriers are combined with reliability techniques such as redundancy and diversity to create systems with a high level of safety. Chemical industries apply similar techniques for protection of the environment against the release of toxic materials.

The paper explores different ways barriers can be represented in Multilevel Flow Modeling (MFM). One of the existing flow functions in MFM is a barrier function. It is shown that other barrier types can be represented and that their combination into barrier chains may be used to analyze and design levels of safety in automated processes. Suggestions for further research on barrier modeling with MFM are included.

Model Predictive Control of a Nonlinear System with Known Scheduling Variable

Model predictive control (MPC) of a class of nonlinear systems is considered in this paper. We will use Linear Parameter Varying (LPV) model of the nonlinear system. By taking the advantage of having future values of the scheduling variable, we will simplify state prediction. Consequently, the control problem of the nonlinear system is simplified into a quadratic programming. Wind turbine is chosen as the case study and we choose wind speed as the scheduling variable. Wind speed is measurable ahead of the turbine, therefore the scheduling variable is known for the entire prediction horizon.

Model Predictive Control of a Nonlinear System with Known Scheduling Variable

Model predictive control (MPC) of a class of nonlinear systems is considered in this paper. We will use Linear Parameter Varying (LPV) model of the nonlinear system. By taking the advantage of having future values of the scheduling variable, we will simplify state prediction. Consequently, the control problem of the nonlinear system is simplified into a quadratic programming. Wind turbine is chosen as the case study and we choose wind speed as the scheduling variable. Wind speed is measurable ahead of the turbine, therefore the scheduling variable is known for the entire prediction horizon.
Model predictive control technologies for efficient and flexible power consumption in refrigeration systems

Considerable amounts of energy are consumed in supermarket refrigeration systems worldwide. Due to the thermal capacity of refrigerated goods and the rather simplistic control most commonly applied, there is a potential for distributing the system load over time in a more cost-optimal way. In this paper we describe a novel economic-optimizing Model Predictive Control (MPC) scheme that reduces operating costs by utilizing the thermal storage capabilities. A nonlinear optimization tool to handle a non-convex cost function is utilized for simulations with validated scenarios. In this way we explicitly address advantages from daily variations in outdoor temperature and electricity prices. Secondly, we formulate a new cost function that enables the refrigeration system to contribute with ancillary services to the balancing power market. This involvement can be economically beneficial for the system itself, while crucial services can be delivered to a future flexible and intelligent power grid (Smart Grid). Furthermore, we discuss a novel incorporation of probabilistic constraints and Second Order Cone Programming (SOCP) with economic MPC. A Finite Impulse Response (FIR) formulation of the system models allows us to describe and handle model as well as prediction uncertainties in this framework. This means we can demonstrate means for robustifying the performance of the controller.
Modular Playware Technology: A Brief Historical Review

In this paper, we present a shortened historical review of the building blocks concept. With the concept we show that three B's can lead to three A's: Building Bodies and Brains leads to applications for Anybody, Anywhere, Anytime. Hence, we outline how the inspiration from artificial life, especially regarding the relationship between the body and brain, leads to a building block concept based upon interactive, distributed parallel processing. The historical outline shows how biomimetic robotics and behavior-based robotics has inspired the development of modular playware. Application examples based upon the concept include LEGO I-Blocks, playgrounds, multi-sensory rooms, robomusic, etc. In the paper, we attempt to explore the theoretical characteristics of the concept and the lessons learned for playware application fields.

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Monitoring of a Wind Turbine Rotor using a Multi-blade Coordinate Framework

In this paper a method to detect asymmetric faults in a wind turbine rotor is presented. The paper describes how fault diagnosis using an observer-based residual generator approach is able to distinguish between the nominal and faulty case by the injection of e.g. a sinusoidal excitation signal into the system. In the case of a wind turbine, an excitation signal is automatically generated by the rotation of the rotor in a turbulent wind field. Using the multi-blade coordinate transformation, the detection of asymmetries in the rotor of the wind turbine is greatly improved.

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Multilayer controller for field robots - High portability and modularity to ease implementation

Various autonomous machines and robots exist in agriculture today as research prototypes. In many prototypes software and hardware are designed and developed from scratch. The MobotWare software framework has been used to create an overall system called multilayer controller. MobotWare is a software framework capable of controlling mobile robot platforms in different environments. The RHD is a real-time device server, which operates only as a hardware interface. The MRC is a low level real-time controller it can control the movements and actions of the robot. The AURS allow connections to advanced sensors and handles tasks like mapping and localization. Along with the MobotWare, machine dedicated firmware controlling specific platforms without internal CAN system has been updated. On the hardware side there has been added various new sensors and a safety circuit. The Multilayer controller has successfully been implemented on two agricultural machines. Future work will include fault tolerant software, introduce compliance to safety standards and update the user interface.

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Multilevel Flow Modeling for Nuclear Power Plant Diagnosis

As complexity and safety requirements of current and future nuclear power plants increase, innovative methods are being investigated to perform accurate and reliable system diagnoses. Detecting malfunctions, identifying their causes and possibly predicting their consequences are major challenges, especially if extended to the whole plant. Monitoring plant performances by means of data reconciliation techniques has proved successful to detect anomalies during operation, provide early warnings and eventually schedule maintenance. At the same time, the large amount of information provided by large-scale monitoring systems is hard to handle manually. In this paper, the use of an innovative function-oriented modeling approach, called Multilevel Flow Modeling, is proposed for performing an automatic analysis of the outcomes of the monitoring systems with the aim of identifying the root causes of the possibly detected anomalies. The combination of a data reconciliation system and the Multilevel Flow Modeling approach is illustrated with regard to the secondary loop of the Loviisa-2 Pressurized Water Reactor located in Finland.

Multilevel Flow Modeling of Domestic Heating Systems

Multilevel Flow Modeling (MFM) is a well recognized methodology for functional modeling of complex systems which primarily focuses on the representation of their goals and functions. It has been successfully used in industrial process, e.g., nuclear power plant, chemical plants etc. to facilitate the operation on fault analysis and control. A significant improvement of the MFM methodology has been recently proposed, where the “role” concept was introduced to enable the representation of structural entities and the conveyance of important information for building up knowledge bases, with the purpose of complementing this reasoning methodology. Domestic heating systems, as the main resource to meet the thermal requirements of end-users, have different implementations in Europe in order to achieve various degrees of controllability and heating efficiencies. As all the heating systems serve the same basic needs i.e. supplying and transferring thermal energy, it is off interest to use MFM to investigate similarities and differences between different implementations. In this paper, three typical domestic European heating systems, which differ from each other in the number of temperature sensors and auxiliary components e.g. storage tanks, are modeled using the MFM methodology. Both the goals and functions of material and energy processes and the control functions of the heating systems are represented in the MFM models. It is found that varying the physical system setup results in only little differences among the MFM models. The ‘role’ concept is used to associate the relation between physical structures and functions in all MFM models. This study contributes to MFM library expansion and provides a significant test of the expressivity of MFM.
Navigation and Tree Mapping in Orchards
In this paper an algorithm for estimating tree positions is presented. The sensors used for the algorithm is GNSS and LiDAR, and data is collected in an orchard with grapefruit trees while driving along the rows. The positions of the trees are estimated using ellipse fitting on point clouds. The average accuracy for the center point estimation is 0.2 m in the along track direction and 0.35 m in the across track direction. The goal of the tree mapping algorithm is create a database of individual trees, and be the basis for creation of a graph map that can be used for mission planning and localization for an autonomous robot.

On Support Functions for the Development of MFM Models
A modeling environment and methodology are necessary to ensure quality and reusability of models in any domain. For MFM in particular, as a tool for modeling complex systems, awareness has been increasing for this need. Introducing the context of modeling support functions, this paper provides a review of MFM applications, and contextualizes the model development with respect to process design and operation knowledge. Developing a perspective for an environment for MFM-oriented model- and application-development a tool-chain is outlined and relevant software functions are discussed. With a perspective on MFM-modeling for existing processes and automation design, modeling stages and corresponding formal model properties are identified. Finally, practically feasible support functions and model-checks to support the model-development are suggested.

Operation Design of Wind Turbines in Strong Wind Conditions
In order to reduce the impact on the electrical grid from the shutdown of MW wind turbines at wind speeds higher than the cut-out wind speed of 25 m/s, we propose in this paper to run the turbines at high wind speeds up to 40 m/s. Two different operation designs are made for both constant speed and variable speed pitch regulated wind turbines. The variable speed design is more suitable for wind turbines to run at very high wind speeds which can help the turbine braking system to stop
the turbine at the new "cut-out" wind speed. Reference power, rotational speed and pitch angle have been designed optimally. In order to reduce the possible increased loading, fatigue due to the wind gusts, control strategies have been considered for both constant speed and variable speed pitch regulated wind turbines. The control study shows that the designed controllers can reduce the standard deviations efficiently for wind turbines at some selected wind high speeds.

**General information**
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Optimising performance in steady state for a supermarket refrigeration system
Using a supermarket refrigeration system as an illustrative example, the paper postulates that by appropriately utilising knowledge of plant operation, the plant wide performance can be optimised based on a small set of variables. Focusing on steady state operations, the total system performance is shown to predominantly be influenced by the suction pressure. Employing appropriate performance function leads to conclusions on the choice of set-point for the suction pressure that are contrary to the existing practice. Analysis of the resulting data leads to a simple method for finding optimal pressure set-point for given load situations.

**General information**
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Particle Filter Based Fault-tolerant ROV Navigation using Hydro-acoustic Position and Doppler Velocity Measurements
This paper presents a fault tolerant navigation system for a remotely operated vehicle (ROV). The navigation system uses hydro-acoustic position reference (HPR) and Doppler velocity log (DVL) measurements to achieve an integrated navigation. The fault tolerant functionality is based on a modified particle filter. This particle filter is able to run in an asynchronous manner to accommodate the measurement drop out problem, and it overcomes the measurement outliers by switching observation models. Simulations with experimental data show that this fault tolerant navigation system can accurately estimate the ROV kinematic states, even when sensor failures appear frequently.

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Particle Filter ROV Navigation using Hydrodynamic Position and Speed log Measurements

An integrated navigation system design is presented for an underwater remotely operated vehicle (ROV). The available navigation information is an acoustic position measurement and a Doppler log speed measurement. Both measurements are studied in detail and modeled statistically. A kinematic model is assigned to the ROV with its driving noise from a Gaussian mixture, and a particle filter is suggested to estimate ROV position and velocity. The advantages of using a particle filter in this ROV navigation scheme are: 1) to make full use of all available information to improve the estimation performance, such as the speed measurement that is a nonlinear function of the states; 2) the particle filter makes good use of a Gaussian mixture as the driving noise, which makes the ROV kinematic model more realistic in both high and low frequency ranges; 3) a good estimate of the ROV velocity vector is achieved. The algorithm of the particle filter is presented and verified through a simulation based on real data. This shows that the estimation performance of the particle filter is clearly better than that of a Kalman filter.

Performance Assessment and Active System Monitoring for Refrigeration Systems

The refrigeration system in a supermarket is an important part of the business for the supermarkets, both in terms of the possibility it provides and because of the associated cost of operating the system. It provides the possibility of selling chilled and frozen food but on the other hand the operation of the refrigeration system is associated with a significant cost. Cost efficient operation of the refrigeration system is therefore very important for the supermarkets. To ensure that the systems are operated cost efficient a performance assessment scheme is required. In addition, there exists a need for algorithms that ensures or improves the performance of the system. A supermarket refrigeration system is usually a complex and distributed control system, and it can therefore be difficult to assess the performance without a formal method. The main interest for a supermarket, with respect to the refrigeration system, is to optimise the total cost of ownership, (TCO). However, directly measuring TCO provides some challenges. It can therefore be beneficial to divide TCO into performance criteria, which can be quantified and measured. For supermarket refrigeration systems the performance criteria can be divided into three categories: quality-, energy- and reliability-related criteria. Hence, it is important to operate the refrigeration system such that it ensures good quality of the stored goods as energy efficient as
possible without compromising the reliability of the system. A performance function that quantifies and measures the criteria has been developed in this project. The quality is measured by the control errors in the system because there is a connection between the quality of the stored goods and the ability of the refrigeration system to provide the required temperature. A deviation from the controller set-point corresponds to a temperature deviation, which will eventually harm the stored goods. The energy efficiency is measured by the coefficient of performance, COP, which basically is the delivered cooling power divided by the consumed electrical power of the system. The reliability criteria is measured by the switch frequency of the compressors in the refrigeration system. The reason is that excessive compressor switching will wear down the compressors too fast and thereby decrease the reliability of the system due to a higher demand for maintenance. The proposed performance function provides a method for assessing the operational performance at a plant-wide level and is therefore providing a tool for improving the plant-wide performance. The performance function has been used in different setups to improve the performance of the refrigeration system. Static and the dynamic performance of the refrigeration system has been addressed in the project. The proposed methods for improvement relies on a minimum of detailed knowledge about the refrigeration system. In addition, since a refrigeration system often operates in steady state an active system monitoring setup has been proposed, to enable improvement of the dynamic performance.

Ping-Pong Robotics with High-Speed Vision System
The performance of vision-based control is usually limited by the low sampling rate of the visual feedback. We address Ping-Pong robotics as a widely studied example which requires high-speed vision for highly dynamic motion control. In order to detect a flying ball accurately and robustly, a multithreshold segmentation algorithm is applied in a stereo-vision running at 150Hz. Based on the estimated 3D ball positions, a novel two-phase trajectory prediction is exploited to determine the hitting position. Benefiting from the high-speed visual feedback, the hitting position and thus the motion planning of the manipulator are updated iteratively with decreasing error. Experiments are conducted on a 7 degrees of freedom humanoid robot arm. A successful Ping-Pong playing between the robot arm and human is achieved with a high successful rate of 88%.
**Plant-wide performance optimisation – The refrigeration system case**

This paper investigates the problem of plant-wide performance optimisation seen from an industrial perspective. The refrigeration system is used as a case study, because it has a distributed control architecture and operates in steady state conditions, which is common for many industrial applications in the process industry. The paper addresses the fact that dynamic performance of the system is important, to ensure optimal changes between different operation conditions. To enable optimisation of the dynamic controller behaviour a method for designing the required excitation signal is presented. Furthermore, invasive weed optimisation is used to find the optimal parameters for local controllers based on the plant wide performance measure.

**Robust Model Predictive Control of a Nonlinear System with Known Scheduling Variable and Uncertain Gain**

Robust model predictive control (RMPC) of a class of nonlinear systems is considered in this paper. We will use Linear Parameter Varying (LPV) model of the nonlinear system. By taking the advantage of having future values of the scheduling variable, we will simplify state prediction. Because of the special structure of the problem, uncertainty is only in the B matrix (gain) of the state space model. Therefore by taking advantage of this structure, we formulate a tractable minimax optimization problem to solve robust model predictive control problem. Wind turbine is chosen as the case study and we choose wind speed as the scheduling variable. Wind speed is measurable ahead of the turbine, therefore the scheduling variable is known for the entire prediction horizon.
Robust Model Predictive Control of a Wind Turbine

In this work the problem of robust model predictive control (robust MPC) of a wind turbine in the full load region is considered. A minimax robust MPC approach is used to tackle the problem. Nonlinear dynamics of the wind turbine are derived by combining blade element momentum (BEM) theory and first principle modeling of the turbine flexible structure. Thereafter the nonlinear model is linearized using Taylor series expansion around system operating points. Operating points are determined by effective wind speed and an extended Kalman filter (EKF) is employed to estimate this. In addition, a new sensor is introduced in the EKF to give faster estimations. Wind speed estimation error is used to assess uncertainties in the linearized model. Significant uncertainties are considered to be in the gain of the system (B matrix of the state space model). Therefore this special structure of the uncertain system is employed and a norm-bounded uncertainty model is used to formulate a minimax model predictive control. The resulting optimization problem is simplified by semidefinite relaxation and the controller obtained is applied on a full complexity, high fidelity wind turbine model. Finally simulation results are presented. First a comparison between PI and robust MPC is given. Afterwards simulations are done for a realization of turbulent wind with uniform profile based on the IEC standard.

General information

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Sequential Convex Programming for Power Set-point Optimization In a Wind Farm using Black-box Models, Simple Turbine Interactions, and Integer Variables

We consider the optimization of power set-points to a large number of wind turbines arranged within close vicinity of each other in a wind farm. The goal is to maximize the total electric power extracted from the wind, taking the wake effects that couple the individual turbines in the farm into account. For any mean wind speed, turbulence intensity, and direction we find the optimal static operating points for the wind farm. We propose an iterative optimization scheme to achieve this goal.

When the complicated, nonlinear, dynamics of the aerodynamics in the turbines and of the fluid dynamics describing the turbulent wind fields' propagation through the farm are included in a highly detailed black-box model, numerical results for any given values of the parameter sets can easily be evaluated. However, analytic expressions for model representation in the optimization algorithms might be hard to derive and their properties are often not suitable for computationally efficient optimization either. To handle this, we propose a sequential convex optimization method, perturbing the model in each iteration, and demonstrate a typical convergence in fewer than 10 iterations. We derive a coupling matrix from the wind farm model, enabling us to use a very simple linear relationship for describing the turbine interactions. In addition, we allow individual turbines to be turned on or off introducing integer variables into the optimization problem. We solve this within the same framework of iterative convex approximation and compare with mixed-integer optimization tools. We demonstrate the method on a verified model and for various sizes and configurations of the wind farm. For all tested scenarios we observe a distribution of the power set-points which is at least as good as, and in many cases is far superior to, a more naive distribution scheme. We employ a fast convex quadratic programming solver to carry out the iterations in the range of microseconds for even large wind farms.

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Ship Roll Damping Control

The technical feasibility of roll motion control devices has been amply demonstrated for over 100 years. Performance, however, can still fall short of expectations because of difficulties associated with control system designs, which have proven to be far from trivial due to fundamental performance limitations and large variations of the spectral characteristics of wave-induced roll motion. This tutorial paper presents an account of the development of various ship roll motion control systems together with the challenges associated with their design. It discusses the assessment of performance and the applicability of different mathematical models, and it surveys the control methods that have been implemented and validated with full scale experiments. The paper also presents an outlook on what are believed to be potential areas of research within this topic.
**Situation Assessment for Mobile Robots**

Mobile robots have become a mature technology. The first cable guided logistics robots were introduced in the industry almost 60 years ago. In this time the market for mobile robots in industry has only experienced a very modest growth and only 2.100 systems were sold worldwide in 2011. In recent years, many other domains have adopted the mobile robots, such as logistics robots at hospitals and the vacuum robots in our homes. However, considering the achievements in research the last 15 years within perception and operation in natural environments together with the reductions of costs in modern sensor systems, the growth potential for mobile robot applications are enormous.

Many new technological components are available to move the limits of commercial mobile robot applications, but a key hindrance is reliability. Natural environments are complex and dynamic, and thus the risk of robots misinterpreting the environment or failing to detect critical circumstances is unavoidable. To deal with this challenge, the control of robot applications must be able to handle imperfect observations and gracefully recover from unavoidable errors. The controller needs to know what is going on.

This thesis addresses exactly this problem from the hypothesis that an assessment of the situation for the robot, will be able to contribute with essential knowledge to the robot control and enable the understanding of the current situation as well as predict the future status.

A novel framework for situation modeling are presented, which applies an Extensible Markov Model (EMM) to represent the spatio-temporal nature of situations. On-line data-streams from the robot sensors and algorithms are processed using stream-based clustering to build the spatio-temporal structure or match the situation of the robot to existing states. Situation prediction is proposed using an on-line graph-search of maximum likelihoods in the EMM. The developed software modules are integrated in a new software architecture, which facilitates integration into any robotic control framework and uses on-line visualization of the spatio-temporal graphs to optimize situation classification. The results are evaluated in three real-world scenarios, which successfully evaluates capabilities of the proposed situation assessment framework within detection of known spatio-temporal relations, deviation from known spatio-temporal patterns, and detection of known critical situations.
Social playware for mediating tele-play interaction over distance

We suggest that novel playware technology can function as a mediator for playful social interaction over long distances, such as where people are separated by physical distance but feel the presence of each other mediated through their interaction with the playware technology. In order to investigate such social playware, we developed the Playware Soccer game and tested it with more than 1000 users during the FIFA World Cup 2010 in South Africa. The test was conducted in townships, orphanages for HIV/AIDS children, markets, FIFA fan parks, etc., along with simultaneous tests with similar set-ups in Europe and Asia. With the social playware, players would compete against each other simultaneously in three continents, Africa, Europe, and Asia, and feel the presence of the competitors on the other continents expressed through the playware. The playware game is set up to motivate players to engage in training in technical soccer skills by receiving immediate feedback and offering challenges to players of all skills at soccer. It is played on a modular interactive wall composed of modular interactive tiles that respond with colored lights, sounds, and scores of the players’ performance. This article outlines the concept of social playware and physical-virtual tele-play, and exemplifies this with the playware soccer game.

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Statistical Change Detection for Diagnosis of Buoyancy Element Defects on Moored Floating Vessels

Floating platforms with mooring systems are used extensively in off-shore operations. Part of the mooring systems are underwater buoyancy elements that are attached to the mooring lines. Loss or damage of a buoyancy element is invisible but changes the characteristics of the mooring system and alters its ability to provide the necessary responses to withstand loads from weather. Damage of a buoyancy element increases the operation risk and could even cause abortion during an oil-offloading. The objective of this paper is to diagnose the loss of a buoyancy element using diagnostic methods. After residual generation, statistical change detection scheme is derived from mathematical models supported by experimental data. To experimentally verify loss of an underwater buoyancy element, an underwater line breaker is designed to create realistic replication of abrupt faults. The paper analyses the properties of residuals and suggests a dedicated GLRT change detector based on a vector residual. Special attention is paid to threshold selection for non ideal (non-IID) test statistics.

Temperature Modelling of the Biomass Pretreatment Process

In a second generation biorefinery, the biomass pretreatment stage has an important contribution to the efficiency of the downstream processing units involved in biofuel production. Most of the pretreatment process occurs in a large pressurized thermal reactor that presents an irregular temperature distribution. Therefore, an accurate temperature model is critical for observing the biomass pretreatment. More than that, the biomass is also pushed with a constant horizontal speed along the reactor in order to ensure a continuous throughput. The goal of this paper is to derive a temperature model that captures the environmental temperature differences inside the reactor using distributed parameters. A Kalman filter is then added to account for any missing dynamics and the overall model is embedded into a temperature soft sensor. The operator of the plant will be able to observe the temperature in any point of the thermal reactor. Real data sets were extracted from the Inbicon biorefinery situated in Kalundborg, Denmark, and will be utilized to validate and test the
temperature model.

Understanding Control Function and Failure From a Process Perspective

In control design, fault-identification and fault tolerant control, the controlled process is usually perceived as a dynamical process, captured in a mathematical model. The design of a control system for a complex process, however, begins typically long before these mathematical models become relevant and available. To consider the role of control functions in process design, a good qualitative understanding of the process as well as of control functions is required. As the purpose of a control function is closely tied to the process functions, its failure has a direct effect on the process behaviour and its function. This paper presents a formal methodology for the qualitative representation of control functions in relation to their process context. Different types of relevant process and control abstractions are introduced and their application to formal analysis of control failure modes from a process perspective is presented. Finally anticipated applications in context of offline analysis and online supervisory control are discussed.
Wind Turbine Control: Robust Model Based Approach

In the 1970s the oil price crisis encouraged investigation of non-petroleum energy sources of which wind energy was the most promising one. Lately global warming concerns have even intensified the demand for green and sustainable energy resources and opened up several lines of research in this area. Wind turbines are the most common wind energy conversion systems and are hoped to be able to compete economically with fossil fuel power plants in near future. However this demands better technology to reduce the price of electricity production. Control can play an essential part in this context. This is because, on the one hand, control methods can decrease the cost of energy by keeping the turbine close to its maximum efficiency. On the other hand, they can reduce structural fatigue and therefore increase the lifetime of the wind turbine.

The power produced by a wind turbine is proportional to the square of its rotor radius, therefore it seems reasonable to increase the size of the wind turbine in order to capture more power. However as the size increases, the mass of the blades increases by cube of the rotor size. This means in order to keep structural feasibility and mass of the whole structure reasonable, the ratio of mass to size should be reduced. This trend results in more flexible structures.

Control of the flexible structure of a wind turbine in a wind field with stochastic nature is very challenging. In this thesis we are examining a number of robust model based methods for wind turbine control. Firstly we examine potentials of -synthesis methods and use -tools to analyze robustness of the resulting controllers both in terms of robust stability and robust performance. Afterwards we employ model predictive control (MPC) and show that the way MPC solves control problems suits wind turbine control problems very well, especially when we have preview measurements of wind speed using LiDARs. For the control problem with LiDAR measurements we have proposed a new MPC approach which gives better results than linear MPC while it has almost the same computational complexity. We have also tackled wind turbine control using robust MPC. In general, robust MPC problems are very computationally demanding, however we have shown that with some approximations the resulting robust MPC problem can be specialized with reduced computational complexity.

After a short introduction on wind energy and wind turbines in chapter 1, we briefly explain wind turbine modeling in chapter 2. Introductions to different control design methods are given in chapter 3. The goal of this chapter is to show how different control methods are chosen. The next eight chapters comprise the body of the thesis and are scientific papers that are published or going to be published. Control methods which were briefly introduced in chapter 3 are explained in these chapters in details.
Adapting Playware to Rehabilitation Practices

We describe how playware and games may become adaptive to the interaction of the individual user and how therapists use this adaptation property to apply modular interactive tiles in rehabilitation practices that demand highly individualized training. Therapists may use the interactive modular tiles to provide treatment for a large number of patients who receive hospital, municipality or home care, although the tiles can as well be used for prevention with elderly or for fitness with normal people. In this paper, we describe the extensive use of the modular tiles with cardiac patients, smoker's lung (COLD) patients and stroke patients in hospitals and in the private homes of patients and elderly. Through a qualitative research methodology of the new practice with the tiles, we find that therapists are using the modular aspect of the tiles for personalized training of a vast variety of elderly patients modulating exercises and difficulty levels. We also find that in physical games there are individual differences in patient interaction capabilities and styles, and that modularity allows the therapist to adapt exercises to the individual patient’s capabilities.

Adaptive Modular Playware

In this paper, we describe the concept of adaptive modular playware, where the playware adapts to the interaction of the individual user. We hypothesize that there are individual differences in user interaction capabilities and styles, and that adaptive playware may adapt to the individual user’s capabilities, so that the activity automatically will match the capability of the individual user. With small test groups, we investigate how different age groups and gender groups physically interact with some specific playware games, and find indications of differences between the groups. Despite the small test set, the results are important as a proof of existence of differences and of the need for adaptation. The fact that there are individual differences makes the results significant for the development of games and interaction. It indicates that it is necessary to adapt the game and interaction, if we desire to make the most appropriate game and interaction for the individual. Hence, we investigate adaptation as an important issue for playware. With simple playware games, we show that the adaptation will speed the game up and down to find the appropriate level that matches the reaction speed of the individual player. The appropriate level will change with game/interaction complexity, and adaptation will automatically find the appropriate level for the individual player, even in multi-player games.
Adaptive Playware in Physical Games

We describe how playware and games may adapt to the interaction of the individual user. We hypothesize that in physical games there are individual differences in user interaction capabilities and styles, and that adaptive playware may adapt to the individual user’s capabilities, so that the activity automatically will match the capability of the individual user. With small test groups, we investigate how different age groups and gender groups physically interact with some playware games, and find indications of differences between the groups. Despite the small test set, the results are a proof of existence of differences and of the need for adaptation, and therefore we investigate adaptation as an important issue for playware. With simple playware games, we show that the adaptation will speed the physical game up and down to find the appropriate level that matches the reaction speed of the individual player. The appropriate level will change with game/interaction complexity, and adaptation finds the appropriate level for the individual player, even in multi-player games.

A method of detecting a structure in a field, a method of steering an agricultural vehicle and an agricultural vehicle

An agricultural vehicle (2) comprises a steering system providing steering signals, said steering system comprising an imaging device (11) for imaging surroundings of the vehicle and an image processing device (13), said steering system operating to provide by means of the imaging device (11) an image of the field (21), analyse the image to obtain texture information, assign to a plurality of areas of the image probability-values reflecting the likelihood that the respective area relates to a specific structure (12), assume at least one geometric property of said specific structure (12), and establish a most possible position parameter of said specific structure taking into account said probability-values and the assumed geometric property; and to provide a steering signal in accordance with the position parameter thus established.
An Educational Tool for Creating Distributed Physical Games

The development of physical interactive games demands extensive knowledge in engineering, computer science and gaming. In this paper we describe how the Modular Interactive Tiles System (MITS) can be a valuable tool for introducing students to interactive parallel and distributed processing programming for physical games development. This is done by providing an educational tool that allows a change of representation of the problems related to game designing from a virtual to a physical representation. Indeed, MITS seems to be a valuable system for bringing into education a vast number of issues (such as parallel programming, distribution, communication protocols, master dependency, connectivity, topology, island modeling software behavioral models, adaptive interactivity, feedback, user and multi-user game interaction, etc.). This can both improve the education-related issues in computer science classes, and enhance the younger and older gamers with a highly interactive and physical experience. We illustrate how the MITS system can be considered a tool for easy, fast, and flexible hands-on exploration of these issues, and through examples show how to implement interactive parallel and distributed processing in games with different software game models such as open loop, randomness based, rule based, user interaction based, AI and ALife based games, morphology based games, and physical teleplay games.

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An Educational Tool for Interactive Parallel and Distributed Processing

In this paper we try to describe how the Modular Interactive Tiles System (MITS) can be a valuable tool for introducing students to interactive parallel and distributed processing programming. This is done by providing an educational hands-on tool that allows a change of representation of the abstract problems related to designing interactive parallel and distributed systems. Indeed, MITS seems to bring a series of goals into the education, such as parallel programming, distributedness, communication protocols, master dependency, software behavioral models, adaptive interactivity, feedback, connectivity, topology, island modeling, user and multuser interaction, which can hardly be found in other tools. Finally, we introduce the system of modular interactive tiles as a tool for easy, fast, and flexible hands-on exploration of these issues, and through examples show how to implement interactive parallel and distributed processing with different software behavioural models such as open loop, randomness based, rule based, user interaction based, AI and ALife based software.

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An Interactive Tool for Creating Multi-Agent Systems and Interactive Agent-based Games

Utilizing principles from parallel and distributed processing combined with inspiration from modular robotics, we developed the modular interactive tiles. As an educational tool, the modular interactive tiles facilitate the learning of multi-agent systems and interactive agent-based games. The modular and physical property of the tiles provides students with hands-on experience in exploring the theoretical aspects underlying multi-agent systems which often appear as challenging to students. By changing the representation of the cognitive challenging aspects of multi-agent systems education to a physical (hands-on) one, the challenge may become much easier and fun to face for the students.

A Nonlinear Observer for Estimating Transverse Stability Parameters of Marine Surface Vessels

This paper presents a nonlinear observer for estimating parameters associated with the restoring term of a roll motion model of a marine vessel in longitudinal waves. Changes in restoring, also referred to as transverse stability, can be the result of changes in the vessel's centre of gravity due to, for example, water on deck and also in changes in the buoyancy triggered by variations in the water-plane area produced by longitudinal waves – propagating along the fore-aft direction along the hull. These variations in the restoring can change dramatically the dynamics of the roll motion leading to dangerous resonance. Therefore, it is of interest to estimate and detect such changes.

