Robotic system and method for manufacturing of objects

The present disclosure relates to a method and a system for manufacturing a mould (17) for creation of complex objects, such as concrete objects, by controlling and moving two end effectors (1) of a robotic system, the two end effectors (1) having a flexible cutting element (3) attached to and extending between the two end effectors (1), the method comprising the steps of: defining at least one surface (8) representing the inner surface of the mould (17); dividing the surface (8) into a number of segments represented by planar curves (9, 11, 12) on the surface (8); for each planar curve, calculating at least one elastic curve representing the planar curve; for each calculated elastic curve, calculating a set of data corresponding to placement and direction of the two end effectors (1) for configuring the flexible cutting element to a shape corresponding to the calculated elastic curve; sequentially positioning the end effectors (1) according to each set of data.
We present a numerical discretization of second order Sobolev metrics on the space of regular curves in $\mathbb{R}^d$, and methods to solve the initial and boundary value problem for geodesics allowing us to compute the Karcher mean and principal components analysis of data of curves. We apply the methods to study shape variation in synthetic data in the Kimia shape database, in HeLa cell nuclei and cycles of cardiac deformations.

Finally we investigate a new application of Riemannian shape analysis in shape optimization. We setup a simple elliptic model problem, and describe how to apply shape calculus to obtain directional derivatives in the manifold of planar curves. We present an implementation based on parametrization of immersions by B-splines, which ties in naturally with Isogeometric Analysis to solve the PDE. We give numerical examples of solutions, and compare the Riemannian optimization algorithms with different choices of metrics to a naive unregularized discretize-first approach.
Approximation by planar elastic curves

We give an algorithm for approximating a given plane curve segment by a planar elastic curve. The method depends on an analytic representation of the space of elastic curve segments, together with a geometric method for obtaining a good initial guess for the approximating curve. A gradient-driven optimization is then used to find the approximating elastic curve.
Cuttable Ruled Surface Strips for Milling

This paper proposes a novel pre-processing method for industrial robotic CNC-milling. The method targets a hybrid machining process, in which the main bulk of material is removed through robotic hot or abrasive wire cutting, after which regular CNC-machining is employed for removal of the remaining material volume. Hereby, the roughing process is significantly sped up, reducing overall machining time. We compare our method to the convex hull and remove between 5% and 75% more material; on most models we obtain a 50% improvement. Our method ensures that no overcutting happens and that the result is cuttable by wire cutting.

**General information**

State: Published
Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Mathematics, Odico Formwork Robotics Aps
Authors: Steenstrup, K. H. (Intern), Nørbjerg, T. B. (Intern), Søndergaard, A. (Ekstern), Bærentzen, J. A. (Intern), Gravesen, J. (Intern)
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Designing for hot-blade cutting: Geometric Approaches for High-Speed Manufacturing of Doubly-Curved Architectural Surfaces

In this paper we present a novel method for the generation of doubly-curved, architectural design surfaces using swept Euler elastica and cubic splines. The method enables a direct design to production workflow with robotic hot-blade cutting, a novel robotic fabrication method under development by authors of the paper, which facilitates high-speed production of doubly-curved foam moulds. Complementary to design rationalisation, in which arbitrary surfaces are translated to hot-blade-cuttable geometries, the presented method enables architects and designers to design directly with the non-trivial constraints of blade-cutting in a bottom-up fashion, enabling an exploration of the unique architectural potential of this fabrication approach. The method is implemented as prototype design tools in MatLAB, C++, GhPython, and Python and demonstrated through cutting of expanded polystyrene foam design examples.

General information
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Authors: Brander, D. (Intern), Bærentzen, J. A. (Intern), Clausen, K. (Ekstern), Fisker, A. (Intern), Gravesen, J. (Intern), Lund, M. N. (Ekstern), Narbjer, T. B. (Intern), Steenstrup, K. H. (Intern), Søndergaard, A. (Ekstern)
Pages: 306-327
Publication date: 2016

Hot Blade Cuttings for the Building Industries

The constructions of advanced architectural designs are presently very labour intensive, time consuming, and expensive. They are therefore only applied to a few prestige projects, and it is a major challenge for the building industry to bring the costs down and thereby offer the architects more variability in the (economically allowed) designs - i.e., to allow them to think out of the box. To address this challenge The Danish National Advanced Technology Foundation (now InnovationsFonden) is currently supporting the BladeRunner project that involves several Danish companies and public institutions. The project aims to reduce the amount of manual labour as well as production time by applying robots to cut expanded polystyrene (EPS) moulds for the concrete to form doubly curved surfaces. The scheme is based upon the so-called Hot Wire or Hot Blade technology where the surfaces are essentially swept out by driving an Euler elastica through a block of EPS. This paper will be centered around the mathematical challenges encountered in the implementation of this idea. Since the elastica themselves are well known and described in the works of Euler et al. already in eighteenth century, these new challenges are mainly concerned with the rationalization of the architects’ CAD drawings into surfaces that can be created via this particular sweeping and cutting technology.

General information
State: Published
Authors: Brander, D. (Intern), Bærentzen, J. A. (Intern), Evgrafov, A. (Ekstern), Gravesen, J. (Intern), Markvorsen, S. (Intern), Narbjer, T. B. (Intern), Nørtoft, P. (Intern), Steenstrup, K. H. (Intern)
Number of pages: 19
Rationalization with ruled surfaces in architecture
This thesis addresses the problems of rationalizing and segmenting large scale 3D models, and how to handle difficult production constraints in this area. The design choices when constructing large scale architecture are influenced by the budget. Therefore I strive to minimize the amount of time and material needed for production. This makes advanced free form architecture viable for low cost projects, allowing the architects to realize their designs.

By pre-cutting building blocks using hot wire robots, the amount of milling necessary can be reduced drastically. I do this by rationalizing the intended shape as a piecewise ruled surface; the developed method was able to cut away up to 95% of the excess material. Methods were developed to minimize the number of blocks necessary to build advanced large scale 3D shapes. Using stochastic optimization to guide the segmentation, it was possible to remove up to 48% of the building blocks. Hot blade cutting for constructing models with positive Gauss curvature is an upcoming technology. Three segmentation algorithms were developed to solve construction constraints that arises when using this technique. One of the algorithms focusses on creating an aesthetic segmentation.

Robotic Hot-Blade Cutting: An Industrial Approach to Cost-Effective Production of Double Curved Concrete Structures
This paper presents a novel method for cost-effective, robotic production of double curved formwork in Expanded Polystyrene (EPS) for in situ and prefabricated concrete construction. A rationalization and segmentation procedure is developed, which allows for the transliteration of double curved NURBS surfaces to Euler elastica surface segments, while respecting various constraints of production. An 18 axis, tri-robot system approximates double curved NURBS surfaces by means of an elastically deformed and heated blade, mounted on the flanges of two manipulators. Re-orienting or translating either end of the blade dynamically deforms the blade’s curvature. The blade follows the contours of the rationalized surface by continuous change in position and orientation of the end-effectors. The concept’s potential is studied by a pilot production of a full-scale demonstrator panel assembly.
Isogeometric analysis of sound propagation through laminar flow in 2-dimensional ducts

We consider the propagation of sound through a slowly moving fluid in a 2-dimensional duct. A detailed description of a flow-acoustic model of the problem using B-spline based isogeometric analysis is given. The model couples the non-linear, steady-state, incompressible Navier-Stokes equation in the laminar regime for the flow field, to a linear, time-harmonic acoustic equation in the low Mach number regime for the sound signal. B-splines are used both to represent the duct geometry and to approximate the flow and sound fields. This facilitates an exact representation of complex duct geometries, as well as high continuity approximations of state variables. Acoustic boundary conditions on artificial truncation boundaries are treated using a mode matching formulation. We validate the model against known acoustic modes for a uniform flow through a straight duct. Improved error convergence rates are found when the acoustic pressure is approximated by higher order polynomials. Based on the model, we examine how the acoustic signal varies with sound frequency, flow speed and duct geometry. A combination of duct geometry and sound frequency is identified for which the acoustic signal is particularly sensitive to the flow speed.
The Metric of Colour Space

The space of colours is a fascinating space. It is a real vector space, but no matter what inner product you put on the space the resulting Euclidean distance does not correspond to human perception of difference between colours.

In 1942 MacAdam performed the first experiments on colour matching and found the MacAdam ellipses which are often interpreted as defining the metric tensor at their centres. An important question is whether it is possible to define colour coordinates such that the Euclidean distance in these coordinates correspond to human perception.

Using cubic splines to represent the colour coordinates and an optimisation approach we find new colour coordinates that make the MacAdam ellipses closer to uniform circles than the existing standards.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Mathematics
Authors: Gravesen, J. (Intern)
Pages: 77-86
Publication date: 2015
Contaminant ingress into multizone buildings: An analytical state-space approach

The ingress of exterior contaminants into buildings is often assessed by treating the building interior as a single well-mixed space. Multizone modelling provides an alternative way of representing buildings that can estimate concentration time series in different internal locations. A state-space approach is adopted to represent the concentration dynamics within multizone buildings. Analysis based on this approach is used to demonstrate that the exposure in every interior location is limited to the exterior exposure in the absence of removal mechanisms. Estimates are also developed for the short term maximum concentration and exposure in a multizone building in response to a step-change in concentration. These have considerable potential for practical use. The analytical development is demonstrated using a simple two-zone building with an inner zone and a range of existing multizone models of residential buildings. Quantitative measures are provided of the standard deviation of concentration and exposure within a range of residential multizone buildings. Ratios of the maximum short term concentrations and exposures to single zone building estimates are also provided for the same buildings.
Differential Geometry Applied to Rings and Möbius Nanostructures

Nanostructure shape effects have become a topic of increasing interest due to advancements in fabrication technology. In order to pursue novel physics and better devices by tailoring the shape and size of nanostructures, effective analytical and computational tools are indispensable. In this chapter, we present analytical and computational differential geometry methods to examine particle quantum eigenstates and eigenenergies in curved and strained nanostructures. Example studies are carried out for a set of ring structures with different radii and it is shown that eigenstate and eigenenergy changes due to curvature are most significant for the groundstate eventually leading to qualitative and quantitative changes in physical properties. In particular, the groundstate in-plane symmetry characteristics are broken by curvature effects, however, curvature contributions can be discarded at bending radii above 50 nm. In the second part of the chapter, a more complicated topological structure, the Möbius nanostructure, is analyzed and geometry effects for eigenstate properties are discussed including dependencies on the Möbius nanostructure width, length, thickness, and strain.
Iso-geometric shape optimization of magnetic density separators

Purpose
The waste recycling industry increasingly relies on magnetic density separators. These devices generate an upward magnetic force in ferro-fluids allowing to separate the immersed particles according to their mass density. Recently, a new separator design has been proposed that significantly reduces the required amount of permanent magnet material. The purpose of this paper is to alleviate the undesired end-effects in this design by altering the shape of the ferromagnetic covers of the individual poles.

