

# **Advances in Intelligent Systems and Computing**

Volume 644

## **Series editor**

Janusz Kacprzyk, Polish Academy of Sciences, Warsaw, Poland  
e-mail: [kacprzyk@ibspan.waw.pl](mailto:kacprzyk@ibspan.waw.pl)

### *About this Series*

The series “Advances in Intelligent Systems and Computing” contains publications on theory, applications, and design methods of Intelligent Systems and Intelligent Computing. Virtually all disciplines such as engineering, natural sciences, computer and information science, ICT, economics, business, e-commerce, environment, healthcare, life science are covered. The list of topics spans all the areas of modern intelligent systems and computing.

The publications within “Advances in Intelligent Systems and Computing” are primarily textbooks and proceedings of important conferences, symposia and congresses. They cover significant recent developments in the field, both of a foundational and applicable character. An important characteristic feature of the series is the short publication time and world-wide distribution. This permits a rapid and broad dissemination of research results.

### *Advisory Board*

#### Chairman

Nikhil R. Pal, Indian Statistical Institute, Kolkata, India

e-mail: [nikhil@isical.ac.in](mailto:nikhil@isical.ac.in)

#### Members

Rafael Bello Perez, Universidad Central “Marta Abreu” de Las Villas, Santa Clara, Cuba

e-mail: [rbellop@uclv.edu.cu](mailto:rbellop@uclv.edu.cu)

Emilio S. Corchado, University of Salamanca, Salamanca, Spain

e-mail: [escorchado@usal.es](mailto:escorchado@usal.es)

Hani Hagrass, University of Essex, Colchester, UK

e-mail: [hani@essex.ac.uk](mailto:hani@essex.ac.uk)

László T. Kóczy, Széchenyi István University, Győr, Hungary

e-mail: [koczy@sze.hu](mailto:koczy@sze.hu)

Vladik Kreinovich, University of Texas at El Paso, El Paso, USA

e-mail: [vladik@utep.edu](mailto:vladik@utep.edu)

Chin-Teng Lin, National Chiao Tung University, Hsinchu, Taiwan

e-mail: [ctlin@mail.nctu.edu.tw](mailto:ctlin@mail.nctu.edu.tw)

Jie Lu, University of Technology, Sydney, Australia

e-mail: [Jie.Lu@uts.edu.au](mailto:Jie.Lu@uts.edu.au)

Patricia Melin, Tijuana Institute of Technology, Tijuana, Mexico

e-mail: [epmelin@hafsamx.org](mailto:epmelin@hafsamx.org)

Nadia Nedjah, State University of Rio de Janeiro, Rio de Janeiro, Brazil

e-mail: [nadia@eng.uerj.br](mailto:nadia@eng.uerj.br)

Ngoc Thanh Nguyen, Wroclaw University of Technology, Wroclaw, Poland

e-mail: [Ngoc-Thanh.Nguyen@pwr.edu.pl](mailto:Ngoc-Thanh.Nguyen@pwr.edu.pl)

Jun Wang, The Chinese University of Hong Kong, Shatin, Hong Kong

e-mail: [jwang@mae.cuhk.edu.hk](mailto:jwang@mae.cuhk.edu.hk)

More information about this series at <http://www.springer.com/series/11156>

Tomáš Březina · Ryszard Jabłoński  
Editors

# Mechatronics 2017

Recent Technological and Scientific Advances

 Springer

*Editors*

Tomáš Březina  
Faculty of Mechanical Engineering,  
Institute of Mathematics  
Brno University of Technology  
Brno  
Czech Republic

Ryszard Jabłoński  
Faculty of Mechatronics, Institute  
of Metrology and Biomedical Engineering  
Warsaw University of Technology  
Warsaw  
Poland

ISSN 2194-5357

ISSN 2194-5365 (electronic)

Advances in Intelligent Systems and Computing

ISBN 978-3-319-65959-6

ISBN 978-3-319-65960-2 (eBook)

DOI 10.1007/978-3-319-65960-2

Library of Congress Control Number: 2017952200

© Springer International Publishing AG 2018

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature

The registered company is Springer International Publishing AG

The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# **Mechatronics 2017 – Preface**

These proceedings comprise carefully selected contributions presented at the 12th International Conference Mechatronics 2017, organized by Brno University of Technology on September 6–8, 2017, in Brno, Czech Republic. Finally, 91 papers were selected for publishing in the proceedings.

Mechatronics systems and products are well established in a large number of industries. This book covers the areas essential in modern engineering: design, modeling, and simulation of mechatronics systems, automatic control, robotics, sensors and actuators, electrical machines and energy harvesting, the list of topics could go on and on.

We hope that this volume can serve as useful reference source in mechatronics not just among academicians, but also in industrial R&D departments, as the mechatronics as a subject should be closely related to the rapid transfer of new ideas to production and products we can meet in our daily lives.