A μ-Synthesis Approach to Robust Control of a Wind Turbine

The problem of robust control of a wind turbine is considered in this paper. A set of controllers are designed based on a 2 degrees of freedom linearized model of a wind turbine. An extended Kalman filter is used to estimate effective wind speed and the estimated wind speed is used to find the operating point of the wind turbine. Due to imprecise wind speed estimation, uncertainty in the obtained linear model is considered. Uncertainties in the drivetrain stiffness and damping parameters are also considered as these values are lumped parameters of a distributed system and therefore they include inherent uncertainties. We include these uncertainties as parametric uncertainties in the model and design robust controllers using the DK-iteration method. Based on estimated wind speed a pair of controllers are chosen and convex combination of their outputs is applied to the plant. The resulting set of controllers is applied on a full complexity simulation model and simulations are performed for stochastic wind speed according to relevant IEC standard.
Cdio as the educational and cultural structuring element in the dtu b.eng. in electronics programme

The aim of this paper is to describe how a CDIO based four semester study can be documented in such a way, that a homogeneous quality can be maintained over time. One purpose is to help new teachers to fully understand their role and obligations, not only in their particular course, but also as a part of the complex CDIO based education. The case used is the B.Eng. study in Electronics at the Technical University of Denmark (DTU) Implementing CDIO calls for many changes in the way that we build and document an program, having implemented CDIO at the B.Eng. program in electronics, it has been found that the normal public and internal course documentation platforms are insufficient to keep the large amount of information needed to describe the program as a whole, and the large amount of interaction between the individual courses, a master document describing the program has been developed to cover the first 4 semesters in the program, this paper is meant as an inspiration to others that might find this method beneficial. In todays modern and constantly changing society it must be expected that staff is constantly moving in and out between different research projects, while at the same time teaching courses at levels ranging from very advanced topics to introductory courses. In most cases a course will be given by the same teacher every semester, but for some courses (often the introductory courses) teachers change frequently. In this dynamic system the master document proposed helps in conveying crucial information from prior to new teachers, that otherwise could be lost in the teacher exchange process.
This paper describes the four cross disciplinary CDIO semester projects in the B.Eng. in Electronics study at DTU, and – along with similar papers describing the other six B.Eng. programs – provides documentation to accompany an exposition with students demonstrating their projects, furthermore the paper is meant as an inspiration to others working on implementing cross disciplinary projects in their curriculum. In the B.Eng. in Electronics programme each of the first 4 semester contains a cross disciplinary project, two of these are CDIO Design Build courses which are placed in the 1st and 4th semesters. Additionally almost all courses contain projects of various size. The 4 cross disciplinary projects are described with emphasis on the two design build projects, the learning objectives are listed for each of the courses and the results of from the course evaluation (performed at the end every course) are listed for the 1st and 2nd semester courses where sufficient material exists.
Constraint Handling within a Multi-blade Coordinate Framework of a Wind Turbine

In this paper the control of a horizontal axis pitch controlled wind turbine using Model Predictive Control is presented. The multi-blade coordinate transformation is utilized to turn the rotating frame time-varying system description into a time-invariant fixed frame system description. Constraints in the rotating frame of reference are not easily described in the fixed frame and a Model Predictive Control formulation accommodating this problem is presented. The presented method is tested with satisfactory results in a numerical simulation.

Control Architecture Modeling for Future Power Systems

Uncontrollable power generation, distributed energy resources, controllable demand, etc. are fundamental aspects of energy systems largely based on renewable energy supply. These technologies have in common that they contradict the conventional categories of electric power system operation. As their introduction has proceeded incrementally in the past, operation strategies of the power system could be adapted. For example much more wind power could be integrated than originally anticipated, largely due to the flexibility reserves already present in the power system, and the possibility of interregional electricity exchange. However, at the same time, it seems that the overall system design cannot keep up by simply adapting in response to changes, but that also new strategies have to be designed in anticipation. Changes to the electricity markets have been suggested to adapt to the limited predictability of wind power, and several new control strategies have been proposed, in particular to enable the control of distributed energy resources, including for example, distributed generation or electric vehicles. Market designs addressing the procurement of balancing resources are highly dependent on the operation strategies specifying the resource requirements. How should one decide which control strategy and market configuration is best for a future power system? Most research up to this point has addressed single isolated aspects of this design problem. Those of the ideas that fit with current markets and operation concepts are lucky; they can be evaluated on the present design. But how could they be evaluated on a potential future power system? Approaches are required that support the design and evaluation of power system operation and control in context of future energy scenarios.

This work addresses this challenge, not by providing a universal solution, but by providing basic modeling methodology that enables better problem formulation and by suggesting an approach to addressing the general chicken/egg problem of planning and re-design of system operation and control. The dissertation first focuses on the development of models, diagrams, that support the conceptual design of control and operation strategies, where a central theme is the focus on
modeling system goals and functions rather than system structure. The perspective is then shifted toward long-term energy scenarios and adaptation of power system operation, considering the integration of energy scenario models with the re-design of operation strategies. The main contributions in the first part are, firstly, by adaptation of an existing functional modeling approach called Multilevel Flow Modeling (MFM) to the power systems domain, identifying the means-ends composition of control levels and development of principles for the consistent modeling of control structures, a formalization of control-as-a-service; secondly, the formal mapping of fluctuating and controllable resources to a multi-scale and multi-stage representation of control and operation structures; and finally the application to some concrete study cases, including a present system balancing, and proposed control structures such as Microgrids and Cells. In the second part, the main contributions are the outline of a formation strategy, integrating the design and model-based evaluation of future power system operation concepts with iterative energy scenario development. Finally, a new modeling framework for development and evaluation of power system operation in context of energy-storage based power system balancing is introduced.

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Control functions in MFM: basic principles
Multilevel Flow Modeling (MFM) has been proposed as a tool for representing goals and functions of complex industrial plants and suggested as a basis for reasoning about control situations. Lind presents an introduction to MFM but do not describe how control functions are used in the modeling. The purpose of the present paper is to serve as a companion paper to this introduction by explaining the basic principles used in MFM for representation of control functions. A theoretical foundation for modeling control functions is presented and modeling examples are given for illustration.

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Control Surface Fault Diagnosis for Small Autonomous Aircraft

Small unmanned aerial vehicles require a large degree of fault-tolerance in order to fulfil their duties in an satisfactory way, both with respect to economy and safety in operation. Small aerial vehicles are commonly constructed without much redundancy in hardware, primarily for reasons of cost but also weight. Single point of failure solutions are therefore commonly used and operation is typically allowed only in closed airspace. In order to enhance dependability, fault prognosis and diagnosis are needed. This paper explores principal redundancies at a very overall level, whether based on hardware or are analytical, and formulates residuals from which faults can be prognosed or diagnosed. An approach is suggested where detailed modelling is not needed but normal behaviour is learned from short segments of flight data using adaptive methods for learning. Statistical characterisation of distributions and change detection methods are employed to reach decisions about not-normal behaviour and it is shown how control surface faults can be diagnosed for a specific UAV without adding additional hardware to the platform. Only telemetry data from the aircraft is used together with a basic model of relations between signals within the aircraft. Frequency domain methods are shown to be robust in exploring relevant properties of the signals. The detection is shown to work on data from a real incident where an aileron gets stuck during launch of a UAV.

Design Concept of Human Interface System for Risk Monitoring for Proactive Trouble Prevention

A new concept is first proposed of distributed human interface system to integrate both operation and maintenance of nuclear power plant. Then, a method of constructing human interface system is introduced by integrating the plant knowledge database system based on Multilevel Flow Model (MFM) with the risk monitor to watch Defense-in-Depth plant safety functions. The proposed concept is applied for a liquid metal fast reactor Monju and necessary R&D subjects are reviewed to realize human interface system for the maintenance work in Monju plant. Because of using high temperature liquid sodium as reactor coolant in Monju plant, the maintenance for Monju should utilize more automated equipments of remote control and robotics than that of light water reactor. It is necessary to design optimum task allocation between human and automated machine as the requisites for good communication design of human interface systems to support the collaboration work between workers at local workplace and the main control room. In this paper, the general issues are reviewed on how to configure the whole human interface system for helping proactive trouble prevention and risk evaluation on the basis of the presented target plant model before the concrete proposition of the hardware and software systems development to be used by both the staffs of operation and maintenance of NPP.
Design of excitation signals for active system monitoring in a performance assessment setup
This paper investigates how the excitation signal should be chosen for a active performance setup. The signal is used in a setup where the main purpose is to detect whether a parameter change of the controller has changed the global performance significantly. The signal has to be able to excite the dynamics of the subsystem under investigation both before and after the parameter change. The controller is well know, but there exists no detailed knowledge about the dynamics of the subsystem.

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Detecting asymmetries in the rotor of a wind turbine using the multi-blade coordinate transformation
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Detection of Oestrus and Lameness in Dairy Cows
This thesis describes studies conducted on the subject of detecting oestrus and lameness in dairy cows. The studies comprise methods of statistical change detection and model based diagnosis, respectively. In the case of statistical change detection the development of algorithms for a decision support system is based on identifying behaviour from patterns of normal and deviant behaviour. Signal processing combined with statistical methods, e.g. likelihood ratio tests, are utilized to correlate observed behaviours with normal and detect changes. Diagnosis includes data from the available population of animals in order to isolate patterns of behaviours outside the norm for individuals, while being robust to common disturbance factors. The research is based on methods from change detection and fault diagnosis. Fault diagnosis techniques are employed to reduce the false alarm ratio, and attempts are made to isolate events and artefacts in signals that otherwise can give rise to false alarms. For the model based diagnosis the diagnosis is generally done evaluating an estimated probability distribution against hypotheses about causes of change behaviour, e.g. oestrus or lameness. The models used for diagnosis are chosen to represent the behaviours. A quantized system description is used as a diagnostic model. This technique is based on automata theory. The methods are in most cases specified to take into account parameters specific to the differences between production systems. The development of these methods and algorithms is an interdisciplinary activity including methods from fault diagnosis, information technology and statistics.
Diagnosis for Control and Decision Support in Complex Systems

Diagnosis and, when possible, prognosis of faults are essential for safe and reliable operation. The area of fault diagnosis has emerged over three decades. The majority of studies related to linear systems but real-life systems are complex and nonlinear. The development of methodologies coping with complex and nonlinear systems have matured and even though there are many un-solved problems, methodology and associated tools have become available in the form of theory and software for design. Genuine industrial cases have also become available. Analysis of system topology, referred to as structural analysis, has proven to be unique and simple in use and a recent extension to active structural techniques have made fault isolation possible in a wide range of systems. Following residual generation using these topology-based methods, deterministic and statistical change detection has proven very useful for on-line prognosis and diagnosis. For complex systems, results from non-Gaussian detection theory have been employed with convincing results. The paper presents the theoretical foundation for design methodologies that now appear as enabling technology for a new area of design of systems that are reliable in practise. Yet they are also affordable due to the use of fault-tolerant philosophies and tools that make engineering efforts minimal for their implementation. The paper includes examples for an autonomous aircraft and a baling system for agriculture.

Differential evolution to enhance localization of mobile robots

This paper focuses on the mobile robot localization problems: pose tracking, global localization and robot kidnap. Differential Evolution (DE) applied to extend Monte Carlo Localization (MCL) was investigated to better solve localization problem by increasing localization reliability and speed. In addition, a novel mechanism for effective robot kidnap detection was proposed. Experiments were performed using computer simulations based on the odometer data and laser range finder measurements collected in advance by a robot in real-life. Experimental results showed that integrating DE enables MCL to provide more accurate robot pose estimations in shorter time while using fewer particles.
Distributed Robotics Education

Distributed robotics takes many forms, for instance, multirobots, modular robots, and self-reconfigurable robots. The understanding and development of such advanced robotic systems demand extensive knowledge in engineering and computer science. In this paper, we describe the concept of a distributed educational system as a valuable tool for introducing students to interactive parallel and distributed processing programming as the foundation for distributed robotics and human-robot interaction development. This is done by providing an educational tool that enables problem representation to be changed, related to multitrobot control and human-robot interaction control from virtual to physical representation. The proposed system is valuable for bringing a vast number of issues into education – such as parallel programming, distribution, communication protocols, master dependency, connectivity, topology, island modeling software behavioral models, adaptive interactivity, feedback, and user interaction. We show how the proposed system can be considered a tool for easy, fast, flexible hands-on exploration of these distributed robotic issues. Through examples, we show how to implement interactive parallel and distributed processing in robotics with different software models such as openloop, randomness-based, rule-based, user-interactionbased, AI- and ALife-based, and morphology-based control.
DK-iteration robust control design of a wind turbine

The problem of robust control of a wind turbine is considered in this paper. A controller is designed based on a 2 degrees of freedom linearized model. An extended Kalman filter is used to estimate effective wind speed and the estimated wind speed is used to find the operating point of the wind turbine. Due to imprecise wind speed estimation, uncertainty in the obtained linear model is considered. Uncertainties in the drivetrain stiffness and damping parameters are also considered as these values are lumped parameters of a distributed system and therefore they include inherent uncertainties. We include these uncertainties as parametric uncertainties in the model and design a robust controller using DK-iteration method. The controller is applied on a full complexity simulation model and simulations are performed for wind speed step changes.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Automation and Control, Department of Electrical Engineering
Authors: Mirzaei, M. (Intern), Niemann, H. H. (Intern), Poulsen, N. K. (Intern)
Publication date: 2011

Fault Diagnosis for Nonlinear Hydraulic-Mechanical Drilling Pipe Handling System

Leakage and increased friction are common faults in hydraulic cylinders that can have serious consequences if they are not detected at early stage. In this paper, the design of a fault detector for a nonlinear hydraulic mechanical system is presented. By considering the system in steady state, two residual signals are generated and analysed with a composite hypothesis test which accommodates for unknown parameters. The resulting detector is able to detect abrupt changes in leakage or friction given the noisy pressure and position measurements. Test rig measurements validate the properties of residuals and high fidelity simulation and experimental results demonstrate the performance and feasibility of the proposed method.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, University of Agder
Authors: Choux, M. (Ekstern), Blanke, M. (Intern)
Pages: 1620-1626
Publication date: 2011

Fault Monitoring and Fault Recovery Control for Position Moored Tanker

This paper addresses fault tolerant control for position mooring of a shuttle tanker operating in the North Sea. A complete framework for fault diagnosis is presented but the loss of a sub-sea mooring line buoyancy element is given particular attention, since this fault could lead to mooring line breakage and a high-risk abortion of an oil-loading operation. With
significant drift forces from waves, non-Gaussian elements dominate forces and the residuals designed for fault diagnosis. Hypothesis testing need be designed using dedicated change detection for the type of distribution encountered. In addition to dedicated diagnosis, an optimal position algorithm is proposed to accommodate buoyancy element failure and keep the mooring system in a safe state. Furthermore, even in the case of line breakage, this optimal position strategy could be utilised to avoid breakage of a second mooring line. Properties of detection and fault-tolerant control are demonstrated by high fidelity simulations.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Norwegian University of Science and Technology
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Scopus rating (2015): SJR 0.71 SNIP 1.589 CiteScore 2.13
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ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): SJR 0.299 SNIP 1.122 CiteScore 1.17
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Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 0.385 SNIP 1.229
Scopus rating (2009): SJR 0.344 SNIP 1.414
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Web of Science (2008): Indexed yes
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Fundamental Principles of Alarm Design
Traditionally alarms are designed on the basis of empirical guidelines rather than on a sound scientific framework rooted in a theoretical foundation for process and control system design. This paper proposes scientific principles and a methodology for design of alarms based on a functional modeling technique (MFM) which represents a process in terms of its goals, functions and operating requirements. The reasoning capabilities of MFM enable identification of operational
situations which threaten to generate an alarm and derivation of potential response scenarios. The design methodology can be applied to any engineering system which can be modeled by MFM. The methodology provides a set of alarms which can facilitate event interpretation and operator support for abnormal situation management. The proposed design methodology provides the information content of the alarms, but does not deal with alarm presentation or display design issues. A hydraulically powered grinding process is employed as an industrially relevant system to show the applicability of the proposed design methodology with promising results.

General information
State: Published
Organisations: Risø National Laboratory for Sustainable Energy, Department of Chemical and Biochemical Engineering, Automation and Control, Department of Electrical Engineering, Computer Aided Process Engineering Center
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Pages: 44-51
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Main Research Area: Technical/natural sciences

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H∞ Control of a Wind Turbine

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Authors: Mirzaei, M. (Intern), Poulsen, N. K. (Intern), Niemann, H. H. (Intern)
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Knowledge based support for multiagent control and automation
This paper presents a mechanism for developing knowledge based support in multiagent based control and diagnosis. In particular it presents a way for autonomous agents to utilize a qualitative means-ends based model for reasoning about control situations. The proposed mechanism have been used in different scenarios of electric power distribution system protection and control. Results show that agents can use local models of their environment and coordinate with other agents to analyze and understand a disturbance situation and choose an appropriate control action. The paper also introduces Multi Level Flow Modeling (MFM) which has been used to model agent environment and describes development of multiagent implementation of MFM Workbench.
Knowledge based support for real time application of multiagent control and automation in electric power systems

This paper presents a mechanism for developing knowledge based support for real time application of multiagent systems (MAS) in control, automation and diagnosis of electric power systems. In particular it presents a way for autonomous agents to utilize a qualitative means-ends based model for reasoning about control situations. The proposed mechanism has been used in different scenarios of electric power distribution system protection and control. Results show that agents can use local models of their environment and coordinate with other agents to analyze and understand a disturbance situation and choose an appropriate control action. The paper also elaborates on real time interfacing between multi-agent systems and industry standard distribution automation and control system.

Modeling of tethered satellite formations using graph theory

Tethered satellite formations have recently gained increasing attention due to future mission proposals. Several different formations have been investigated for their dynamic properties and control schemes have been suggested. Formulating the equations of motion and investigation which geometries could form stable formations in space are cumbersome when done at a case to case basis, and a common framework providing a basic model of the dynamics of tethered satellite formations can therefore be advantageous. This paper suggests the use of graph theoretical quantities to describe a tethered satellite formation and proposes a method to deduce the equations of motion for the attitude dynamics of the formation in a compact form. The use of graph theory and Lagrange mechanics together allows a broad class of formations to be described using the same framework. A method is stated for finding stationary configurations and an upper limit of their number is determined. The method is shown to be valid for general tethered satellite formations that form a tree structure.
Modularity for Modulating Exercises and Levels: Observations from Cardiac, Stroke, and COLD Patients Therapy

The modular interactive tiles aim at engaging anybody (elderly, carer, hospital personnel, children) in performing playful and motivating physical activities. Inspired by modular robotics, each tile is a self-contained module with processing power and communication to neighbouring modules, and a number of these can be put together in any physical shape by the user within a minute. The tiles light up in different colors and can perceive the pressure when people press them with their hands or jump on them with their feet. Numerous games (exercises) are running on the tiles, and these games aim at providing high motivation for people to engage physically with the tiles. Therapists may use the tiles to provide treatment for a large number of patients who receive hospital, municipality or home care, although the tiles can as well be used for prevention with elderly or for fitness with normal people. In this paper, we investigate the therapeutic use. We show how the tiles are tested extensively with cardiac patients, COLD patients and stroke patients in hospitals and in the private homes of patients and elderly. We find that therapists are using the modular aspect of the tiles for personalized training of a vast variety of elderly patients modulating exercises and difficulty levels.

Modular Robotics in an African Context

In this paper, we review the concept, development and use of modular robotic devices for education, health improvements, and business in Africa. The modular robotics inspired technology has the advantage of allowing any user easy access to a physical construction of new and advanced technology. We conceptualized several educational tools inspired by modular robotics for contextualized IT education in Tanzania, leading to a novel IT degree program and the development of East Africa’s first science and business park in Iringa, Tanzania. The prototypes inspired by modular robotics were developed in the local, rural context and tested by local users in hospitals and rehabilitation centres. In this paper, we review the development of both modular building blocks for education and modular robotic tiles for rehabilitation in Tanzania.

General information
State: Published
Organisations: Department of Electrical Engineering, Centre for Playware
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Modular Robotics in an African Context
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Multilevel Flow Modeling of Monju Nuclear Power Plant

Multilevel Flow Modeling is a method for modeling complex processes on multiple levels of means-end and part-whole abstraction. The modeling method has been applied on a wide range of processes including power plants, chemical engineering plants and power systems. The modeling method is supported with reasoning tools for fault diagnosis and control and is proposed to be used as a central knowledge base giving integrated support in diagnosis and maintenance tasks. Recent developments of MFM include the introduction of concepts for representation of control functions and the relations between plant functions and structure. The paper will describe how MFM can be used to represent the goals and functions of the Japanese Monju Nuclear Power Plant. A detailed explanation will be given of the model describing the relations between levels of goal, function and structural. Furthermore, it will be explained how goals and functions of the control systems are represented using the recent MFM extensions for modeling control functions.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Computer Aided Process Engineering Center, Department of Chemical and Biochemical Engineering, Harbin Engineering University, Japan Atomic Energy Agency
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Nonlinear, Adaptive and Fault-tolerant Control for Electro-hydraulic Servo Systems

Fluid power systems have been in use since 1795 with the first hydraulic press patented by Joseph Bramah and today form the basis of many industries. Electro hydraulic servo systems are uid power systems controlled in closed-loop. They transform reference input signals into a set of movements in hydraulic actuators (cylinders or motors) by the means of hydraulic uid under pressure. With the development of computing power and control techniques during the last few decades, they are used increasingly in many industrial elds which require high actuation forces within limited space. However, despite numerous attractive properties, hydraulic systems are always subject to potential leakages in their components, friction variation in their hydraulic actuators and de ciency in their sensors. These violations of normal behaviour reduce the system performances and can lead to system failure if they are not detected early and handled. Moreover, the task of controlling electro hydraulic systems for high performance operations is challenging due to the highly nonlinear behaviour of such systems and the large amount of uncertainties present in their models. This thesis focuses on nonlinear adaptive fault-tolerant control for a representative electro hydraulic servo controlled motion system. The thesis extends existing models of hydraulic systems by considering more detailed dynamics in the servo valve and in the friction inside the hydraulic cylinder. It identies the model parameters using experimental data from a test bed by analysing both the time response to standard input signals and the variation of the outputs with dierent excitation frequencies. The thesis also presents a model that accurately describes the static and dynamic normal behaviour of the system. Further, in this thesis, a fault detector is designed and implemented on the test bed that successfully diagnoses internal or external leakages, friction variations in the actuator or fault related to pressure sensors. The presented algorithm uses the position and pressure measurements to detect and isolate faults, avoiding missed detection and false alarm. The thesis also develops a high performance adaptive nonlinear controller for the hydraulic system which outperforms comparable linear controllers widely used in the industry. Because of the controller adaptivity, uncertainties in the model parameters can be handled. Moreover, a special attention is given to reduce the complexity of the controller in order to demonstrate its real-time implementation. Finally the thesis combines the techniques developed in fault detection and nonlinear control in order to develop an active fault-tolerant controller for electro hydraulic servo systems. In order to maintain overall service and performances as high as possible when a potential fault occurs, the fault-tolerant controlled system prognoses the fault and changes its controller parameters or structure. The consequences of an unexpected fault are avoided, high availability is ensured and the overall safety in electro hydraulic servo systems is increased.
Oestrus Detection in Dairy Cows from Activity and Lying Data using on-line Individual Models
Automated monitoring and detection of oestrus in dairy cows is attractive for reasons of economy in dairy farming. While high performance detection has been shown possible using high-priced progesterone measurements, detection results were less reliable when only low-cost sensor data were available. Aiming at improving detection scheme reliability with the use of low-cost sensor data, this study combines information from step count and leg tilt sensors. Introducing a lying balance for the individual animal, a novel change detection scheme is derived from observed distributions of the step count data and the lying balance. Detection and hypothesis testing are based on generalised likelihood ratio optimisation combined with time-wise joint probability windowing based on the duration of oestrus and oestrus intervals. It is shown to be essential that cow-specific parameters and test statistics are derived on-line from data to cope with behaviours of individuals. Performance is validated on 18 sequences of data where definite proof of prior oestrus was available in form of subsequent pregnancy. These data were extracted from data sequences from 44 dairy cows over an 8 months period. The results show sensitivity 88.9% and error rate 5.9%, which is very satisfactory when only cheap sensor data are used.

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Optimal charging schedule of an electric vehicle fleet

In this paper, we propose an approach to optimize the charging schedule of an Electric Vehicle (EV) fleet both taking into account spot price and individual EV driving requirement with the goal of minimizing charging costs. A flexible and suitable mathematic model is introduced to characterize the smart charging behavior and detailed parameters needed for charging behavior of an individual EV are analyzed. The individual charging schedule is extended to the EV fleet. Simulation results are presented to illustrate the effectiveness of the proposed model.

General information

State: Published
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Authors: Hu, J. (Intern), You, S. (Intern), Østergaard, J. (Intern), Lind, M. (Intern), Wu, Q. (Intern)
Publication date: 2011

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Source-ID: 312659
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Orchard navigation using derivative free Kalman filtering

This paper describes the use of derivative free filters for mobile robot localization and navigation in an orchard. The localization algorithm fuses odometry and gyro measurements with line features representing the surrounding fruit trees of
The line features are created on basis of 2D laser scanner data by a least square algorithm. The three derivative-free filters are compared to an EKF based localization method on a typical run covering four rows in the orchard. The Matlab R toolbox Kalmtool is used for easy switching between different filter implementations without the need for changing the base structure of the system.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Hansen, S. (Intern), Bayramoglu, E. (Intern), Andersen, J. C. (Intern), Ravn, O. (Intern), Andersen, N. A. (Intern), Poulsen, N. K. (Intern)
Pages: 4679-4684
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Passivity-Based Control of a Rigid Electrodynamic Tether
Electrodynamic tethers provide actuation for performing orbit correction of spacecrafts. When an electrodynamic tether system is orbiting the Earth in an inclined orbit, periodic changes in the magnetic field result in a family of unstable periodic solutions in the attitude motion. This paper shows how these periodic solutions can be stabilized by controlling only the current through the tether. A port-controlled Hamiltonian formulation is employed to describe the tethered satellite system and a passive input-output connection is utilized in the control design. The control law consists of two parts, a feedback connection, which stabilizes the open-loop equilibrium, and a bias term, which is able to drive the system trajectory away from this equilibrium, a feature necessary to obtain orbit adjustment capabilities of the electrodynamic tether. It is then shown how the periodic solutions of the closed-loop system can be approximated by power series and a relation is found between control gain and perturbations around the open-loop solution. Stability properties of the system are investigated using Floquet analysis and the region of stability is found in the plane defined by the control parameters.

General information
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Organisations: Automation and Control, Department of Electrical Engineering
Authors: Larsen, M. B. (Intern), Blanke, M. (Intern)
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BFI (2017): BFI-level 2
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 1.181 SNIP 2.477 CiteScore 2.77
Prediction of Parametric Roll Resonance by Multilayer Perceptron Neural Network

Parametric roll resonance is a ship stability related phenomenon that generates sudden large amplitude oscillations up to 30-40 degrees of roll. This can cause severe damage, and it can put the crew in serious danger. The need for a parametric rolling real time prediction system has been acknowledged in the last few years. This work proposes a prediction system based on a multilayer perceptron (MP) neural network. The training and testing of the MP network is accomplished by feeding it with simulated data of a three degrees-of-freedom nonlinear model of a fishing vessel. The neural network is shown to be capable of forecasting the ship’s roll motion in realistic scenarios.
Reliability-based dynamic positioning of floating vessels with riser and mooring system

To maintain safety of a floating vessel with associated slender components such as risers and mooring line, the vessel is normally kept within a limited region. To specify a safe position in that region, this paper suggests a new position chasing algorithm with the consideration of both riser angles and mooring line tensions. The riser angles were considered in an object function in [1] and the mooring line tension was considered in an object function in [2]. The contribution of this paper is to combine riser angle and mooring line tension together in one unified object function. A combination of scaled riser angles and structural reliability index is utilized to evaluate the “reserve capacity” relative to failure events. With this object function, the riser angles and mooring line tension are considered in a unified formulation, with higher weight added to the riser angles due to their criticality. An optimal position set-point is produced by minimization of the value of the cost function. Numerical simulations show the effectiveness of the proposed algorithm.

RoboMusic with modular playware

Based on the concepts of RoboMusic and modular playware, we developed a system composed of modular playware devices which allow any user to perform music in a simple, interactive manner. The key features exploited in the modular playware approach are modularity, flexibility, construction, immediate feedback to stimulate engagement, creative exploration of play activities, and in some cases activity design by end-users (e.g., DJs). We exemplify the approach with the development of 11 rock genres and 6 pop music pieces for modular I-BLOCKS, which are exhibited and in daily use at the Rock Me exhibition, and have been used at several international music events in Japan and the USA. A key finding is that professional music design is essential for the development of primitives in a musical behavior-based system, and this professional esthetics is necessary to engage the users in the activity of assembling and coordinating these “professional” musical primitives. This article describes, explores, and discusses this concept.
Robust stability in constrained predictive control through the Youla parameterisations

In this article we take advantage of the primary and dual Youla parameterisations to set up a soft constrained model predictive control (MPC) scheme. In this framework it is possible to guarantee stability in face of norm-bounded uncertainties. Under special conditions guarantees are also given for hard input constraints. In more detail, we parameterise the MPC predictions in terms of the primary Youla parameter and use this parameter as the on-line optimisation variable. The uncertainty is parameterised in terms of the dual Youla parameter. Stability can then be guaranteed through small gain arguments on the loop consisting of the primary and dual Youla parameter. This is included in the MPC optimisation as a constraint on the induced gain of the optimisation variable. We illustrate the method with a numerical simulation example.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Automation and Control, Department of Electrical Engineering
Authors: Thomsen, S. C. (Intern), Niemann, H. H. (Intern), Poulsen, N. K. (Intern)
Pages: 653-664
Publication date: 2011
Main Research Area: Technical/natural sciences
Social playware for mediating teleplay interaction over distance

We suggest that novel playware technology can function as a mediator for playful social interaction over distance, where people are separated by physical distance but feel the presence of each other mediated through the interaction with the playware technology. In order to investigate such social playware, we developed the Playware Soccer game and tested this with more than 1,000 users during the FIFA World Cup 2010 in South Africa. The test was conducted in townships, orphanages for HIV/AIDS children, markets, FIFA fan parks, etc. along with simultaneous tests with similar set-ups in Europe and Asia. With the social playware, players would compete against each other simultaneously in the three continents, Africa, Europe and Asia, and feel the presence of the competitors on the other continents expressed through the playware. The playware game is set up to motivate players to engage in training of technical soccer skills by receiving immediate feedback and offering challenges to players of all skills on the soccer playing on a modular interactive wall composed of modular interactive tiles that respond with coloured light, sound and scores on the players performance. This paper outlines the concept of social playware and physicalvirtual teleplay, and exemplifies this with the playware soccer game.

General information
State: Published
Organisations: Department of Electrical Engineering, Centre for Playware
Authors: Lund, H. H. (Intern), Thorsteinsson, T. (Ekstern)
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Spacio-temporal situation assessment for mobile robots

In this paper, we present a framework for situation modeling and assessment for mobile robot applications. We consider situations as data patterns that characterize unique circumstances for the robot, and represented not only by the data but also its temporal and spacial sequence. Dynamic Markov chains are used to model the situation states and sequence, where stream clustering is used for state matching and dealing with noise. In experiments using simulated and real data, we show that we are able to learn a situation sequence for a mobile robot passing through a narrow passage. After learning the situation models we are able to robustly recognize and predict the situation.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Danish Technological Institute
Authors: Beck, A. B. (Ekstern), Risager, C. (Ekstern), Andersen, N. A. (Intern), Ravn, O. (Intern)
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Stochastic Automata for Outdoor Semantic Mapping using Optimised Signal Quantisation

Autonomous robots require many types of information to obtain intelligent and safe behaviours. For outdoor operations, semantic mapping is essential and this paper proposes a stochastic automaton to localise the robot within the semantic map. For correct modelling and classification under uncertainty, this paper suggests quantising robotic perceptual features, according to a probabilistic description, and then optimising the quantisation. The proposed method is compared with other state-of-the-art techniques that can assess the confidence of their classification. Data recorded on an autonomous agricultural robot are used for verification and the new method is shown to compare very favourably with existing ones.
Terrain Mapping and Obstacle Detection Using Gaussian Processes

In this paper we consider a probabilistic method for extracting terrain maps from a scene and use the information to detect potential navigation obstacles within it. The method uses Gaussian process regression (GPR) to predict an estimate function and its relative uncertainty. To test the new methods, we have arranged two setups: an artificial flat surface with an object in front of the sensors and an outdoor unstructured terrain. Two sensor types have been used to determine the point cloud fed to the system: a 3D laser scanner and a stereo camera pair. The results from both sensor systems show that the estimated maps follow the terrain shape, while protrusions are identified and may be isolated as potential obstacles. Representing the data with a covariance function allows a dramatic reduction of the amount of data to process, while maintaining the statistical properties of the measured and interpolated features.

The Assemble and Animate Control Framework for Modular Reconfigurable Robots

This paper describes the “Assemble and Animate” (ASE) control framework. The objective of ASE is to provide a flexible and extendable control framework, which facilitates rapid development and deployment of modular reconfigurable robots. ASE includes a simple event-driven application framework, a library of common control and adaptation strategies, and a module abstraction layer which allows ASE to be cross-compiled for a number of different modular robotic platforms and easily ported to new platforms. In this paper we describe the design of ASE and present example applications utilizing ASE for planetary contingency, adaptive locomotion, self-reconfiguration, and tangible behavior-based programming.
Towards Competitive Commercial Autonomous Robots: The Configuration Problem

This article presents a framework for configuring the individual components used in component based robot control systems. Using smart parameters that adapt to the respective robot system makes it possible to obtain optimal parameter values while reusing the software components, without expert knowledge about the underlying algorithms. The framework also makes it possible for the robot to autonomously calibrate itself, resulting in higher stability of the robot and less development time required. The work is a result of an industrial research project aimed at lowering development costs and improving robustness of autonomous robot applications.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Prevas A/S
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Towards Python-based Domain-specific Languages for Self-reconfigurable Modular Robotics Research

This paper explores the role of operating system and high-level languages in the development of software and domain-specific languages (DSLs) for self-reconfigurable robotics. We review some of the current trends in self-reconfigurable robotics and describe the development of a software system for ATRON II which utilizes Linux and Python to significantly improve software abstraction and portability while providing some basic features which could prove useful when using Python, either stand-alone or via a DSL, on a self-reconfigurable robot system. These features include transparent socket communication, module identification, easy software transfer and reliable module-to-module communication. The end result is a software platform for modular robots that where appropriate builds on existing work in operating systems, virtual machines, middleware and high-level languages.