Design/methodology/approach
The paper represents the shape of the ferromagnetic pole covers with B-splines and defines a cost functional that measures the non-uniformity of the magnetic field in an area above the poles. The authors apply an iso-geometric shape optimization procedure, which allows us to accurately represent, analyze and optimize the geometry using only a few design variables. The design problem is regularized by imposing constraints that enforce the convexity of the pole cover shapes and is solved by a non-linear optimization procedure. The paper validates the implementation of the algorithm using a simplified variant of the design problem with a known analytical solution. The algorithm is subsequently applied to the problem posed.

Findings
The shape optimization attains its target and yields pole cover shapes that give rise to a magnetic field that is uniform over a larger domain.

Research limitations/implications
This increased magnetic field uniformity is obtained at the cost of a pole cover shape that differs per pole. This limitation has negligible impact on the manufacturing of the separator. The new pole cover shapes therefore lead to improved performance of the density separation.

Practical implications
Due to the larger uniformity the generated field, these shapes should enable larger amounts of waste to be processed than the previous design.

Originality/value
This paper treats the shapes optimization of magnetic density separators systematically and presents new shapes for the ferromagnetic poles covers.
Planar Parametrization in Isogeometric Analysis

Before isogeometric analysis can be applied to solving a partial differential equation posed over some physical domain, one needs to construct a valid parametrization of the geometry. The accuracy of the analysis is affected by the quality of the parametrization. The challenge of computing and maintaining a valid geometry parametrization is particularly relevant in applications of isogemetric analysis to shape optimization, where the geometry varies from one optimization iteration to another. We propose a general framework for handling the geometry parametrization in isogeometric analysis and shape optimization. It utilizes an expensive non-linear method for constructing/updating a high quality reference parametrization, and an inexpensive linear method for maintaining the parametrization in the vicinity of the reference one. We describe several linear and non-linear parametrization methods, which are suitable for our framework. The non-linear methods we consider are based on solving a constrained optimization problem numerically, and are divided into two classes, geometry-oriented methods and analysis-oriented methods. Their performance is illustrated through a few numerical examples.
Isogeometric shape optimization in fluid mechanics

The subject of this work is numerical shape optimization in fluid mechanics, based on isogeometric analysis. The generic goal is to design the shape of a 2-dimensional flow domain to minimize some prescribed objective while satisfying given geometric constraints. As part of the design problem, the steady-state, incompressible Navier-Stokes equations, governing a laminar flow in the domain, must be solved. Based on isogeometric analysis, we use B-splines as the basis for both the design optimization and the flow analysis, thereby unifying the models for geometry and analysis, and, at the same time, facilitating a compact representation of complex geometries and smooth approximations of the flow fields. To drive the shape optimization, we use a gradient-based approach, and to avoid inappropriate parametrizations during optimization, we regularize the optimization problem by adding to the objective function a measure of the quality of the boundary parametrization. A detailed description of the methodology is given, and three different numerical examples are considered, through which we investigate the effects of the regularization, of the number of geometric design variables, and of variations in the analysis resolution, initial design and Reynolds number, and thereby demonstrate the robustness of the methodology.

General information

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Organisations: Department of Applied Mathematics and Computer Science, Scientific Computing, Mathematics
Authors: Nørtoft, P. (Intern), Gravesen, J. (Intern)
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  Scopus rating (2015): CiteScore 2.42

Optical scanning is rapidly becoming ubiquitous. From industrial laser scanners to medical CT, MR and 3D ultrasound scanners, numerous organizations now have easy access to optical acquisition devices that provide huge volumes of image data. However, the raw geometry data acquired must first be processed before it is useful.

This Guide to Computational Geometry Processing reviews the algorithms for processing geometric data, with a practical focus on important techniques not covered by traditional courses on computer vision and computer graphics. This is balanced with an introduction to the theoretical and mathematical underpinnings of each technique, enabling the reader to not only implement a given method, but also to understand the ideas behind it, its limitations and its advantages.

Topics and features:

- Presents an overview of the underlying mathematical theory, covering vector spaces, metric space, affine spaces, differential geometry, and finite difference methods for derivatives and differential equations
- Reviews geometry representations, including polygonal meshes, splines, and subdivision surfaces
- Examines techniques for computing curvature from polygonal meshes
- Describes algorithms for mesh smoothing, mesh parametrization, and mesh optimization and simplification
- Discusses point location databases and convex hulls of point sets
Investigates the reconstruction of triangle meshes from point clouds, including methods for registration of point clouds and surface reconstruction.

Provides additional material at a supplementary website.

Includes self-study exercises throughout the text.

Graduate students will find this text a valuable, hands-on guide to developing key skills in geometry processing. The book will also serve as a useful reference for professionals wishing to improve their competency in this area.

**General information**

State: Published

Organisations: Department of Informatics and Mathematical Modeling, Image Analysis and Computer Graphics, Department of Mathematics, Geometry

Authors: Bærentzen, J. A. (Intern), Gravesen, J. (Intern), Anton, F. (Intern), Aanæs, H. (Intern)

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**Isogeometric analysis and shape optimization in electromagnetism**

In this thesis a recently proposed numerical method for solving partial differential equations, isogeometric analysis (IGA), is utilized for the purpose of shape optimization, with a particular emphasis on applications to two-dimensional design problems arising in electromagnetic applications. The study is motivated by the fact that in contrast with most commonly utilized finite element approximations, IGA allows one to exactly represent geometries arising in computer aided design applications with relatively few variables using splines. The following problems coming from theoretical considerations or engineering applications are solved in the thesis utilizing IGA: finding a shape having a few prescribed eigenvalues of the Laplace operator; shape optimization of sub-wavelength micro-antennas for energy concentration; shape optimization of nano-antennas for field enhancement; economical design of magnetic density separators. From the point of view of method development, several heuristic approaches for extending a valid parametrization of the boundary onto the domain's interior are examined in the thesis. The parametrization approaches and a method for validating a spline parametrization are combined into an iterative algorithm for shape optimization of two dimensional electromagnetic problems. The algorithm may also be relevant for problems in other engineering disciplines. Using the methods developed in this thesis, remarkably we have obtained antennas that perform one million times better than an earlier topology optimization result. This shows a great potential of shape optimization using IGA in the area of electromagnetic antenna design in particular, and for electromagnetic

**General information**

State: Published

Organisations: Geometry, Department of Mathematics, Applied functional analysis

Authors: Nguyen, D. M. (Intern), Gravesen, J. (Intern), Evgrafov, A. (Intern)

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Isogeometric Analysis and Shape Optimization in Fluid Mechanics

This thesis brings together the fields of fluid mechanics, as the study of fluids and flows, isogeometric analysis, as a numerical method to solve engineering problems using computers, and shape optimization, as the art of finding "best" shapes of objects based on some notion of goodness. The flow problems considered in the thesis are governed by the 2-dimensional, steady-state, incompressible Navier-Stokes equations at low to moderate Reynolds numbers. We use isogeometric analysis both to solve the governing equations, and as framework for the shape optimization procedure. Isogeometric analysis unites the power to solve complex engineering problems from finite element analysis (FEA) with the ability to effectively represent complex shapes from computer aided design (CAD). The methodology is appealing for flow modeling purposes also due to the inherent high regularity of velocity and pressure approximations, and for shape optimization purposes also due to its tight connection between the analysis and geometry models. The thesis is initiated by short introductions to fluid mechanics, and to the building blocks of isogeometric analysis. As the first contribution of the thesis, a detailed description is given of how isogeometric analysis is applied to flow problems. We present several new discretizations of the velocity and pressure spaces, we investigate these in terms of stability and error convergence properties, and a benchmark flow problem is analyzed. As the second contribution, we show how isogeometric analysis may serve as a natural framework for shape optimization within fluid mechanics. We construct an efficient regularization measure for avoiding inappropriate parametrizations during optimization, and various numerical examples of shape optimization for fluids are considered, serving to demonstrate the robustness of the method. As the third contribution, the methodology is extended to acoustics. We establish a coupled flow-acoustic model of sound propagation through flow in ducts based on isogeometric analysis. Validations using known acoustic duct modes demonstrate the powers of the methodology. Based on the model, we identify distinct geometric effects that enhance the sensitivity of the acoustic signal to the background flow. The thesis is concluded by suggestions for future studies within the field.

General information
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Organisations: Geometry, Department of Mathematics, Department of Mechanical Engineering, Solid Mechanics
Authors: Nielsen, P. N. (Intern), Gravesen, J. (Intern), Gersborg, A. R. (Intern), Pedersen, N. L. (Intern)
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ISOGEOMETRIC SHAPE OPTIMIZATION FOR ELECTROMAGNETIC SCATTERING PROBLEMS

We consider the benchmark problem of magnetic energy density enhancement in a small spatial region by varying the shape of two symmetric conducting scatterers. We view this problem as a prototype for a wide variety of geometric design problems in electromagnetic applications. Our approach for solving this problem is based on shape optimization and isogeometric analysis. One of the major difficulties we face to make these methods work together is the need to maintain a valid parametrization of the computational domain during the optimization. Our approach to generating a domain parametrization is based on minimizing a second order approximation to the Winslow functional in the vicinity of a reference parametrization. Furthermore, we enforce the validity of the parametrization by ensuring the non-negativity of the coefficients of a B-spline expansion of the Jacobian. The shape found by this approach outperforms earlier design computed using topology optimization by a factor of one billion.

