Resonant power converter with dead-time control of synchronous rectification circuit
The invention relates in a first aspect to a resonant power converter comprising a synchronous rectifier for supplying a DC output voltage. The synchronous rectifier is configured for alternatingly connecting a resonant output voltage to positive and negative DC output nodes via first and second semiconductor switches, respectively, separated by intervening dead-time periods in accordance with first and second rectification control signals. A dead-time controller is coupled to the resonant output voltage or the resonant input voltage and configured for adaptively adjusting lengths of the dead-time periods via the first and second rectification control signals.

Resonant power converter comprising adaptive dead-time control.
The invention relates in a first aspect to a resonant power converter comprising: a first power supply rail for receipt of a positive DC supply voltage and a second power supply rail for receipt of a negative DC supply voltage. The resonant power converter comprises a resonant network with an input terminal for receipt of a resonant input voltage from a driver circuit. The driver circuit is configured for alternatingly pulling the resonant input voltage towards the positive and negative DC supply voltages via first and second semiconductor switches, respectively, separated by intervening dead-time periods in accordance with one or more driver control signals. A dead-time controller is configured to adaptively adjusting the dead-time periods based on the resonant input voltage.
Advances in Piezoelectric Systems: An Application-Based Approach.

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

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Class-D amplifier design and performance for driving a Piezo Actuator Drive servomotor.
This paper investigates the behavior of piezoelectric stacks in a Piezoelectric Actuator Drive (PAD) motor, which shows non-linear equivalent impedance and has a dramatic impact on the overall system performance. Therefore, in this paper, the piezo stack's model is discussed and an improved large signal model is proposed and verified by measurement. Finally, a Class-D amplifier as a power driver and its associated closed-loop control are implemented and tested to control PAD drive effectively.
Improved Kayaking Ergometer Using a Switch-mode Converter Driven Alternator

This paper describes the implementation of a generator as a source of resistance in a modern kayaking ergometer. This ergometer can function as a platform for emulation of the athlete-kayak-paddle system. The system was considered and described. A possible model for digital regulation has also been described. A synchronous-rectified buck converter has been designed to control the current through the rotor and, by extension, the mechanical resistance felt by the oarsman. The circuit was designed to function with a 12V car battery as a supply. Necessary specifications for efficiency and output stability were set, measured and met. The prototype without regulation was presented at the 2015 Kayaking World Cup, and was met with appreciation and positive feedback.
Temperature dependency of the hysteresis behaviour of PZT actuators using Preisach model
The Preisach model is a powerful tool for modelling the hysteresis phenomenon on multilayer piezo actuators under large signal excitation. In this paper, measurements at different temperatures are presented, showing the effect on the density of the Preisach matrix. An energy-based approach is presented, aiming at defining a temperature-dependent phenomenological model of hysteresis for a better understanding of the non-linear effects in piezo actuators.

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

This paper evaluates breaking performance of an electrostatic surface induction actuator. The actuator is equipped with piezoelectric vibrator such that the friction between the slider and the stator electrodes can be dramatically reduced by squeeze-film effect. In such an actuator, the friction force can be changed by turning on and off the vibrator. The friction change can be utilized for high-performance slider motion control; for example, friction can be increased by switching off the vibrator when the slider needs to stop. In this paper, we evaluated how fast the slider can stop in several conditions. The result clearly shows the effect of friction change in breaking performance of the actuator.

Preisach model of hysteresis for the Piezoelectric Actuator Drive

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

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Using squeeze-film effect to reduce surface friction in electrostatic actuators

This paper presents a method of reducing load friction in two degrees-of-freedom (2-DOF) transparent electrostatic induction actuator by using vibration-induced squeeze film effect. An experimental set-up was built to prove the concept. An overall 70% reduction in required driving voltage was obtained when the squeeze film is present.

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

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

The Piezoelectric Actuator Drive (PAD) is a type of rotary motor that transforms the linear motion of piezoelectric stack actuators into a precise rotational motion. The very high stiffness of the actuators employed make this type of motor suited for open-loop control, but the inherent hysteresis exhibited by piezoelectric ceramics causes losses. Therefore, this paper presents a straightforward method to measure piezoelectric stack actuator equivalent parameters that includes nonlinearities. By folding the nonlinearities into a newly-defined coupling coefficient, the inherent hysteretic behavior of piezoelectric stack actuators can be greatly reduced through precompensation. Experimental results show a fitting accuracy of 98.8% between the model and measurements and a peak absolute error reduction by a factor of 10 compared to the manufacturer-provided parameter. This method improves both the static and dynamic performance of the Piezoelectric Actuator Drive (PAD) while still permitting open-loop control.
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Ultrasonic lubrication: concept and application
Period: 4 Oct 2016
Tiberiu-Gabriel Zsurzsan (Invited speaker)
Department of Electrical Engineering
Electronics

Related event
69th ICAT International Smart Actuator Symposium
04/10/2016 → 05/10/2016
State College, United States
Activity: Talks and presentations › Conference presentations

2016 IEEE International Conference on Industrial Technology
Tiberiu-Gabriel Zsurzsan (Participant)
Department of Electrical Engineering
Electronics

Description
2016 IEEE International Conference on Industrial Technology

Related event
2016 IEEE International Conference on Industrial Technology
14/03/2016 → 17/03/2016
Taipei, Taiwan, Province of China
Activity: Attending an event › Participating in or organising a conference

6th International Conference on Advanced Mechatronics 2015
Period: 5 Dec 2015 → 8 Dec 2015
Tiberiu-Gabriel Zsurzsan (Participant)
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6th International Conference on Advanced Mechatronics 2015
05/12/2015 → 08/12/2015
Tokyo, Japan
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2015 41th IEEE Industrial Electronics Society Annual Conference
Period: 9 Nov 2015 → 12 Nov 2015
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Related event

2015 41th IEEE Industrial Electronics Society Annual Conference
09/11/2015 → 12/11/2015
Yokohama, Japan
Activity: Attending an event › Participating in or organising a conference

The 50th International Universities Power Engineering Conference
Period: 1 Sep 2015 → 4 Sep 2015
Tiberiu-Gabriel Zsurzsan (Participant)
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Related event

The 50th International Universities Power Engineering Conference
01/09/2015 → 04/09/2015
Staffordshire, United Kingdom
Activity: Attending an event › Participating in or organising a conference

IEEE International Power Electronics and Application Conference and Exposition
Period: 5 Nov 2014 → 8 Nov 2014
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Related event

IEEE International Power Electronics and Application Conference and Exposition
05/11/2014 → 08/11/2014
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Tiberiu-Gabriel Zsurzsan (Participant)
Department of Electrical Engineering
Electronics

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