General information
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Organisations: Department of Electrical Engineering, Centre for Playware, University of Southern Denmark
Authors: Moghadam, M. (Intern), Christensen, D. J. (Intern), Brandt, D. (Ekstern), Schultz, U. P. (Ekstern)
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http://www.wikicfp.com/cfp/servlet/event.showcfp?eventid=16741&copyownerid=2394
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Using an Agent-oriented Framework for Supervision, Diagnosis and Prognosis Applications in Advanced Automation Environments

This paper demonstrates how a generic agent-oriented framework can be used in advanced automation environments, for systems analysis in general and supervision, diagnosis and prognosis purposes in particular. The framework's background and main application areas are briefly described. Next, the function-oriented method Multilevel Flow Modeling (MFM) and its reasoning mechanisms that have proven strength in qualitative planning, modeling and diagnosis activities are introduced. The main enhancements of the framework, as well as an MFM editor based on the framework and towards function-oriented supervision, diagnosis and prognosis purposes are equally explained. Finally, the paper sums up by also addressing plans for further enhancement and in that respect integration with other tailor-made tools for joint treatment of various modeling and analysis activities upon advanced automation environments.

Vertical Position Control for Top Tensioned Riser with Active Heave Compensator

The top and bottom angles of a marine riser are of crucial importance during e.g. drilling and workover operations. A vertical position control with active heave compensator (AHC) is proposed to maintain the safety of the riser when subjected to environmental excitations. The possibility of reducing the maximum angular response level by adjusting the vertical rod position by means of an active heave compensator is investigated with a positioning algorithm based on adaptive backstepping. Riser top and bottom angles are dealt with by the algorithm in order to minimize both angles.

Wearable Playware

In this paper we define and trace the contours of a new approach to robotic systems, composed of interactive robotic modules that can be worn on the body, as for an ordinary suit. We label the field as Modular Robotic Wearable (MRW). Further, we describe how the use of modular robotics in creating wearable, besides being possible, is a path to obtain a flexible wearable processing system, where freely inter-changeable input/output modules can be positioned on the body suit in accordance with the task at hand. In this concept paper we describe the initial prototypes and show, as an example, an artistic application. We then show drawing of future works and projects. Finally, by focusing on the intersection of the combination of modular robotic systems, wearability, and body-mind we attempt to explore the theoretical characteristics of such an approach and exploit the possible playware application fields.
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Authors: Pagliarini, L. (Ekstern), Lund, H. H. (Intern)
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Art, Playware, Entertainment, Wearable, Modular robotics
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Wearing the playware
In this conceptual paper, we describe and define the range of possible applications, and the technical contours, of a robotic system to be worn on the body for playful interactions. Earlier work on a modular robotic wearable (MRW) described how, by using modular robotics to create a wearable, it is possible to obtain a flexible wearable processing system where freely interchangeable input/output modules can be positioned on a body suit in accordance with the task at hand. Here, we guide attention toward early prototypes to show the potentialities of such an approach, and focus on depicting possible applications in the electronic games domain. Indeed, the MRW is an example of modular playware which can create playful interactions for many application domains, including electronic games.

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Authors: Pagliarini, L. (Ekstern), Lund, H. H. (Intern)
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Fault-Tolerant Onboard Monitoring and Decision Support Systems

The purpose of this research project is to improve current onboard decision support systems. Special focus is on the onboard prediction of the instantaneous sea state. In this project a new approach to increasing the overall reliability of a monitoring and decision support system has been established. The basic idea is to convert the given system into a fault-tolerant system and to improve multi-sensor data fusion for the particular system. The background of the project is the SeaSense system, which has been installed on several container ships and navy vessels. The SeaSense system provides a crude and simple estimation of the actual sea state (Hs and Tz), information about the longitudinal hull girder loading, seakeeping performance of the ship, and decision support on how to operate the ship within acceptable limits. The system is able to identify critical forthcoming events and to give advice regarding speed and course changes to decrease the wave-induced loads. The SeaSense system is based on the combined use of a mathematical model and measurements from a set of sensors. The overall dependability of a shipboard monitoring and decision support system such as the SeaSense system can be improved using fault-tolerant techniques (Fault Diagnosis and System Re-design) and a Sensor Fusion Quality (SFQ) test. Fault diagnosis means to detect the presence of faults in the system. In case sea state estimation is conducted by a ship-wave buoy analogy the best solution is achieved when a set of three different ship responses are used. Faulty signals should be discarded from the procedure for sea state estimation if it is possible, if not the fault should be estimated. The fault diagnosis can be divided into three steps: Fault detection, fault isolation and fault estimation. Fault detection means to decide whether or not a fault has occurred. This step determines the time at which the system is subjected to the given fault. Fault isolation will find in which component a fault has occurred. This step determines the location of the fault. Fault estimation provides an estimate of magnitude of a fault. A supervisory function determines the severity of the fault once its origin has been isolated and its magnitude estimated. Fault-tolerant Sensor Fusion means that the monitoring and decision support system can accommodate faults so that the overall system continues to satisfy its goal and on the other hand in the absence of a fault, the system should be able to provide the most accurate information using the SFQ test.

General information
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Organisations: Coastal, Maritime and Structural Engineering, Department of Mechanical Engineering, Automation and Control, Department of Electrical Engineering
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Modeling and Control of Electrodynamic Tethers - an Energy and Topology Approach

A space tether is a cable used to connect spacecrafts in an orbiting structure. If an electrical current is lead through the tether, it can be utilized to provide propulsion for the spacecraft. In this case the cable is referred to as an electrodynamic tether. The system utilizes the magnetic field of the Earth for creating a Lorentz force along the tether which occur when a current carrying wire operates in a magnetic field. The use of electrodynamic tethers are interesting since they operate solely on electrical energy, which can be provided by solar panels of the spacecrafts. In this way the amount of propellant a spacecraft need to bring from Earth can be reduced. In this thesis the modeling and control of electrodynamic tethers are investigated, both when a single tether is used to connect two spacecrafts, and when the tethers are used in more general formations of spacecrafts. One of the main challenges when using electrodynamic tethers is that the force created along the tether is based on an external uncontrollable condition, namely the magnetic field. Even with a known model of the magnetic field, limitations to the creation of the Lorentz force still exists, since the force can only be generated perpendicular to the instantaneous magnetic field. Furthermore, the control problem is complicated by the time variations in the magnetic field. This thesis solves these problems by utilizing an energy-based system description and a passivity-based control design. An advantage of the energy-based approach is that the stability of the system can easily be investigated, based on the energy flow in the system. Systems of several spacecrafts connected by tethers has many applications, for example in connection with space telescopes and space stations. Tethered formations are advantageous, compared to formations of free-flying spacecrafts, since a predetermined geometry of spacecrafts is easily maintained. This thesis investigates the use of electrodynamic tethers for such tethered satellite formations with focus on the modeling and control aspects. One can think of many different structures for solving tasks in space, and separate derivations of the dynamical equations can be cumbersome. It can therefore be advantageous to be able to model a formation independent of its topology, i.e. the way tethers and satellites are interconnected. The thesis treats a class of formations in a generic framework, using graph theory to describe the topology of the formations. The framework can be used both to deduce the equations of motion for the attitude motion of the formation and for control design regarding the same motion. The main part of the thesis consists of five scientific papers which have been submitted for international journals and conferences during the PhD project.

General information
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Organisations: Automation and Control, Department of Electrical Engineering
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Publication: Research › Ph.D. thesis – Annual report year: 2010

Wind turbine control and model predictive control for uncertain systems
This thesis presents both an applied study and a theoretical study within the field of control theory. Control theory is an interdisciplinary branch between mathematics and engineering dealing with the manipulation of systems to produce a desired output. The applied study deals with wind turbine control. Wind turbines are controlled to optimize energy extraction from the wind. This must be done while respecting physical restrictions and ensuring that loads on the wind turbine structure does not seriously reduce the lifetime of components. This poses a trade-off in the design and the wind turbine problem is hence a complex multivariable problem. In this thesis the main focus is on design of controllers which optimally attenuates the impact of the variability in the wind. The angles of the wind turbine blades have been used as the primary control variable to achieve this goal. Strategies have been studied in which the blades are controlled collectively and individually. The wind has both temporal and spatial variations with a stochastic nature. Furthermore, the wind has deterministic (or slowly varying) trends. Large parts of the thesis hence deals with developing wind models which can be used as disturbance models for controller design. The theoretical study deals with Model Predictive Control (MPC). MPC is an optimal control method which is characterized by the use of a receding prediction horizon. MPC has risen in popularity due to its inherent ability to systematically account for time-domain constraints on signals. During the last decades several theoretical advances have been made, so that it can handle a wide variety of system structures. In this thesis, the focus is on handling uncertain linear system description. To this end the so-called Youla parameterizations...
have been used. Two methods are proposed: The first method exploits the modularity of the parameterizations so that the uncertainty can be identified and the MPC controller can be reconfigured in a modular setting. The second method is a robust MPC method in which the Youla parameters are used as an integral part of the online optimization. In this way stability can be guaranteed given an assumed bound on the uncertainty. The contributions of the thesis have been documented in a series of scientific papers. The papers form the main part of this thesis.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Automation and Control, Department of Electrical Engineering
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A Goal based methodology for HAZOP analysis
This paper presents a goal based methodology for HAZOP studies in which a functional model of the plant is used to assist in a functional decomposition of the plant starting from the purpose of the plant and continuing down to the function of a single node, e.g. a pipe section. This approach leads to nodes with simple functions such as liquid transport, gas transport, liquid storage, gas-liquid contacting etc. From the functions of the nodes the selection of relevant process variables and deviation variables follows directly. The knowledge required to perform the pre-meeting HAZOP task of dividing the plant along functional lines is that of chemical unit operations and transport processes plus a some familiarity with the plant a hand. Thus the preparatory work may be performed by a chemical engineer with just an introductory course in risk assessment. The goal based methodology lends itself directly for implementation into a computer aided reasoning tool for HAZOP studies to perform root cause and consequence analysis. Such a tool will facilitate finding causes far away from the site of the deviation. A Functional HAZOP Assistant is proposed and investigated in a HAZOP study of an industrial scale Indirect Vapour Recompression Distillation pilot Plant (IVaRDIP) at the DTU-Dept. of Chemical and Biochemical Engineering. The study shows that the goal based methodology using a functional approach provides a very efficient paradigm for facilitating HAZOP studies and for enabling reasoning to reveal potential hazards in safety critical operations.

General information
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Organisations: Automation and Control, Department of Electrical Engineering, Computer Aided Process Engineering Center, Department of Chemical and Biochemical Engineering, F.L. Smidth A/S, Safepark Consultancy
Authors: Rossing, N. L. (Ekstern), Lind, M. (Intern), Jensen, N. (Ekstern), Jørgensen, S. B. (Intern)
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Fault-Tolerant Vision for Vehicle Guidance in Agriculture

The emergence of widely available vision technologies is enabling for a wide range of automation tasks in industry and other areas. Agricultural vehicle guidance systems have benefitted from advances in 3D vision based on stereo camera technology. By automatically guiding vehicles along crops and other field structures the operator’s stress levels can be reduced. High precision steering in sensitive crops can also be maintained for longer periods of time as the driver is less tired. Safety and availability must be inherent in such systems in order to get widespread market acceptance. To tolerate dropout of 3D vision, faults in classification, or other defects, redundant information should be utilized. Such information can be used to diagnose faulty behavior and to temporarily continue operation with a reduced set of sensors when faults or artifacts occur. Additional sensors include GPS receivers and inertial sensors. To fully utilize the possibilities in 3D vision, the system must also be able to learn and adapt to changing environments. By learning features of the environment new diagnostic relations can be generated by creating redundant feed-forward information about crop location. Also, by mapping the field that is seen by the stereo camera, it is possible to support the guidance system by storing salient information about the environment. By tracking the motion of the vehicle, vision output can be fused over time to create more reliable and robust estimates of crop location. This thesis approaches these challenges by considering systematic design methods using graph-based analysis. It is demonstrated how diagnostic relations can be derived and remedial actions can be done to maintain safety and healthy functioning of vision systems. The combination of redundant information from 3D vision, mapping, and aiding sensors such as GPS provide means to detect and isolate single faults in the system. In addition, learning is employed to adapt the system to variational changes in the natural environment. 3D vision is enhanced by learning texture and color information. Intensity gradients on small neighborhoods of pixels are shown to provide a superior approach to modeling texture information than other methods. Stochastic automatas using optimally quantized data is demonstrated as a strong approach for offline learning. It is considered how 3D vision provides labeling of training data that subsequently can be fed into a learning system. Statistical change detection theory is shown to be a suitable approach to detecting artifacts in the learning process so safe operation can be maintained. The system can be used to perform real-time classification using a fast online approach that is superior to state-of-the-art. Advances in tracking vehicle motion using 3D vision is demonstrated to allow unprecedented high accuracy maps to be created of the local environment. Features in the environment are extracted and tracked using novel feature detectors relying on approximating the Laplacian operator with a bi-level octagonal kernel. It is shown how these features display high levels of accuracy and stability while being considerably faster than similar feature detectors. Artifacts in 3D vision range measurements are demonstrated to be detectable by using the generated 3D maps and a probabilistic approach to fusing and comparing range measurements.

Autonomous Supervision and Control of Parametric Roll Resonance

When ships sail in longitudinal waves, and the encounter frequency and wave length satisfy certain conditions, passage of wave crest and wave trough along the hull continuously amplifies the roll motion at half the frequency of encounter. This gives the onset of a resonance condition. The phenomenon can induce a rapid increase in roll motion that can reach 40 degrees or more. Recent incidents have shown that modern container ships and some fishing vessels are particularly prone to this due to their hull shape. Such incidents can result in damages counting to millions of USD. Theoretically, the resonance behaviour is well understood and it can be reproduced by quasi-periodic changes in parameters of nonlinear differential equations that describe ship motion. Practically, the challenge is whether detection and stabilization can be achieved in time to avoid damage. The research in this thesis has therefore two objectives. The first is to develop methods for detection of the inception of parametric roll resonance. The second is to develop control strategies to stabilize the motion after parametric roll has started. Stabilisation of parametric roll resonance points to two possible courses of action. One is a direct stabilisation through an increase of damping in roll, which increases the threshold that triggers the resonant
motion. A second is to obtain a change in wave encounter frequency by means of changes in ship forward speed and/or heading. As direct stabilisation, this thesis considers the increase of roll damping by using fin stabilisers, which are controlled using integrator backstepping methods. As indirect stabilisation, a shift in the encounter frequency is considered by varying the ship forward speed. The speed controller is designed using nonlinear Lyapunov methods. The two control strategies are then combined to stabilise parametric roll resonance within few roll cycles. Limitations on the maximum stabilisable roll angle are analysed and linked to the slew rate saturation and hydrodynamic stall characteristics of the fin stabilisers. The study on maximum stabilisable roll angle leads to the requirements for early detection. Two novel detectors are proposed, which work within a short-time prediction horizon, and issue early warnings of parametric roll inception within few roll cycles from its onset. The main idea behind these detection schemes is that of exploiting the link between the second harmonic of roll angle and the first harmonic of heave or pitch motions. A nonlinear energy flow indicator, which measures the transfer of energy from the first harmonic of heave or pitch into the second harmonic of roll, is at the core of the first detector. The second detector relies on a driving signal that carries information about the phase correlation between either pitch or heave and roll. A generalised likelihood ratio test is designed to detect a change in distribution of the driving signal. The detectors are validated against experimental data of tests of a 1:45 scale model of a container ship. The validation shows excellent performance in terms of time to detect and false-alarm rate for both the proposed detectors. The detectors are the main contribution of this research. The thesis also offers a contribution regarding modeling. A 3 degree-offreedom nonlinear model in heave-pitch-roll of a container ship suitable for parametric roll resonance study is proposed. The model, which has been developed in collaboration with other researchers, provides a benchmark for the study and simulation of parametric roll over a large range of ship speeds and sea states. The results of this research have been published in articles enclosed in this dissertation and in an international patent application.

General information
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A Course Programme in Mobile Robotics with Integrated Hands-on Exercises and Competitions
The paper describes the design of and the considerations for a course programme in mobile robotics at the Technical University of Denmark. An integrated approach was taken designing mobile robot hardware, software and course curricula in an interconnected way. The courses in the programme all feature hands-on elements and competitions to motivate the students and support the learning objectives of the particular course. As the design of such competitions is not trivial some examples and observations are presented.

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Active fault diagnosis by controller modification

Two active fault diagnosis methods for additive or parametric faults are proposed. Both methods are based on controller reconfiguration rather than on requiring an exogenous excitation signal, as it is otherwise common in active fault diagnosis. For the first method, it is assumed that the system considered is controlled by an observer-based controller. The method is then based on a number of alternate observers, each designed to be sensitive to one or more additive faults. Periodically, the observer part of the controller is changed into the sequence of fault sensitive observers. This is done in a way that guarantees the continuity of transition and global stability using a recent result on observer parameterization. An illustrative example inspired by a field study of a drag racing vehicle is given. For the second method, an active fault diagnosis method for parametric faults is proposed. The method periodically adds a term to the controller that for a short period of time renders the system unstable if a fault has occurred, which facilitates rapid fault detection. An illustrative example is given.

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Authors: Stoustrup, J. (Ekstern), Niemann, H. H. (Intern)
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Scopus rating (2014): SJR 0.974 SNIP 1.359 CiteScore 2.21
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BFI (2009): BFI-level 1
Active Sensor Configuration Validation for Refrigeration Systems

Major faults in the commissioning phase of refrigeration systems are caused by defects related to sensors. With a number of similar sensors available that do not differ by type but only by spatial location in the plant, interchange of sensors is a common defect. With sensors being used quite differently by the control system, fault-finding is difficult in practice and defects are regularly causing commissioning delays at considerable expense. Validation and handling of faults in the sensor configuration are therefore essential to cut costs during commissioning. With passive fault-diagnosis methods falling short on this problem, this paper suggests an active diagnosis procedure to isolate sensor faults at the commissioning stage, before normal operation has started. Using statistical methods, residuals are evaluated versus multiple hypothesis models in a minimization process to uniquely identify the sensor configuration. The method as such is generic and is shown in the paper to work convincingly on refrigeration systems with significant nonlinear behaviors.

A Functional HAZOP Methodology

A HAZOP methodology is presented where a functional plant model assists in a goal oriented decomposition of the plant purpose into the means of achieving the purpose. This approach leads to nodes with simple functions from which the selection of process and deviation variables follow directly. The functional HAZOP methodology lends itself directly for implementation into a computer aided reasoning tool to perform root cause and consequence analysis. Such a tool can facilitate finding causes and/or consequences far away from the site of the deviation. A functional HAZOP assistant is proposed and investigated in a HAZOP study of an industrial scale Indirect Vapor Recompression Distillation pilot Plant (IVaRDiP) at DTU-Chemical and Biochemical Engineering. The study shows that the functional HAZOP methodology
provides a very efficient paradigm for facilitating HAZOP studies and for enabling reasoning to reveal potential hazards in safety critical operations.
Agent Based Control of Electric Power Systems with Distributed Generation

Distributed generation, decentralized and local control, self organization and autonomy are evident trends of today's electric power systems focusing on innovative control architectures such as MicroGrids, Virtual Power Plants, Cell based systems, plug-in electric vehicles and real time markets. Situation in Denmark is even more interesting, with a current 20% penetration of wind energy it is moving towards an ambitious goal of 50% penetration by the year 2050. Realization of these concepts requires that power systems should be of distributed nature (consisting of autonomous components and subsystems that are able to coordinate, communicate, cooperate, adapt to emerging situations and self organize in an intelligent way. At the same time, rapid development in information and communication technologies (ICT) have brought new opportunities and elucidations. New Technologies and standards have been developed particularly in the area of communication and distributed control. Electric power industry is eager to explore, evaluate and adopt these new advancements in ICT for improving its current practices of automation and control in order to cope with above mentioned challenges. This thesis focuses on making a systematic evaluation of using intelligent software agent technology for control of electric power systems with high penetration of distributed generation. The thesis is based upon a requirement driven approach. It starts with investigating new trends and challenges in Electric power systems brought by introduction of distributed generation (DG). It reviews innovative control architectures and precisely identifies the requirements in these control architectures which are interesting for application of the intelligent agents and maps them to the capabilities of the intelligent agents. It suggests a multiagent based flexible control architecture (subgrid control) suitable for the implementation of the innovative control concepts. This subgrid control architecture is tested on a novel distributed software platform which has been developed to design, test and evaluate distributed control strategies. The results have been discussed from case studies of multiagent based distributed control scenarios in electric power systems. The main contribution of this work is a proposal for system design methodology for application of intelligent agent technology in power systems. The methodology consists of suggestions for redesign of control architecture, a prototype for a software platform which facilitates implementation of multiagent control and results from case studies of specific scenarios. The work also contributes to agent based control with an approach of model based agents. In this approach the agents contain a model of their environment in order to select and reason about implications of a control action. This approach has showed promising results to improve the fault diagnosis and automation in electric power system.

General information
State: Published
Organisations: Department of Electrical Engineering, Centre for Electric Technology, Automation and Control, Center for Electric Power and Energy
Authors: Saleem, A. (Intern), Lind, M. (Intern)
Number of pages: 161
Publication date: 2010

Publication information
Publisher: Technical University of Denmark, Department of Electrical Engineering
ISBN (Print): 978-87-92465-32-0
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
Saleem10.pdf
Publication: Research › Ph.D. thesis – Annual report year: 2010
A model-based approach for fault-tolerant control

A model-based controller architecture for fault-tolerant control (FTC) is presented in this paper. The controller architecture is based on the Youla-Jabr-Bongiorno-Kucera (YJBK) parameterization. The FTC architecture consists of two central parts, fault detection and isolation (FDI) part and a controller reconfiguration part. The theoretical basis for the architecture will be given followed by an investigation of the single parts in the architecture. At last, system interconnection will be considered with respect to the described controller architecture.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Niemann, H. H. (Intern)
Publication date: 2010

An adaptive exposure algorithm for stereo imaging and its performance in an orchard

Stereo vision is being introduced in perception systems for autonomous agricultural vehicles. When working outdoors, light conditions change continuously. The perception system should be able to continuously adapt and correct camera exposure parameters to obtain the best interpretation of the scene practically possible. We describe the development and testing of an algorithm to update exposure parameter camera setting of a stereoscopic camera under dynamic light conditions. Static tests using a stereo camera were carried out in an orchard to determine how 2D image histograms and the 3D reconstruction change with exposure. An algorithm based on an "ideal mean pixel value" in the image was developed and implemented on the perception system of an automatic tractor. The system was tested in an orchard and found to perform satisfactorily under different orchard and light conditions.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, University of Copenhagen
Authors: Garcia, F. (Ekstern), Wulfsohn, D. (Ekstern), Andersen, J. C. (Intern), Larsen, M. (Ekstern)
Publication date: 2010

Autonomous Rule Based Robot Navigation In Orchards

Orchard navigation using sensor-based localization and exible mission management facilitates successful missions independent of the Global Positioning System (GPS). This is especially important while driving between tight tree rows where the GPS coverage is poor. This paper suggests localization based on an a priori map of the tree rows, a laser scanner based tree row detection, detecting both the row line and the row ends. The localization is combined with mission objectives in a rule-based inference interpreter. This rule-based mission handler combines the functional modules: localization, obstacle avoidance, path planning and drive control. The system is tested successfully using a Hako 20 kW tractor during autonomous missions in both cherry and apple orchards with mission length of up to 2.3 km including the headland turns.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Contextualised ICT4D: a Bottom-Up Approach

The term ICT4D refers to the opportunities of Information and Communication Technology (ICT) as an agent of development. Much of the research in the field is based on evaluating the feasibility of existing technologies, mostly of Western or Asian origin, in the context of developing countries. In a certain way, this agenda can be understood as a top-down approach which transfers technology in a hierarchical way to actual users. Complementary to the traditional approach, a bottom-up approach starts by identifying communities that are ready to participate in a process to use technology to transform their own strengths to new levels by designing appropriate technologies with experts of technology and design. The bottom-up approach requires a new kind of ICT education at the undergraduate level. An example of the development of a contextualized IT degree program at Tumaini University in Tanzania shows that the training requires a close collaboration with local stakeholders and a creative problem solving approach throughout the studies.

General information
State: Published
Organisations: Centre for Playware, Department of Electrical Engineering, University of Eastern Finland
Authors: Lund, H. H. (Intern), Sutilen, E. (Ekstern)
Publication date: 2010
Derivative free filtering using Kalmtool

In this paper we present a toolbox enabling easy evaluation and comparison of different filtering algorithms. The toolbox is called Kalmtool 4 and is a set of MATLAB tools for state estimation of nonlinear systems. The toolbox contains functions for extended Kalman filtering as well as for DD1 filter and the DD2 filter. It also contains functions for Unscented Kalman filters as well as several versions of particle filters. The toolbox requires MATLAB version 7, but no additional toolboxes are required.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Bayramoglu, E. (Intern), Hansen, S. (Intern), Ravn, O. (Intern), Poulsen, N. K. (Intern)
Publication date: 2010

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Title of host publication: Derivative free filtering using Kalmtool
ISBN (Print): 978-0-9824438-1-1
Main Research Area: Technical/natural sciences
Conference: 13th International Conference on Information Fusion, Edinburgh, United Kingdom, 26/07/2010 - 26/07/2010
Source: orbit
Source-ID: 265619
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Derivative free Kalman filtering used for orchard navigation

In this paper the use of derivative free filters for mobile robot localisation is investigated. Three different filters are tested on real life data from an autonomous tractor running in an orchard environment. The localisation algorithm fuses odometry and gyro measurements with line features representing the surrounding fruit trees. The line features are created on basis of 2D laser scanner data by a least square algorithm. The Matlab (R) toolbox Kalmtool is used for easy switching between different filter implementations without the need for changing the base structure of the system.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Hansen, S. (Intern), Bayramoglu, E. (Intern), Andersen, J. C. (Intern), Ravn, O. (Intern), Andersen, N. A. (Intern), Poulsen, N. K. (Intern)
Publication date: 2010

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Source: orbit
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Diagnosis of UAV Pitot Tube Defects Using Statistical Change Detection

Unmanned Aerial Vehicles need a large degree of tolerance to faults. One of the most important steps towards this is the ability to detect and isolate faults in sensors and actuators in real time and make remedial actions to avoid that faults develop to failure. This paper analyses the possibilities of detecting faults in the pitot tube of a small unmanned aerial vehicle, a fault that easily causes a crash if not diagnosed and handled in time. Using as redundant information the velocity measured from an onboard GPS receiver, the air-speed estimated from engine throttle and the pitot tube based airspeed, the paper analyses the properties of residuals. A dedicated change detector is suggested that works on pre-whitened residuals and a generalised likelihood ratio test is derived for a Cauchy probability density, which the residuals are observed to have. A detection scheme is obtained using a threshold that provides desired quantities of false alarm and detection probabilities. Fault detectors are build based on raw residual data and on a whitened edition of these. The two detectors are compared against recorded telemetry data of an actual event where a pitot tube defect occurred.

General information
State: Published
Fault Isolation and quality assessment for shipboard monitoring

In this paper a new approach for increasing the overall reliability of a monitoring and decision support system will be explained. The focus is on systems used for ship operator guidance with respect to, say, speed and heading. The basic idea is to convert the given system into a fault tolerant system and to improve multi-sensor data fusion for the particular system. Fault isolation is an important part of the fault tolerant design for in-service monitoring and decision support systems for ships. In the paper, a virtual example of fault isolation will be presented. Several possible faults will be simulated and isolated using residuals and the generalized likelihood ratio (GLR) algorithm. It will be demonstrated that the approach can be used to increase accuracy of sea state estimations employing sensor fusion quality test.

Fault Isolation for Shipboard Decision Support

Fault detection and fault isolation for in-service decision support systems for marine surface vehicles will be presented in this paper. The stochastic wave elevation and the associated ship responses are modeled in the frequency domain. The paper takes as an example fault isolation of a containership on which a decision support system has been installed and it will be demonstrated that all the faults can be isolated. The paper shows how a shipboard decision support system could become highly reliable and comprise built-in supervision of the quality of the sensor signals that are crucial to the quality of decisions given to navigators.
Knowledge representation for integrated plant operation and maintenance

Integrated operation and maintenance of process plants has many advantages. One advantage is the improved economy obtained by reducing the number of plant shutdowns. Another is to increase reliability of operation by monitoring of risk levels during on-line maintenance. Integrated plant operation and maintenance require knowledge bases which can capture the interactions between the two plant activities. As an example, taking out a component or a subsystem for maintenance during operation will require a knowledge base representing the interactions between plant structure, functions, operating states and goals and incorporate knowledge about redundancy and reliability data. Multilevel Flow Modeling can be used build knowledge bases representing plant goals and functions and has been applied for fault diagnosis and supervisory control but currently it does not take into account structural information. The paper will extend Multilevel Flow Modeling with foundational concepts to represent relations between plant structure and functions. The paper will present results from MFM studies of heat transfer and chemical engineering systems showing that structural information can be included in MFM models by a few extensions of the modeling language. Extending MFM with information of plant structure will make it possible to reason about consequences of component outages and their consequences for plant operation. The extensions provide also a significant general expansion of the expressivity of MFM.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Lind, M. (Intern)
Publication date: 2010

Maintenance of Process Control Algorithms based on Dynamic Program Slicing

Today's industrial control systems gradually lose performance after installation and must be regularly maintained by means of adjusting parameters and modifying the control algorithm, in order to regain high performance. Industrial control algorithms are complex software systems, and it is particularly difficult to locate causes of performance loss, while readjusting the algorithm once the cause of performance loss is actually realized and found is relatively simple. In this paper we present a software-engineering approach to the maintenance problem, which provides tools for exploring the behavior of a control algorithm, enables maintenance personnel to focus on only relevant parts of the algorithm and semi-automatically locate the part of the algorithm that is responsible for the reduced performance. The solution is tuning-free and can be applied to installed and running systems without modifying the existing control algorithm, which makes the solution well suited for industrial applications.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Hansen, O. F. (Intern), Andersen, N. A. (Intern), Ravn, O. (Intern)
Publication date: 2010
Methodological Challenges for Design-based Research into Learning Games

General information
State: Published
Organisations: Centre for Playware, Department of Electrical Engineering
Authors: Magnussen, R. (Intern), Hanhøj, T. (Ekstem)
Publication date: 2010

Host publication information
Title of host publication: Global Learn Asia Pacific 2010 - Global Conference on Learning and Technology
Main Research Area: Technical/natural sciences
Conference: Global Learn Asia Pacific 2010 - Global Conference on Learning and Technology, Malaysia, 01/01/2010
Source: orbit
Source-ID: 256714
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Mobotware – A Plug-in Based Framework For Mobile Robots
This paper describes a plug-in based software framework developed at Automation and Control, DTU Electrical Engineering. The software has been used for education and research in mobile robotics for the last decade. Important design criteria have been real-time performance of the control level, easy integration of sensors, fast porting to new robots and core system stability and maintainability in an undisciplined programming environment. Real-time performance is assured by using RTAI-Linux; core stability is obtained by using plug-ins for user developed modules. The plug-in based module structure combined with inter-module communication based on TCP/IP sockets and human readable XML-protocol makes it easy to use the system on a wide range of hardware platforms, configurations and computer platform distributions. The framework has until now been interfaced to 7 different hardware platforms and has enabled many application i.e. robust navigation in an orchard with an autonomous tractor (Andersen, 2010). Furthermore by providing a simple scripting robot control language the system also supports use by non-technicians.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Beck, A. B. (Intern), Andersen, N. A. (Intern), Andersen, J. C. (Intern), Ravn, O. (Intern)
Publication date: 2010

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Title of host publication: IAV 2010
Publisher: International Federation of Automatic Control
Main Research Area: Technical/natural sciences
Conference: 7th IFAC Symposium on Intelligent Autonomous Vehicles, Lecce, Italy, 06/09/2010 - 06/09/2010
Robotic framework, Real-time systems, Robot control, Hierarchical systems, Autonomous mobile robots, Reusable robotic software, Multisensor integration., Architectures
Source: orbit
Source-ID: 268284
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Modelling Cow Behaviour Using Stochastic Automata
This report covers an initial study on the modelling of cow behaviour using stochastic automata with the aim of detecting lameness. Lameness in cows is a serious problem that needs to be dealt with because it results in less profitable production units and in reduced quality of life for the affected livestock. By featuring training data consisting of measurements of cow activity, three different models are obtained, namely an autonomous stochastic automaton, a stochastic automaton with coinciding state and output and an autonomous stochastic automaton with coinciding state and output, all of which describe the cows’ activity in the two regarded behavioural scenarios, non-lame and lame. Using the experimental measurement data the different behavioural relations for the two regarded behavioural scenarios are assessed. The three models comprise activity within last hour, activity within last hour supplying with information on which hour of the day it is and lastly modelling the general activity level. Diagnosis algorithms for the three approaches are implemented and tested using the real data measurements and show that the diagnosis algorithm can distinguish between
data belonging to nominal behaviour and data belonging to lame behaviour.