General information
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Organisations: Department of Mathematics, Applied functional analysis, Department of Informatics and Mathematical Modeling, SINTEF Information and Communication Technology
Authors: Nguyen, D. M. (Ekstern), Evgrafov, A. (Intern), Gravesen, J. (Intern)
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Strong curvature effects in Neumann wave problems

Waveguide phenomena play a major role in basic sciences and engineering. The Helmholtz equation is the governing equation for the electric field in electromagnetic wave propagation and the acoustic pressure in the study of pressure dynamics. The Schro"dinger equation simplifies to the Helmholtz equation for a quantum-mechanical particle confined by infinite barriers relevant in semiconductor physics. With this in mind and the interest to tailor waveguides towards a desired spectrum and modal pattern structure in classical structures and nanostructures, it becomes increasingly important to understand the influence of curvature effects in waveguides. In this work, we demonstrate analytically strong curvature effects for the eigenvalue spectrum of the Helmholtz equation with Neumann boundary conditions in cases where the waveguide cross section is a circular sector. It is found that the linear-in-curvature contribution originates from parity symmetry breaking of eigenstates in circular-sector tori and hence vanishes in a torus with a complete circular cross section. The same strong curvature effect is not present in waveguides subject to Dirichlet boundary conditions where curvature contributions contribute to second-order in the curvature only. We demonstrate this finding by considering wave propagation in a circular-sector torus corresponding to Neumann and Dirichlet boundary conditions, respectively. Results for relative eigenfrequency shifts and modes are determined and compared with three-dimensional finite element method results. Good agreement is found between the present analytical method using a combination of differential geometry with perturbation theory and finite element results for a large range of curvature ratios.

General information

State: Published
Organisations: Department of Mathematics, Geometry, University of Southern Denmark
Authors: Willatzen, M. (Intern), Pors, A. (Forskerdatabase), Gravesen, J. (Intern)
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BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.737 SNIP 1.231 CiteScore 1.434
Discretizations in isogeometric analysis of Navier-Stokes flow

This paper deals with isogeometric analysis of 2-dimensional, steady state, incompressible Navier-Stokes flow subjected to Dirichlet boundary conditions. We present a detailed description of the numerical method used to solve the boundary value problem. Numerical inf-sup stability tests for the simplified Stokes problem confirm the existence of many stable discretizations of the velocity and pressure spaces, and in particular show that stability may be achieved by means of knot refinement of the velocity space. Error convergence studies for the full Navier-Stokes problem show optimal convergence rates for this type of discretizations. Finally, a comparison of the results of the method to data from the literature for the lid-driven square cavity for Reynolds numbers up to 10,000 serves as benchmarking of the discretizations and confirms the robustness of the method. © 2011 Elsevier B.V.
Effects of hydrostatic strain on eigenstates of Möbius strips

In this paper we theoretically investigate the allowed energies and associate wave-functions for Möbius strips with varying thicknesses. We show that the induced strain in fabricating these Möbius strips will have a pronounced impact on the energies and wave-functions for thick strips, while for thin strips the impact of strain is negligible. We furthermore show that a simpler strain free approximate theory based on differential geometry is in excellent agreement with detailed finite element calculations. © 2011 IEEE.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, University of Southern Denmark
Authors: Lassen, B. (Ekstern), Willatzen, M. (Intern), Gravesen, J. (Intern)
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Efficiency of a gyroscopic device for conversion of mechanical wave energy to electrical energy: Technical report from ESGI-83 workshop in industrial mathematics 2011

We consider a recently proposed gyroscopic device for conversion of mechanical ocean wave energy to electrical energy. Two models of the device derived from standard engineering mechanics from the literature are analysed, and a model is derived from analytical mechanics considerations. From these models, estimates of the power production, efficiency, forces and moments are made. We find that it is possible to extract a significant amount of energy from an ocean wave using the described device. Further studies are required for a full treatment of the device.

General information
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Isogeometric Analysis and Shape Optimisation

One of the attractive features of isogeometric analysis is the exact representation of the geometry. The geometry is furthermore given by a low number of control points and this makes isogeometric analysis an ideal basis for shape optimisation. One of the problems is that the geometry of the shape is given by the boundary alone. And, it is the parametrisation of the boundary which is changed by the optimisation procedure. But isogeometric analysis requires a parametrisation of the whole domain. So in every optimisation cycle we need to extend a parametrisation of the boundary of a domain to the whole domain. It has to be fast in order not to slow the optimisation down but it also has to be robust and give a parametrisation of high quality. These are conflicting requirements so we propose the following approach. During the optimisation a fast linear method is used, but if the parametrisation becomes singular or close to singular then the optimisation is stopped and the parametrisation is improved using a nonlinear method. The optimisation then continues using a linear method. We will explain how the validity of a parametrisation can be checked and we will describe various ways to parametrise a domain. We will in particular study the Winslow functional which turns out to have some desirable properties. Other problems we touch upon is clustering of boundary control points (design variables) and self intersection of the design. The first problem can be solved by a suitable regularisation and the latter by a method that resembles how the validity of the parametrisation is secured.

General information
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Organisations: Geometry, Department of Mathematics, Applied functional analysis, Department of Mechanical Engineering
Authors: Gravesen, J. (Intern), Evgrafov, A. (Intern), Gersborg, A. R. (Intern), Nguyen, D. M. (Intern), Nielsen, P. N. (Intern)
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Isogeometric Shape Optimization of Vibrating Membranes

We consider a model problem of isogeometric shape optimization of vibrating membranes whose shapes are allowed to vary freely. The main obstacle we face is the need for robust and inexpensive extension of a B-spline parametrisation from the boundary of a domain onto its interior, a task which has to be performed in every optimization iteration. We experiment with two numerical methods (one is based on the idea of constructing a quasi-conformal mapping, whereas the other is based on a spring-based mesh model) for carrying out this task, which turn out to work sufficiently well in the present situation. We perform a number of numerical experiments with our isogeometric shape optimization algorithm and present smooth, optimized membrane shapes. Our conclusion is that isogeometric analysis fits well with shape optimization.

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BFI (2016): BFI-level 2
Möbius semiconductor nanostructures and deformation potential strain effects

A discussion of Möbius nanostructures is presented with focus on (1) the accuracy of the approximate differential-geometry formalism by Gravesen and Willatzen and (2) to assess the influence of bending-induced strain on Schrödinger equation eigenstates in semiconductor Möbius structures. The differential-geometry model assumed complete...
confinement of a quantum-mechanical particle to a zero-thickness Möbius structure where the shape was computed based on minimization of elastic bending energy only and imposing the relevant boundary conditions. In the latter work, while bending was accounted for in finding the shape of the Möbius structure it was, for simplicity, neglected altogether in determining the direct strain influence on electronic eigenstates. However, as is well-known, deformation-potential strain effects in many semiconductor materials can lead to important changes in not only the energy levels but, perhaps more so, the symmetry of the associated eigenstates and, henceforth, optical and electronic properties. In this, work we investigate finite-thickness effects of different-sized Möbius structures as well as deformation-potential hydrostatic strain implications using the Finite Element Model commercial software COMSOL. The paper contains a detailed comparison of general Finite Element Model results with the differential geometry method. Copyright © 2011 American Scientific Publishers All rights reserved.

**On the sensitivities of multiple eigenvalues**

We consider the generalized symmetric eigenvalue problem where matrices depend smoothly on a parameter. It is well known that in general individual eigenvalues, when sorted in accordance with the usual ordering on the real line, do not depend smoothly on the parameter. Nevertheless, symmetric polynomials of a number of eigenvalues, regardless of their multiplicity, which are known to be isolated from the rest depend smoothly on the parameter. We present explicit readily computable expressions for their first derivatives. Finally, we demonstrate the utility of our approach on a problem of finding a shape of a vibrating membrane with a smallest perimeter and with prescribed four lowest eigenvalues, only two of which have algebraic multiplicity one.

**General information**

State: Published
Organisations: Geometry, Department of Mathematics
Authors: Gravesen, J. (Intern), Evgrafov, A. (Intern), Nguyen, D. M. (Intern)
Pages: 583-587
Analytic theory of curvature effects for wave problems with general boundary conditions

A formalism based on a combination of differential geometry and perturbation theory is used to obtain analytic expressions for confined eigenmode changes due to general curvature effects. In cases of circular-shaped and helix-shaped structures, where alternative analytic solutions can be found, the perturbative solution is shown to yield the same result. The present technique allows the generalization of earlier results to arbitrary boundary conditions. The power of the method is illustrated using examples based on Maxwell's and Schrödinger's equations for applications in photonics and nanoelectronics.

General information
State: Published
Organisations: Geometry, Department of Mathematics, Wright State University
Authors: Willatzen, M. (Intern), Gravesen, J. (Intern), Voon, L. C. L. Y. (Ekstern)
Pages: 060102
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Physical Review A (Atomic, Molecular and Optical Physics)
Volume: 81
Issue number: 6
ISSN (Print): 1050-2947
Ratings:
  BFI (2017): BFI-level 1
  Web of Science (2017): Indexed yes
  BFI (2016): BFI-level 1
  Scopus rating (2016): CiteScore 2.25 SJR 1.281 SNIP 0.852
  Web of Science (2016): Indexed yes
  BFI (2015): BFI-level 1
  Scopus rating (2015): SJR 1.451 SNIP 0.903 CiteScore 2.06
  Web of Science (2015): Indexed yes
  BFI (2014): BFI-level 1
  Scopus rating (2014): SJR 2.121 SNIP 1.146 CiteScore 2.46
  Web of Science (2014): Indexed yes
  BFI (2013): BFI-level 1
  Scopus rating (2013): SJR 2.317 SNIP 1.179 CiteScore 2.86
  ISI indexed (2013): ISI indexed yes
  Web of Science (2013): Indexed yes
  BFI (2012): BFI-level 1
  Scopus rating (2012): SJR 2.515 SNIP 1.239 CiteScore 2.81
  ISI indexed (2012): ISI indexed yes
  Web of Science (2012): Indexed yes
  BFI (2011): BFI-level 1
  Scopus rating (2011): SJR 2.31 SNIP 1.261 CiteScore 2.79
  ISI indexed (2011): ISI indexed yes
  Web of Science (2011): Indexed yes
  BFI (2010): BFI-level 1
  Scopus rating (2010): SJR 2.403 SNIP 1.22
  Web of Science (2010): Indexed yes
  BFI (2009): BFI-level 1
  Scopus rating (2009): SJR 2.475 SNIP 1.305
  Web of Science (2009): Indexed yes
  BFI (2008): BFI-level 1
  Scopus rating (2008): SJR 2.559 SNIP 1.241
  Web of Science (2008): Indexed yes
  Scopus rating (2007): SJR 2.618 SNIP 1.259
  Web of Science (2007): Indexed yes
Electron conductance in curved quantum structures

A differential-geometry analysis is employed to investigate the transmission of electrons through a curved quantum-wire structure. Although the problem is a three-dimensional spatial problem, the Schrodinger equation can be separated into three general coordinates. Hence, the proposed method is computationally fast and provides direct (geometrical) parameter insight as regards the determination of the electron transmission coefficient. We present, as a case study, calculations of the electron conductivity of a helically shaped quantum-wire structure and discuss the influence of the quantum-wire centerline radius of curvature and pitch length for the conductivity versus the chemical potential.
Isogeometric analysis and shape optimisation

General information
State: Published
Organisations: Geometry, Department of Mathematics, Applied functional analysis, Department of Mechanical Engineering
Authors: Gravesen, J. (Intern), Evgrafov, A. (Intern), Gersborg, A. R. (Intern), Nguyen, D. M. (Intern), Nielsen, P. N. (Intern)
Pages: 14-17
Publication date: 2010

Host publication information
Title of host publication: Proceedings of NSCM-23
Editors: Erikson, A., Tibert, G.
Main Research Area: Technical/natural sciences
Conference: 23rd Nordic Seminar on Computational Mechanics, Stockholm, Sweden, 21/10/2010 - 21/10/2010
Source: orbit
Source-ID: 268625
Publication: Research › Article in proceedings – Annual report year: 2010
Isogeometric Design of Vibrating Membranes

General information
State: Published
Organisations: Geometry, Department of Mathematics, Department of Mechanical Engineering
Authors: Nguyen, D. M. (Intern), Evgrafov, A. (Intern), Grøvesen, J. (Intern), Jensen, J. S. (Intern)
Publication date: 2010

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 271881
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Isogeometric Shape Optimization

General information
State: Published
Organisations: Department of Mathematics, Department of Mechanical Engineering
Authors: Nielsen, P. N. (Intern), Nguyen, D. M. (Intern), Evgrafov, A. (Intern), Gersborg, A. R. (Intern), Grøvesen, J. (Intern)
Publication date: 2010

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 272282
Publication: Research › Sound/Visual production (digital) – Annual report year: 2010

Isogeometric Shape Optimization of freely varying shapes

General information
State: Published
Organisations: Geometry, Department of Mathematics, Applied functional analysis, Department of Mechanical Engineering
Authors: Nguyen, D. M. (Intern), Evgrafov, A. (Intern), Gersborg, A. R. (Intern), Grøvesen, J. (Intern)
Publication date: 2010
Event: Abstract from 9th World Congress on Computational Mechanics and 4th Asian Pacific Congress on Computational Mechanics, Sydney, Australia, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 272284
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2010

Isogeometric Shape Optimization of Vibrating Membranes
Isogeometric Shape Optimization of Vibrating Membranes

General information
State: Published
Organisations: Geometry, Department of Mathematics, Applied functional analysis, Department of Mechanical Engineering
Authors: Nguyen, D. M. (Intern), Evgrafov, A. (Intern), Gersborg, A. R. (Intern), Gravesen, J. (Intern)
Publication date: 2010

Host publication information
Title of host publication: ECCM 2010
Main Research Area: Technical/natural sciences
Conference: 4th European Conference on Computational Mechanics, Paris, France, 16/05/2010 - 16/05/2010
Source: orbit
Source-ID: 275472
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Iso-geometric Analysis and Shape Optimization in Mechanics

General information
State: Published
Organisations: Department of Mathematics, Solid Mechanics, Department of Mechanical Engineering, Geometry
Authors: Nielsen, P. N. (Intern), Gersborg, A. R. (Intern), Gravesen, J. (Intern)
Publication date: 2009

Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 257712
Publication: Research › Poster – Annual report year: 2009

Iso-geometric Analysis in Structural Analysis

General information
State: Published
Organisations: Department of Mathematics, Applied functional analysis, Solid Mechanics, Department of Mechanical Engineering, Geometry
Authors: Nguyen, D. M. (Intern), Evgrafov, A. (Intern), Gersborg, A. R. (Intern), Gravesen, J. (Intern)
Publication date: 2009

Event: Poster session presented at DCAMM 12th Internal Symposium, Ringsted, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 257742
Publication: Research - peer-review › Poster – Annual report year: 2009

Iso-geometric Analysis in Structural Vibrations

General information
State: Published
Organisations: Department of Mathematics, Solid Mechanics, Department of Mechanical Engineering, Geometry
Authors: Nielsen, P. N. (Intern), Gersborg, A. R. (Intern), Gravesen, J. (Intern)
Isogeometric Design of Vibrating Membranes

General information
State: Published
Organisations: Department of Mathematics, Applied functional analysis, Solid Mechanics, Department of Mechanical Engineering, Geometry
Authors: Nguyen, D. M. (Intern), Evgrafov, A. (Intern), Gersborg, A. R. (Intern), Gravesen, J. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 257743
Publication: Research - peer-review › Poster – Annual report year: 2009

Parametrisation in Isogeometric Analysis: A first report

General information
State: Published
Organisations: Department of Mathematics, Department of Mechanical Engineering
Authors: Nguyen, D. M. (Intern), Nielsen, P. N. (Intern), Gersborg, A. R. (Intern), Evgrafov, A. (Intern), Gravesen, J. (Intern)
Number of pages: 10
Publication date: 2009

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
first-report.pdf
Source: orbit
Source-ID: 255351
Publication: Research › Report – Annual report year: 2009

Curves and surfaces represented by polynomial support functions
This paper studies shapes (curves and surfaces) which can be described by (piecewise) polynomial support functions. The class of these shapes is closed under convolutions, offsetting, rotations and translations. We give a geometric discussion of these shapes and present methods for the approximation of general curves and surfaces by them. Based on the rich theory of spherical spline functions, this leads to computational techniques for rational curves and surfaces with rational offsets, which can deal with shapes without inflections/parabolic points.

General information
State: Published
Organisations: Geometry, Department of Mathematics
Authors: Sir, Z. (Ekstern), Gravesen, J. (Intern), Juttler, B. (Ekstern)
Pages: 141-157
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Theoretical Computer Science
Volume: 392
Issue number: 1-3
ISSN (Print): 0304-3975
Ratings:
BFI (2017): BFI-level 2
Design for Change

General information
State: Published
Organisations: Geometry, Department of Mathematics
Electron states in curved quantum structures with varying radius

The influence of size and shape is investigated for quantum-dot electronic states and intra-band oscillator strengths adapting a method originally due to Stevenson. The present work solves the one-band envelope-function problem for conduction-band eigenstates in the framework of k⋅p theory using general curved coordinates. The eigenstates found are subsequently employed to express intra-band oscillator strengths and emphasis is given to the dependence of oscillator strengths on quantum-dot size and shape. We finally provide four simple examples.

General information
State: Published
Organisations: Geometry, Department of Mathematics
Authors: Gravesen, J. (Intern), Willatzen, M. (Intern)
Pages: 441-444
Publication date: 2008
Conference: Physics of Light-Matter in Nanostructures, Havana, Cuba, 01/01/2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Superlattices and Microstructures
Volume: 43
Issue number: 5-6
ISSN (Print): 0749-6036
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
Scopus rating (2016): SJR 0.583 SNIP 0.994 CiteScore 2.09
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.583 SNIP 1.007 CiteScore 2.21
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.62 SNIP 1.032 CiteScore 2.18
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.66 SNIP 1.006 CiteScore 2.19
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.59 SNIP 0.833 CiteScore 1.59
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.707 SNIP 0.836 CiteScore 1.47
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.717 SNIP 0.642
On rationally supported surfaces

We analyze the class of surfaces which are equipped with rational support functions. Any rational support function can be decomposed into a symmetric (even) and an antisymmetric (odd) part. We analyze certain geometric properties of surfaces with odd and even rational support functions. In particular it is shown that odd rational support functions correspond to those rational surfaces which can be equipped with a linear field of normal vectors, which were discussed by Sampoli et al. (Sampoli, M.L., Peternell, M., Juttler, B., 2006. Rational surfaces with linear normals and their convolutions with rational surfaces. Comput. Aided Geom. Design 23, 179-192). As shown recently, this class of surfaces includes non-developable quadratic triangular Bezier surface patches (Lavicka, M., Bastl, B., 2007. Rational hypersurfaces with rational convolutions. Comput. Aided Geom. Design 24, 410-426; Peternell, M., Odehnal, B., 2008. Convolution surfaces of quadratic triangular Bezier surfaces. Comput. Aided Geom. Design 25, 116-129).
The geometry of the Moineau pump

General information
State: Published
Organisations: Geometry, Department of Mathematics
Authors: Gravesen, J. (Intern)
Pages: 792-800
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Computer-Aided Geometric Design
Volume: 25
Issue number: 9
ISSN (Print): 0167-8396
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 0.753 SNIP 1.126 CiteScore 1.55
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.961 SNIP 1.618 CiteScore 1.71
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.404 SNIP 2.05 CiteScore 2.09

rational support function, LN-surfaces, triangular quadratic Bezier surface patches
DOIs:
10.1016/j.cagd.2007.10.005
Source: orbit
Source-ID: 222084
Publication: Research - peer-review › Journal article – Annual report year: 2008
Approximating Offsets of Surfaces by using the Support Function Representation

General information
State: Published
Organisations: Geometry, Department of Mathematics, Charles University, Johannes Kepler University of Linz
Authors: Gravesen, J. (Intern), Jüttler, B. (Ekstern), Šír, Z. (Ekstern)
Pages: 719-723
Publication date: 2007

Host publication information
Title of host publication: Progress in Industrial Mathematics at ECMI 2006
Publisher: Springer Verlag
ISBN (Print): 978-3-540-71991-5
Main Research Area: Technical/natural sciences
Conference: European Conference on Mathematics for Industry, Madrid, Spain, 01/01/2006
Source: orbit
Source-ID: 198838
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

Computing Convolutions and Minkowski sums via Support Functions

General information
State: Published
Organisations: Geometry, Department of Mathematics, Charles University, Johannes Kepler University of Linz
Authors: Šír, Z. (Ekstern), Gravesen, J. (Intern), Jüttler, B. (Ekstern)
Pages: 244-253
Surfaces parametrised by the normals

For a surface with non vanishing Gaussian curvature the Gauss map is regular and can be inverted. This makes it possible to use the normal as the parameter, and then it is trivial to calculate the normal and the Gauss map. This in turns makes it easy to calculate offsets, the principal curvatures, the principal directions, etc. Such a parametrization is not only a theoretical possibility but can be used concretely. One way of obtaining this parametrization is to specify the support function as a function of the normal, i.e., as a function on the unit sphere. The support function is the distance from the origin to the tangent plane and the surface is simply considered as the envelope of its family of tangent planes. Suppose we are given points and normals and we want a $C^k$-surface interpolating these data. The data gives the value and gradients of the support function at certain points (the given normals) on the unit sphere, and the surface can be defined by determining the support function as a $C^k$ function interpolating the given values and gradients.
Surfaces with Piecewise Linear Support Functions over Spherical Triangulations