**Modular Interactive Tiles for Rehabilitation – Evidence and Effect**

We developed modular interactive tiles to be used for playful physiotherapy, which is supposed to motivate patients to engage in and perform physical rehabilitation exercises. We report on evidence for elderly training. We tested the modular interactive tiles for an extensive period of time (4 years) in daily use in a hospital rehabilitation unit e.g. for cardiac patients. Also, the tiles were tested for performing physical rehabilitation of stroke patients both in hospital, rehabilitation centre and in their private home. In all test cases qualitative feedback indicate that the patients find the playful use of modular interactive tiles engaging and motivating for them to perform the rehabilitation. Also, test data suggest that some playful exercises on the tiles demand an average heart rate of 75% and 86% of the maximum heart rate.

**Non-Linear State Estimation Using Pre-Trained Neural Networks**

This article presents a method to track non-Gaussian parametric probability density functions under nonlinear transformations and posterior calculations. The optimal set of parameters for the transformed distribution is a function of the parameters for the prior distribution and any other variables effecting the transformation. This function is approximated by a neural network using offline training. The training is based on monte carlo sampling. A way to obtain parametric distributions of flexible shape to be used easily with these networks is also presented. The method can also be used to improve other parametric methods around regions with strong non-linearities by including them inside the network.
On the choice of performance assessment criteria and their impact on the overall system performance: The refrigeration system case study

The aim of this paper is to illuminate the impact of the choice of a system’s performance criteria on the quality of the corresponding monitoring system’s assessment results. Special attention is given to the performance issues that are caused by or can be solved by control actions. The compressor capacity gap issue in the supermarket refrigeration systems is used as a case study to elaborate on the problem through employment of both real life field data as well as simulation data. A performance function that can capture the compressor capacity gap problem is presented in the paper and used to evaluate both data from the real supermarket system and the data generated by the simulation model.

Optimal Set-point Chasing of Position Moored Vessel

Dynamic positioning of surface vessels moored to the seabed via a spread mooring system are referred to as position mooring (PM), the main objective of which is to keep the vessel within a small radius from a given position while preventing mooring line breakage. When environmental loads become high, position mooring systems apply thruster forces to protect mooring lines and position accuracy may need be relaxed. This paper suggests an new position chasing algorithm that works entirely online, is optimal according to a criterion and can protect any number of mooring lines simultaneously. Tensions of all mooring lines are included in a cost function where the criticality for each mooring line determine individual weights. With this strategy, external environment effects are included directly by without needing predefined tabular settings of environmental loads as in earlier approaches. There is no limitation to the number of mooring lines that can be close to critical tension. A reliability index is used as weight to include the dynamic influence of mooring line tension. Detailed simulations illustrate the features and advantages of the new method and results are compared with those of a fixed weight algorithm.
Playware Soccer – flexibility through modularity and layered multi-modal feedback
We developed the Playware Soccer game and tested this with more than 1,000 users during the FIFA World Cup 2010 in South Africa in townships, orphanages for HIV/AIDS children, markets, FIFA fan parks, etc. The playware game is set up to motivate players to engage in training of technical soccer skills by receiving motivating, immediate feedback on the soccer playing on a modular interactive wall composed of modular interactive tiles that respond with coloured light, sound and scores on the players performance. The flexibility of the system was designed for with the modular interactive tiles and the layered multi-modal feedback design, which together aimed at creating a system that could be setup and used by anybody anywhere within minutes. The modular interactive tiles can be viewed to provide hardware building blocks, and the layered multi-modal feedback design to provide feedback building blocks, and simple construction with these building blocks should give a high degree of flexibility for the designer and the user to create various set-ups and interaction possibilities in an easy manner.

Prediction of resonant oscillation
The invention relates to methods for prediction of parametric rolling of vessels. The methods are based on frequency domain and time domain information in order do set up a detector able to trigger an alarm when parametric roll is likely to occur. The methods use measurements of e.g. pitch and roll oscillations and compare the measured oscillations using FFT analysis of signal correlations, variance analysis of signals and other comparisons. As an example, the presence of a growing peak around a frequency that doubles the roll natural frequency indicates the possibility that parametric roll is going to happen. L

Representing Causality and Reasoning about Controllability of Multi-level Flow-Systems
Safe operation of complex processes requires that operators maintain situational-awareness even in highly automated environments. Automatic reasoning can support operators as well as the automation system itself to react effectively and appropriately to disturbances. However, knowledge-based reasoning about control situations remains a challenge due to the entanglement of process and control systems that co-establish the intended causal structure of a process. Due to this entanglement, reasoning about such systems depends on a coherent representation of control and process. This paper
explains modeling of controlled processes with multilevel flow models and proposes a new framework for modeling causal influence in multilevel flow models on the basis of a flow/potential analogy. The results are illustrated on examples from the domain of electric power systems.

**General information**

**State:** Published

**Organisations:** Electric Energy Systems, Department of Electrical Engineering, Automation and Control, Centre for Electric Technology

**Authors:** Heussen, K. (Intern), Lind, M. (Intern)

**Publication date:** 2010

**Host publication information**

**Title of host publication:** 2010 IEEE International Conference on Systems, Man, and Cybernetics: Intelligent Systems for a Safe and Secure World

**Publisher:** IEEE

**ISBN (Print):** 978-1-4244-6586-6

**Main Research Area:** Technical/natural sciences

**Conference:** IEEE International Conference on Systems, Man, and Cybernetics: Intelligent Systems for a Safe and Secure World, Istanbul, 01/01/2010

**Causality, Knowledge-based Systems, Functional Modeling, Model-based reasoning, Power Systems, Intelligent Control, Means-ends**

**Electronic versions:** smc2010.pdf

**DOIs:** 10.1109/ICSMC.2010.5642272

**Bibliographical note**

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**Source:** orbit

**Source-ID:** 264771

**Publication:** Research - peer-review › Article in proceedings – Annual report year: 2010

**RoboMusic with Modular Playware**

Based on the concepts of RoboMusic and Modular Playware, we developed a system composed of modular playware devices, which allow any user to perform music in a simple, interactive manner. The key features exploited from the Modular Playware approach are modularity, flexibility, and construction, immediate feedback to stimulate engagement, creative exploration of play activities, and in some cases activity design by end-users (e.g. DJ's). We exemplify the approach with the development of 11 rock genres and 6 pop music pieces for modular I-BLOCKS, which are exhibited and in daily use at the Rock Me exhibition and used at several international music events in Japan and USA. A key finding is that the professional music design is essential for the development of primitives in a musical behaviour-based system and this professional aesthetics is necessary for engaging the users in the activity of assembling and coordinating these ‘professional’ musical primitives. The paper describes, explores and discusses this concept.

**General information**

**State:** Published

**Organisations:** Centre for Playware, Department of Electrical Engineering

**Authors:** Lund, H. H. (Intern), Bærendsen, N. K. (Intern), Nielsen, J. (Intern), Jessen, C. (Intern), Falkenberg, K. (Intern)

**Publication date:** 2010

**Host publication information**

**Title of host publication:** Proceedings of International Symposium on Artificial Life and Robotics (AROB’10)

**Main Research Area:** Technical/natural sciences

**Conference:** International Symposium on Artificial Life and Robotics (AROB’10), ISAROB, Japan, 01/01/2010

**Source:** orbit

**Source-ID:** 271587

**Publication:** Research - peer-review › Article in proceedings – Annual report year: 2010

**Robotic Art for Wearable**

We present the robot art and how it may inspire to create a new type of wearable termed modular robotic wearable. Differently from the related works, modular robotic wearable aims at making no use of mechatronic devices (as, for example, in Cyberpunk and related research branches) and mostly relies on “simple” plug-and-play circuits, ranging from pure sensors-actuators schemes to artefacts with a smaller level of elaboration complexity. Indeed, modular robotic wearable focuses on enhancing the body perception and proprioception by trying to substitute all of the traditional exoskeletons perceptive functions - in most of the cases strongly rigid, cabled and centralized - through the use of local
sensing circuits. It is exemplified here with the early prototype art work called Fatherboard, and the concept is believed to be applicable to different application fields, such as sport, health and entertainment.

General information
State: Published
Organisations: Centre for Playware, Department of Electrical Engineering, Center for Playware
Authors: Lund, H. H. (Intern), Pagliarini, L. (Ekstern)
Publication date: 2010

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Main Research Area: Technical/natural sciences
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Playware, Wearable, Robot art., Interactivity, Modular technology
Source: orbit
Source-ID: 273846
Publication: Research › Article in proceedings – Annual report year: 2010

Robust stability in predictive control with soft constraints
In this paper we take advantage of the primary and dual Youla parameterizations for setting up a soft constrained model predictive control (MPC) scheme for which stability is guaranteed in face of norm-bounded uncertainties. Under special conditions guarantees are also given for hard input constraints. In more detail, we parameterize the MPC predictions in terms of the primary Youla parameter and use this parameter as the online optimization variable. The uncertainty is parameterized in terms of the dual Youla parameter. Stability can then be guaranteed through small gain arguments on the loop consisting of the primary and dual Youla parameter. This is included in the MPC optimization as a constraint on the induced gain of the optimization variable. We illustrate the method with a numerical simulation example.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Automation and Control, Department of Electrical Engineering
Authors: Thomsen, S. C. (Intern), Niemann, H. H. (Intern), Poulsen, N. K. (Intern)
Publication date: 2010

Host publication information
Title of host publication: Proceedings of the American Control Conference 2010
Main Research Area: Technical/natural sciences
Conference: American Control Conference (ACC 2010), Baltimore, MD, United States, 03/06/2010 - 03/06/2010
Model Predictive Control, Youla parameterization, Robust control
Source: orbit
Source-ID: 257384
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Satellite Dynamics and Control in a Quaternion Formulation (2nd edition)
This lecture note treats modelling and attitude control design using a quaternion description of attitude for a rigid body in space. Dynamics and kinematics of a satellite is formulated as a non-linear model from Euler’s moment equations and a description of kinematics using the attitude quaternion to represent rotation. A general linearised model is derived such that the user can specify an arbitrary point of operation in angular velocity and wheel angular momentum, specifying the a inertia matrix for a rigid satellite. A set of Simulink® models that simulate the satellite’s nonlinear behaviour are described and a Matlab® function is described that has been written to calculate the linear model in an arbitrary point of operation.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Blanke, M. (Intern), Larsen, M. B. (Intern)
Number of pages: 50
Publication date: 2010

Publication information
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Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
Satdyn_mb_2010f.pdf
Self-Reconfigurable Robots: An Introduction

General information
State: Published
Organisations: Centre for Playware, Department of Electrical Engineering
Authors: Stoy, K. (Ekstern), Brandt, D. (Ekstern), Christensen, D. J. (Intern)
Publication date: 2010

Publication information
Place of publication: Cambridge, Massachusetts
Publisher: MIT Press
ISBN (Print): 978-0262013710
Original language: English

Series: Intelligent robotics and autonomous agents
Main Research Area: Technical/natural sciences

Electronic versions:
book[1].pdf
Source: orbit
Source-ID: 274004
Publication: Research - peer-review › Book – Annual report year: 2010

Ship Roll Motion Control
The technical feasibility of roll motion control devices has been amply demonstrated for over 100 years. Performance, however, can still fall short of expectations because of deficiencies in control system designs, which have proven to be far from trivial due to fundamental performance limitations. This tutorial paper presents an account of the development of various ship roll motion control systems and the challenges associated with their design. The paper discusses how to assess performance, the applicability of different models, and control methods that have been applied in the past.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, University of Newcastle
Authors: Perez, T. (Ekstern), Blanke, M. (Intern)
Number of pages: 12
Publication date: 2010

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Place of publication: Rostock
Publisher: Elsevier
Main Research Area: Technical/natural sciences
Conference: IFAC Conference on Control Applications in Marine Systems, Rostock-Warnemünde, Germany, 01/01/2010
Ship Roll Damping, Roll stabilisation, Marine Control Systems
Electronic versions:
2010_IFAC_CAMS_Perez_Blanke.pdf

Bibliographical note
Invited Tutorial
Source: orbit
Source-ID: 266910
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Stereo vision with texture learning for fault-tolerant automatic baling
This paper presents advances in using stereovision for automating baling. A robust classification scheme is demonstrated for learning and classifying based on texture and shape. Using a state-of-the-art texton approach a fast classifier is obtained that can handle non-linearities in the data. The addition of shape information makes the method robust to large variations and greatly reduces false alarms by applying tight geometrical constraints. The classifier is tested on data from a stereovision guidance system on a tractor. The system is able to classify cut plant material (called swath) by learning its appearance. A 3D classifier is used to train and supervise the texture classifier.
Stochastic wind turbine control in multiblade coordinates

In this paper we consider wind turbine load attenuation through model based control. Asymmetric loads caused by the wind field can be reduced by pitching the blades individually. To this end we investigate the use of stochastic models of the wind which can be included in a model based individual pitch controller design. In this way the variability of the wind can be estimated and compensated for by the controller. The wind turbine model is in general time-variant due to its rotational nature. For this reason the modeling and control is carried out in so-called multiblade coordinates. A controller based on the H2 methodology is designed and tested in simulations.

System-Awareness for Agent-based Power System Control

Operational intelligence in electric power systems is focused in a small number of control rooms that coordinate their actions. A clear division of responsibility and a command hierarchy organize system operation. With multi-agent based control systems, this control paradigm may be shifted to a more decentralized open access collaboration control paradigm. This shift cannot happen at once, but must fit also with current operation principles. In order to establish a scalable and transparent system control architecture, organizing principles have to be identified that allow for a smooth transition. This paper presents a concept for the representation and organization of control- and resource-allocation, enabling computational reasoning and system awareness. The principles are discussed with respect to a recently proposed Subgrid operation concept.

Visual Navigation for Mobile Robots

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Andersen, N. A. (Intern), Andersen, J. C. (Intern), Bayramoglu, E. (Intern), Ravn, O. (Intern)
Wearing the Playware

In this conceptual paper, we describe and define the range of possible applications and the technical contours of a robotic system to be worn on the body for playful interactions. Earlier work on Modular Robotic Wearable, MRW, described how, by using modular robotics for creating wearable, it is possible to obtain a flexible wearable processing system, where freely interchangeable input/output modules can be positioned on the body suit in accordance with the task at hand. Here, we drive the attention on early prototypes to show the potentialities of such an approach, and focus on depicting possible application in the electronic games domain. Indeed, the Modular Robotic Wearable is an example of modular playware, which can create playful interactions for many application domains, including electronic games.

General information

State: Published
Organisations: Centre for Playware, Department of Electrical Engineering, Academy of Fine Arts of Bari
Authors: Lund, H. H. (Intern), Pagliarini, L. (Ekstern)
Publication date: 2010

Host publication information

Title of host publication: The Fifteenth International Symposium on Artificial Life and Robotics 2010
Main Research Area: Technical/natural sciences
Conference: The Fifteenth International Symposium on Artificial Life and Robotics 2010, Oita, Japan, 01/01/2010
Source: orbit
Source-ID: 273819
Publication: Research › Article in proceedings – Annual report year: 2010

Maintenance Free and Sustainable High-Level Control in Cement and Mining Industry

High-level control systems have been utilized in the process industry for decades, and also in cement production their use is well established. In comparison to manual control their ability to increase production and quality of end product, while reducing energy consumption and emission, is well recognized. Therefore, the payback time may be less than one year. It is common however, that the systems are disabled only a few months after commissioning because the process has changed in such a way that it does no longer matching the systems' tuning. The cause of this can be raw materials changing, wear of machinery, and reconstruction of the plant etc. Therefore, in order to keep a constant, high performance, the high-level control system requires regular maintenance by means of expert personnel readjusting and modifying the algorithm, which is resource demanding. The aim of this Ph.D. project is to minimize or eliminate the amount of resources needed to keep a high performance. Current high-level control algorithms are sophisticated and complex software. An analysis of such algorithms shows that only 10% of the source code can be considered implementation of control theory. The remaining 90% handles other tasks but nevertheless still require maintenance. For the 10% of the algorithm that is control related, the maintenance issue is to some extent addressed by research topics such as adaptive control, which aim at retuning the parameters of the algorithm to match the changing process. In this project however, it has been chosen to focus on the remaining 90% of the algorithm which still require manual modifications to cope with a changed process. Although this issue has gained limited attention from academia so far it is well recognized by the industry. In the process of maintaining an algorithm it has turned out that navigating the source code, understanding the interaction of signals and tracking down the statement in the code responsible for the problem is the issues which require expert knowledge and they are very time consuming. In contrast, it is relatively simple to conduct the actual modification once the few statements to be modified have been found. Current SCADA systems allow logging of signals while the control system is running which may be useful in the diagnostic process. However, each signal to be logged must be explicitly specified, and typically only measurements, setpoints and key performance indicators are therefore logged. Thus, critical algorithm-related information is not available post-mortem. A number of tools and methods has therefore been developed which aim firstly at monitoring a running algorithm to raise an alarm in case the algorithm starts to behave abnormally. Secondly, a set of tools and methods are proposed to help the human expert to diagnose and locate the part of the algorithm that is responsible for the malfunction. These steps are based on information extracted from the
algorithm at runtime by means of a technique called program slicing. Thus, instead of monitoring the process to detect changes, attention is focused on the control algorithm itself. In addition to the signals already logged by the SCADA system, enough data is collected at each execution of the control algorithm so an exact replay of its execution can be performed later. The resolution of this replay is down to single-stepping through the lines of source code, keeping track of variable values from the execution of one statement to the other. The method has been tested on a full scale control algorithm, showing that computational cost at runtime is neglectable and that the amount of additional data to be logged is compatible with the storage capacity of current computers. Preliminary statistical analysis of the logged data shows that normal and abnormal behavior of a real-world control algorithm can be distinguished so an alarm can be raised. The method enables backtracking of signal dependencies in the algorithm which can be used to semi-automatically guide the human expert to the responsible part of the algorithm. This feature is demonstrated in a simple control algorithm.

**A Concept for fault tolerant controllers**

This paper describes a concept for fault tolerant controllers (FTC) based on the YJBK (after Youla, Jabr, Bongiorno and Kucera) parameterization. This controller architecture will allow to change the controller on-line in the case of faults in the system. In the described FTC concept, a safe mode controller is applied as the basic feedback controller. A controller for normal operation with high performance is obtained by including certain YJBK parameters (transfer functions) in the controller. This will allow a fast switch from normal operation to safe mode operation in case of critical faults in the system. The described FTC architecture allow the different feedback controllers to apply different sets of sensors and actuators.

**Active Fault Diagnosis - A Stochastic Approach**

This paper describes a concept for fault tolerant controllers (FTC) based on the YJBK (after Youla, Jabr, Bongiorno and Kucera) parameterization. This controller architecture will allow to change the controller on-line in the case of faults in the system. In the described FTC concept, a safe mode controller is applied as the basic feedback controller. A controller for normal operation with high performance is obtained by including certain YJBK parameters (transfer functions) in the controller. This will allow a fast switch from normal operation to safe mode operation in case of critical faults in the system. The described FTC architecture allow the different feedback controllers to apply different sets of sensors and actuators.
Active Fault Diagnosis for Systems with Reduced Model Information

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Niemann, H. H. (Intern), Poulsen, N. K. (Intern)
Number of pages: 88
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Main Research Area: Technical/natural sciences
Conference: 7th IFAC Symposium on Fault Detection, Supervision and Safety of Technical Processes, Barcelona, Spain, 30/06/2009 - 30/06/2009
Source: orbit
Source-ID: 251826
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2009

Active Fault Isolation and Estimation

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Automation and Control, Department of Electrical Engineering
Authors: Poulsen, N. K. (Intern), Niemann, H. H. (Intern)
Number of pages: 306
Pages: 151-158
Publication date: 2009

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Place of publication: Gdansk
Publisher: Pomerian Science and Technology Publishers
ISBN (Print): 9788392680635
Main Research Area: Technical/natural sciences
Conference: Information Technology Control Theory Fault and System Diagnosis : Control and Computer Science, Gdansk, 01/01/2009
Source: orbit
Source-ID: 251824
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Active system monitoring applied on wind turbines

A concept for active system monitoring (ASM) applied on wind turbines is presented in this paper. The concept is based on an injection of a small periodic auxiliary signal in the system. An investigation of the signature from the auxiliary input in residual (error) signals can then be applied for an online monitoring of central parameters/elements of the system. Statistical tests are applied on the residual signals for obtaining a correct monitoring.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Mathematical Statistics, Department of Informatics and Mathematical Modeling, Technical University of Denmark
Agent Services for Situation Aware Control of Power Systems With Distributed Generation

Electric Power system of Denmark exhibits some unique characteristics. An increasing part of the electricity is produced by distributed generators (DGs). Most of these DGs are connected to the network at the distribution level. At the same time the concept of vehicle to grid (V2G) is already in the process of realization. This situation has created an incentive in electric power industry to utilize modern information and communication technologies (ICT) for improving the distribution system automation. This paper describes our work on how significantly increased amount of distributed generation could be exploited for the robust control of electric power systems. In particular, we present our work on the implementation of a dynamic service oriented system, in which autonomous agents represent different components of low voltage grid. These agents could offer and utilize electric power control services. We present results from several experiments where agents offer and utilize services in order to achieve distributed and autonomous control for subgrid operation of a distribution system. Finally it is discussed how the service oriented architecture can be combined with knowledge based reasoning to implement situation awareness required in complex control situations.

Bibliographical note
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A Goal Based HAZOP Assistant

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Computer Aided Process Engineering Center, Department of Chemical and Biochemical Engineering
Authors: Rossing, N. L. (Ekstern), Lind, M. (Intern), Jensen, N. (Ekstern), Jørgensen, S. B. (Intern)
Attenuating wind turbine loads through model based individual pitch control

In this paper we consider wind turbine load attenuation through model based control. Asymmetric loads caused by the wind field can be reduced by pitching the blades individually. To this end we investigate the use of stochastic models of the wind which can be included in a model based individual pitch controller design. In this way the variability of the wind can be estimated and compensated for by the controller. The wind turbine model is in general time-variant due to its rotational nature. For this reason the modeling and control is carried out in so-called multiblade coordinates. The individual pitch controller design is investigated in simulations.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics, Department of Electrical Engineering, Automation and Control
Authors: Thomsen, S. C. (Intern), Niemann, H. H. (Intern), Poulsen, N. K. (Intern)
Publication date: 2009

Autonomous Tractor Navigation in Orchard - Diagnosis and Supervision for Enhanced Availability

Autonomous vehicles require a very high degree of availability and safety to become accepted by authorities and the public. Diagnosis and supervision are necessary means to achieve this. This paper investigates ways of using laser-scanner data to do localisation, and as a source of independent supervision, using expectation maximisation of laser-scanner output against uncertain map features. Analysis of system behaviours and their structure shows which redundant information is available to construct a supervisor. Tests on real life orchard data demonstrates the feasibility of the new approach.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Hansen, S. (Intern), Blanke, M. (Intern), Andersen, J. C. (Intern)
Pages: 360-365
Publication date: 2009

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Main Research Area: Technical/natural sciences
Conference: 7th IFAC Symposium on Fault Detection, Supervision and Safety of Technical Processes, Barcelona, Spain, 30/06/2009 - 30/06/2009
Autonomous vehicle, Structural analysis, Statistical methods
DOIs:
10.3182/20090630-4-ES-2003.00060
Source: orbit
Source-ID: 241844
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009
Challenges to Cognitive Systems Engineering: Understanding Qualitative Aspects of Control Actions
The paper discusses the future role of Cognitive Systems Engineering (CSE) in contributing to integrated design of process, automation and human machine systems. Existing concepts and methods of Cognitive Systems Engineering do not integrate well with control theory and industrial automation tools. It is argued that better integration may be obtained by deeper understanding of the purposes of control actions. Examples show how process functions and control purposes are integrated in Multilevel Flow Modeling. The paper concludes that these results should be considered in future developments of CSE.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Lind, M. (Intern)
Publication date: 2009

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Title of host publication: Proceedings of ECCE09
Main Research Area: Technical/natural sciences
Means-end analysis, Multilevel Flow Modeling, Process Control, Cognitive System Engineering
Source: orbit
Source-ID: 316013
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Combination of activity and lying/standing data for detection of oestrus in cows
The objective of this study is to develop an algorithm for detecting oestrus in dairy cows from measurements of activity and duration of lying/standing periods. Each cows activity is measured by a sensor attached to the neck that returns an activity index for each hour. Duration of lying is measured by a sensor attached to the hind leg of the cow. Activity and lying/standing behaviour are modelled as a discrete event system, constructed using automata theory. In an attempt to estimate a biologically relevant lying balance, a lying balance indicator is constructed and is influencing transition probabilities in the stochastic automata. The cows lying-balance indicates how much the cow has been resting during the immediately past period, and the balance express to the automata, the tendency of the cow to continue resting or not. Automata for describing the two scenarios; normal and oestrus are designed and results of decision algorithms are presented for Oestrus detection. Detection based on the lying balance indicator and the two sets of measured information are demonstrated to increase the detection sensitivity to 100% for a set of 10 cows.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Mathematical Statistics, Department of Informatics and Mathematical Modeling, Aarhus University
Authors: Jónsson, R. I. (Intern), Blanke, M. (Intern), Poulsen, N. K. (Intern), Munksgaard, L. (Ekstern), Hejsgaard, S. (Ekstern)
Pages: 207-214
Publication date: 2009

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Title of host publication: Precision livestock farming '09
Main Research Area: Technical/natural sciences
Conference: The Joint International Agricultural Conference, 01/01/2009
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Source-ID: 242344
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Combining Stochastic Automata and Classification Techniques for Supervision and Safe Orchard Navigation
Cost drivers in commercial orchards are time-consuming tasks as the drive through rows for spraying, cutting grass or collecting fruit. An automated tractor can be an answer to enhance production efficiency. For this to be acceptable by public and authorities, safety and reliability are crucial, hence information redundancy is needed to achieve a fault tolerant system. This paper addresses ways to extract information from laser scanner data. A Gaussian Mixture model is used to classify laser data into obstacles, while through diagnosis, a stochastic automaton model gives a semantic position estimate relying only on laser perception. Results demonstrate the feasibility of implementation in an autonomous tractor that use diagnosis and active fault-tolerant control to enhance availability and safety.
Comparing mobile robot localisation algorithms using Kalmtool

In this paper we present an estimation platform with simulation capabilities to evaluate methods for localisation of a mobile robot using a feature map. The platform is based on the Kalmtool 4 toolbox which is a set of MATLAB tools for state estimation of nonlinear systems. The toolbox contains functions for extended Kalman filtering as well as for the DD1 filter and the DD2 filter. It also contains functions for Unscented Kalman filters as well as three versions of particle filters. The toolbox requires MATLAB version 7, but no additional toolboxes are required.

Control architecture of power systems: Modeling of purpose and function

Many new technologies with novel control capabilities have been developed in the context of "smart grid" research. However, often it is not clear how these capabilities should best be integrated in the overall system operation. New operation paradigms change the traditional control architecture of power systems and it is necessary to identify requirements and functions. How does new control architecture fit with the old architecture? How can power system functions be specified independent of technology? What is the purpose of control in power systems? In this paper, a method suitable for semantically consistent modeling of control architecture is presented. The method, called Multilevel Flow Modeling (MFM), is applied to the case of system balancing. It was found that MFM is capable of capturing implicit control knowledge, which is otherwise difficult to formalize. The method has possible future applications in agent-based intelligent grids.
Control by damping Injection of Electrodynamic Tether System in an Inclined Orbit
Control of a satellite system with an electrodynamic tether as actuator is a time-periodic and underactuated control problem. This paper considers the tethered satellite in a Hamiltonian framework and determines a port-controlled Hamiltonian formulation that adequately describes the nonlinear dynamical system. Based on this model, a nonlinear controller is designed that will make the system asymptotically stable around its open-loop equilibrium. The control scheme handles the time-varying nature of the system in a suitable manner resulting in a large operational region. The performance of the closed loop system is treated using Floquet theory, investigating the closed loop properties for their dependency of the controller gain and orbit inclination.

Controller Architectures for Switching
This paper investigate different controller architectures in connection with controller switching. The controller switching is derived by using the Youla-Jabr-Bongiorno-Kucera (YJBK) parameterization. A number of different architectures for the implementation of the YJBK parameterization are described and applied in connection with controller switching. An architecture that does not include inversion of the coprime factors is introduced. This architecture will make controller switching particular simple.
Designing Modular Robotic Playware

In this paper, we explore the design of modular robotic objects that may enhance playful experiences. The approach builds upon the development of modular robotics to create a kind of playware, which is flexible in both set-up and activity building for the end-user to allow easy creation of games. Key features of this design approach are modularity, flexibility, and construction, immediate feedback to stimulate engagement, activity design by end-users, and creative exploration of play activities. These features permit the use of such modular playware by a vast array of users, including disabled children who often could be prevented from using and taking benefits from modern technologies. The objective is to get any children moving, exchanging, experimenting and having fun, regardless of their cognitive or physical ability levels. The paper describes two prototype systems developed as modular robotic tiles, and discusses the challenges and opportunities of this modular playware when used by children with different cognitive abilities.

General information
State: Published
Organisations: Centre for Playware, Department of Electrical Engineering
Authors: Lund, H. H. (Intern), Marti, P. (Ekstern)
Pages: 115-121
Publication date: 2009
scenarios (regular/irregular waves) since it does not rely on any specific assumption on the signal to be detected.

**General information**
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Galeazzi, R. (Intern), Blanke, M. (Intern), Poulsen, N. K. (Intern)
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Roll resonance, Marine systems, Marine applications, Parametric resonance, Statistical methods
DOI:
10.3182/20090630-4-ES-2003.00058
Source: orbit
Source-ID: 246429
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

**DIAGNOSIS OF PITCH AND LOAD DEFECTS**
The invention relates to a method, system and computer readable code for diagnosis of pitch and/or load defects of e.g. wind turbines as well as wind turbines using said diagnosis method and/or comprising said diagnosis system.

**General information**
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, VESTAS Wind Systems A/S
Authors: Blanke, M. (Intern), Dalsgaard, S. (Ekstern), Brath, P. (Ekstern)
Publication date: 2009

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Source: orbit
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Publication: Research › Patent – Annual report year: 2009

**Discussion on: "Structural Analysis of the Partial State and Input Observability for Structured Linear Systems. Application to Distributed Systems"**

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State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Izadi-Zamanabadi, R. (Ekstern), Blanke, M. (Intern)
Pages: 519-520
Publication date: 2009
Main Research Area: Technical/natural sciences

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FaultBuster: data driven fault detection and diagnosis for industrial systems

Efficient and reliable monitoring systems are mandatory to assure the required security standards in industrial complexes. This paper describes the recent developments of FaultBuster, a purely data-driven diagnostic system. It is designed so to be easily scalable to different monitor tasks. Multivariate statistical models based on principal components are used to detect abnormal situations. Tailored to alarms, a probabilistic inference engine process the fault evidences to output the most probable diagnosis. Results from the DX 09 Diagnostic Challenge shown strong detection properties, while further investigations of the diagnostic system are still needed.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Integra Software srl, Universita Politecnica delle Marche
Authors: Bergantino, N. (Ekstern), Caponetti, F. (Intern), Longhi, S. (Ekstern)
Pages: 46
Publication date: 2009
Fault Detection for Shipboard Monitoring – Volterra Kernel and Hammerstein Model Approaches
In this paper nonlinear fault detection for in-service monitoring and decision support systems for ships will be presented. The ship is described as a nonlinear system, and the stochastic wave elevation and the associated ship responses are conveniently modelled in frequency domain. The transformation from time domain to frequency domain has been conducted by use of Volterra theory. The paper takes as an example fault detection of a containership on which a decision support system has been installed.

Fault Monitoring and Fault Recovery Control for Position Moored Tanker
This paper addresses fault tolerant control for position mooring of a shuttle tanker operating in the North Sea. A complete framework for fault diagnosis is presented but the loss of a sub-sea mooring line buoyancy element is given particular attention, since this fault could lead to line breakage and risky abortion of an oil-loading operation. With significant drift forces from waves, non-Gaussian elements dominate in residuals and fault diagnosis need be designed using dedicated change detection for the type of distribution encountered. In addition to dedicated diagnosis, an optimal position algorithm is proposed to accommodate buoyancy element failure and keep the mooring system in a safe state. Detection properties and fault-tolerant control are demonstrated by high fidelity simulations.
Fault-tolerant 3D Mapping with Application to an Orchard Robot

In this paper we present a geometric reasoning method for dealing with noise as well as faults present in 3D depth maps. These maps are acquired using stereo-vision sensors, but our framework makes no assumption about the origin of the underlying data. The method is based on observations made on the environment from different camera poses (viewpoints), where the occupied space as well as uncertainties in the range measurement are modelled using dynamic octree structures. This scheme allows us to detect and diagnose faulty range measurements in an efficient manner. We present results on the acquisition of comprehensive 3D maps for an agricultural robot operating in an orchard.