General information
State: Published
Organisations: Section for Structural Engineering, Department of Civil Engineering, Geometry, Department of Mathematics, Charles University, Johannes Kepler University of Linz
Authors: Almegaard, H. (Intern), Bagger, A. (Intern), Gravesen, J. (Intern), Jüttler, B. (Ekstern), Šír, Z. (Ekstern)
Pages: 42-63
Publication date: 2007

Host publication information
Title of host publication: Mathematics of Surfaces XII
Publisher: Springer Verlag
Editors: Martin, R., Sabin, M., Winkler, J.
ISBN (Print): 978-3-540-73842-8
Series: Lecture Notes in Computer Science
Number: 4647
Main Research Area: Technical/natural sciences
Conference: Mathematics of Surfaces, Sheffield, England, 01/01/2007
Source: orbit
Source-ID: 198837
Publication: Research - peer-review › Conference article – Annual report year: 2007

Acoustic waves in a medium bounded by curved surfaces

General information
State: Published
Organisations: Geometry, Department of Mathematics
Authors: Willatzen, M. (Ekstern), Gravesen, J. (Intern)
Pages: 46-58
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Sound and Vibration
Volume: 296
ISSN (Print): 0022-460X
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Determination of Distance from a 2D Picture

General information
Electronic structure of helically coiled carbon nanotubes

General information
State: Published
Organisations: Geometry, Department of Mathematics
Quantum eigenstates of curved nanowire structures

General information
State: Published
Organisations: Geometry, Department of Mathematics
Authors: Gravesen, J. (Intern), Willatzen, M. (Ekstern)
Pages: 112-119
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Physica B: Physics of Condensed Matter
Volume: 371
Issue number: 1
ISSN (Print): 0921-4526
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.39 SJR 0.455 SNIP 0.848
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.488 SNIP 0.849 CiteScore 1.41
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.553 SNIP 0.942 CiteScore 1.45
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.555 SNIP 0.998 CiteScore 1.41
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.583 SNIP 0.888 CiteScore 1.21
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.586 SNIP 0.809 CiteScore 1.13
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.582 SNIP 0.707
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.594 SNIP 0.707
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.582 SNIP 0.646
Scopus rating (2007): SJR 0.551 SNIP 0.619
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.541 SNIP 0.617
Beneath the Wheel - Greenwood Engineering
This is the report from the 54th European Study Group with Industry of the Greenwood Engineering problem. We model pavement response to both a point and distributed loads and compare with data from Greenwood’s High Speed Deflectograph Measurements.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Mathematics, Department of Mathematics, Technical University of Denmark
Authors: Dias, K. (Intern), Gravesen, J. (Intern), Hjorth, P. G. (Intern), Larsen, P. (Ekstern), Please, C. (Ekstern), Radulovic, N. (Ekstern), Wang, L. (Ekstern), Aagaard Pedersen, L. (Ekstern)
Number of pages: 14
Publication date: 2005

Publication information
Publisher: University of Southern Denmark
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
greenwood.pdf

Bibliographical note
ESGI-54 Final Report
Source: orbit
Source-ID: 186289
Publication: Research › Report – Annual report year: 2005

Curved nanowire structures

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern), Willatzen, M. (Ekstern)
Publication date: 2005
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 183957
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2005

Eigenstates of Mobius nanostructures including curvature effects

General information
State: Published
Electronic structure of helically coiled carbon nanotubes

General information
State: Published
Organisations: Department of Mathematics
Authors: Guzmán-Verri, G. (Ekstern), Voon, L. L. Y. (Ekstern), Willatzen, M. (Ekstern), Gravesen, J. (Intern)
Publication date: 2005
Event: Poster session presented at 2005 Material Research Society Fall Meeting & Exhibit, Boston, MA, United States.
Main Research Area: Technical/natural sciences

Measuring glucose content in the aqueous humor

General information
State: Published
Organisations: Department of Mathematics
Authors: Aguareles, M. (Ekstern), Fozard, J. (Ekstern), Gravesen, J. (Intern), Hinch, R. (Ekstern), Hjorth, P. G. (Intern), Kaouri, K. (Ekstern), Parker, D. (Ekstern), Willatzen, M. (Ekstern)
Publication date: 2005

Host publication information
Title of host publication: Final report from 49th European Study Group with Industry
Place of publication: Oxford
Publisher: Smith Institute
Main Research Area: Technical/natural sciences
Conference: 49th European Study Group with Industry, Oxford, 01/01/2004
Source: orbit
Source-ID: 183983
Publication: Research - peer-review ▶ Article in proceedings – Annual report year: 2005

Piecewise planar Möbius bands
It is shown that a closed polygon with an odd number of vertices is the median of exactly one piecewise planar cylinder and one piecewise planar Möbius band, intersecting each other orthogonally. A closed polygon with an even number of vertices is in the generic case neither the median of a piecewise planar cylinder nor the median of a piecewise planar Möbius band. In special cases it is however the median of either a one-parameter family of piecewise planar cylinders or of a one-parameter family of piecewise planar Möbius bands.

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Publication date: 2005
Quantum-Mechanical Particle Confined to Surfaces of Revolution - Truncated Cone and Elliptic Torus Case Studies

The theory of a quantum-mechanical particle confined to a surface of revolution is described using differential geometry methods including the derivation of a general set of three ordinary differential equations in curved coordinates. The problem is shown to be completely separable with the present hard-wall boundary conditions. Two case studies of recent experimental interest, the nanocone and torus-shaped nanoring structures, are analyzed in terms of eigenstates, energies, and symmetry characteristics based on the theory presented.

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern), Willatzen, M. (Ekstern), Voon, L. L. Y. (Ekstern)
Pages: 105-111
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Physica Scripta
Volume: 72
Issue number: 2-3
ISSN (Print): 0031-8949
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.84
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.64
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.62
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.61
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.67
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.85
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
BFI (2008): BFI-level 1
Web of Science (2006): Indexed yes
Web of Science (2005): Indexed yes
Web of Science (2004): Indexed yes
Web of Science (2002): Indexed yes
Web of Science (2000): Indexed yes
Original language: English
DOIs:
Schrödinger eigenstates for surface-confinement problems

General information
State: Published
Organisations: Department of Mathematics
Authors: Willatzen, M. (Ekstern), Gravesen, J. (Intern), Voon, L. L. Y. (Ekstern)
Publication date: 2005
Main Research Area: Technical/natural sciences
Source: orbit
Publication: Research - peer-review › Journal article – Annual report year: 2005

Schrödinger problems for surfaces of revolution - the finite cylinder as a test example

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern), Willatzen, M. (Ekstern), Voon, L. L. Y. (Ekstern)
Pages: 012107
Publication date: 2005
Main Research Area: Technical/natural sciences
Source: orbit
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2005

Space curves parametrized by arc length on the tangent image

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Publication date: 2005
Event: Abstract from SIAM conference on geometric design and computing, Phoenix, USA,
Main Research Area: Technical/natural sciences
Source: orbit
Publication: Research - peer-review › Journal article – Annual report year: 2005

Spatial emission characteristics of waveguiding organic nanofibers

General information
State: Published
Organisations: Department of Mathematics
Authors: Frese, R. (Ekstern), Maibohm, C. (Ekstern), Gravesen, J. (Intern), Willatzen, M. (Ekstern), Rubahn, H. (Ekstern)
Publication date: 2005
Event: Poster session presented at German Physical Society Annual Meeting: Symposium Organic Optoelectronics and Photonics, SYOO 6.44,
Main Research Area: Technical/natural sciences
Source: orbit
Publication: Research - peer-review › Poster – Annual report year: 2005
The Cut Locus of a Torus of Revolution

We determine the structure of the cut locus of a class of tori of revolution, which includes the standard tori in 3-dimensional Euclidean space.
Waveguiding in organic nanofibers: measurements and simulations

General information
State: Published
Organisations: Department of Mathematics
Authors: Frese, R. (Ekstern), Brewer, J. (Ekstern), Maibohm, C. (Ekstern), Gravesen, J. (Intern), Willatzen, M. (Ekstern), Rubahn, H. (Ekstern)
Publication date: 2005
Event: Poster session presented at Workshop Linz.
Main Research Area: Technical/natural sciences
Source: orbit
Publication: Research - peer-review › Journal article – Annual report year: 2005

The Intrinsic Equation of Planar Curves and G2 Hermite Interpolation

This paper presents the intrinsic equation of a planar curve as a practical tool for curve design. It is demonstrated that the tangent direction, the arc length, and the curvature is readily available. It is furthermore shown that a parametrization of the curve by tangent direction is easily obtained, as are the evolute, the involutes and the offsets. It is finally shown how Hermite data can be fitted in a local and convexity preserving way.

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Publication date: 2004

Publication information
Original language: English
Series: Mat-Report
Number: 2004-02
Main Research Area: Technical/natural sciences
Source: orbit
Publication: Research - peer-review › Report – Annual report year: 2004

The Intrinsic Equation of Planar Curves and G2 Hermite Interpolation

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Pages: 295-310
Publication date: 2004

Host publication information
Title of host publication: Seattle Geometric Design Proceedings
Publisher: Nashboro Press, Incorporated
ISBN (Print): 0-9728402-3-1
Main Research Area: Technical/natural sciences
Conference: SIAM Conference on Geometric Design and Computing, Seattle, USA, 01/01/2003
Source: orbit
Publication: Research - peer-review › Article in proceedings – Annual report year: 2004

Third Order Invariants on Surfaces

General information
State: Published
Definition of features on surfaces

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Publication date: 2003
Event:
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 28365
Publication: Research › Conference abstract for conference – Annual report year: 2003

Invariants of implicit surfaces

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Publication date: 2003
Event:
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 28367
Publication: Research › Conference abstract for conference – Annual report year: 2003

Planar curves parametrized by tangent direction

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Publication date: 2003
Event:
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 28368
Publication: Research › Conference abstract for conference – Annual report year: 2003

The Cut Locus of a Torus of Revolution

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern), Markvorsen, S. (Intern), Sinclair, R. (Intern), Tanaka, M. (Ekstern)
Publication date: 2003
The Scroll Compressor

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Publication date: 2003
Event:
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 28366
Publication: Research › Conference abstract for conference – Annual report year: 2003

Constructing invariant fairness measures for surfaces
The paper proposes a rational method to derive fairness measures for surfaces. It works in cases where isophotes, reflection lines, planar intersection curves, or other curves are used to judge the fairness of the surface. The surface fairness measure is derived by demanding that all the given curves should be fair with respect to an appropriate curve fairness measure. The method is applied to the field of ship hull design where the curves are plane intersections. The method is extended to the case where one considers, not the fairness of one curve, but the fairness of a one parameter family of curves. Six basic third order invariants by which the fairing measures can be expressed are defined. Furthermore, the geometry of a plane intersection curve is studied, and the variation of the total, the normal, and the geodesic curvature and the geodesic torsion is determined.

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern), Ungstrup, M. (Intern)
Pages: 67-88
Publication date: Jul 2002
Main Research Area: Technical/natural sciences

Publication information
Journal: Advances in Computational Mathematics
Volume: 17
Issue number: 1-2
ISSN (Print): 1019-7168
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.848 SNIP 1.06 CiteScore 1.3
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.161 SNIP 1.354 CiteScore 1.33
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.307 SNIP 1.54 CiteScore 1.57
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.039 SNIP 1.604 CiteScore 1.5
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.05 SNIP 1.696 CiteScore 1.42
The Geometry of the Scroll Compressor

General information
State: Published
Organisations: Geometry, Department of Mathematics, Dynamical systems
Authors: Gravesen, J. (Intern), Henriksen, C. (Intern)
Pages: 113-126
Publication date: 2001
Main Research Area: Technical/natural sciences

Publication information
Journal: S I A M Review
Volume: 43
Issue number: 1
ISSN (Print): 0036-1445
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 2.254 SNIP 3.594 CiteScore 3.26
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.654 SNIP 4.178 CiteScore 2.62
BFI (2014): BFI-level 2
Third Order Invariants on Surfaces

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Publication date: 2001

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 154349
Publication: Research - peer-review › Report – Annual report year: 2001

AMROSE: Kinematic parameters for a robot

General information
State: Published
Organisations: Department of Mathematics, University of Southern Denmark
Authors: Gravesen, J. (Intern), Petersen, H. G. (Ekstern), Sinclair, R. (Intern)
Pages: 29-44
Publication date: 2000

Host publication information
Geometrien af en scroll-kompressor: Fra et konkret problem til abstrakt matematik

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern), Henriksen, C. (Intern)
Number of pages: 20
Publication date: 1999

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 172760
Publication: Research - peer-review › Article in proceedings – Annual report year: 2000

Geometrien af en scroll-kompressor: Fra et konkret problem til abstrakt matematik

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern), Henriksen, C. (Intern)
Number of pages: 1-19
Publication date: 1999

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 172182
Publication: Research - peer-review › Report – Annual report year: 1999

Kurver for Computer Assisteret Geometrisk Design

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Number of pages: 19
Publication date: 1999

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 172183
Publication: Research - peer-review › Report – Annual report year: 1999

The intrinsic equation of planar curves and the geometry of the scroll compressor

General information
32nd European Study Group with Industry, Final Report

ESGI (European Study Group with Industry) is Europe's leading workshop for interaction between mathematicians and industry. These workshops have taken place in Great Britain for a number of years, going back to 1968 when Prof. Alan Tayler initiated the so-called Oxford Study Group with Industry. The coordination of the study groups is now done by the European Consortium for Mathematics in Industry (ECMI). This is the final report for the first study group in Denmark, (and the first ESGI outside Great Britain). Six Danish companies brought problems to the Study Group, requiring a wide range of mathematical expertise. Danfoss wanted an analysis and optimization of a scroll compressor. DANISCO wanted a model for the heat and moisture transport in sugar silos. Danish Maritime Institute wanted to optimize a dynamical position system in order to keep a wessel stationary on the surface of the ocean. Grundfos wanted a model describing the chlorination of swimming pools. LEGO wanted an algorithm for building an arbitrary model with LEGO bricks in stable manner. SCANtechnology wanted an algorithm to identify features in an image from a 3D laser scanning.

Constructing Invariant Fairness Measures for Surfaces

Danfoss: Scroll Optimization
de Casteljau's Algorithm Revisited
It is demonstrated how all the basic properties of Bezier curves can be derived swiftly and efficiently without any reference to the Bernstein polynomials and essentially with only geometric arguments. This is achieved by viewing one step in de Casteljau's algorithm as an operator (the de Casteljau operator) acting on a sequence of points, producing a sequence with one point less. The properties of Bezier curves are then derived by analysing de Casteljau's operator.

Efficient Implementation of Volterra Filters for De-interlacing TV Images - Snell and Wilcox

Adaptive subdivision and the length and energy of Bézier curves
It is an often used fact that the control polygon of a Bézier curve approximates the curve and that the approximation gets better when the curve is subdivided. In particular, if a Bézier curve is subdivided into some number of pieces, then the arc-length of the original curve is greater than the sum of the chord-lengths of the pieces, and less than the sum of the polygon-lengths of the pieces. Under repeated subdivisions, the difference between this lower and upper bound gets
If $L_c$ denotes the total chord-length of the pieces and $L_p$ denotes the total polygon-length of the pieces, the best estimate of the true arc-length is $(2L_c+(n-1)L_p)/(n+1)$, where $n$ is the degree of the Bézier curve. This convex combination of $L_c$ and $L_p$ is best in the sense that the error goes to zero under repeated subdivision asymptotically faster than the error of any other convex combination, and it forms the basis for a fast adaptive algorithm, which determines the arc-length of a Bézier curve.

The energy of a curve is half the square of the curvature integrated with respect to arc-length. Like in the case of the arc-length, it is possible to use the chord-length and polygon-length of the pieces of a subdivided Bézier curve to estimate the energy of the Bézier curve.
Opgaver i Lineær Algebra

General information
State: Published
Organisations: Department of Mathematics
Authors: Eising, J. (Intern), Gravesen, J. (Intern), Jensen, J. M. (Intern)
Number of pages: 94
Publication date: 1997

Publication information
Place of publication: Lyngby
Publisher: Institut for Matematik
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 166604
Publication: Research - peer-review › Book – Annual report year: 1997

The arc-length and energy of rational Bézier curves

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Number of pages: 11
Publication date: 1997

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 166980
Publication: Research - peer-review › Report – Annual report year: 1997

De Casteljau's Algorithm Revisited

General information
State: Published
Organisations: Department of Mathematics
Authors: Gravesen, J. (Intern)
Number of pages: 8
Publication date: 1996

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 165819
Publication: Research - peer-review › Report – Annual report year: 1996

Projects:

Efficient 3D Shape Optimization
Department of Applied Mathematics and Computer Science
Period: 01/09/2017 → 31/08/2020
Number of participants: 3
Phd Student: Limkilde, Asger (Intern)
Surface Design and Rationalization for Robotic Hotwire and Hotblade Cutting Techniques

Department of Applied Mathematics and Computer Science
Period: 15/12/2015 → 14/12/2018
Number of participants: 4
Phd Student:
Fisker, Ann-Sofie (Intern)
Supervisor:
Bærentzen, Jakob Andreas (Intern)
Gravesen, Jens (Intern)
Main Supervisor:
Brander, David (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Digital Factory
Collaboration with Odico APS and GXN. Constraint based design and rationalization for robotic hot-wire and hot-blade production of architectural formwork. Supported by Innovation Fund Denmark

Department of Applied Mathematics and Computer Science
Mathematics
Image Analysis & Computer Graphics
Period: 01/03/2015 → 15/12/2018
Number of participants: 4
Project participant:
Gravesen, Jens (Intern)
Bærentzen, Jakob Andreas (Intern)
Project Manager, organisational:
Brander, David (Intern)
Phd Student:
Fisker, Ann-Sofie (Intern)

Optimization on Manifolds - with applications to shape optimization.

Department of Applied Mathematics and Computer Science
Number of participants: 7
Phd Student:
Møller-Andersen, Jakob (Intern)
Supervisor:
Evgrafov, Anton (Intern)
Nørtoft, Peter (Intern)
Main Supervisor:
Gravesen, Jens (Intern)
Examiner:
Markvorsen, Steen (Intern)
Grandine, Thomas A. (Ekstern)
Michor, Peter W. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)

Relations
Publications:
Optimization on Spaces of Curves
Project: PhD

BladeRunner - Applied Geometry
Department of Applied Mathematics and Computer Science
Period: 01/06/2013 → 26/10/2016
Number of participants: 6
Phd Student:
Nørbjerg, Toke Bjerge (Intern)
Supervisor:
Brander, David (Intern)
Main Supervisor:
Gravesen, Jens (Intern)
Examiner:
Røgen, Peter (Intern)
Polthier, Konrad (Ekstern)
Wallner, Johannes (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: 1/3 FUU, 1/3 inst 1/3 Andet

Relations
Publications:
Rationalization in architecture with surfaces foliated by elastic curves
Project: PhD

Rationalization with ruled surfaces in architecture
Department of Applied Mathematics and Computer Science
Period: 01/05/2013 → 25/08/2016
Number of participants: 6
Phd Student:
Steenstrup, Kasper Hornbak (Intern)
Supervisor:
Bærentzen, Jakob Andreas (Intern)
Main Supervisor:
Gravesen, Jens (Intern)
Examiner:
Christensen, Niels Jørgen (Intern)
Lauze, Francois Bernard (Ekstern)
Singh, Karan Sher (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: 1/3 FUU, 1/3 inst 1/3 Andet

Relations
Publications:
Rationalization with ruled surfaces in architecture
Project: PhD
BLADERUNNER - Large scale cost-effective robotic production of advanced formwork

Department of Mechanical Engineering
Manufacturing Engineering
Department of Applied Mathematics and Computer Science
Mathematics

Danish Technological Institute
Period: 01/03/2013 → 31/08/2016
Number of participants: 3
Acronym: BLADERUNNER
Project ID: 76421
Project participant:
Hattel, Jesper Henri (Intern)
Petkov, Kiril (Intern)
Gravesen, Jens (Intern)