Fault tolerant control - a residual based set-up

A new set-up for fault tolerant control (FTC) for stable systems is presented in this paper. The new set-up is based on a simple implementation of the Youla-Jabr-Bongiorno-Kucera (YJBK) parameterization. This implementation of the YJBK parameterization will allow a direct and simple reconfiguration of the feedback controller. Another central part of fault tolerant control is fault diagnosis. The controller implementation can be applied directly in connection with both passive diagnosis (PFD) as well as with active fault diagnosis (AFD). The presented FTC set-up is investigated with respect to sensor reconfiguration. Actuator reconfiguration can be dealt with in a similar way.
Fault Tolerant Software: a Multi Agent System Solution
Development of high dependable systems remains a labour intensive task. This paper explores recent advances on the adaptation of the software agent architecture for control application while looking to dependability issues. Multiple agent systems theory will be reviewed giving methods to supervise it. Software ageing is shown to be the most common problem and rejuvenation its counteract. The paper will show how an agent population can be monitored, faulty agents isolated and reloaded in a healthy state, hence rejuvenated. The aim is to propose an architecture as basis for the design of control software able to tolerate faults and residual bugs without the need of maintenance stops.

Future Challenges of the Danish Power System: Results of Ecogrid.dk - Phase 1
Eficient automated oestrus detection in cows and heifers deeply influences reproductive performance of the animals, and the livestock farmers’ protability. The main problem for practical application of automated detection is the high number generation of false-positive alerts. False alerts could be triggered by changes in feeding or heard behaviour. The detection to false alarm ratio need be very high to get farmers’ condence in an oestrus detection system. Therefore, a method to enhance detection and reduce false alarm probabilities is necessary. Earlier research investigated statistical change detection and hypothesis testing applied on activity sensor data. This paper enhances earlier method by employing fuzzy
logic technique to classify oestrus alerts from a model-based detection method utilising the cyclic nature of oestrus. Based on the distribution of the trait period since last detected oestrus, a set of membership functions is introduced with the objective of decreasing the number of false positive alerts as well as improve missed detection rate. The approach was tested on data from twelve diary cows collected over six months. The results show that the number of true detected cases decreased slightly after classification but false positive alerts were almost eliminated.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Abootorabi Zarchi, H. (Intern), Jónsson, R. I. (Intern), Blanke, M. (Intern)
Publication date: 2009

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Main Research Area: Technical/natural sciences
Conference: Advanced Control and Diagnosis, Zielona Góra, Poland, 01/01/2009
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Electronic versions:
34_ACD_2009.pdf

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Proceedings on CD-rom
Source: orbit
Source-ID: 255011
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Interconnection of subsystems in closed-loop systems
The focus in this paper is analysis of stability and controller design for interconnected systems. This includes both the case with known and unknown interconnected sub-system. The key element in both the stability analysis and controller design is the application of the Youla-Jabr-Bongiorno-Kucera (YJBK) parameterization. The dual YJBK transfer function is applied in connection with the closed-loop stability analysis. The primary YJBK parameterization is applied in connection with design of controllers. Further, it is shown how it is possible to obtain a direct estimation of a connected sub-system without having a direct access to it.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Niemann, H. H. (Intern), Poulsen, N. K. (Intern)
Pages: 632-637
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Publisher: IEEE
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controller architecture, dynamic systems, stability, interconnected systems, Linear systems
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Source: orbit
Source-ID: 256272
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009
Kalmtool used for laser scanner aided navigation in orchard
This paper concerns localisation of an autonomous tractor in an orchard environment, with the purpose of designing a localisation solution to be compared with GPS. The localisation is based on an estimate found by an extended Kalman filter, which fuses measurements from encoders and gyro with row measurements provided by a laser scanner. Kalmtool is used as a toolbox for developing the localisation algorithm. The result shows that the toolbox can be used successfully for dealing with localisation and sensor fusion.

General information
State: Published
Organisations: Automation, Department of Electrical Engineering, Automation and Control, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Mogensen, L. V. (Intern), Hansen, S. (Intern), Andersen, J. C. (Intern), Ravn, O. (Intern), Andersen, N. A. (Intern), Blanke, M. (Intern), Poulsen, N. K. (Intern)
Publication date: 2009

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Title of host publication: Proceeding of 15. IFAC Symposium on System Identification, SYSID 2009
Main Research Area: Technical/natural sciences
Conference: 15th IFAC Symposium on System Identification (SYSID 2009), Saint-Malo, France, 06/07/2009 - 06/07/2009
Bayesian Methods, Toolboxes
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Source: orbit
Source-ID: 247934
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

Landbrugsrobotter på vej

General information
State: Published
Organisations: Division of Food Production Engineering, National Food Institute, Automation and Control, Department of Electrical Engineering
Authors: Jørgensen, S. B. (ed.) (Intern), Ravn, O. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: FoodDTU Midt i Ugen
Issue number: 104
Original language: Danish
Source: orbit
Source-ID: 257847
Publication: Communication › Journal article – Annual report year: 2009

Mapping, Navigation, and Learning for Off-Road Traversal
The challenge in the DARPA Learning Applied to Ground Robots (LAGR) project is to autonomously navigate a small robot using stereo vision as the main sensor. During this project, we demonstrated a complete autonomous system for off-road navigation in unstructured environments, using stereo vision as the main sensor. The system is very robust—we can typically give it a goal position several hundred meters away and expect it to get there. In this paper we describe the main components that comprise the system, including stereo processing, obstacle and free space interpretation, long-range perception, online terrain traversability learning, visual odometry, map registration, planning, and control. At the end of 3 years, the system we developed outperformed all nine other teams in final blind tests over previously unseen terrain.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Willow Garage, SRI International
Authors: Konolige, K. (Ekstern), Agrawal, M. (Ekstern), Blas, M. R. (Intern), Bolles, R. C. (Ekstern), Gerkey, B. (Ekstern), Sola, J. (Ekstern), Sundaresan, A. (Ekstern)
Pages: 88-113
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Field Robotics
Volume: 26
MES Development Framework: Concepts, Ideas, Implementation

MES development remains primarily a labour-intensive effort, thus subject to human limitations. ISA-95 defines a modeling road map, however, engineering techniques have advanced only moderately. Inevitably, the development process introduces errors beginning in requirements formulation, continuing through product design, coding and testing. Cutting down the time between early analysis and working releases makes the adoption of an iterative development procedure possible and effective, like Unified Process. The key idea relies on the definition of a system. It should be able to use as input a MES logical model to output customized structures compliant to standards. ISA-95 defines the information organization and store NET2.0 as the application kernel while B2MML and OPC are the way to integrate into enterprises. Repetitive tasks and standardized structures are embedded in tools leading to the definition of a novel MES Development Framework, MDF. MDF empowers Visual Studio .NET with an Addin for MES definition. A custom class generator (CCG) generates from scratch to a fully customized ISA-95 compliant database and related C#.NET project in a few seconds.
Customized classes are created as a data interface and as a model of physical entities. Through the C# partial class techniques, further customisations are possible. Even if the MES is regenerated several times, any custom change will remain. MES behavior is described by a work-flow in a graphical way as a work-flow foundation project. High performance, reduced dimensions, easier maintenance and coding are the key results of the project.

**General information**
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, EmPy Studio - IT Plant Solutions
Authors: Caponetti, F. (Intern), Papaleo, M. (Ekstern)
Publication date: 2009

**Publication information**
Original language: English
Main Research Area: Technical/natural sciences
MES, development framework, .NET, ISA95, B2MML, OPC
Links:
http://www.mesa.org/conference/2009/eu/
Source: orbit
Source-ID: 253115
Publication: Research › Sound/Visual production (digital) – Annual report year: 2009

### Mission Management for Mobile Robots

**General information**
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Beck, A. B. (Intern), Andersen, N. A. (Intern), Ravn, O. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences
Mobile Robots, Hybrid control systems
Electronic versions:
Mission Management for Mobile Robots.pdf
Source: orbit
Source-ID: 250267
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2009

### Mobile Robot Navigation in a Corridor Using Visual Odometry

Incorporation of computer vision into mobile robot localization is studied in this work. It includes the generation of localization information from raw images and its fusion with the odometric pose estimation. The technique is then implemented on a small mobile robot operating in a corridor environment. A new segmented Hough transform with an improved way of discretization is used for image line extraction. The vanishing point concept is then incorporated to classify lines as well as to estimate the orientation. A method involving the iterative elimination of the outliers is employed to find both the vanishing point and the camera position. The fusion between the vision based pose estimation and the odometry is achieved with an extended Kalman filter. A distance driven error model is used for the odometry while a simple error model with constant noise is assumed for the vision. An extended Kalman filter as a parameter estimator is also applied to estimate odometry parameters. Experimental results are included. The robustness and the precision of the entire system is illustrated by performing simple navigation tasks.

**General information**
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Bayramoglu, E. (Intern), Andersen, N. A. (Intern), Poulsen, N. K. (Intern), Andersen, J. C. (Intern), Ravn, O. (Intern)
Pages: 58
Publication date: 2009

**Host publication information**
Title of host publication: Proceedings of the 14th International Conference on Advanced Robotics
Publisher: IEEE
Main Research Area: Technical/natural sciences
Conference: International Conference on Advanced Robotics, Munich, Germany, 01/01/2009
Modular playware as a playful diagnosis tool for autistic children

Based upon user-configurable modular robotics and design principles for modular playware, we developed modular robotic tiles to be used as playful, interactive tools for children with autism. The modular playware can make automatic documentation of the construction play activities by the autistic children. Using artificial neural networks for automatic classification of the individual construction practices, we may compare this classification with the diagnosis of the children, and possible obtain a supplementary diagnosis tool which is based on the autistic children's free play with the modular robotic tiles. Preliminary experiments with 7 autistic children show that the automatic neural network classification with post-processing can be done with a 100% accuracy for this small sample set, and thereby give some preliminary indications of the potential of the approach.

Modular robotics for playful physiotherapy

We developed modular robotic tiles to be used for playful physiotherapy, which is supposed to motivate patients to engage in and perform physical rehabilitation exercises. We tested the modular robotic tiles for an extensive period of time (3 years) in daily use in a hospital rehabilitation unit e.g. for cardiac patients. Also, the tiles were tested for performing physical rehabilitation of stroke patients in their private home. In all pilot test cases qualitative feedback indicate that the patients find the playful use of modular robotic tiles engaging and motivating for them to perform the rehabilitation. Also, initial pilot test data suggest that some playful exercises on the tiles demand an average heart rate of 75% and 86% of the maximum heart rate.
Modular Robotic System as Multisensory Room in Children's Hospital

We developed a system composed of different modular robotic devices, which can be used e.g. as a multi-sensory room in hospital settings. The system composed of the modular robotic devices engage the user in physical activities, and should motivate to perform physical activities by providing immediate feedback based upon physical interaction with the system. The modularity, ease of use and the functionality of the devices such as modular robotic tiles and cubic I-BLOCKS suit well into these kinds of scenarios, because they can provide feedback in terms of light, vibration, sound and possibly many other ways, since the devices are fairly generic, which means that they can be augmented with other sensors or actuators. It is therefore possible to create applications with different stimuli and to dynamically change parameters to provide immediate feedback to the users. A main finding of the tests conducted here at a children's hospital, is that it was found to be very important to create feedback that was easily recognised by the users, and it was found that the interaction was boring if the feedback was too implicit (subtle) and not well understood by the user. Instead, users appreciated explicit immediate feedback very much because it was obvious and understandable, and did not require any a priori knowledge of the application.

General information
State: Published
Organisations: Centre for Playware, Department of Electrical Engineering, Entertainment Robotics
Authors: Lund, H. H. (Intern), Henningsen, A. (Ekstern), Nielsen, R. (Ekstern)
Publication date: 2009

Modular robotic tiles: experiments for children with autism

We developed a modular robotic tile and a system composed of a number of these modular robotic tiles. The system composed of the modular robotic tiles engages the user in physical activities, e.g., physiotherapy, sports, fitness, and entertainment. The modular robotic tiles motivate the user to perform physical activities by providing immediate feedback based upon their physical interaction with the system. With the modular robotic tiles, the user is able to make new physical set-ups within less than a minute. The tiles are applicable for different forms of physical activities (e.g., therapeutic rehabilitation), and with the proper radio communication mechanism they may give unique possibilities for documentation of the physical activity (e.g., therapeutic treatment). A major point of concern in modular robotics is the connection mechanism, so we investigated different solutions for the connection between the modules, and outline their pros and cons for utilizing modules with different connection mechanisms as different kinds of playware. This kind of playware is highly motivating because of its immediate feedback and fun, interesting games.

General information
State: Published
Organisations: Centre for Playware, Department of Electrical Engineering, Center for Playware
Authors: Lund, H. H. (Intern), Dam Pedersen, M. (Ekstern), Beck, R. (Ekstern)
Pages: 394-400
Publication date: 2009
Main Research Area: Technical/natural sciences
Modular Robotic Wearable

In this concept paper we trace the contours and define a new approach to robotic systems, composed of interactive robotic modules which are somehow worn on the body. We label such a field as Modular Robotic Wearable (MRW). We describe how, by using modular robotics for creating wearable, it is possible to obtain a flexible wearable processing system, where freely inter-changeable input/output modules can be positioned on the body suit in accordance with the task at hand. We describe the first rough prototypes and show an artistic application, as well as some drawing of future works and projects. Finally, by focusing on the intersection of the combination modular robotic systems, wearability, and bodymind we attempt to explore the theoretical characteristics of such approach and exploit the possible playware application fields.
Music-Making and Musical Comprehension with Robotic Building Blocks
Being able to express oneself musically and experiment with music composition is traditionally determined by one’s ability to play an actual instrument with a certain degree of craftsmanship. Lack of skills may cause difficulties for children and young people to experience the joy of musical creativity. This paper presents a project where modular robotics is used to create a platform for creative musical expression that allows users to experiment with musical genres without any prior musical knowledge or skills. The project is an example of how to create “intelligent learning material” for educational use.

General information
State: Published
Organisations: Centre for Playware, Department of Electrical Engineering, Center for Playware
Authors: Nielsen, J. (Intern)
Pages: 399-409
Publication date: 2009

Host publication information
Title of host publication: Learning by Playing, Game-based Education System Design and Development
Volume: Volume 5670/2009
Place of publication: Berlin / Heidelberg
Publisher: Springer
ISBN (Print): 978-3-642-03363-6

Series: Lecture Notes in Computer Science
Main Research Area: Technical/natural sciences
Conference: The 4th International Conference on E-Learning and Games : Edutainment 2009, Banff, Canada, 01/01/2009
Playware
DOIs: 10.1007/978-3-642-03364-3

Oestrus Detection in Dairy Cows using Automata Modelling and Diagnosis Techniques
This paper addresses detection of oestrus in dairy cows using automata-based modelling and diagnosis. Measuring lying/standing behaviour of the cows by a sensor attached to the cows hindleg, lying/standing behaviour is modelled as a stochastic automaton. The paper introduces a cow's lying-balance as a biologically inspired quantity describing how much the cow has been resting for a preceding period. A dynamic lying-balance model is identified from real data and the lying balance is used as input, together with lying/standing sensor measurements. Using different automata models for oestrus and non-oestrus conditions, with state transition probability densities identified from observations, diagnosis theory for stochastic automata is employed to obtain diagnoses of oestrus. The oestrus cases are detected using consistency based diagnosis on real data.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Jönsson, R. I. (Intern), Caponetti, F. (Intern), Blanke, M. (Intern), Poulsen, N. K. (Intern)
Pages: 1402-1407
Publication date: 2009

Host publication information
Title of host publication: Procedings of 7. IFAC Symposium on Fault Detection, Supervision and Safety of Technical Processes
ISBN (Print): 978-3-902661-46-3
Main Research Area: Technical/natural sciences
Conference: 7th IFAC Symposium on Fault Detection, Supervision and Safety of Technical Processes, Barcelona, Spain, 30/06/2009 - 30/06/2009
Parametric Roll Resonance Detection using Phase Correlation and Log-likelihood Testing Techniques

Real-time detection of parametric roll is still an open issue that is gathering an increasing attention. A first generation warning systems, based on guidelines and polar diagrams, showed their potential to face issues like long-term prediction and risk assessment. This paper presents a second generation warning system the purpose of which is to provide the master with an onboard system able to trigger an alarm when parametric roll is likely to happen within the immediate future. A detection scheme is introduced, which is able to issue a warning within five roll periods after a resonant motion started. After having determined statistical properties of the signals at hand, a detector based on the generalised log-likelihood ratio test (GLRT) is designed to look for variation in signal power. The ability of the detector to trigger alarms when parametric roll is going to onset is evaluated on two sets of experimental data, covering both regular and irregular seas in a model basin.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Mathematical Statistics, Department of Informatics and Mathematical Modeling
Authors: Galeazzi, R. (Intern), Blanke, M. (Intern), Poulsen, N. K. (Intern)
Pages: 316-321
Publication date: 2009

Host publication information
Title of host publication: Proceedings 8. IFAC International Conference on Manoeuvring and Control of Marine Craft: MCMC'2009
Main Research Area: Technical/natural sciences
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Information systems and methods, Roll damping
DOI: 10.3182/20090916-3-BR-3001.00051

Bibliographical note
This paper received the Best Regular Paper Award at MCMC'2009

Playtesting the Digital Playground

General information
State: Published
Organisations: Centre for Playware, Department of Electrical Engineering, Center for Playware
Authors: Majgaard, G. (Ekstern), Jessen, C. (Intern)
Publication date: 2009

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Title of host publication: Proceedings of the The IADIS International Conference Games and Entertainment Technologies
Publisher: International Association for Development, IADIS
Main Research Area: Technical/natural sciences
Conference: The IADIS International Conference Games and Entertainment Technologies, 01/01/2009
Source: orbit
Source-ID: 256911
Publication: Research › Article in proceedings – Annual report year: 2009

Playware robotica modular per il gioco

General information
State: Published
Organisations: Centre for Playware, Department of Electrical Engineering
Authors: Lund, H. H. (Intern)
Reasoning about Control Situations in Power Systems

Introduction of distributed generation, deregulation and distribution of control has brought new challenges for electric power system operation, control and automation. Traditional power system models used in reasoning tasks such as intelligent control are highly dependent on the task purpose. Thus, a model for intelligent control must represent system features, so that information from measurements can be related to possible system states and to control actions. These general modeling requirements are well understood, but it is, in general, difficult to translate them into a model because of the lack of explicit principles for model construction. Available modeling concepts for intelligent control do not assist the model builder in the selection of model content i.e. in deciding what is relevant to represent for a particular reasoning task and thereby faced with a difficult interpretation problem. In this paper, we present our work on using explicit means-ends model based reasoning about complex control situations which results in maintaining consistent perspectives and selecting appropriate control action for goal driven agents.

Robust Adaptive Backstepping Control Design for a Nonlinear Hydraulic-Mechanical System

The complex dynamics that characterize hydraulic systems make it difficult for the control design to achieve prescribed goals in an efficient manner. In this paper, we present the design and analysis of a robust nonlinear controller for a nonlinear hydraulic-mechanical (NHM) system. The system consists of an electrohydraulic servo valve and two hydraulic cylinders. Specifically, by considering a part of the dynamics of the NHM system as a norm-bounded uncertainty, two adaptive controllers are developed based on the backstepping technique that ensure the tracking error signals asymptotically converge to zero despite the uncertainties in the system according to the Barbalat lemma. The resulting
controllers are able to take into account the interval uncertainties in Coulomb friction parameters and in the internal leakage parameters in the cylinders. Two adaptation laws are obtained by using the Lyapunov functional method and inequality techniques. Simulation results demonstrate the performance and feasibility of the proposed method.

**General information**
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, University of Agder
Authors: Choux, M. (Intern), Karimi, H. R. (Ekstern), Holvand, G. (Ekstern), Hansen, M. R. (Ekstern), Ottestad, M. (Ekstern), Blanke, M. (Intern)
Pages: 2460-2467
Publication date: 2009

**Host publication information**
Title of host publication: Proceedings of 48th IEEE Conference on Decision and Control
Publisher: IEEE
ISBN (Print): 978-1-4244-3871-6
Main Research Area: Technical/natural sciences
Conference: 48th IEEE Conference on Decision and Control, Shanghai, China, 01/01/2009
DOIs: 10.1109/CDC.2009.5400438
Source: orbit
Source-ID: 254262
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

**Safe and Reliable - Further Development of a Field Robot**

**General information**
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, University of Copenhagen, Hako Werke GmbH, Agrocom Vision
Authors: Griepentrog, H. W. (Ekstern), Andersen, N. A. (Intern), Andersen, J. C. (Intern), Blanke, M. (Intern), Heinemann, O. (Ekstern), Nielsen, J. (Ekstern), Pedersen, S. M. (Ekstern), Madsen, T. E. (Ekstern), Ravn, O. (Intern), Wulfsøhn, D. (Ekstern)
Pages: 857-866
Publication date: 2009

**Host publication information**
Title of host publication: Proceedings of the 7th European Conference on Precision Agriculture
Publisher: Wageningen Academic Publishers
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Main Research Area: Technical/natural sciences
Conference: European Conference on Precision Agriculture, Wageningen, The Netherlands, 01/01/2009
Source: orbit
Source-ID: 256866
Publication: Research - peer-review › Article in proceedings – Annual report year: 2009

**Stabilisation of Parametric Roll Resonance by Combined Speed and Fin Stabiliser Control**
Parametric roll resonance on a ship is a condition where large roll motion develops rapidly in moderate head or following seas. The phenomenon is caused by bifurcation in the nonlinear equations of motion when a restoring moment is subject to periodic variation. This paper analyzes the stability of the nonlinear system and suggests active control of both ship speed and fin stabilizers to stabilise the roll resonance condition. Lyapunov and backstepping designs are employed to achieve two nonlinear controllers, which are proved to stabilise the nonlinear system. The designed controllers are validated employing a high fidelity simulation model. The combined speed and fin stabiliser control is shown to efficiently drive the vessel out of the bifurcation condition and to quickly damp the residual roll motion.

**General information**
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Norwegian University of Science and Technology
Authors: Galeazzi, R. (Intern), Holden, C. (Ekstern), Blanke, M. (Intern), Fossen, T. I. (Ekstern)
Pages: 4895-4900
Publication date: 2009

**Host publication information**
Title of host publication: Proceedings of the European Control Conference 2009 : ECC 2009
Stabilization of Parametric Roll Resonance with Active U-Tanks via Lyapunov Control Design

Parametric ship roll resonance is a phenomenon where a ship can rapidly develop high roll motion while sailing in longitudinal waves. This effect can be described mathematically by periodic changes of the parameters of the equations of motion, which lead to a bifurcation. In this paper, the control design of an active u-tank stabilizer is carried out using Lyapunov theory. A nonlinear backstepping controller is developed to provide global exponential stability of roll. An extension of commonly used u-tank models is presented to account for large roll angles, and the control design is tested via simulation on a high-fidelity model of a vessel under parametric roll resonance.

Stabilization of periodic solutions in a tethered satellite system by damping injection

A spacecraft with electrodynamic tether orbiting the Earth will be subject to a periodic forcing term induced by the variation of the magnetic field along the orbit. The periodic forcing term leads to a family of unstable periodic solutions for a tether carrying a constant current. This paper presents a control design for stabilizing these periodic solutions. The design consists of a control law for stabilizing the open-loop equilibrium and a bias term which forces the system trajectory away from the equilibrium. The tether needs to be positioned away from open-loop equilibrium for the tether to affect the orbit parameters. An approximation of the periodic solutions of the closed loop system is found as a series expansion in the parameter plane spanned by the controller gain and the bias term. The stability of the solutions is investigated using linear Floquet analysis of the variational equation and the region of stable periodic solutions in the parameter plane is found.
Stabilization of Periodic Solutions in a Thedered Satellite System by Damping Injection

A spacecraft with electrodynamic tether orbiting the Earth will be subject to a periodic forcing term induced by the variation of the magnetic field along the orbit. The periodic forcing term leads to a family of unstable periodic solutions for a tether carrying a constant current. This paper presents a control design for stabilizing these periodic solutions. The design consists of a control law for stabilising the open-loop equilibrium and a bias term which forces the system trajectory away from the equilibrium. The tether needs to be positioned away from open-loop equilibrium for the tether to affect the orbit parameters. An approximation of the periodic solutions of the closed loop system is found as a series expansion in the parameter plane spanned by the controller gain and the bias term. The stability of the solutions is investigated using linear Floquet analysis of the variational equation and the region of stable periodic solutions in the parameter plane is found.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Larsen, M. B. (Intern), Blanke, M. (Intern)
Pages: 2169-2174
Publication date: 2009

Stochastic wind turbine modeling for individual pitch control
By pitching the blades of a wind turbine individually it is possible to attenuate the asymmetric loads caused by a non-uniform wind field - this is denoted individual pitch control. In this work we investigate how to set up a simplified stochastic and deterministic description of the wind and a simplified description of the aerodynamics with sufficient detail to design model-based individual pitch controllers. Combined with a simplified model of the wind turbine, we exemplify how to use the model elements to systematically design an individual pitch controller. The design is investigated in simulations.

General information
State: Published
Organisations: Mathematical Statistics, Department of Informatics and Mathematical Modeling, Automation and Control, Department of Electrical Engineering
Authors: Thomsen, S. C. (Intern), Niemann, H. H. (Intern), Poulsen, N. K. (Intern)
Publication date: 2009

Structural Analysis Extended with Active Fault Isolation - Methods and Algorithms
Isolability of faults is a key issue in fault diagnosis whether the aim is maintenance or active fault-tolerant control. It is often encountered that while faults are detectable, they are only group-wise isolable from a usual diagnostic point of view. However, active injection of test signals on system inputs can considerably enhance fault isolability. This paper investigates this possibility of active fault isolation from a structural point of view. While such extension of the structural analysis approach was suggested earlier, algorithms and case studies were needed to explore this theory. The paper develops algorithms for investigation of the possibilities of active structural isolation and it offers illustrative examples and a larger case study to explore the properties of active structural isolability ideas.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Universitat de Girona
Authors: Gelso, E. R. (Ekstern), Blanke, M. (Intern)
The development of robot art

Going through a few examples of robot artists who are recognized worldwide, we try to analyze the deepest meaning of what is called "robot art" and the related art field definition. We also try to highlight its well-marked borders, such as kinetic sculptures, kinetic art, cyber art, and cyberpunk. A brief excursion into the importance of the context, the message, and its semiotics is also provided, case by case, together with a few hints on the history of this discipline in the light of an artistic perspective. Therefore, the aim of this article is to try to summarize the main characteristics that might classify robot art as a unique and innovative discipline, and to track down some of the principles by which a robotic artifact can or cannot be considered an art piece in terms of social, cultural, and strictly artistic interest.
The Role of Modular Robotics in Mediating Nonverbal Social Exchanges

This paper outlines the use of modular robotics to encourage and facilitate nonverbal communication during therapeutic intervention in dementia care. A set of new socially interactive modular robotic devices called rolling pins (RPs) has been designed and developed to assist the therapist in interacting with dementia-affected patients. The RPs are semitransparent plastic tubes that are capable of measuring their orientation and the speed of their rotation; at a local level, they have three types of feedback: red, green, and blue light, sound, and vibration. The peculiarity of the RPs is that they are able to communicate with each other or with other devices equipped with the same radio communication technology. The RPs are usually used in pairs, as the local feedback of an RP can be set depending not only on its own speed and orientation but also on the speed and the orientation of the peer RP. The system is not used as a therapeutic tool per se but as a facilitator and a mediator of social dynamics during normal therapy to counteract social isolation that can result in dementia through the loss of social skills. An experiment is reported that shows that by using the RPs, the patients participated in the activity by coordinating their behavior with the therapist and imitating the same interaction patterns generated by the therapist.

General information
State: Published
Organisations: Centre for Playware, Department of Electrical Engineering
Authors: Marti, P. (Ekstern), Giusti, L. (Ekstern), Lund, H. H. (Intern)
Pages: 602-613
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
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Volume: 25
Issue number: 3
ISSN (Print): 1552-3098
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 3.147 SJR 1.822 CiteScore 6.07
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 1.7 SNIP 2.477 CiteScore 4.93
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.271 SNIP 2.814 CiteScore 4.86
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.632 SNIP 3.551 CiteScore 5.53
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.066 SNIP 3.626 CiteScore 5.88
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Towards a Danish power system with 50% wind: — Smart grids activities in Denmark

The new Danish Energy Strategy implies 50% wind power penetration for the Danish electric power system by 2025. Accordingly, it is the vision to develop the Danish electric power system into world's best renewable based electricity system, and many research and development activities have taken place with collaborations nationally and internationally. This paper describes the research activities in relation to implementation of renewable energy targets set out by the Danish Energy Strategy and initiatives of the EcoGrid.dk program to facilitate this process. Based on the analysis and evaluation of research needs and related research activities, the remaining gaps are identified for future activities to support a transition into sustainable energy networks.
Towards a modern concept for teaching control engineering

A new concept for teaching an introduction course in control engineering is described. The main issue is that the concept is based directly on the students' knowledge from previous courses in math, physics and electronics. This will provide the students with a more direct and clear link between these previous courses and the introduction course in control theory.

As a direct consequence, it is now possible to introduce and use feedback control from the first lecture. The new teaching concept has had a major effect on the exam results. In the two semesters before the changes, only 53% of the students passed the course. In the first two semesters after the changes, 86% of the students passed the course.

High Performance Low Cost Digitally Controlled Power Conversion Technology

Digital control of switch-mode power supplies and converters has within the last decade evolved from being an academic subject to an emerging market in the power electronics industry. This development has been pushed mainly by the computer industry that is looking towards digital power management in order to reduce the power consumption of servers and datacenters. The work presented in this thesis includes digital control methods for switch-mode converters implemented in microcontrollers, digital signal controllers and field programmable gate arrays. Microcontrollers are cheap devices that can be used for real-time control of switch-mode converters. Software design in the assembly language of the microcontroller is important because of the limited resources of the microcontroller. Microcontrollers are best suited for power electronics applications with low bandwidth requirements because the execution time of the software algorithm that realises the digital control law will constitute a considerable delay in the control loop. Digital signal controllers are powerful devices capable of performing arithmetic functions much faster than a microcontroller can. Digital signal controllers are well suited for digital control schemes involving multiple control loops such as digital control of a switch-mode power supply with several converter stages. Customised digital control solutions implemented in application specific integrated circuits are the best solution for high bandwidth digital control of non-isolated DC-DC converters. A customised digital control solution for a voltage mode control scheme should include a digital pulse width modulator which can generate a pulse width modulated signal with high switching frequency and high resolution, a digital compensator with a short execution time and an analogue to digital converter with a short sampling time. A digital self-oscillating modulator is proposed in the present thesis. The modulator is a free-running modulator which operates without an external carrier signal. Customised digital control solutions offers the best performance for non-isolated DC-DC converters. The best digital control solution presented in this thesis, which was implemented with the digital self-oscillating modulator, performs comparable to common analogue control IC solutions. It is however possible to achieve an even better performance with an analogue control circuit built with separate analogue components.
Stability Analysis of the Parametric Roll Resonance under Non-constant Ship Speed

The aim of this work is to analyze the influence of a nonconstant ship speed on the onset and development of the parametric roll resonance. A 2-DOF nonlinear surge-roll model is set up and analyzed. Perturbation methods are also applied to evaluate the influence of dynamic variations of surge velocity on the onset of parametric roll. The theoretical results are illustrated and validated using a 4-DOF hydrodynamic and control theory model.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Coastal, Maritime and Structural Engineering, Department of Mechanical Engineering
Authors: Galeazzi, R. (Intern), Vidic-Perunovic, J. (Intern), Blanke, M. (Intern), Jensen, J. J. (Intern)
Publication date: 2008

Context-Aware user interfaces in automation

Automation is deployed in a great range of different domains such as the chemical industry, the production of consumer goods, the production of energy (both in terms of power plants and in the petrochemical industry), transportation and several others. Through several decades the complexity of automation systems and the level of automation have been rising. This has caused problems regarding the operator's ability to comprehend the overall situation and state of the automation system, in particular in abnormal situations. The amount of data available to the operator results in information overload. Because the notion of what information is relevant continually changes, the suggestion is to develop context-aware systems that can assist the operator. In order to create a context-aware system we must first examine what context is, and what kinds of data we should consider constituting the context. Since context-aware applications have been developed in other research areas it seems natural to analyze the findings of this research and examine how this can be applied to the domain of automation systems. By evaluating existing architectures for the development of context-aware applications we find that some important differences exist between the notion of context in these systems and in the automation domain. We find important differences in the needs for information between the control room operators and field operators in complex automation systems, and the need for the field operator to be present at various locations in the facility suggests the use of wireless mobile devices. We present a number of applications where a wireless mobile device can provide the field operator with great benefits, both in terms of information and interaction. The use of mobile devices presents a number of limitations in terms of input and output capabilities, which make the use or context-aware computing even more relevant in this case. Different types of mobile devices are discussed. The use of a positioning system for locating the field operator and inferring his tasks and intentions from the location is proposed. In combination with other types of context information this allows the system to present a usable interface on the mobile device. An architecture for processing context information in the automation domain is presented and two cases are used to support the applicability of the architecture. The use of context-awareness in automation is found to provide several benefits, in particular in applications for field operators.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Image Analysis and Computer Graphics, Department of Informatics and Mathematical Modeling
Authors: Olsen, M. H. (Intern), Lind, M. (Intern), Ravn, O. (Intern), Rose, M. (Intern)
Number of pages: 139
Publication date: Mar 2007

Publication information
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Main Research Area: Technical/natural sciences
Electronic versions:
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Mobile Robot Navigation

Abstract Robots will soon take part in everyone's daily life. In industrial production this has been the case for many years, but up to now the use of mobile robots has been limited to a few and isolated applications like lawn mowing, surveillance, agricultural production and military applications. The research is now progressing towards autonomous robots which will be able to assist us in our daily life. One of the enabling technologies is navigation, and navigation is the subject of this thesis. Navigation of an autonomous robot is concerned with the ability of the robot to direct itself from the current position to a desired destination. This thesis presents and experimentally validates solutions for road classification, obstacle avoidance and mission execution. The road classification is based on laser scanner measurements and supported at longer ranges by vision. The road classification is sufficiently sensitive to separate the road from flat roadsides, and to distinguish asphalt roads from gravelled roads. The vision-based road detection uses a combination of chromaticity and edge detection to outline the traversable part of the road based on a laser scanner classified sample area. The perception of these two sensors are utilised by a path planner to allow a number of drive modes, and especially the ability to follow road edges are investigated. The navigation mission is controlled by a script language. The navigation script controls route sequencing, junction detection, junction crossing calculations and drive mode selection. The entire system is tested on a combination of narrow asphalt and gravelled roads connected by a number of junctions. Missions of up to 3km in length have been successfully completed using the described system. The main focus of the thesis has been the experimental validation of the implemented solutions and the ability of the methods to solve real world problems. The amount of software needed by an autonomous robot can be overwhelming. Software reuse and distributed development are therefore important issues. The thesis describes a new component architecture for robotics software that promotes software reuse and distributed development and maintenance.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Andersen, J. C. (Intern), Ravn, O. (Intern), Andersen, N. A. (Intern)
Publication date: Jan 2007

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Original language: English
Main Research Area: Technical/natural sciences
Electronic versions: oersted-du2868.pdf
Source: orbit
Source-ID: 193297
Publication: Research › Ph.D. thesis – Annual report year: 2007

A Unified Approach to Controllability Analysis for Hybrid Control Systems

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Aalborg University
Authors: Yang, Z. (Ekstern), Blanke, M. (Intern)
Pages: 212 - 222
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Nonlinear Analysis: Hybrid Systems
Volume: 1
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Scopus rating (2017): SNIP 1.661 SJR 1.82 CiteScore 4.36
Web of Science (2017): Indexed Yes
Scopus rating (2016): SJR 1.556 SNIP 1.598 CiteScore 3.91
Scopus rating (2015): SJR 1.856 SNIP 1.699 CiteScore 3.61
Scopus rating (2014): SJR 1.397 SNIP 1.747 CiteScore 3.08
Scopus rating (2013): SJR 1.169 SNIP 1.756 CiteScore 2.53
Interpreting laser data to allow autonomous robot navigation on paved as well as dirt roads using a fixed angle 2D laser scanner is a daunting task. This paper introduces an algorithm for terrain classification that fuses seven distinctly different classifiers: raw height, roughness, step size, curvature, slope, width and invalid data. These are then used to extract road borders, traversable terrain and identify obstacles. Experimental results are shown and discussed. The results were obtained using a DTU developed mobile robot, and the autonomous tests were conducted in a national park environment.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Technical University of Denmark
Authors: Andersen, J. C. (Intern), Blas, M. R. (Ekstern), Andersen, N. A. (Intern), Ravn, O. (Intern), Blanke, M. (Intern)
Pages: 223-232
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Integrated Computer-Aided Engineering
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BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.263 SJR 0.665 CiteScore 3.66
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.02 SJR 1.271 SNIP 1.406
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.944 SNIP 1.377 CiteScore 4.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.929 SNIP 1.314 CiteScore 2.93
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.081 SNIP 1.617 CiteScore 3.73
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.9 SNIP 1.224 CiteScore 2.85
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.647 SNIP 1.425 CiteScore 2.69
ISI indexed (2011): ISI indexed yes
**Design of Process Displays based on Risk Analysis Techniques**

This thesis deals with the problems of designing display systems for process plants. We state the reasons why it is important to discuss information systems for operators in a control room, especially in view of the enormous amount of information available in computer-based supervision systems. The state of the art is discussed: How are supervision systems designed today and why? Which strategies are used? What kind of research is going on? Four different plants and their display systems, designed by the author, are described and discussed. Next we outline different methods for eliciting knowledge of a plant, particularly the risks, which is necessary information for the display designer. A chapter presents an overview of the various types of operation references: constitutive equations, set points, design parameters, component characteristics etc., and their validity in different situations. On the basis of her experience with the design of display systems; with risk analysis methods and from 8 years, as an engineer-on-shift at a research reactor, the author developed a method to elicit necessary information to the operator. The method, a combination of a Goal-Tree and a Fault-Tree, is described in some detail. Finally we address the problem of where to put the dot and the lines: when all information is 'on the table', how should it be presented most adequately. Included, as an appendix is a paper concerning the analysis of maintenance reports and visualization of their information. The purpose was to develop a software tool for maintenance supervision of components in a nuclear power plant.

**General information**

State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Paulsen, J. L. (Intern), Lind, M. (Intern)
Number of pages: 144
Publication date: Feb 2005
A fault tolerant control approach for descriptor systems

Fault tolerant control (FTC) of descriptor systems is considered in this paper. A general FTC architecture for descriptor systems is proposed.

Autonomous Robot Navigation In Public Nature Park

This extended abstract describes a project to make a robot travel autonomously across a public nature park. The challenge is to detect and follow the right path across junctions and open squares avoiding people and obstacles. The robot is equipped with a laser scanner, a (low accuracy) GPS, wheel odometry and a rate gyro. The initial results shows that this configuration is (almost) sufficient to traverse the park, when following simple preplanned guidelines. This paper describes the decisions and solutions, results so far, and expected further development.
Compact and Accurate Turbocharger Modelling for Engine Control

With the current trend towards engine downsizing, the use of turbochargers to obtain extra engine power has become common. A great difficulty in the use of turbochargers is in the modelling of the compressor map. In general this is done by inserting the compressor map directly into the engine ECU (Engine Control Unit) as a table. This method uses a great deal of memory space and often requires on-line interpolation and thus a large amount of CPU time. In this paper a more compact, accurate and rapid method of dealing with the compressor modelling problem is presented and is applicable to all turbocharges with radial compressors for either Spark Ignition (SI) or diesel engines.

Modeling Goals and Functions of Control and Safety Systems in (MFM)

Pay-load Estimation of a 2 DOF Flexible Link Robot

The paper presents a new method for online identification of pay-loads for a two-link flexible robot. The method benefits from the close correspondence between parameters of a discrete-time model represented by means of the Delta-Operator, and those of the underlying continuous-time model. Although the applied principle might be general in nature, the paper is applied to the well-known problem of identifying a pay-load of a moving flexible robot. This problem is almost impossible to solve by measurements, so an estimation technique must be applied. The presented method benefits from the close correspondence with the continuous-time representation to allow a scalar and implicit adaptive technique which based on flexibility measurements leads to the online estimation of the pay-load.
Terrain Classification for Outdoor Autonomous Robots using 2D Laser Scans.: Robot perception for dirt road navigation

Interpreting laser data to allow autonomous robot navigation on paved as well as dirt roads using a fixed angle 2D laser scanner is a daunting task. This paper introduces an algorithm for terrain classification that fuses four distinctly different classifiers: raw height, step size, slope, and roughness. Input is a single 2D laser scan and output is a classification of each laser scan range reading. The range readings are classified as either returning from an obstacle (not traversable) or from traversable ground. Experimental results are shown and discussed from the implementation done with a department developed Medium Mobile Robot and tests conducted in a national park environment.

Description of composite actions - Towards a formalization of safety functions

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Authors: Lind, M. (Intern)
Publication date: 2004

Publication information
Place of publication: DK- Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 182976
Publication: Research › Report – Annual report year: 2004
Fault tolerant controllers for sampled-data systems

A general compensator architecture for fault tolerant control (FTC) for sampled-data systems is proposed. The architecture is based on the YJBK parameterization of all stabilizing controllers, and uses the dual YJBK parameterization to quantify the performance of the fault tolerant system. The FTC architecture is based on a discrete-time nominal feedback controller and with the FTC part also in discrete-time. Further, a number of problems for the design of the controller reconfiguration part in the FTC architecture is considered. It is shown how these design problems can be transformed into standard design problems for feedback controllers.

Loss optimizing low power 50 Hz transformers intended for AC/DC standby power supplies

This paper presents the measured efficiency on selected low power conventional 50 Hz/230 V-AC transformers. The small transformers are intended for use in 1 W@5 V-DC series- or buck-regulated power supplies for standby purposes. The measured efficiency is compared for cheap off-the-self transformer and for some which are optimized for a lower no-load loss. The optimization is done by simple and low cost means.
Optimizing efficiency on conventional transformer based low power AC/DC standby power supplies
This article describes the research results for simple and cheap methods to reduce the idle- and load-losses in very low power conventional transformer based power supplies intended for standby usage. In this case "very low power" means 50 Hz/230 V-AC to 5 V-DC@1 W. The efficiency is measured on two common power supply topologies designed for this power level. The two described topologies uses either a series (or linear) or a buck regulation approach. Common to the test power supplies is they either are using a standard cheap off-the-shelf transformer, or one, which are loss optimized by very simple means.

Analysis and design of controllers for a double inverted pendulum
A physical control problem is studied with the μ methodology. The issues of modelling, uncertainty modelling, performance specification, controller design and laboratory implementation are discussed. The laboratory experiment is a double inverted pendulum placed on a cart. The limitations in the system with respect to performance are the limitation in the control signal and the limitation of the movement of the chart. It is shown how these performance limitation will effect the design of a μ controller for the system.
Making Sense of the Abstraction Hierarchy in the Power Plant Domain

The paper discusses the abstraction hierarchy proposed by Rasmussen [(1986) Information processing and human-machine interaction, North-Holland] for design of human-machine interfaces for supervisory control. The purpose of the abstraction hierarchy is to represent a work domain by multiple levels of means-end and part-whole abstractions. It is argued in the paper that the abstraction hierarchy suffers from both methodological and conceptual problems. A cluster of selected problems are analyzed and illustrated by concrete examples from the power plant domain. It is concluded that the semantics of the means-end levels and their relations are vaguely defined and therefore should be improved by making more precise distinctions. Furthermore, the commitment to a fixed number of levels of means-end abstractions should be abandoned and more attention given to the problem of level identification in the model-building process. It is also pointed out that attempts to clarify the semantics of the abstraction hierarchy will invariably reduce the range of work domains where it can be applied.

General information
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Organisations: Automation and Control, Department of Electrical Engineering
Authors: Lind, M. (Intern)
Pages: 67-81
Publication date: 2003
Main Research Area: Technical/natural sciences

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Journal: Cognition, Technology and Work
Volume: 5
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.179 SJR 0.641 CiteScore 1.66
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.48 SNIP 0.953 CiteScore 1.18
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.459 SNIP 0.85 CiteScore 1.14
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.648 SNIP 1.653 CiteScore 1.67
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.542 SNIP 1.577 CiteScore 1.53
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.396 SNIP 1.156 CiteScore 0.83
The Internal Combustion Engine Modelling: Modelling, Estimation and Control Issues

General information
State: Published
Organisations: Department of Electrical Engineering, Fluid Mechanics, Department of Mechanical Engineering, Automation and Control
Authors: Vigild, C. W. (Intern), Sorenson, S. C. (Intern), Hendricks, E. (Intern), Sorenson, S. C. (Intern)
Publication date: Aug 2002

Publication information
ISBN (Print): 87-87950-90-1
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:

Bibliographical note
Project title: Robust control of non-linear systems
Source: orbit
Source-ID: 60520
Publication: Research › peer-review › Journal article – Annual report year: 2003

Mathematical Ship Modeling for Control Applications.
In this report, we review the models for describing the motion of a ship in four degrees of freedom suitable for control applications. We present the hydrodynamic models of two ships: a container and a multi-role naval vessel. The models are based on experimental results in the four degrees of freedom roll planar motion mechanism (RPMM) facility at the Danish Maritime Institute, and have also been validated via extensive full scale trials. Based on the RPMM hydrodynamic models, we also present non-linear and linearized state space models suitable for simulation and control applications. Finally, we evaluate the quality of the linearized models with respect to their nonlinear counterparts and analyze sensitivity to parameter variations.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, University of Newcastle
Authors: Perez, T. (Ekstern), Blanke, M. (Intern)
Number of pages: 22
Publication date: 2002
An ultra low-power off-line APDM-based switchmode power supply with very high conversion efficiency

This article describes the results from the research work on design of a ultra low power off-line power supply with very high conversion efficiency. The input voltage is 230 VAC nominal and output voltage is 5 VDC. By ultra low power levels, an output power level in the area ranging from 50 mW and up to 1000 mW is meant. The small power supply is intended for use as a standby power supply in mains operated equipment, which requires a small amount of power in standby mode.

Fault diagnosis for non-minimum phase systems using $\mathcal{H}_\infty$ optimization

The analysis and design algorithms for residual generators for nonminimum phase systems are given. It is shown that the $\mathcal{H}_\infty$ optimization of residual generators applied directly to systems including nonminimum phase zeros can be very conservative. To remove this conservatism in the $\mathcal{H}_\infty$ optimization of the residual generators, a factorization of the nonminimum phase system into a minimum phase part and an all-pass factor including the nonminimum phase zeros can be applied. The optimization of the residual generator can then be done with respect to the minimum phase part of the system only. It is shown that the effect from the all-pass factor will not affect the 2-norm of the residual vector.
NNSYSID and NNCTRL Tools for system identification and control with neural networks

Two toolsets for use with MATLAB have been developed: the neural network based system identification toolbox (NNSYSID) and the neural network based control system design toolkit (NNCTRL). The NNSYSID toolbox has been designed to assist identification of nonlinear dynamic systems. It contains a number of nonlinear model structures based on neural networks, effective training algorithms and tools for model validation and model structure selection. The NNCTRL toolkit is an add-on to NNSYSID and provides tools for design and simulation of control systems based on neural networks. The user can choose among several designs such as direct inverse control, internal model control, nonlinear feedforward, feedback linearisation, optimal control, gain scheduling based on instantaneous linearisation of neural network models and nonlinear model predictive control. This article gives an overview of the design of NNSYSID and NNCTRL.
Pay-load estimation of a 2DOF flexible link robot using a delta-operator technique

The paper presents a new method for online identification of pay-loads for a two-link flexible robot. The method benefits from the close correspondence between parameters of a discrete-time model represented by means of the Delta-Operator, and those of the underlying continuous-time model. Although the applied principle might be general in nature, the paper is applied to the well-known problem of identifying a pay-load of a moving flexible robot. This problem is almost impossible to solve by measurements, so an estimation technique must be applied. The presented method benefits from the close correspondence with the continuous-time representation to allow a scalar and implicit adaptive technique which based on flexibility measurements leads to the online estimation of the pay-load.

Design of fault detectors using $H_\infty$ optimization

The problem of detecting and/or isolating faults in dynamical systems is assessed. In contrast to previous approaches, the residual vector is considered to be a design variable as a free transfer function in addition to the actual filter which is supposed to minimize the residual. Some main directions are suggested, and a numerical algorithm implementing part of these is proposed.
Dynamic Model for Thrust Generation of Marine Propellers

Mathematical models of propeller thrust and torque are traditionally based on steady state thrust and torque characteristics obtained in model basin or cavitation tunnel tests. Experimental results showed that these quasi steady state models do not accurately describe the transient phenomena in a thruster. A recently published dynamic model was based on the experimental observations. Describing zero advance speed conditions accurately, this model, however, does not work for a vessel at non-zero relative water speed. This paper derives a large signal dynamic model of propeller that includes the effects of transients in the flow over a wide range of operation. The results are essential for accurate thrust control in dynamic positioning and in underwater robotics.

Knowledge Based Support for Situation Assessment in Human Supervisory Control

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Petersen, J. (Intern), Lind, M. (Intern)
Publication date: 2000

Publication information
Place of publication: Lyngby, Denmark
Publisher: Technical University of Denmark: Ørsted-DTU, Automation
ISBN (Print): 87-87950-84-7
Original language: English
Tuning controllers using the dual Youla parameterization
This paper describes the application of the Youla parameterization of all stabilizing controllers and the dual Youla parameterization of all systems stabilized by a given controller in connection with tuning of controllers. In the uncertain case, it is shown that the use of the Youla parameterization will allow us to optimize both the model and the controller.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Aalborg University
Authors: Niemann, H. H. (Intern), Stoustrup, J. (Ekstern)
Pages: 1337-1338
Publication date: 2000

An architecture for implementation of multivariable controllers
This paper appears in: American Control Conference, 1999. Proceedings of the 1999 Issue Date: 1999 Volume: 6 On page(s): 4029 - 4033 vol.6 Location: San Diego, CA Meeting Date : 02 Jun 1999-04 Jun 1999 Print ISBN: 0-7803-4990-3 References Cited: 7 INSPEC Accession Number: 6403075 Digital Object Identifier : 10.1109/ACC.1999.786292 Date of Current Version : 06 august 2002 Abstract An architecture for implementation of multivariable controllers is presented in this paper. The architecture is based on the Youla-Jabr-Bongiorno-Kucera parameterization of all stabilizing controllers. By using this architecture for implementation of multivariable controllers, it is shown how it is possible to change from one multivariable controller to another multivariable controller online in a smooth way with guarantee for closed loop stability. This includes also the case where the controllers are unstable. Gain scheduled controllers can be implemented in this architecture. The general architecture for smooth online changes of multivariable controllers can also handle the start up and close down of multivariable systems. Furthermore, the start up of unstable multivariable controllers can also be handled in this architecture. Finally, implementation of (unstable) controllers as a stable Q parameter in a Q-parameterized controller can also be achieved.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Aalborg University
Authors: Niemann, H. H. (Intern), Stoustrup, J. (Ekstern)
Pages: 4029-4033
Publication date: 1999

Host publication information
Title of host publication: Proceedings of the American Control Conference
Conceptual Design of Industrial Process Displays

Today, process displays used in industry are often designed on the basis of piping and instrumentation diagrams without any method of ensuring that the needs of the operators are fulfilled. Therefore, a method for a systematic approach to the design of process displays is needed. This paper discusses aspects of process display design taking into account both the designer's and the operator's points of view. Three aspects are emphasized: the operator tasks, the display content and the display form. The distinction between these three aspects is the basis for proposing an outline for a display design method that matches the industrial practice of modular plant design and satisfies the needs of reusability of display design solutions. The main considerations in display design in the industry are to specify the operator's activities in detail, to extract the information the operators need from the plant design specification and documentation, and finally to present this information. The form of the display is selected from existing standardized display elements such as trend curves, mimic diagrams, ecological interfaces, etc. Further knowledge is required to invent new display elements. That is, knowledge about basic visual means of presenting information and how humans perceive and interpret these means and combinations. This knowledge is required in the systematic selection of graphical items for a given display content. The industrial part of the method is first illustrated in the paper by a simple example from a plant with batch processes. Later the method is applied to develop a supervisory display for a condenser system in a nuclear power plant. The differences between the continuous plant domain of power production and the batch processes from the example are analysed and broad categories of display types are proposed. The problems involved in specification and invention of a supervisory display are analysed and conclusions from these problems are made. It is concluded that the design method proposed provides a framework for the progress of the display design and is useful in pin-pointing the actual problems. The method was useful in reducing the number of existing displays that could fulfill the requirements of the supervision task. The method provided at the same time a framework for dealing with the problems involved in inventing new displays based on structured analysis. However the problems in a systematic approach to display invention still need consideration.
Exact, almost and delayed fault detection: an observer based approach

Considers the problem of fault detection and isolation while using zero or almost zero threshold. A number of different fault detection and isolation problems using exact or almost exact disturbance decoupling are formulated. Solvability conditions are given for the formulated design problems. The l-step delayed fault detection problem is also considered for discrete-time systems.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Washington State University, Eindhoven University of Technology, Rutgers University
Authors: Niemann, H. H. (Intern), Saberi, A. (Ekstern), Stoorvogel, A. A. (Ekstern), Sannuti, P. (Ekstern)
Pages: 99-103
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ISBN (Print): 0-7803-4990-3
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Conference: American Control Conference 1999, San Diego, CA, United States, 02/06/1999 - 02/06/1999
Electronic versions: Saberi.pdf
DOIs:
Plant Modeling for Human Supervisory Control

This paper provides an overview of multilevel flow modeling (MFM) and its application for design of displays for the supervisory control of industrial plant. The problem of designing the information content of supervisory displays is discussed and plant representations like MFM using levels of means-end and part-whole abstractions are proposed as a solution to this design problem. The basic concepts of MFM are explained and its use in reasoning about means and ends, and part and whole in diagnosis are illustrated in detail by way of an example. A deeper elaboration of the semantics of MFM is also provided by an analysis of the relations between levels of abstraction. It is also described how MFM supports reasoning about control actions by defining levels of intervention and by modal distinctions between function enablement and initiation.
In many practical systems there is a delay in some of the sensor devices, for instance vision measurements that may have a long processing time. How to fuse these measurements in a Kalman filter is not a trivial problem if the computational delay is critical. Depending on how much time there is at hand, the designer has to make trade-offs between optimality and computational burden of the filter. In this paper various methods in the literature along with a new method proposed by the authors will be presented and compared. The new method is based on “extrapolating” the measurement to present time using past and present estimates of the Kalman filter and calculating an optimal gain for this extrapolated measurement.
Location Estimation using Delayed Measurements

When combining data from various sensors it is vital to acknowledge possible measurement delays. Furthermore, the sensor fusion algorithm, often a Kalman filter, should be modified in order to handle the delay. The paper examines different possibilities for handling delays and applies a new technique to a sensor fusion system for estimating the location of an autonomous guided vehicle. The system fuses encoder and vision measurements in an extended Kalman filter. Results from experiments in a real environment are reported.

General information
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Organisations: Department of Automation, Department of Informatics and Mathematical Modeling, Automation and Control, Department of Electrical Engineering, Mathematical Statistics
Authors: Bak, M. (Intern), Larsen, T. D. (Intern), Nørgård, P. M. (Intern), Andersen, N. A. (Intern), Poulsen, N. K. (Intern), Ravn, O. (Intern)
Pages: 180-185
Publication date: 1998

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Title of host publication: Advanced Motion Control, 1998. AMC '98-Coimbra., 1998 5th International Workshop on
Publisher: IEEE
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Main Research Area: Technical/natural sciences
Conference: International Workshop on Advanced Motion Control, AMC '98, Coimbra, Portugal, 01/01/1998

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Source: orbit
Source-ID: 171857
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

Static Decoupling in fault detection

An algebraic approach is given for a design of a static residual weighting factor in connection with fault detection. A complete parameterization is given of the weighting factor which will minimize a given performance index.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Niemann, H. H. (Intern)
Pages: 1131-1136
Publication date: 1998

Host publication information
Title of host publication: Decision and Control, 1998. Proceedings of the 37th IEEE Conference on
Volume: 1
Publisher: IEEE
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Main Research Area: Technical/natural sciences

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Copyright: 1998 IEEE. Personal use of this material is permitted. However, permission to reprint/republish this material for advertising or promotional purposes or for creating new collective works for resale or redistribution to servers or lists, or to reuse any copyrighted component of this work in other works must be obtained from the IEEE
Source: orbit
Source-ID: 170984
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998
Robust fault detection in open loop vs. closed loop
The robustness aspects of fault detection and isolation (FDI) for uncertain systems are considered. The FDI problem is considered in a standard problem formulation. The FDI design problem is analyzed both in the case where the control input signal is considered as a known external input signal (open loop) and when the input signal is generated by a feedback controller.

General information
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Organisations: Automation and Control, Department of Electrical Engineering, Aalborg University
Authors: Niemann, H. H. (Intern), Stoustrup, J. (Ekstern)
Pages: 4496 - 4497
Publication date: 1997
Conference: 36th IEEE Conference on Decision and Control, San Diego, CA, United States, 10/12/1997 - 10/12/1997
Main Research Area: Technical/natural sciences

Publication information
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Volume: 5
Original language: English
Electronic versions:
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DOIs:
10.1109/CDC.1997.649678

Bibliographical note
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Source: orbit
Source-ID: 168484
**The Emergence of Levels of Abstraction in Complex Systems**

**General information**
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Lind, M. (Intern)
Pages: 96-107
Publication date: 1997
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Culture & History
Volume: 15
ISSN (Print): 0902-7521
Ratings:
BFI (2018): BFI-level 2
BFI (2017): BFI-level 2
BFI (2016): BFI-level 2
BFI (2015): BFI-level 2
BFI (2014): BFI-level 2
BFI (2013): BFI-level 2
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 2
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 2
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 2
BFI (2009): BFI-level 2
BFI (2008): BFI-level 1
Original language: English
Source: orbit
Source-ID: 182942

**μ-synthesis for the coupled mass benchmark problem**
A robust controller design for the coupled mass benchmark problem is presented in this paper. The applied design method is based on a modified D-K iteration, i.e. μ-synthesis which take care of mixed real and complex perturbations sets. This μ-synthesis method for mixed perturbation sets is a straightforward extension of the standard D-K iteration for complex perturbation sets

**General information**
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Niemann, H. H. (Intern), Stoustrup, J. (Ekstern), Tøffner-Clausen, S. (Ekstern), Andersen, P. (Ekstern)
Pages: 2611-2615
Publication date: 1997

**Host publication information**
Publisher: IEEE
ISBN (Print): 0-7803-3832-4
Main Research Area: Technical/natural sciences
Conference: 1997 American Control Conference, Albuquerque, NM, United States, 04/06/1997 - 04/06/1997
Electronic versions:
Niemann.pdf
DOIs:
10.1109/ACC.1997.609270
Status and Challenges of Intelligent Plant Control

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Lind, M. (Intern)
Pages: 23-41
Publication date: 1996
Main Research Area: Technical/natural sciences

Publication information
Journal: Annual Reviews in Control
Volume: 20
ISSN (Print): 1367-5788
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.457 SJR 0.824 CiteScore 2.87
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.04 SNIP 2.214 CiteScore 3.52
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.157 SNIP 5.005 CiteScore 5.65
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.019 SNIP 3.655 CiteScore 4.63
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.157 SNIP 3.704 CiteScore 3.99
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.177 SNIP 3.404 CiteScore 3.66
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.984 SNIP 4.958 CiteScore 4.06
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.07 SNIP 4.07
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.817 SNIP 2.347
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.11 SNIP 2.745
Scopus rating (2007): SJR 0.781 SNIP 2.092
Scopus rating (2006): SJR 0.737 SNIP 1.286
Scopus rating (2005): SJR 0.452 SNIP 1.367
Scopus rating (2004): SJR 0.329 SNIP 1.226
Scopus rating (2003): SJR 0.767 SNIP 1.032
Scopus rating (2002): SJR 0.386 SNIP 0.913
An Introduction to the special issue on loop transfer recovery

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Niemann, H. H. (Intern)
Pages: 611-613
Publication date: 1995
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Robust and Nonlinear Control
Volume: 5
ISSN (Print): 1049-8923
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.942 SJR 2.028 CiteScore 4.26
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.57 SJR 1.772 SNIP 1.687
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.992 SNIP 1.698 CiteScore 3.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.037 SNIP 1.911 CiteScore 3.51
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.86 SNIP 1.91 CiteScore 3.41
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.685 SNIP 1.791 CiteScore 2.83
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.77 SNIP 1.769 CiteScore 2.41
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.519 SNIP 1.486
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.061 SNIP 2.065
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.659 SNIP 1.398
Scopus rating (2007): SJR 1.254 SNIP 1.145
Scopus rating (2006): SJR 1.528 SNIP 1.358
Scopus rating (2005): SJR 0.652 SNIP 0.946
Scopus rating (2004): SJR 0.905 SNIP 1.221
LTR Design of proportional integral observers

This paper applies the proportional-integral (PI) observer in connection with loop transfer recovery (LTR) design for continuous-time systems. We show that a PI observer makes it possible to obtain time recovery, i.e., exact recovery for $t-\to t+$, under mild conditions. Based on an extension of the LQG/LTR method of proportional (P) observers, a systematic LTR design method is derived for the PI observer. Our recovery design method allows time recovery and frequency (normal) recovery to be done independently. Furthermore, we give explicit expressions for the recovery error when asymptotic recovery cannot be obtained. A design example demonstrates the advantages of time recovery in the nonminimum phase case.
LTR design of proportional-integral observers

This paper applies the proportional-integral (PI) observer in connection with loop transfer recovery (LTR) design for continuous-time systems. We show that a PI observer makes it possible to obtain time recovery, i.e., exact recovery for $t-\infty$, under mild conditions. Based on an extension of the LQG/LTR method of proportional (P) observers, a systematic LTR design method is derived for the PI observer. Our recovery design method allows time recovery and frequency (normal) recovery to be done independently. Furthermore, we give explicit expressions for the recovery error when asymptotic recovery cannot be obtained. A design example demonstrates the advantages of time recovery in the nonminimum phase case.