Iso-geometric analysis and shape optimization in electromagnetism

Department of Mathematics
Period: 15/02/2009 → 29/05/2012
Number of participants: 6
Phd Student:
Nguyen, Dang Manh (Intern)
Supervisor:
Evgrafov, Anton (Intern)
Main Supervisor:
Gravesen, Jens (Intern)
Examiner:
Breinbjerg, Olav (Intern)
Dokken, Tor (Ekstern)
Grandine, Thomas A. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Iso-geometric analysis and shape optimization in fluid mechanics

Department of Mathematics
Period: 01/02/2009 → 30/04/2012
Number of participants: 6
Phd Student:
Nørtoft, Peter (Intern)
Supervisor:
Pedersen, Niels Leergaard (Intern)
Main Supervisor:
Gravesen, Jens (Intern)
Examiner:
Stolpe, Mathias (Intern)
Bazilevs, Yuri (Ekstern)
Jüttler, Bert (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
3D Printing and Scanning

This project is concerned with the theory and practice of 3D printing and 3D scanning. The project is concretely based upon a donation of a Z450 3D Printer and a Roland LPX 60 scanner from DTU's Strategic Fund. The purpose is two-fold: To study and optimize 3D color printing and 3D scanning procedures on these platforms and to develop corresponding new assets for teaching, research, and prototyping in mathematics/geometry and applications. Part of the project is to interchange ideas concerning these topics with colleagues from DTU Mechanical Engineering, Informatics, Civil Engineering, and Chemistry. The findings and productions from this project will tentatively be integrated into the activities organized around Mathematicum, the mathematical Inspiratorium at DTU Mathematics, as well as into the relevant DTU courses e.g.: 01005 Mathematics 1, 01234 Differential Geometry with Applications, and 02585 Computational Geometry Processing.

Geometry

Department of Mathematics
Period: 01/08/2007 → 01/01/2010
Number of participants: 3
Project ID: Grant from DTU's Strategic Fund 2007
Project participant:
Gravesen, Jens (Intern)
Madsen, Poul-Erik (Intern)
Project Manager, organisational:
Markvorsen, Steen (Intern)

Financing sources
Source: Udenfor rammen
Name of research programme: Uorden
Amount: 300,000.00 Danish Kroner

57th European Study Group with Industry

A Study Group is a forum where academic mathematicians work on problems directly related to industry. Workshops of this nature have taken place in Great Britain for a number of years, going back to 1963 when Prof. Alan Tayler started the Oxford Study Group with Industry. The coordination of Study Groups is now in the hands of European Consortium for Mathematics in Industry (ECMI), and the name is currently European Study Group with Industry (ESGI). At a meeting in 1997 of the ECMI Council it was decided that Study Groups should also be held outside Great Britain, and the first one of those was ESGI32 in Lyngby, Denmark. The format of a Study Group is a week long meeting (Monday - Friday) where a number of companies on the first day of the meeting each present a research problem they believe to be of a mathematical nature. Each such problem is taken up by a group of mathematicians who, together with the company representative, work towards the solution of the problem, through Thursday afternoon. Friday is used to present in a plenary session the results from each of the problem groups. The reasons for the continuing success of the Study Groups are simple: The industrial participants get, for a very modest sum, a highly qualified "think tank" of mathematicians to focus on their particular research problem. Besides a full or partial resolution of the problem, the companies establish useful contacts with international researchers. The academics benefit from new ideas and challenges from the real world, providing inspiration for both education and their own research. The success criterion for a Study Group is that participating companies experience the meeting as useful and that it brings them a significant step closer to the resolution of their problem. For the Danish study groups we also have the goal that it will establish closer ties between Danish Industry and Danish mathematicians.

Department of Mathematics
University of Southern Denmark
Period: 01/05/2006 → 31/12/2006
Number of participants: 4
Acronym: ESGI57
Project ID: 10083
Project participant:
Gravesen, Jens (Intern)
Hjorth, Poul G. (Intern)
Petersen, Henrik Gordon (Ekstern)
Willatzen, Morten (Ekstern)

Financing sources
Design of pump geometry
Analysis and design of some parts of a pump-system. Work resulted in a new geometry being applied by the company sponsoring the work.

Department of Mathematics
Period: 01/03/2005 → 31/05/2005
Number of participants: 5
Contact person:
Bendsøe, Martin P. (Intern)
Project participant:
Gravesen, Jens (Intern)
Røgen, Peter (Intern)
Markvorsen, Steen (Intern)
Stolpe, Mathias (Intern)

Financing sources
Source: Indtægtsdækket virksomhed UK 90
Name of research programme: Indtægtsdækket virksomhed UK 90
Amount: 72,500.00 Danish Kroner

51st European Study Group with Industry
A Study Group is a forum where academic mathematicians work on problems directly related to industry. Workshops of this nature have taken place in Great Britain for a number of years, going back to 1963 when Prof. Alan Tayler started the Oxford Study Group with Industry. The coordination of Study Groups is now in the hands of European Consortium for Mathematics in Industry (ECMI), and the name is currently European Study Group with Industry (ESGI). At a meeting in 1997 of the ECMI Council it was decided that Study Groups should also be held outside Great Britain, and the first one of those was ESGI32 in Lyngby, Denmark. The format of a Study Group is a week long meeting (Monday - Friday) where a number of companies on the first day of the meeting each present a research problem they believe to be of a mathematical nature. Each such problem is taken up by a group of mathematicians who, together with the company representative, work towards the solution of the problem, through Thursday afternoon. Friday is used to present in a plenary session the results from each of the problem groups. The reasons for the continuing success of the Study Groups are simple: The industrial participants get, for a very modest sum, a highly qualified 'think tank' of mathematicians to focus on their particular research problem. Besides a full or partial resolution of the problem, the companies establish useful contacts with international researchers. The academics benefit from new ideas and challenges from the real world, providing inspiration for both education and their own research. The success criterion for a Study Group is that participating companies experience the meeting as useful and that it brings them a significant step closer to the resolution of their problem. For the Danish study groups we also have the goal that it will establish closer ties between Danish Industry and Danish mathematicians.

Department of Mathematics
University of Southern Denmark
Period: 01/06/2004 → 31/12/2004
Number of participants: 4
Acronym: ESGI51
Project ID: 10055
Project participant:
Gravesen, Jens (Intern)
Hjorth, Poul G. (Intern)
Petersen, Henrik Gordon (Ekstern)
Willatzen, Morten (Ekstern)

Financing sources
Source: Udenfor rammen
Name of research programme: Ukendt
Amount: 45,000.00 Danish Kroner
MACSI-net
Department of Mathematics
Period: 04/01/2001 → 30/04/2004
Number of participants: 1
Project participant:
Gravesen, Jens (Intern)

Financing sources
Source: Forsk. EU - Rammeprogram
Name of research programme: Forsk. EU - Rammeprogram
Amount: 159,840.00 Danish Kroner

Length of general subdivision curves
Subdivision curves has recently become popular objects of studies and in this project we search for fast algorithms to evaluate the length of these curves.

Department of Mathematics
University of Stellenbosch
Period: 28/03/2000 → …
Number of participants: 3
Project participant:
Villiers, Johan de (Ekstern)
Goosen, Karin (Ekstern)
Project Manager, organisational:
Gravesen, Jens (Intern)

Invariants in differential geometry and elasticity
This project is concerned with finding an explicit fundamental system of invariants, in the case of third order invariants on a surface and in the case of the elasticity tensor in dimension two and three.

Department of Mathematics
Period: 01/02/1999 → …
Number of participants: 1
Project Manager, organisational:
Gravesen, Jens (Intern)

VIDIGEO (Visual Interactive Differential Geometry)
A modern tool for the learning of elementary differential geometry is being developed. One key feature will be the inclusion of the computer at several levels in the teaching and learning process.

Department of Mathematics
Aalborg University
Aarhus School of Engineering
Period: 01/09/1998 → …
Number of participants: 6
Project participant:
Gravesen, Jens (Intern)
Sinclair, Robert (Intern)
Fajstrup, Lisbeth (Ekstern)
Karstoft, Henrik (Ekstern)
Raussen, Martin (Ekstern)
Project Manager, organisational:
Markvorsen, Steen (Intern)

Financing sources
Modelling and Fairing of Ship Hulls

If one consider the hull of modern commercial vessel, then 90% of the hull is quite simple. The midship section is more or less a simple cylinder; but the bulbous bow and the stern with the propeller bossing has a very complex geometry and the transition from the simple cylindrical shape to the complex double curved shapes at the bow and stern gives the designer many problems. It also makes the use of ordinary B-spline or NURBS surfaces difficult. In the project we propose to use a generalization of NURBS-surfaces by Frank Weller to model ship hulls. As an other part of the project we want to replace the tedious manual fairing of the ship hull by an automated process which minimizes a suitable chosen fairness measure. The surface fairness measure is derived by demanding that all the planar intersection curves shall have a small curvature variation.

Department of Mathematics
Department of Naval Architecture and Offshore Engineering

Dynamics of Plane Euler Elastica

The configuration space of plane Euler elastica is a two dimensional space with a simple potential function. The associated dynamical system is studied in order to describe the movement of the free end.

Classification of Closed Strips in the Three Dimensional Euclidean Space

Take a strip of paper and ‘twist’ it, tie a knot on it, and glue its ends together. This is the model for a class of geometric objects which we call the class of closed strips. We define the twisting number of a closed strip which is an invariant of ambient isotopy measuring its topological twist. We classify closed strips in euclidean 3-space by their knots and their twisting number. We have proven that this classification exactly divides closed strips into isotopy classes. Using this classification we point out how some polynomial invariants for links lead to polynomial invariants for strip links. We give a method for knotting a strip with braid on its twist, and our method includes a closed braid description of a closed strip. Finally, we generalize the notion of closed braids, allowing braids to be closed by any oriented knot and not only by the unknot. The inverse braid closing operator problem is still open, but it contains Markovs Theorem for classical closed braids as a special case.

Department of Mathematics
Deformation of Surfaces in Threespace
Given an embedded two-dimensional surface in three space, and a smooth deformation of the metric (the first fundamental form), is it then possible for this intrinsic deformation of the metric to be induced by an extrinsic deformation of the embedding. If the intrinsic deformation is trivial (the metric is constant), then the question is the so called bending problem.

Reconstruction of Surfaces for Reverse Engineering
Whereas conventional engineering uses CAD/CAM systems to create real parts, reverse engineering transforms a real part into a computer model, in particular it develops a CAD model of the part. In this project, we deal with problems that arise in the context of reverse engineering of geometric models. The surface of a part may consist of different surface types. There might be simple surfaces like planes, spheres, cones and cylinders of revolution and tori. It might also contain more general surfaces of revolution, general cylinders, helical and spiral surfaces, and it might exhibit general freeform surfaces. Both for the CAD representation and for the manufacturing of the part, it is essential to recognize the simpler surface types and fit the given data, usually clouds of points with measurement errors, by surfaces of the determined type.

The Mobius Strip Embedding Problem
We present necessary and sufficient conditions for a curve to be the center curve of an analytic and flat embedding of the Mobius strip (or an orientable cylinder) into euclidean 3-space. Using these conditions we extend an example by G. Schwarz into a continuous family of analytic and flat Mobius strips. This family is split into two connected components. We give a topological argument that explains this behaviour. A connection to the work of C. Chicone and N.J. Kalton on the Mobius strip embedding problem, suggests a close relation between a linking number and the total torsion of the orthogonal axes of a Mobius strip or an orientable cylinder.
Design and Engineering of Double Curved Ship Surfaces

The objective of the project is to invent new mathematical methods for the design of ship surfaces. These methods should take into account the actual processes at a shipyard; rolling and heating. In the production the developed (plane) surface is by rolling turned into a single-curved plate, mostly, cylinder shaped. Henceforth, heating is applied to deform it to its final shape. The first part of the project is to find the developed shape, such that after the rolling process the obtained developable surface is closest to the desired final shape hereby minimizing the heat input. The second part consists of modelling the heating process in geometrical terms.

Department of Mathematics
Number of participants: 2
Project participant:
Gravesen, Jens (Intern)
Project Manager, organisational:
Randrup, Thomas (Intern)

Financing sources
Source: Unknown
Name of research programme: Uken dt
Amount: 596,700.00 Danish Kroner
Project

Konstruktion af flader i computer assisteret geometrisk skibsdesignsk design (GAGD) via Gauss-afbildningen

Department of Mathematics
Period: 01/09/1995 → ...
Number of participants: 5
PhD Student:
Randrup, Thomas (Intern)
Main Supervisor:
Gravesen, Jens (Intern)
Examiner:
Dæhlen, Morten (Ekstern)
Jensen, Jørgen Juncher (Intern)
Perram-John, William (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Erhvervsforskerordningen
Project: PhD

Lænker og knuder i differential-geometrisk perspektiv

Department of Mathematics
Period: 01/02/1995 → 14/04/1999
Number of participants: 3
PhD Student:
Røgen, Peter (Intern)
Main Supervisor:
Hansen, Vagn Lundsgaard (Intern)
Examiner:
Gravesen, Jens (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-Su Stipendium, Eksperiment
Project: PhD

Geometric Heat Kernel Comparison Theory

Using comparison theory for the Laplacian of geometrically restricted distance functions we obtain relations between essential features of diffusion processes, isoperimetric inequalities and curvature.

Department of Mathematics
Visualization of Cut-loci
The purpose of this project is to visualize the cut-locus for a point on a two-dimensional surface.

Subdivision and geometric properties of Bézier Curves and Surfaces
Subdivision is a wellknown algorithm which often is used to evaluate Bézier curves and surfaces. In this project we investigate the possibility to use subdivision to determine important geometric properties of the curve or surface, such as length, area, and curvature.

Geometrisk og topologisk definition af maritime konstruktioner
Department of Mechanical Engineering
Period: 01/07/1991 → 07/11/1995
Number of participants: 3
Phd Student:
Michelsen, Jacob (Intern)
Main Supervisor:
Jensen, Jørgen Juncher (Intern)
Examiner:
Gravesen, Jens (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådene via projektbe
Project: PhD

Activities:
University of Southern Denmark (External organisation)
Period: 29 Sep 2015 → 21 Dec 2015
Jens Gravesen (Participant)
Department of Applied Mathematics and Computer Science
Mathematics

Description
The Ph.D. committee of Konstantin Filonenko, University of Southern Denmark
Thesis: Mathematical modelling of the Purcell effect in plasmonic nanostructures

Body type: Ph.D committee
Degree of recognition: International

Related external organisation
University of Southern Denmark
Odense, Denmark
Activity: Membership › Membership in review committee

Daniella Kornelia Fußeder, TU Kaiserslautern (External organisation)
Period: 1 Jul 2015 → 29 Oct 2015
Jens Gravesen (Participant)
Department of Applied Mathematics and Computer Science
Mathematics

Description
On the Ph.D. committee for Daniella Kornelia Fußeder, TU Kaiserslautern
Thesis: Isogeometric finite element methods for shape optimization

Body type: Ph.D committee
Degree of recognition: International

Related external organisation
Daniella Kornelia Fußeder, TU Kaiserslautern
Activity: Membership › Membership in review committee

University of Southern Denmark (External organisation)
Jens Gravesen (Participant)
Department of Applied Mathematics and Computer Science
Mathematics

Description
Assessment committee for position as Associate Professor in Applied Mathematics and Control, University of Southern Denmark

Body type: Assessment committee
Degree of recognition: International
Related external organisation

University of Southern Denmark
Odense, Denmark
Activity: Membership › Membership in review committee

SIAM Conference on Geometric and Physical Modeling
Jens Gravesen (Participant)
Department of Mathematics

Description
Regularization in Isogeometric Shape Optimization for Fluids: Poster presented at SIAM Conference on Geometric and Physical Modeling

The goal in shape optimization for fluids is to find an optimal boundary of the flow domain that minimizes a prescribed objective, while satisfying suitable constraints. Inclusion of an artificial objective term is often needed to avoid inappropriate boundary parametrizations and thereby regularize the optimization problem. This work uses isogeometric analysis as framework for the numerical method and discusses various regularizations by comparing their effects in different examples.

Place: Orlando, Florida, USA

Related event

SIAM Conference on Geometric and Physical Modeling
24/10/2011 → 27/10/2011
Orlando, United States
Activity: Attending an event › Participating in or organising a conference

SAGA Fall School 2011
Period: 27 Sep 2011 → 30 Sep 2011
Jens Gravesen (Participant)
Department of Mathematics

Description
Isogeometric Analysis of Sound Propagation through Flow in 2-Dimensional Ducts: Talk given at the fall school "Shapes, Geometry and Algebra (SAGA)"

The aim of this work is to use isogeometric analysis, a unification of finite element methods (FEM) and computer aided design (CAD), to solve the coupled flow-acoustic problem that governs the propagation of sound through flow in ducts. The background flow in the duct is governed by the steady-state, incompressible Navier-Stokes equation, while the sound propagation is governed by the advected Helmholtz equation. The crux of isogeometric analysis is to approximate the flow fields and the acoustic pressure by B-splines. The accurate geometry representation and high degree of continuity of the state variables are some of the method's advantages. We firstly review the concepts of how to apply isogeometric analysis to the coupled flow-acoustic problem, and we then report on the effects of the flow field and of the duct geometry on the acoustic response.

Related event

SAGA Fall School 2011: Shapes, Geometry and Algebra
Vilnius, Lithuania
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

New Trends in Applied Geometry
Period: 20 Feb 2011 → 25 Feb 2011
Jens Gravesen (Participant)
Department of Mathematics

Description
Isogeometric Shape Optimization for Fluids: Talk given at the workshop "New Trends in Applied Geometry"

The aim of this work is to use isogeometric analysis, a unification of finite element methods (FEM) and computer aided
design (CAD), to solve shape optimization problems within fluid mechanics. The flow problems considered are governed by the 2-dimensional steady-state, incompressible Navier-Stokes equations. The crux of isogeometric analysis is to approximate the fluid velocity and pressure fields by B-splines. The accurate geometry representation and high degree of continuity of the flow fields are some of the method’s advantages. In shape optimization for fluids we search for an optimal design of the flow domain that minimizes a prescribed objective, while satisfying suitable constraints. The design variables in the isogeometric approach are the coordinates of control points that define the boundary of the domain. With the ability to represent complex shapes in few design variables, and the unification of the analysis and geometry models, isogeometric analysis is highly suited for shape optimization purposes. The methodology is firstly presented through a simple example in which a pipe bend is designed to minimize the drag with a constraint on the area of the pipe. The basics of how to apply isogeometric analysis to the Navier-Stokes equations are briefly covered, some regularization methods to ensure good boundary parametrizations during optimization are discussed, and different design results for a range of Reynolds numbers are presented. Lastly, we present results for a simple airfoil optimization, in which an airfoil is designed to minimize the drag with a constraint on the lift and the size of the wing.

Related event

**New Trends in Applied Geometry**
20/02/2011 → 25/02/2011
Hurdalsjøen, Norway
Activity: Attending an event › Participating in or organising a conference

**New Trends in Applied Geometry**
Period: 14 Jan 2011
Jens Gravesen (Participant)
Department of Mathematics

Description
Isogeometric Shape Optimization for Fluids: Talk given at the workshop "Isogeometric Analysis 2011: Integrating Design and Analysis"

The aim of this work is to use the unification of finite element methods (FEM) and computer aided design (CAD) embedded in isogeometric analysis to solve shape optimization problems within fluid mechanics. The flow problems considered are governed by the 2-dimensional steady-state, incompressible Navier-Stokes equations. These partial differential equations are solved for fluid velocity and pressure using B-spline based isogeometric analysis. The accurate geometry representation and high degree of continuity of the flow fields are some of the method’s advantages. To ensure stable discretizations, though, care has to taken in the choice of polynomial degrees and knots vectors for the velocity and pressure approximations. In shape optimization for fluids we search for an optimal design of the flow domain that minimizes a prescribed objective, while satisfying suitable constraints. With the ability to represent complex shapes in few design variables, and the unification of the analysis and geometry models, isogeometric analysis is highly suited for shape optimization purposes. The design variables are the coordinates of control points that define the boundary of the domain. As the optimizer moves the control points around, though, control points are sometimes seen to coalesce and the control net might even fold over severely, causing an improper design and the analysis to break down. Regularization methods to ensure a good boundary representation are therefore often needed. The methodology is presented through a simple example in which a pipe bend is designed to minimize the drag with a constraint on the area of the pipe. The basics of the analysis of the Navier-Stokes equations are briefly covered, some regularization methods to ensure good boundary parametrizations during optimization are discussed, and different design results for a range of Reynolds numbers are presented.

Place: Austin, Texas, USA

Related event

**New Trends in Applied Geometry**
20/02/2011 → 25/02/2011
Hurdalsjøen, Norway
Activity: Attending an event › Participating in or organising a conference