General information

State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Northeastern University
Authors: Niemann, H. H. (Intern), Stoustrup, J. (Intern), Shafai, B. (Ekstern), Beale, S. (Ekstern)
Pages: 671-693
Publication date: 1995
Main Research Area: Technical/natural sciences

Publication information

Journal: International Journal of Robust and Nonlinear Control
Volume: 5
ISSN (Print): 1049-8923
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.942 SJR 2.028 CiteScore 4.26
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.57 SJR 1.772 SNIP 1.687
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.992 SNIP 1.698 CiteScore 3.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.037 SNIP 1.911 CiteScore 3.51
Web of Science (2014): Indexed yes
Robust Performance of Systems with Structured Uncertainties in State Space

This paper considers robust performance analysis and state feedback design for systems with time-varying parameter uncertainties. The notion of a strongly robust % performance criterion is introduced, and its applications in robust performance analysis and synthesis for nominally linear systems with time-varying uncertainties are discussed and compared with the constant scaled small gain criterion. It is shown that most robust performance analysis and synthesis problems under this strongly robust % performance criterion can be transformed into linear matrix inequality problems, and can be solved through finite-dimensional convex programming. The results are in general less conservative than those using small gain type criteria.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, Louisiana State University, University of Michigan
Authors: Zhou, K. (Ekstern), Khargonekar, P. P. (Ekstern), Stoustrup, J. (Intern), Niemann, H. H. (Intern)
Pages: 249-255
Publication date: 1995
Main Research Area: Technical/natural sciences

Publication information
Journal: Automatica
Volume: 31
Issue number: 2
ISSN (Print): 0005-1098
Ratings:
BFI (2018): BFI-level 2
General predictive control using the delta operator

This paper deals with two-discrete-time operators, the conventional forward shift-operator and the δ-operator. Both operators are treated in view of construction of suitable solutions to the Diophantine equation for the purpose of prediction. A general step-recursive scheme is presented. Finally a general predictive control (GPC) is formulated and applied adaptively to a continuous-time plant.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics, Automation and Control, Department of Electrical Engineering
Host publication information
Title of host publication: Proceedings of the 32th Conference on Decision and Control
Volume: Volume 2
Publisher: IEEE
ISBN (Print): 07-80-31298-8
Main Research Area: Technical/natural sciences
Conference: 32nd Conference on Decision and Control, San Antonio, TX, United States, 15/12/1993 - 15/12/1993
Electronic versions:
Rost.pdf
DOIs:
10.1109/CDC.1993.325494

Bibliographical note
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Source: orbit
Source-ID: 200372
Publication: Research - peer-review › Article in proceedings – Annual report year: 1993

H-infinity Optimization of the Recovery Matrix

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, SimCorp A/S
Authors: Niemann, H. H. (Intern), Søgaard-Andersen, P. (Ekstern), Stoustrup, J. (Intern)
Pages: 547-564
Publication date: 1993
Main Research Area: Technical/natural sciences

Publication information
Journal: Control-Theory And Advanced Technology
Volume: 9
Issue number: 2
Original language: English
Loop transfer recovery, Robust control, Observer-based controllers
Electronic versions:
1993-CTAT.pdf
Source: dtu
Source-ID: u::5555
Publication: Research - peer-review › Journal article – Annual report year: 1993

State-space solutions to the h_inf/ltr design problem
The LTR design problem using an JC optimality criterion is presented for two types of recovery errors, the sensitivity recovery error and the input-output recovery error. For both errors two different approaches are presented. First, following the classical LTR design philosophy, a Luenberger observer based approach is proposed, where the Z part of the controller is appended to a standard full-order observer. Second, allowing for general controllers, an JC state-space problem is formulated directly from the recovery errors. Both approaches lead to controller orders of at most 2n. In the minimum phase case, though, the order of the controllers can be reduced to n in all cases. The control problems corresponding to the various controller types are given as four different singular state-space problems, and the solutions are given in terms of the relevant equations and inequalities

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control
Authors: Niemann, H. H. (Intern)
Pages: 1-45
Publication date: 1993
Main Research Area: Technical/natural sciences
Higher Order Continuous SI Engine Observers

A nonlinear compensator for the fuel film dynamics and a second order nonlinear observer for a spark ignition engine are presented in this paper. The compensator and observer are realized as continuous differential equations and an especially designed integration algorithm is used to integrate them in real time. Using these means, accurate steady state and transient air/fuel control can be obtained with excellent robustness properties. Some useful condition monitoring facilities
The evolution of CACSD tools—a software engineering perspective

The earlier evolution of computer-aided control system design (CACSD) tools is discussed from a software engineering perspective. A model of the design process is presented as the basis for principles and requirements of future CACSD tools. Combinability, interfacing in memory, and an open workspace are seen as important concepts in CACSD. Some points are made about the problem of buy or make when new software is required, and the idea of buy and make is put forward. Emphasis is put on the time perspective and the life cycle of the software.
asymptotic recovery problem turn
out to be equivalent, since the minimization of the recovery errors all amount to the minimization of a certain matrix, the
recovery matrix. Using the recovery
error definitions, simple necessary and sufficient conditions for the controllers are derived both for the exact and
asymptotic recovery cases. This general recovery formulation covers all known observer based compensator types as
special cases. The conditions given in this setting are effectively the aim of all known LTR design methods. The recovery
formulation is interpreted in terms of a modelmatching problem as well, which is examined by means of the Q-
parametrization. It is shown how the general controller obtained by the Q-parametrization can be written as a Luenberger
observer based controller. In all cases, n controller states suffice to achieve recovery. The compensators are
characterized for errors both on the input- and on the output-node (dual case).
Real-time adaptive control using CPAS on a MC68010-based process computer

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Henningsen, A. (Ekstern), Laursen, S. (Ekstern), Ravn, O. (Intern)
Pages: 370-375
Publication date: 1991

Host publication information
Title of host publication: Control '91., International Conference on Control 1991.
Volume: 1
ISBN (Print): 0852965095
Main Research Area: Technical/natural sciences
Conference: International Conference on Control, 01/01/1991
Source: orbit
Source-ID: 267318
Publication: Research - peer-review › Article in proceedings – Annual report year: 1991

An Analysis Of Pole/zero Cancellation In LTR-based Feedback Design
The pole/zero cancellation in LTR-based feedback design will be analyzed for both full-order as well as minimal-order observers. The asymptotic behaviour of the sensitivity function from the LTR-procedure are given in explicit expressions in the case when a zero is not cancelled by an equivalent pole. It will be shown that the non-minimum phase case is included as a special case. The results are not based on any specific LTR-method.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering
Authors: Niemann, H. H. (Intern), Jannerup, O. E. (Intern)
Pages: 848-853
Publication date: 1990

Host publication information
Title of host publication: American Control Conference
Place of publication: San Diego, CA, USA
Publisher: IEEE
Main Research Area: Technical/natural sciences
Electronic versions:
Niemann.pdf

Bibliographical note
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Source: orbit
Continuous Identification of a Four-Stroke SI Engine
Compact engine models often consist of a set of nonlinear differential equations which predict the time development of the mean value of the engine state variables (and perhaps some internal variables); such models are sometimes called mean value engine models. Currently a great deal of attention is focused on constructing such continuous time models and on finding their parameters. This paper shows, that it is possible to identify an engine model from a linearized version of a mean value model for a CFI four-cycle spark ignition (SI) engine. Such an approach is useful because it preserves a physical understanding of the engine throughout the identification stage. Afterwards the identification results are available for general dynamic engine studies. The identification techniques discussed in this paper include classical methods (step response) as well as modern statistical methods (Kalman filtering and Maximum Likelihood estimation). These techniques have been applied to a four cylinder SI engine. The results include an identification of the most important parameters and time constants of the engine. These are of interest for the construction of engine simulation models, for control studies and condition monitoring applications.

On user-friendly interface construction for CACSD packages
Some ideas that are used in the development of user-friendly interface for a computer-aided control system design (CACSD) package are presented. The concepts presented are integration and extensibility through the use of object-oriented programming, man-machine interface and user support using direct manipulation, and multiple views and multiple actions on objects in different domains. The use of multiple views and actions in combination with graphics enhances the user's ability to get an overview of the system to be designed. Good support for iteration is provided, and the short time between action and presentation allows the user to evaluate actions quickly. Object-oriented programming has been used to provide modularity and encapsulation.
New Results in Discrete-Time Loop Transfer Recovery

For discrete-time compensators incorporating prediction observers asymptotic loop transfer recovery is not feasible. Instead loop transfer recovery objectives must be satisfied via exact recovery techniques. In this note the model-based compensators which achieves exact recovery are parametrized in terms of the system zeros and the corresponding zero-directions. Full-order as well as minimal-order observers are treated. Further it is shown how exact recovery is also applicable to non-minimum phase plants. In this case the achievable performance is parameterized explicitly.

Stability Margins for Discrete-Time Optimal Regulators

A simple equation for guaranteed gain and phase margins for LQ state feedback in discrete-time systems will be presented. The results are based on the feedback gain and are made for SISO systems. An extension to MIMO systems are also showed. These new equations can also be used to find guaranteed gain and phase margins for optimal eigenvalue design methods.
The Impact of Analog and Bang-Bang Steering Gear Control on Ship's Fuel Economy

The latest years have shown considerable efforts towards improving steering generated propulsion losses of ships by the introduction of various sophisticated control algorithms in the autopilots. However, little previous attention has been given to the steering gear control loop, although it is found to be at least equally important regarding steering performance and fuel economy. The paper presents a comprehensive survey of steering gear principles commonly used, including relevant details of three analog steering gear servo principles, which have outperformed conventional designs. Control system performance is evaluated from direct measurements of speed and fuel consumption, and results from several ships are given. The results presented should enhance the ability of ship owners and steering gear manufacturers to choose and design systems, which will minimize steering generated propulsion losses.

General information
State: Published
Organisations: Department of Electrical Engineering, Automation and Control, EMRI APS, University of Illinois
Authors: Nørtoft Thomsen, J. C. (Ekstern), Blanke, M. (Intern), Reid, R. E. (Ekstern), Youhanaie, M. (Ekstern)
Pages: 51-63.
Publication date: 1982

Host publication information
Title of host publication: Preprint of Paper to be Presented at IFIP/IFAC 4. International Symposium on Ship Operation Automation.
Publisher: International Federation of Automatic Control
Main Research Area: Technical/natural sciences
Electronic versions:
ISSOA_1982_jcnt_mb_reer_my_Genoa.pdf
Source: PublicationPreSubmission
Source-ID: 101182480
Publication: Research - peer-review › Article in proceedings – Annual report year: 1982

Electrical Resistivity Investigations on Metallic Rare-Earths

Temperature Variation of the Magnetic Structure of HoSb

Neutron diffraction has been used to show that the magnetic moment vector in the antiferromagnet HoSb changes direction as a function of temperature below TN=5.7K. The experimental results are in qualitative agreement with a recent theoretical prediction by Jensen et al. (1980) which ascribe the changing directions to a competition between the crystal fields and the dipolar interactions.

General information
State: Published
Organisations: Automation and Control, Department of Electrical Engineering, Risø National Laboratory for Sustainable Energy
Projects:

**Human Brain Project. Subproject 10 Neurorobotics Platform (HBP) - SGA2**
Department of Electrical Engineering
Automation and Control
Centre for Playware
Centre for Playware
Copenhagen Center for Health Technology
Period: 02/04/2018 → 01/04/2020
Number of participants: 4
Acronym: HBP SGA2
Number of related Ph.D. students: 1
Project participant:
Capolei, Marie Claire (Intern)
Corchado Miralles, Carlos (Intern)
Project Manager, academic:
Lund, Henrik Hautop (Intern)
Project Coordinator:
Tolu, Silvia (Intern)

**Electronic Outlook**
Research-based evaluation of human versus electronic outlook for ships' navigation
Department of Applied Mathematics and Computer Science
Department of Electrical Engineering
Automation and Control
Period: 15/10/2017 → 30/09/2018
Number of participants: 2
Project ID: 56322
Project participant:
Blanke, Mogens (Intern)
Hansen, Søren (Intern)

**A Biomimetic Learning Control Scheme for control of Modular Robots**
Department of Electrical Engineering
Automation and Control
Centre for Playware  
Period: 16/01/2017 → 14/01/2019  
Number of participants: 1  
Acronym: Biomodular  
Project applicant:  
Tolu, Silvia (Intern)  

**Human Brain Project. Subproject 10 Neurorobotics Platform - SGA1**  
The Neurorobotics Platform (NRP) developed in the Human Brain Project (HBP) is an Internet-accessible simulation system that allows the simulation of robots controlled by spiking neural networks. It targets researchers of multiple fields. Prospected users include but are not limited to neuroscientists wanting to validate brain models in the context of closed action-perception loops as well as robotics researchers wanting to develop new neuro-inspired controllers.

Department of Electrical Engineering  
Automation and Control  
Centre for Playware  

Centre for Playware  

Copenhagen Center for Health Technology  
Period: 01/04/2016 → 01/04/2018  
Number of participants: 4  
Acronym: HBP SGA1  
Project participant:  
Capolei, Marie Claire (Intern)  
Corchado Miralles, Carlos (Intern)  
Project Manager, academic:  
Lund, Henrik Hautop (Intern)  
Project Coordinator:  
Tolu, Silvia (Intern)  

**Reconfigurable Modular Robotic System for Aquatic Environment**  
Department of Electrical Engineering  
Automation and Control  
Centre for Playware  

National Institute of Aquatic Resources  
Section for Oceans and Arctic  
Department of Mechanical Engineering  
Engineering Design and Product Development  
Fluid Mechanics, Coastal and Maritime Engineering  
Period: 01/02/2016 → 31/01/2018  
Number of participants: 6  
Acronym: REMORA  
Project participant:  
Christensen, David Johan (Intern)  
Mariani, Patrizio (Intern)  
Visser, Andre (Intern)  
Özkil, Ali Gürcan (Intern)  
Nielsen, Ulrik Dam (Intern)  
Project Manager, academic:  
Galeazzi, Roberto (Intern)  
Project
ERIGrid: European Research Infrastructure supporting Smart Grid Systems Technology Development, Validation and Roll Out

Renewable energy sources are key enablers to decrease greenhouse gas emissions and to cope with the anthropogenic global warming. The intermittent behaviour of them and their limited storage capabilities present new challenges to power system operators in maintaining power quality and reliability. However, the increased availability of advanced automation and communication technologies has also provided new intelligent solutions to these challenges. Previous work has presented various new methods to operate highly interconnected power grids with corresponding components in a more effective way. As a consequence of these developments the traditional power system is transformed into a cyber-physical system, a Smart Grid. Previous and ongoing research activities have mainly focused on validating certain aspects of Smart Grids, but until now no integrated approach for analysing and evaluating complex configurations in a cyber-physical systems manner is available.

The lack of system validation approaches for Smart Grids is especially addressed by ERIGrid. By providing a Pan-European research infrastructure ERIGrid supports the technology development as well as the roll out of Smart Grid solutions and concepts in Europe. It tackles a holistic, cyber-physical systems based approach by integrating 18 European research centres and institutions with outstanding research infrastructures and jointly develops common methods, concepts, and procedures. ERIGrid also integrates and enhances the necessary research services for analysing, validating and testing Smart Grid configurations. System level support and education for industrial and academic researchers is provided as well to foster future innovation.

ERIGrid addresses these challenging aims by providing a single entry point to the provided research infrastructure and offering a broad spectrum of services to researchers active in Smart Grids. This will strengthen the technical leadership of Europe in the energy domain.

Department of Electrical Engineering
Center for Electric Power and Energy
Energy System Management
Automation and Control
Period: 01/11/2015 → 30/04/2020
Number of participants: 5
Acronym: ERIGrid
Project participant:
Gehrke, Oliver (Intern)
Bondy, Daniel Esteban Morales (Intern)
Bindner, Henrik W. (Intern)
Heussen, Kai (Intern)
Project Coordinator:
Kosek, Anna Magdalena (Intern)

Relations
Publications:
Cyber-Physical Energy Systems Modeling, Test Specification, and Co-Simulation Based Testing

Use of Multilevel Flow Modelling for on-line supervision in the oil and gas industry

Department of Electrical Engineering
Automation and Control
Eldor Technology AS
Period: 01/05/2015 → 01/09/2015
Number of participants: 3
Acronym: AlarmTracker
Project participant:
Zhang, Xinxin (Intern)
Project Manager, organisational:
Ravn, Ole (Intern)
Project Manager, academic:
Lind, Morten (Intern)
Project
**Dynamic Propeller Shaft Speed Control**
Department of Electrical Engineering
Automation and Control
Department of Mechanical Engineering
Fluid Mechanics, Coastal and Maritime Engineering
Maersk Maritime Technology
Lyngsø Marine A/S
Propelco
Period: 01/04/2015 → 01/05/2017
Number of participants: 2
Project participant:
Galeazzi, Roberto (Intern)
Andersen, Poul (Intern)

---

**Intelligent Quality Assessment of Railway Switches and Crossings**
This project aims at significantly improving the safety, reliability and operational lifetime of the 3500 switches and crossings (S&Cs) in the Danish railway network. The project is a close cooperation between the Technical University of Denmark (DTU), the Danish rail infrastructure provider Rail Net Denmark and four affiliated European partners with significant expertise within this field. An inter-disciplinary scientific effort is employed to obtain enhanced rail transport reliability and regularity simultaneously with significant savings in S&Cs maintenance costs. The project results will make maintenance based on intelligent fault prediction tools, instead of the presently used regular planned inspections, and it will provide sophisticated tools to prevent hidden faults from developing to failure in the future. In a novel approach, the project will install state-of-the-art sensor technology in selected S&Cs and correlate dynamic parameters during train passage with static geometry data from conventional measurement vehicles. Monitoring of the dynamic responses will provide diagnosis of patterns that indicate when components or ballast begin to deviate from fully functional conditions. Modelling of dynamics will identify root causes to signs of degradation. Damage assessment of components identified by anomalous readings will be done by metallurgical examinations. Data and results will be processed by a holistic model that can produce Maintenance Performance Indicators (MPI) for the S&C condition. The correlation of sensor data to measuring vehicle data will allow existing data to be used reliably as input for the MPI model. It is expected that this project will enable optimisation of maintenance procedures, by which appropriate maintenance can be predicted in advance, thus avoiding unscheduled repairs and delays in the railway traffic.

Department of Wind Energy
Materials science and characterization
Department of Electrical Engineering
Automation and Control
Department of Mechanical Engineering
Solid Mechanics
Department of Applied Mathematics and Computer Science
Statistics and Data Analysis
Banedanmark
Period: 01/03/2015 → 28/02/2019
Number of participants: 14
Acronym: INTELLISWITCH
Number of related Ph.D. students: 1
Project participant:
Galeazzi, Roberto (Intern)
Blanke, Mogens (Intern)
Hansen, Søren (Intern)
Barkhordari, Pegah (Intern)
Asadzadeh, Seyed Mohammad (Intern)
Santos, Ilmar (Intern)
Tejada, Alejandro de Miguel (Intern)
Danielsen, Hilmar Kjartansson (Intern)
Dhar, Somrita (Intern)
Ersbøll, Bjarne Kjaer (Intern)
Kulahci, Murat (Intern)
Thyregod, Camilla (Intern)
Hovad, Emil (Intern)

Project Manager, academic:
Juul Jensen, Dorte (Intern)

Financial sources
Source: Public research council
Name of research programme: Innovationsfonden
Web address: http://innovationsfonden.dk/da
Amount: 12,700,000.00 Danish Kroner
Year of approval: 2014

Fault-Tolerant Control with Coarse Models in industrial Application

Department of Electrical Engineering
Automation and Control
Period: 15/08/2014 → 15/08/2017
Number of participants: 3
Fault-tolerant control, fault diagnosis, fault estimation, nonlinear control, nonlinear systems, industrial motors

Project participant:
Papageorgiou, Dimitrios (Intern)

Supervisor:
Niemann, Hans Henrik (Intern)
Main Supervisor:
Blanke, Mogens (Intern)

Relations
Activities:
2015 IEEE Multi-Conference on Systems and Control

SALVAGE: Cyber-physical security for Low-Voltage grids
This project proposes research in cyber-security of the power system, aiming at model-based power system intrusion detection and probability of an event causing the ICT system security to be compromised. The alarms from both ICT and power system components need to be collected and fused into possible fault or intrusion suggestions. The system operator uses these suggestions to estimate the system state and assess if the system security and stability was compromised. This project considers the distribution power grid. The CEE part contributes power system model based estimation methods, to detect if false measurements are being fed to the system or if behaviour of components has been manipulated.

Center for Electric Power and Energy
Energy System Management
Department of Electrical Engineering
Automation and Control
KTH - Royal Institute of Technology
Wroclaw University of Science and Technology

Period: 01/04/2014 → 01/04/2017
Number of participants: 4
cyber-physical security in power systems
Acronym: SALVAGE
Number of related Ph.D. students: 3
Project participant:
Gehrke, Oliver (Intern)
Heusen, Kai (Intern)
Phd Student:
Prostejovsky, Alexander Maria (Intern)
Project Manager, academic:
Kosek, Anna Magdalena (Intern)

Relations
Activities:
Intrusion detection systems for Smart Grid: model-based anomaly detection
NREL Cybersecurity & Resilience Workshop “Security and Resilience of Grid Integration with Distributed Energy Resources: Lessons Learned & Future Outlook”
2016 Joint Workshop on Cyber-Physical Security and Resilience in Smart Grids
Publications:
Deliverable 1.1 Smart grid scenario
SALVAGE Report D2.1 Description of existing and extended smart grid component models for use in the intrusion detection system

Kunstig intelligence og sprogudvikling
Department of Electrical Engineering
Automation and Control
Centre for Playware
Period: 01/02/2014 → 30/11/2014
Number of participants: 1
Project participant:
Jessen, Jari Due (Intern)

European Liaison on Electricity grid Committed Towards long-term Research Activities
European FP7 funded IRP project, which will develop radically new control schemes for the real time operation of the 2030 power system and provide support for the EERA Joint Programme on Smart Grids activity in order to realize the European SET Plan objectives. The EERA JP on Smart Grids intends to facilitate and encourage European coordination of member state research in the domain of Smart Grids

Department of Electrical Engineering
Center for Electric Power and Energy
Distributed Energy Resources
Energy System Management
Automation and Control
Period: 01/12/2013 → 30/11/2017
Number of participants: 8
smart grid, Power systems
Acronym: ELECTRA
Project ID: 609687
Project participant:
Marinelli, Mattia (Intern)
Bindner, Henrik W. (Intern)
Heusen, Kai (Intern)
Gehrke, Oliver (Intern)
Hu, Junjie (Intern)
Prostejovsky, Alexander Maria (Intern)
Rezkalla, Michel Maher Naguib (Intern)
Pertl, Michael Gerold (Intern)
**Financing sources**
Source: EU research programme (public)
Name of research programme: EU FP7 IRP
Amount: 10,000,000.00 Euro
Year of approval: 2013

**Relations**
Related projects:
ELECTRA Top-Up
Activities:
Enhancing the role of EVs in the smart grid: Resources or threats to power system operation? Trends and research drivers in Europe
Publications:
Requirements for future control room and visualisation features in the Web-of-Cells framework defined in the ELECTRA project
Scenario-based approach adopted in the ELECTRA project for deriving innovative control room functionality
Adaptive Assessment of Future Scenarios and Mapping of Observability Needs. Deliverable D5.1
Towards modeling future energy infrastructures - the ELECTRA system engineering approach
Grid Frequency Support by Single-Phase Electric Vehicles Employing an Innovative Virtual Inertia Controller
A Novel Grid-Wide Transient Stability Assessment and Visualization Method for Increasing Situation Awareness of Control Room Operators
Reduction of Topological Connectivity Information in Electric Power Grids
Supporting Control Room Operators in Highly Automated Future Power Networks
Voltage and Frequency Control for Future Power Systems: the ELECTRA IRP Proposal
Identification of observables for future grids – the framework developed in the ELECTRA project
Toward Coordinated Robust Allocation of Reserve Policies for a Cell-based Power System
Description of the detailed Functional Architecture of the Frequency and Voltage control solution (functional and information layer)
Distributed Framework for Prototyping of Observability Concepts in Smart Grids
Functional description of the monitoring and observability detailed concepts for the Pan-European Control Schemes
Implementation of fuzzy logic for mitigating conflicts of frequency containment control
Demonstration of visualization techniques for the control room engineer in 2030.
Grid Frequency Support by Single-Phase Electric Vehicles: Fast Primary Control Enhanced by a Stabilizer Algorithm
Enhanced Situational Awareness and Decision Support for Operators of Future Distributed Power Network Architectures
A Decision Support Tool for Transient Stability Preventive Control
Trade-off Analysis of Virtual Inertia and Fast Primary Frequency Control During Frequency Transients in a Converter Dominated Network
Key requirements for future control room functionality
Detailed requirements and constraints for the control of flexibility
The Pan-European Reference Grid Developed in the ELECTRA Project for Deriving Innovative Observability Concepts in the Web-of-Cells Framework
Identification of Requirements for Distribution Management Systems in the Smart Grid Context.
Documents:
CEE_Fact_sheet_ELECTRA_2015

**Play for Children with Disabilities**
This Action aims at the creation of a novel and autonomous field of research and intervention on play for children with disabilities. The network has three main objectives: a) collecting and systematizing all existing competence and skills: educational researches, clinical initiatives, know-how of resources centers and users’ associations; b) developing new knowledge related to settings, tools and methodologies associated with the play of children with disabilities; c) disseminating the best practices emerging from the joint effort of researchers, practitioners and users.

Department of Electrical Engineering
Automation and Control
Centre for Playware
**RTLabOS: Phase I - Exploring software infrastructure for smart grid labs**

The project RTLabOS: Phase I explored the evolving requirements of software infrastructure for smart grid labs. Best practice and gaps in the relevant state-of-the-art have been identified through workshops, survey and analysis. By means of user survey, exploratory feasibility studies and structured use case documentation, the current practice, requirements and feasibility of next generation functionality of laboratory software infrastructure have been identified.

Department of Electrical Engineering

Automation and Control

Center for Electric Power and Energy

Energy System Management

Period: 01/04/2013 → 31/08/2014

Number of participants: 6

laboratory software infrastructure, ICT, power systems, strategy formation

Acronym: RTLabOS

Project participant:

Kosek, Anna Magdalena (Intern)

Gehrke, Oliver (Intern)

Hu, Junjie (Intern)

Thavlov, Anders (Intern)

Project Manager, organisational:

Bindner, Henrik W. (Intern)

Project Manager, academic:

Heussen, Kai (Intern)

**Relations**

Activities:

Software Ecosystems for Power System Integration Labs

Smart Grid Labs: Software Infrastructure

Designing the Next Generation of Smart Grid Laboratories

Publications:

Evaluation of smart grid control strategies in co-simulation - integration of IPSYS and mosaik

RTLabOS Dissemination Activities

RTLabOS Feasibility Studies

Use Cases for Laboratory Software Infrastructure

RTLabOS Phase I: Software Infrastructure for Smart Grid Labs - Summary and Recommendations

Model-driven development of smart grid services using SoaML

The Requirements Domain for Laboratory Software Infrastructure. RTLabOS: Phase I – Deliverable 1.1

Fair division of generation profile and fuel consumption in isolated micro-grids

State of the Art Smart Grid Laboratories - A Survey about Software Use

Survey and Characterization of User Profiles and User Requirements

Optimal sizing and control of balancing power in the future European system considering transmission system constraints

1 PROBLEM DESCRIPTION

It is a well-established fact that the future European power system will require an increasing amount of balancing power capability, in form of what today is called secondary and tertiary control reserves, in order to accommodate the increasing amount of fluctuating power producers, i.e. primarily wind power and photo-voltaic. In a sustainable scenario this balancing power must be provided by renewable power sources in order to fulfil the energy policies of EU and other European countries, e.g. Norway and Switzerland. There are in principle five possible means to reduce the need for balancing power or to provide the needed balancing power in a sustainable way:

1. Improved forecasts of power production from fluctuating power sources.
2. Increased controllability of the fluctuating power sources
3. Designated storage devices close to the fluctuating power producers, e.g. Battery Energy Storage Systems (BESS)
4. Hydro power from a storage reservoir, possibly pumped storage
5. Demand Side Participation (DSP), i.e. load management

The first action is obvious and would lead to that the accuracy in the power production forecasts are improved, which will reduce the need for balancing power. The second one of these means would imply that the power plants are not operating at optimal efficiency and would consequently lead to energy losses of these power plants, which could be substantial. Local energy storage would lead to a higher energy output from the power plants but requires an additional investment. The advantage of items two and three above is that the balancing power is provided locally and the transmission system is not utilized to supply the needed balancing power. For the first three means above one does not provide more balancing power but rather decreases the need for additional balancing power and storage.

2 PROJECT OBJECTIVES

Hydro power, possibly with pumping capabilities, is a well proven effective source of sustainable balancing power. In Europe hydro power is of limited capacity and is located in a few geographical areas, i.e. basically in Scandinavia and in the Alps, implying that a certain transmission capacity be required. This is particularly obvious for the Scandinavian hydro power, which requires HVDC cables in order to be integrated in the balancing power scheme of the continental system, but this is also the case for the hydro power in the Alps. Demand Side Participation (DSP) is an instrument that hitherto has not been utilized as balancing power to any larger extent. The potential available is deemed to be significant and various concepts how it should be implemented have been proposed. Also for DSP power transmission capacity is needed for its utilization.

It is thus clear that the need for more balancing power will also introduce additional requirements on the transmission system. These requirements are concerning demands on transmission capabilities but also concerning the management and control of the transmission grid. Both these aspects must be addressed in order to obtain a viable and effective solution for handling balancing power in the European system. The overall objectives are to address the problems related to balancing power in a future European system with a substantial part of the power generation in form of fluctuating renewable power sources. More specifically the following aspects will be addressed:

1. Estimation of the need of balancing power in different scenarios
2. Assessment of the different methods listed above to provide balancing power including the limitations imposed by the transmission system with regard to technical and economic criteria. Environmental issues will also be considered.
3. Development of planning methods and operational strategies for the future European system incorporating the needs of balancing power.

Department of Electrical Engineering
Electric Energy Systems
Centre for Electric Technology
Automation and Control
Swiss Federal Institute of Technology
Norwegian University of Science and Technology
Swissgrid - Transmission system operator of Switzerland

Period: 01/09/2012 → 01/09/2015
Number of participants: 3
Acronym: BPES
Project participant:
Østergaard, Jacob (Intern)
Heussen, Kai (Intern)
Project Manager, academic:
Andersson, Goran (Extern)

Financing sources
Source: Public research programme (public)
Name of research programme: SmartGrids ERA-Net
Web address: http://www.eranet-smartgrids.eu/
Amount: 1,350,000.00 Danish Kroner
Year of approval: 2011
Documents:
CEE_Fact_sheet_BPES_2015
Project
**Innovation consortium Real time Controlled Robots for the Meat Industry**

Department of Electrical Engineering  
Automation and Control  
Department of Automation  
Danish Technological Institute  
University of Copenhagen  
Robotcenter Danmark A/S  
IHFood A/S  
LINCO Food Systems A/S  
Butina A/S  
Rose Poultry A/S  
Lantmännan Danpo A/S  
Tican Fresh Meat A/S  
Danish Crown A/S  
Period: 01/05/2012 → 30/04/2016  
Number of participants: 4  
Acronym: RealRobot  
Project participant:  
Ravn, Ole (Intern)  
Andersen, Nils Axel (Intern)  
Wu, Haiyan (Intern)  
Phd Student:  
Andersen, Thomas Timm (Intern)  

**Secure Operation of Sustainable Power Systems**  
Funded by the Danish Council for strategic research (DSF)

The project period spans four years, starting in January 2012. The total budget for the project is approximately 30.2 million DKK, which covers among others the funding of 5 PhD and 3 PostDoc positions. The project is managed by prof. Jacob Østergaard, head of Centre for Electric Technology.

The SOSPO project focuses on a critical, difficult and not yet treated problem regarding how secure operation of future sustainable power systems (based on wind and solar energy) can be ensured.

The research in the SOSPO project focuses on methods that enable system stability and security assessment in real-time and on methods for automatically determining control actions that regain system security when an insecure operation has been detected.

Centre for Electric Technology  
Department of Electrical Engineering  
Electric Energy Systems  
Automation and Control  
Center for Electric Power and Energy  
Electric Power Systems  
Eidgenössische Technische Hochschule  
Lund University  
Chalmers University of Technology  
Energinet.dk
Siemens
Ken M Consulting
Period: 01/01/2012 → 31/12/2015
Number of participants: 13
Stability sustainable power system
Acronym: SOSPO
Number of related Ph.D. students: 5
Project participant:
Nielsen, Arne Hejde (Intern)
Garcia-Valle, Rodrigo (Intern)
Yang, Guangya (Intern)
Lind, Morten (Intern)
Blanke, Mogens (Intern)
Zhang, Xinxin (Intern)
Phd Student:
Weckesser, Johannes Tilman Gabriel (Intern)
Wittrock, Martin Lindholm (Intern)
Møller, Jakob Glarbo (Intern)
Perez, Angel (Intern)
Pedersen, Andreas Søndergaard (Intern)
Project Manager, academic:
Østergaard, Jacob (Intern)
Jóhannsson, Hjörtur (Intern)

Relations
Publications:
Method of determining remedial control actions for a power system in an insecure state
Wide Area Prosumption Control and Sensitivities of Aperiodic Small Signal Stability Indicators
Early Prevention Method for Power Systems Instability
Uncertainty in real-time voltage stability assessment methods based on Thevenin equivalent due to PMU's accuracy
Sensitivity based Assessment of Transient Voltage Sags caused by Rotor Swings
Impact of Model Detail of Synchronous Machines on Real-time Transient Stability Assessment
Evaluation of enhancements to Thevenin equivalent based methods for real-time voltage stability assessment
Suitability of voltage stability study methods for real-time assessment
Evaluation of HVDC interconnection models for considering its impact in real-time voltage stability assessment
Wide-Area Assessment of Aperiodic Small Signal Rotor Angle Stability in Real-Time
Computation of Steady State Nodal Voltages for Fast Security Assessment in Power Systems
Wide-Area Assessment of Aperiodic Small Signal Rotor Angle Stability in Real-Time
Real-Time Thevenin Impedance Computation
Improved method for considering PMU's uncertainty and its effect on real-time stability assessment methods based on Thevenin equivalent
Identification of Critical Transmission Limits in Injection Impedance Plane
System security assessment in real-time using synchrophasor measurements
Fast assessment of the effect of preventive wide area emergency control
Critical machine cluster identification using the equal area criterion
Convex Relaxation of Power Dispatch for Voltage Stability Improvement
Investigation of Suitability of Cascading Outage Assessment Methods for Real-Time Assessment
Early prevention of instability - search for optimal grid nodes for applying countermeasures
Addressing the security of a future sustainable power system: The Danish SOSPO project
Improved method for considering PMU's uncertainty and its effect on real-time stability assessment methods based on Thevenin equivalent
Early Prevention of Instability-Use of Self Propagating Graph for the Fast Search for Optimal Grid Nodes to Apply Countermeasures
Thevenin Equivalent Method for Dynamic Contingency Assessment
Technical Resource Potential of Non-disruptive Residential Demand Response in Denmark
Wind farms generation limits and its impact in real-time voltage stability assessment
Investigation of the Adaptability of Transient Stability Assessment Methods to Real-Time Operation
Early Prediction of Transient Voltage Sags caused by Rotor Swings
An implementation and test platform for wide area stability assessment methods
Assessment of the impact that individual voltage source has on a generator’s stability
SW-platform for R&D in Applications of Synchronphasor Measurements for Wide-Area Assessment, Control and Visualization in Real-Time
Influence of current limitation on voltage stability with voltage sourced converter HVDC
Stabiliser Fault Emergency Control using Reconfiguration to Preserve Power System Stability
Derivation and application of sensitivities to assess transient voltage sags caused by rotor swings
Early Prevention Method for Power System Instability
Real-Time Stability Assessment based on Synchrophasors

Documents:
SOSPO Public Fact Sheet 2013
Project

Activities:

**Automation and Control (Organisational unit)**
Period: 15 Sep 2018 → 15 Oct 2018
Mogens Blanke (Chairman)
Department of Electrical Engineering
Automation and Control

**Description**
International Evaluation of NTNU Education Program in Engineering Cybernetics
Degree of recognition: International

**Related organisation**

**Automation and Control (Organisational unit)**
Blanke, M. (Chairman)
15 Sep 2018 → 15 Oct 2018
Activity: Membership › Membership in review committee

**4th EU-Japan Workshop on Neurorobotics**
Period: 18 Apr 2018
Silvia Tolu (Participant)
Department of Electrical Engineering
Automation and Control
Centre for Playware

**Description**
Title of the talk: Using robots for understanding the cerebellar role in sensorimotor control

**Related event**

**4th EU-Japan Workshop on Neurorobotics**
18/04/2018 → 20/04/2018
Tokyo, Japan
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.
International Symposium on Future I&C for Nuclear Power Plants
Period: 26 Nov 2017 → 29 Nov 2017
Denis Kirchhübel (Speaker)
Department of Electrical Engineering
Automation and Control
Degree of recognition: International

Related external organisation
IAEA
Activity: Talks and presentations › Conference presentations

A Scalable Neuro-inspired Robot Controller Integrating a Machine Learning Algorithm and a Spiking Cerebellar-Like Network
Period: 28 Jul 2017
Silvia Tolu (Speaker)
Henrik Hautop Lund (Other)
Department of Electrical Engineering
Automation and Control
Centre for Playware
Centre for Playware

Description
Conference on Biomimetic and Biohybrid Systems
Living Machines 2017
Degree of recognition: International

Related event
Living Machines 2017
25/07/2017 → 28/07/2017
Stanford, United States
Activity: Talks and presentations › Conference presentations

Department of Mechanical Engineering (Organisational unit)
Period: 1 Jul 2017 → 26 Sep 2017
Mogens Blanke (Chairman)
Department of Electrical Engineering
Automation and Control

Description
Chairman for PhD evaluation Committee for Jonas Lauridsen
Degree of recognition: National

Related organisation
Department of Mechanical Engineering (Organisational unit)
Blanke, M. (Chairman)
1 Jul 2017 → 26 Sep 2017
Activity: Membership › Membership in review committee

Linköping University (External organisation)
Period: 1 Feb 2017 → 8 Mar 2017
Mogens Blanke (Member)

Department of Electrical Engineering
Automation and Control
Description
Member of evaluation committee, Dr. Ing. degree Jonas Linder,
Linköping University, Sweden
Degree of recognition: International

Related external organisation

Linköping University
Sweden
Activity: Membership › Membership in review committee

13th European Workshop on Advanced Control and Diagnosis
Period: 19 Nov 2016
Denis Kirchhübel (Speaker)
Department of Electrical Engineering
Automation and Control
Description
Presentation on “Representing Operational Modes for Situation Awareness”
Workshop participation at ACD2016

Related event
13th European Workshop on Advanced Control and Diagnosis
17/11/2016 → 19/11/2016
Lille, France
Activity: Talks and presentations › Conference presentations

Professorship evaluation (External organisation)
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control
Description
Member of evaluation committee for Professorship at Linköping University (SE)
Evaluation of candidate(s) for Professorship at Linköping University (SE)
Body type: University
Degree of recognition: International
Related external organisation

Professorship evaluation
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

5th Neurorobotics Performance Show
Period: 17 Feb 2016 → 19 Feb 2016
Silvia Tolu (Participant)
Department of Electrical Engineering
Automation and Control
Centre for Playware
Description
Participation at the 5th Neurorobotics Performance show (HBP SP 10) in Geneva
5th Neurorobotics Performance show
Related event

5th Neurorobotics Performance Show: HBP SP 10
17/02/2016 → 19/02/2016
Geneva, Switzerland
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

3rd HBP Education Programme
Period: 11 Jan 2016 → 15 Jan 2016
Silvia Tolu (Participant)
Department of Electrical Engineering
Automation and Control
Centre for Playware

Description
Title: A modular cerebellar based control architecture for a modular robot, S. Tolu, D. J. Christensen, H. H. Lund.
Poster Presentation and course

Related event

3rd HBP Education Programme: Workshop - Future Computing
11/01/2016 → 15/01/2016
Manchester, United Kingdom
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Member of DTU Academic Council (External organisation)
Period: 2015 → …
Ole Ravn (Participant)
Department of Electrical Engineering
Automation and Control

Member of external organisation

Member of DTU Academic Council
Activity: Membership › Membership of commitees, commissions, boards, councils, associations, organisations, or similar

Dynamic Modeling, Advanced Control, Diagnosis and Optimization of Large-Scale Lignocellulosic Biorefineries
Period: 11 Nov 2015
Remus Mihail Prunescu (Speaker)
Department of Electrical Engineering
Automation and Control

Related event

2015 AIChE Annual Meeting
08/11/2015 → 13/11/2015
Salt Lake City, United States
Activity: Talks and presentations › Conference presentations

Plantwide Model-Based Optimization of a Large Scale Second Generation Biorefinery
Period: 10 Nov 2015
Remus Mihail Prunescu (Speaker)
Department of Electrical Engineering
Automation and Control
Related event

**2015 AIChE Annual Meeting**
08/11/2015 → 13/11/2015
Salt Lake City, United States
Activity: Talks and presentations › Conference presentations

**International Journal of Adaptive Control and Signal Processing (Journal)**
Period: 1 Oct 2015 → 1 May 2017
Mogens Blanke (Reviewer)
Department of Electrical Engineering
Automation and Control

**Description**
Editor for Special Issue on Marine Systems Applications
Degree of recognition: International

**Related journal**
International Journal of Adaptive Control and Signal Processing
0890-6327
Central database
Activity: Research › Journal editor

**EuroAsianPacific Joint Conference on Cognitive Science**
Period: 25 Sep 2015 → 27 Sep 2015
Silvia Tolu (Speaker)
Department of Electrical Engineering
Automation and Control
Centre for Playware

**Description**
Talk: "Cerebellar internal models for a modular robot"
Links:
http://www.eapcogsci2015.it/

**Related event**

**EuroAsianPacific Joint Conference on Cognitive Science**
25/09/2015 → 27/09/2015
Turin, Italy
Activity: Talks and presentations › Conference presentations

**2015 IEEE Multi-Conference on Systems and Control**
Period: 23 Sep 2015
Dimitrios Papageorgiou (Participant)
Department of Electrical Engineering
Automation and Control

**Related event**

**2015 IEEE Multi-Conference on Systems and Control**
21/09/2015 → 23/09/2015
Sydney, Australia
10th IFAC Conference on Manoeuvring and Control of Marine Craft
Period: 24 Aug 2015
Mogens Blanke (Organizer)
Department of Electrical Engineering
Automation and Control

Description
Organiser of 10th IFAC Conference on Marine Craft Manoeuvring and Control (MCMC’2015)
Links:
http://www.mcmc2015.dk

Related event
10th IFAC Conference on Manoeuvring and Control of Marine Craft
24/08/2015 → 26/08/2015
Lyngby, Denmark
Activity: Attending an event › Participating in or organising a conference

Dynamic Modeling and Optimization of Large Scale Lignocellulosic Biorefineries
Period: 18 Aug 2015
Remus Mihail Prunescu (Invited speaker)
Department of Electrical Engineering
Automation and Control
Department of Chemical and Biochemical Engineering
CAPEC-PROCESS

Related event
BioPro World Talent Campus 2015
17/08/2015 → 21/08/2015
Sørø, Denmark
Activity: Talks and presentations › Conference presentations

Field Robot Event 2015
Ole Ravn (Participant)
Department of Electrical Engineering
Automation and Control

Description
Judge of the competition
Field robot competition
Links:
http://fre2015.um.si/ (Robot competition)

Related event
Field Robot Event 2015
16/06/2015 → 18/06/2015
Maribor, Slovenia
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

DAu Konference: Den 4. Industrielle Revolution
Period: 10 Jun 2015
Ole Ravn (Organizer)
Department of Electrical Engineering
Automation and Control

Related event
DAu Konference: Den 4. Industrielle Revolution: Fra hype til konkrete resultater
10/06/2015 → …
Aarhus, Denmark
Activity: Attending an event › Participating in or organising a conference

In committee for PhD thesis evaluation at Linköping University, Sweden (External organisation)
Period: 22 May 2015
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

Description
Thesis by Daniel Jung

Body type: University
Degree of recognition: International

Related external organisation
In committee for PhD thesis evaluation at Linköping University, Sweden
Activity: Membership › Membership in review committee

Professorship Evaluation for NTNU - International Chair (External organisation)
Period: 1 May 2015 → 30 Jun 2015
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

Description
Evaluation of candidate for position as NTNU International Chair

Body type: International Evaluation Committee
Degree of recognition: International

Related external organisation
Professorship Evaluation for NTNU - International Chair
Activity: Membership › Membership in review committee

Kompetenceudviklingsdage
Period: 21 Apr 2015
Ole Ravn (Speaker)
Department of Electrical Engineering
Automation and Control

Links:
http://www.samtaenkning.dk/Pages/Forside.aspx

Related event
Kompetenceudviklingsdage
21/04/2015 → …
København, Denmark
Control of Drones
Period: 11 Mar 2015
Søren Hansen (Lecturer)
Automation and Control
Department of Electrical Engineering

Description
Lecture for UNF

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Evaluation for University of Cambridge (External organisation)
Period: 25 Jan 2015 → 6 Feb 2015
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

Description
Faculty member evaluation

Body type: University
Degree of recognition: International

Related external organisation

Evaluation for University of Cambridge
Activity: Membership › Membership in review committee

IFAC Technical Committee on Marine Systems (External organisation)
Period: 2014 → 2017
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

Description
Member of IFAC TC on Marine Systems 2014 -2017
Member of IFAC TC on Marine Systems 2014 -2017

Body type: Technical Committee
Degree of recognition: International

Related external organisation

IFAC Technical Committee on Marine Systems
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

PhD Thesis Jury Member at Universitat Politecnica de Catalunya (External organisation)
Period: 2014
Mojtaba Tabatabaeipour (Participant)
Department of Electrical Engineering
Automation and Control
Related external organisation

PhD Thesis Jury Member at Universitat Politecnica de Catalunya
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

University of Bordeaux (External organisation)
Period: 19 Nov 2014
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

Description
Opponent on PhD thesis by Robert Fonod

Body type: University
Degree of recognition: International

Related external organisation

University of Bordeaux
France
Activity: Membership › Membership in review committee

2014 AIChE Annual Meeting: American Institute of Chemical Engineers
Period: 17 Nov 2014 → 21 Nov 2014
Remus Mihail Prunescu (Speaker)
Department of Electrical Engineering
Automation and Control

Description
Dynamic Simulation, Sensitivity and Uncertainty Analysis of a Demonstration Scale Lignocellulosic Enzymatic Hydrolysis Process

Related event

2014 AIChE Annual Meeting: American Institute of Chemical Engineers
16/11/2014 → 21/11/2014
Atlanta, United States
Activity: Talks and presentations › Conference presentations

Dynamic Simulation, Sensitivity and Uncertainty Analysis of a Demonstration Scale Lignocellulosic Enzymatic Hydrolysis Process
Period: 16 Nov 2014 → 21 Nov 2014
Remus Mihail Prunescu (Speaker)
Department of Electrical Engineering
Automation and Control
CAPEC-PROCESS
Department of Chemical and Biochemical Engineering

Related event

2014 AIChE Annual Meeting: American Institute of Chemical Engineers
16/11/2014 → 21/11/2014
Atlanta, United States
Activity: Talks and presentations › Conference presentations
Model-Based Filtering of Large-Scale Datasets - A Biorefinery Application
Period: 16 Nov 2014 → 21 Nov 2014
Remus Mihail Prunescu (Speaker)
Department of Electrical Engineering
Automation and Control

Related event

2014 AIChE Annual Meeting: American Institute of Chemical Engineers
16/11/2014 → 21/11/2014
Atlanta, United States
Activity: Talks and presentations › Conference presentations

Aarhus University (External organisation)
Period: 12 Nov 2014
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

Description
Opponent on PhD thesis by Martin Andreas Falk Jensen

Body type: University

Related external organisation

Aarhus University
Inge Lehmanns Gade 10, 8000, Aarhus C, Denmark
Activity: Membership › Membership in review committee

University of Cambridge (External organisation)
Period: 3 Nov 2014
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

Description
External examiner of PhD thesis

Body type: University
Degree of recognition: International

Related external organisation

University of Cambridge
United Kingdom
Activity: Membership › Membership in review committee

Linköping University (External organisation)
Period: 25 Apr 2014
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

Description
Opponent for the PhD thesis of Christofer Sundström
Referee, Professor in Robotics at Queensland University of Technology (External organisation)
Period: 28 Jan 2014 → 10 Feb 2014
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

Description
Referee for Employment of Professor in Robotics at Queensland University of Technology
Degree of recognition: International

Related external organisation

Drones on Autopilot
Period: 14 Jan 2014
Søren Hansen (Lecturer)
Automation and Control
Department of Electrical Engineering

Description
Presentation and tour for E-gruppen, IDA.

Related external organisation

International Journal of Adaptive Control and Signal Processing (Journal)
Period: 1 Jan 2014 → 1 May 2015
Mogens Blanke (Editor)
Department of Electrical Engineering
Automation and Control

Description
Journal of Adaptive Control and Signal Processing
Special Issue on Adaptive Control and Signal Processing in Marine Systems
Designated Editor for Special Issue on Adaptive control and Signal Processing in Marine Systems

Related journal

International Journal of Adaptive Control and Signal Processing
0899-6327
Central database
Activity: Research › Journal editor
52nd IEEE Conference on Decision and Control (CDC 2013)
Period: 10 Dec 2013 → 13 Dec 2013
Remus Mihail Prunescu (Speaker)
Department of Electrical Engineering
Automation and Control

Related event
52nd IEEE Conference on Decision and Control (CDC 2013)
10/12/2013 → 13/12/2013
Florence, Italy
Activity: Talks and presentations › Conference presentations

Biofuel Session
Remus Mihail Prunescu (Speaker)
Department of Electrical Engineering
Automation and Control

Description
Chairman and Speaker of the Biofuel Session

Related event
9th World Congress of Chemical Engineering Incorporating 15th Asian Pacific Confederation of Chemical Engineering Congress
18/08/2013 → 23/08/2013
Seoul, Korea, Republic of
Activity: Talks and presentations › Conference presentations

2013 American Control Conference
Period: 17 Jun 2013 → 19 Jun 2013
Remus Mihail Prunescu (Speaker)
Department of Electrical Engineering
Automation and Control

Description
Oral presentation with Best Presentation in Session Award

Related event
2013 American Control Conference
17/06/2013 → 19/06/2013
Washington, DC, United States
Activity: Talks and presentations › Conference presentations

10th IEEE International Conference on Control & Automation
Period: 12 Jun 2013 → 14 Jun 2013
Ole Ravn (Speaker)
Department of Electrical Engineering
Automation and Control
Links:
http://ieee-icca.org/

Related event
10th IEEE International Conference on Control & Automation  
12/06/2013 → 14/06/2013  
Hangzhou, China  
Activity: Talks and presentations › Conference presentations

Danvak Dagen 2013  
Period: 10 Apr 2013  
Tobias Gybel Hovgaard (Invited speaker)  
Department of Applied Mathematics and Computer Science  
Scientific Computing  
Department of Electrical Engineering  
Automation and Control

Description  
Presentation given at "Danvak Dagen 2013" Invited talk after receiving "Prof. P.Ole Fangers Forkningslegat 2013".

Documents:  
PDF

Related event  
Danvak Dagen 2013  
10/04/2013 → …  
København, Denmark  
Activity: Talks and presentations › Conference presentations

DTU RoboCup 2013  
Period: 9 Apr 2013 → 11 Apr 2013  
Ole Ravn (Organizer)  
Department of Electrical Engineering  
Automation and Control

Description  
DTU RoboCup 2013: A DTU Blue Dot Project

Links:  
http://www.robocup.dtu.dk

Related event  
DTU RoboCup 2013  
09/04/2013 → 11/04/2013  
Kgs. Lyngby, Denmark  
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

European Robotic Forum 2013  
Period: 19 Mar 2013 → 21 Mar 2013  
Ole Ravn (Speaker)  
Department of Electrical Engineering  
Automation and Control

Links:  
http://www.eurobotics2013.com/

Related event  
European Robotic Forum 2013  
19/03/2013 → 21/03/2013  
Lyon, France  
Activity: Talks and presentations › Conference presentations
37th Enlarged Halden Programme Group Meeting
Period: 10 Mar 2013 → 15 Mar 2013
Xinxin Zhang (Speaker)
Department of Electrical Engineering
Automation and Control

37th Enlarged Halden Programme Group Meeting
10/03/2013 → 15/03/2013
Storefjell, Norway
Activity: Talks and presentations › Conference presentations

10th European Workshop on Advanced Control and Diagnosis
Period: 8 Nov 2012 → 9 Nov 2012
Ole Ravn (Participant)
Department of Electrical Engineering
Automation and Control

10th European Workshop on Advanced Control and Diagnosis
08/11/2012 → 09/11/2012
Kgs. Lyngby, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

10th European Workshop on Advanced Control and Diagnosis
Period: 8 Nov 2012 → 9 Nov 2012
Remus Mihail Prunescu (Speaker)
Department of Electrical Engineering
Automation and Control

10th European Workshop on Advanced Control and Diagnosis
08/11/2012 → 09/11/2012
Kgs. Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

International Workshop on Functional Modelling
Period: 6 Nov 2012 → 7 Nov 2012
Ole Ravn (Participant)
Department of Electrical Engineering
Automation and Control

International Workshop on Functional Modelling: For Design and Operation of Industrial Systems and Infrastructures
06/11/2012 → 07/11/2012
Kgs. Lyngby, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

International Workshop on Functional Modelling
Period: 6 Nov 2012 → 7 Nov 2012
Xinxin Zhang (Speaker)
Department of Electrical Engineering
Automation and Control

**Description**
Organize and participate the International Workshop on Functional Modelling: for Design and Operation of Industrial Systems and Infrastructures.

**Links:**
http://indico.conferences.dtu.dk/conferenceDisplay.py?confId=121

**Related event**

**International Workshop on Functional Modelling: For Design and Operation of Industrial Systems and Infrastructures**
06/11/2012 → 07/11/2012
Kgs. Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

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**8th HOLMUG meeting**

**Period:** 18 Oct 2012 → 19 Oct 2012

**Ole Ravn (Participant)**

Department of Electrical Engineering
Automation and Control

**Related event**

**8th HOLMUG meeting: Halden On-Line Monitoring User Group**
18/10/2012 → 19/10/2012
Rome, Italy
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

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**8th HOLMUG meeting**

**Period:** 18 Oct 2012 → 19 Oct 2012

**Xinxin Zhang (Speaker)**

Department of Electrical Engineering
Automation and Control

**Description**
Presentation on "Apply Functional Modeling to Consequence Analysis in Supervision Systems"

Presentation on the 8th HOLMUG (Halden On-Line Monitoring User Group) Meeting

**Documents:**
APPLY FUNCTIONAL MODELING TO CONSEQUENCE ANALYSIS IN SUPERVISION SYSTEMS

**Related event**

**8th HOLMUG meeting: Halden On-Line Monitoring User Group**
18/10/2012 → 19/10/2012
Rome, Italy
Activity: Talks and presentations › Conference presentations

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**Aalborg University (External organisation)**

**Period:** 5 Oct 2012 → 18 Dec 2012

**Mogens Blanke (Participant)**

Department of Electrical Engineering
Automation and Control

**Description**
Member of evaluation committee for position as full professor in automation and control
Body type: University

Related external organisation

Aalborg University
A.C. Meyers Vænge 15, 2450 Copenhagen SV, Aalborg, Denmark
Activity: Membership › Membership in review committee

Modelling and Control of Stiff Robots for Flexible Manufacturing (External organisation)
Period: 7 Sep 2012
Ole Ravn (Participant)
Department of Electrical Engineering
Automation and Control

Description
Isolde Dressler, LTH, Lund, Sweden

Body type: Ph.D. evaluation committee
Degree of recognition: International

Related external organisation

Modelling and Control of Stiff Robots for Flexible Manufacturing
Activity: Membership › Membership in review committee

1st International Symposium on Socially and Technically Symbiotic Systems
Period: 29 Aug 2012 → 31 Aug 2012
Xinxin Zhang (Speaker)
Department of Electrical Engineering
Automation and Control
Links:
http://stss2012.org/homepage.html

Related event

1st International Symposium on Socially and Technically Symbiotic Systems
29/08/2012 → 31/08/2012
Okayama, Japan
Activity: Talks and presentations › Conference presentations

16th IFAC Symposium on System Identification
Period: 11 Jul 2012 → 13 Jul 2012
Ole Ravn (Invited speaker)
Department of Electrical Engineering
Automation and Control
Links:
http://www.sysid2012.org

Related event

16th IFAC Symposium on System Identification
11/07/2012 → 13/07/2012
Brussels, Belgium
Activity: Talks and presentations › Conference presentations

Linköping University (External organisation)
Period: 15 Jun 2012
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

Description
Official opponent for PhD candidate Carl Svärd's defense for the degree Dr.Ing
Official opponent for PhD candidate Carl Svärd's defense for the degree Dr.Ing

Body type: University
Degree of recognition: International

Related external organisation

Linköping University
Sweden
Activity: Membership › Membership in review committee

Aalborg University (External organisation)
Period: 21 Mar 2012
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

Description
Opponent for PhD Candidate Tom Nørgaard Jensen's Thesis
External examiner for PhD Thesis

Body type: University

Related external organisation

Aalborg University
A.C. Meyers Vænge 15, 2450 Copenhagen SV, Aalborg, Denmark
Activity: Membership › Membership in review committee

DTU RoboCup 2012
Ole Ravn (Organizer)
Department of Electrical Engineering
Automation and Control

Description
DTU RoboCup 2012: A DTU Blue Dot Project

Related event

DTU RoboCup 2012
20/03/2012 → 22/03/2012
Kgs. Lyngby, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

European Robotic Forum 2012
Period: 5 Mar 2012 → 7 Mar 2012
Ole Ravn (Speaker)
Department of Electrical Engineering
Automation and Control

Related event

European Robotic Forum 2012
05/03/2012 → 07/03/2012
Odense, Denmark
Activity: Talks and presentations › Conference presentations

5th International Conference on Cognitive Systems
Period: 22 Feb 2012 → 23 Feb 2012
Ole Ravn (Participant)
Department of Electrical Engineering
Automation and Control
Links:
http://cogsys2012.acin.tuwien.ac.at/

Related event

5th International Conference on Cognitive Systems
22/02/2012 → 23/02/2012
Vienna, Austria
Activity: Attending an event › Participating in or organising a conference

17th Nordic Process Control Workshop
Period: 25 Jan 2012 → 27 Jan 2012
Remus Mihail Prunescu (Speaker)
Department of Electrical Engineering
Automation and Control

Related event

17th Nordic Process Control Workshop
25/01/2012 → 27/01/2012
Kongens Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

Innovation Network RoboCluster (External organisation)
Period: 1 Jan 2012 → 31 Dec 2012
Ole Ravn (Chairman)
Department of Electrical Engineering
Automation and Control

Description
RoboCluster is a national innovation network that brings together the Danish competences and expertise within robotics, automation and intelligent mechanical systems.

Links:
http://www.robocluster.dk

Related external organisation

Innovation Network RoboCluster
Activity: Membership › Membership of research networks or expert groups

Member IFAC Technical Committee on Marine Systems (External organisation)
Period: 2011 → 2014
Mogens Blanke (Participant)
Department of Electrical Engineering
Automation and Control

**Description**
Member of IFAC TC on Marine Systems 2011 -2014
Member of IFAC TC on Marine Systems 2014 -2017

Body type: International Organization
Degree of recognition: International

**Related external organisation**

*Member IFAC Technical Committee on Marine Systems*
Activity: Membership » Membership of committees, commissions, boards, councils, associations, organisations, or similar

**Teaching Evaluation Exercise at Aalto University (External organisation)**
Period: 2011 → …
Ole Ravn (Chairman)

Department of Electrical Engineering
Automation and Control

**Description**
Chairman of the Electrical Engineering Panel
Degree of recognition: International
Links:
https://into.aalto.fi/display/enaalto/Teaching+Evaluation+Exercise+%28TEE%29

**Related external organisation**

*Teaching Evaluation Exercise at Aalto University*
Activity: Membership » Membership in review committee

**Linköping University (External organisation)**
Period: 28 Dec 2011 → 1 Mar 2012
Mogens Blanke (Participant)

Department of Electrical Engineering
Automation and Control

**Description**
External evaluator for promotion to Docent

Evaluation of promotion to Docent

Body type: Evaluation committee
Degree of recognition: International

**Related external organisation**

*Linköping University*
Sweden
Activity: Membership » Membership in review committee

**2011 American Control Conference**
Period: 29 Jun 2011 → 1 Jul 2011
Ole Ravn (Speaker)

Department of Electrical Engineering
Automation and Control

Related event

2011 American Control Conference
29/06/2011 → 01/07/2011
San Francisco, CA, United States
Activity: Talks and presentations › Conference presentations

DTU RoboCup 2011
Ole Ravn (Organizer)
Department of Electrical Engineering
Automation and Control

Description
DTU RoboCup 2011: A DTU Blue Dot Project

Related event

DTU RoboCup 2011
22/03/2011 → 24/03/2011
Kgs. Lyngby, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

The Industrial PhD Programme Committee (External organisation)
Period: 1 Jan 2009 → 31 Dec 2014
Ole Ravn (Participant)
Department of Electrical Engineering
Automation and Control

Description
The Industrial PhD Programme Committee (IPPC) is appointed by The Danish Council for Technology and Innovation (DCTI). The committee has 25 members and can be supplemented with members appointed by the Minister.
Links:
http://www.erhvervspdh.dk

Related external organisation

The Industrial PhD Programme Committee
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

International Conference On Cognitive Systems
Period: 2008
Silvia Tolu (Participant)
Department of Electrical Engineering
Automation and Control
Centre for Playware

Description

Related event

International Conference On Cognitive Systems
02/01/2008 → …
Karlsruhe, Germany
Activity: Attending an event › Participating in or organising a conference

Member of the board of DIRA, Danish Industrial Robot Association (External organisation)
Period: 2008 → 2015
Ole Ravn (Participant)
Department of Electrical Engineering
Automation and Control
Links:
http://www.dira.dk

Related external organisation

Member of the board of DIRA, Danish Industrial Robot Association
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

Control Engineering Practice (Journal)
Period: Oct 2008 → …
Mogens Blanke (Reviewer)
Department of Electrical Engineering
Automation and Control

Description
Control Engineering Practice
Associate Editor

Related journal

Control Engineering Practice
0967-0661
Central database
Activity: Research › Journal editor

Seventh International Workshop on Information Processing in Cells and Tissues
Period: 2007
Silvia Tolu (Speaker)
Department of Electrical Engineering
Automation and Control
Centre for Playware

Description

Related event

Seventh International Workshop on Information Processing in Cells and Tissues
29/08/2007 → 31/08/2007
Oxford, United Kingdom
Activity: Talks and presentations › Conference presentations

IEEE Transactions on Aerospace and Electronic Systems (Journal)
Mogens Blanke (Editor)
Department of Electrical Engineering
Automation and Control

**Description**
Transactions on Aerospace and Electronic Systems

Technical Editor for Fault-tolerant Systems

Technical editor for Fault-tolerant Systems

**Related journal**

**IEEE Transactions on Aerospace and Electronic Systems**
0018-9251

Central database

Activity: Research › Journal editor

**International Work Conference on Artificial Neural Networks**
Period: Jun 2007

Silvia Tolu (Speaker)

Department of Electrical Engineering

Automation and Control

Centre for Playware

**Description**

**Related event**
9th International Work-Conference on Artificial Neural Networks
20/06/2007 → 22/06/2007
San Sebastián, Spain

Activity: Talks and presentations › Conference presentations

**Member of DTU Academic Council (External organisation)**
Period: 2005 → 2011
Ole Ravn (Participant)
Department of Electrical Engineering
Automation and Control

Related external organisation

Member of DTU Academic Council
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

Prizes:

Best Student Paper Award
Emil Krabbe Nielsen (Recipient)
Department of Electrical Engineering, Automation and Control

Details
Awarded date: 29 Nov 2017
Granting Organisations: Korean Nuclear Society
event: International Symposium on Future Instrumentation & Control for Nuclear Power Plants
Prize: Prizes, scholarships, distinctions

Press clippings:

New Universal Robots Driver Makes Manipulation Research Easier
Thomas Timm Andersen
09/02/2016
Automation and Control, Department of Electrical Engineering

Media contribution (1)

New Universal Robots Driver Makes Manipulation Research Easier
09/02/2016
ROS Spotlight, Web
Clearpath Robotics
http://www.clearpathrobotics.com/2016/02/new-universal-robots-driver-makes-manipulation-easier/
Thomas Timm Andersen
Automation and Control, Department of Electrical Engineering

Relations
Research outputs:
Optimizing the Universal Robots ROS driver.

Press / Media

Go morgen P3
Ole Ravn
24/06/2015

Description
Talking about Terminator
Automation and Control, Department of Electrical Engineering

Media contribution (1)

Go morgen P3
24/06/2015
Radio
Ole Ravn
Department of Electrical Engineering, Automation and Control
Press / Media
Tag iPad'en med hjem
Jari Due Jessen
23/04/2015
Automation and Control, Department of Electrical Engineering, Centre for Playware

Media contribution (1)

Tag iPad'en med hjem
23/04/2015
Børn og Unge, Print
http://www.epaper.dk/buplforbund/b%C3%B8rnogunge/2015/072015/
Interview for theme in "Børn og Unge" about digital technology and programming in daycare.
Jari Due Jessen
Centre for Playware, Automation and Control, Department of Electrical Engineering
Press / Media

Go morgen P3
Ole Ravn
28/10/2014
Automation and Control, Department of Electrical Engineering

Media contribution (1)

Go morgen P3
28/10/2014
Radio
Ole Ravn
Department of Electrical Engineering, Automation and Control
Press / Media

DR2 Morgen
Ole Ravn
24/10/2014

Subject
Robotter skal passe ebola-syge
Automation and Control, Department of Electrical Engineering

Media contribution (1)

DR2 Morgen
24/10/2014
DR2, Television
Ole Ravn
Department of Electrical Engineering, Automation and Control
Press / Media

P1 Morgen
Ole Ravn
24/10/2014

Description
For at mindske smittefaren ved den frygtede sygdom ebola skal robotter tages i brug for at handle og pleje patienter, der er ramt af sygdommen. Det mener de amerikanske myndigheder, som nu sætter gang i møder med ledende amerikanske robotforskere. Men hvad kan robotter hjælpe med - og hvilken effekt vil en ren maskinel behandling have på patienterne? Medvirkende: Ole Ravn, robotforsker, Danmarks Tekniske Universitet

Subject
USA vil bruge bedemands-robotter i kampen mod ebola
Automation and Control, Department of Electrical Engineering

Media contribution (1)
Børn koder robotter: Coding Pirates
Jari Due Jessen
20/03/2014
Automation and Control, Centre for Playware, Department of Electrical Engineering

Derfor er det smart at dreje batterierne i fjernbetjeningen
Ole Ravn
16/01/2014
Automation and Control, Department of Electrical Engineering

DR2 Dagen
Ole Ravn
18/12/2013
Automation and Control, Department of Electrical Engineering

Automatiske dræber-robotter møder kritik
Ole Ravn
31/05/2013
Automation and Control, Department of Electrical Engineering

Automatiske dræber-robotter møder kritik
31/05/2013
TV2 News, Television
http://nyhederne.tv2.dk/article.php?id=69000609:tv-automatiske-dr%C3%A6berrobotter-m%C3%B8der-kritik.html
Ole Ravn
Department of Electrical Engineering, Automation and Control
Press / Media

Aftenshowet
Ole Ravn
11/04/2013
Automation and Control, Department of Electrical Engineering

Media contribution (1)

Aftenshowet
11/04/2013
DR 1, Television
http://www.dr.dk/tv/se/aftenshowet
Ole Ravn
Department of Electrical Engineering, Automation and Control
Press / Media