We would like to thank all the authors for their contribution to the proceedings.

Tomáš Březina  
Conference Chairman

# Contents

## **Mechatronics**

<b>A Compact Device for Urine Collection and Transport in Porous Media</b> .....	3
Haakon Karlsen and Tao Dong	
<b>Innovation of Pressing with TRIZ Methodology</b> .....	11
Bohuslav Bušov and Vladimír Dostál	
<b>Evaluation of Postural Stability During Quiet Standing Using MatLab Software and Promising Parameters</b> .....	19
Veronika Kotolova, Patrik Kutilek, Slavka Viteckova, Jonas Palicka, Zdenek Svoboda, Vaclav Krivanek, Radek Dorskocil, and Alexandr Stefek	
<b>Comparison of Deformation and Stress States of the Total Trapeziometacarpal Replacement</b> .....	27
Tomáš Svojanovský, Vladimír Fuis, and Lubomír Trtík	
<b>Analysis of Single-Phase Voltage-Source Active Rectifier Under PWM</b> .....	34
Vojtech Blahnik and Jakub Talla	
<b>Minimization of Equivalent Series Resistance of Coupling Coils for Wireless Power Transfer Applications</b> .....	43
Vladimir Kindl, Martin Zavrel, and Tomas Kavalir	
<b>Optimal Efficiency and Power Control of High Efficient Wireless Power Transfer System</b> .....	50
Martin Zavrel and Vladimir Kindl	
<b>Design of Consecutive Compensator for Servo System with Signal Uncertainty</b> .....	58
Sergey Bystrov, Nina Vunder, Anatoly Ushakov, and Sergey Vrazhevsky	

<b>Multi-criteria Decision-Making Problems in Cutting Tool Wear Evaluation</b> . . . . .	65
Piotr Wittbrodt, Iwona Lapunka, and Katarzyna Marek-Kołodziej	
<b>The Novel Device for Irreversible Electroporation: Thermographic Comparison with Radiofrequency Ablation</b> . . . . .	72
Veronika Novotna and Dalibor Cervinka	
<b>High-Voltage Pulse Source for Cell Electroporation</b> . . . . .	80
Dalibor Červinka and Veronika Novotná	
<b>Valve for Testing Rocket Engines</b> . . . . .	87
M. Krawczyk, B. Bartkowiak, and J. Wierciak	
<b>System Approach to the Mass Production Improvement</b> . . . . .	95
Irina Makarova, Vadim Mavrin, and Ksenia Shubenkova	
<b>An Automatic PCI Assignment Framework for Femtocells in LTE Networks</b> . . . . .	103
Marek Sedlacek and Robert Bestak	
<b>Classical Interpretation of Ultra-Low Intensity Optical Heterodyning as a Pragmatic Approach to Photon Size Determination</b> . . . . .	111
Ryszard Jablonski, Amin Al-Tabich, and Vladimir Rysakov	
<b>Numerical Integrator System for Drift Compensated Fluxmeter</b> . . . . .	119
Piotr Gazda, Andrzej Ziółek, and Michał Nowicki	
<b>Investigation of Magnetic Properties of Amorphous Fe-Based Alloy Magnetized in Rayleigh Region</b> . . . . .	126
Maciej Kachniarz, Jacek Salach, and Roman Szewczyk	
<b>Cutting Insert Wear Analysis Using Industry 4.0</b> . . . . .	133
Tomas Prokes, Katerina Mouralova, Jiri Kovar, Radim Zahradnicek, and Ondrej Andrs	
<b>Analysis of Machinability of Pure-Cobalt Disc for Magnetron Deposition Using WEDM</b> . . . . .	141
Katerina Mouralova, Jiri Kovar, Radim Zahradnicek, and Michal Holub	
<b>Using Industry 4.0 Technologies for Teaching and Learning in Education Process</b> . . . . .	149
Ondrej Andrs	
<b>Mth Root Mth Power SNR MPSK Estimator</b> . . . . .	157
Abdelrahman Elewah, Abdelkarim Taman, Amr A. Awamry, and Mahmoud Elbahy	

**Electrical Machines**

**Increasing the Efficiency of Induction Generator in Small Hydro Power Plant for Varying River Flow Rate** ..... 169  
 Ondrej Rubes and Dalibor Cervinka

**Volume Minimization of Power Pulse Transformer for a Two-Switch Forward Converter** ..... 177  
 Pavel Vorel and Jan Martis

**Efficiency Mapping of a Small Permanent Magnet Synchronous Motor** ..... 185  
 Martin Novak, Jaroslav Novak, and Zdenek Novak

**Dynamic Model of Wye Connected Induction Machine** ..... 194  
 Radoslav Cipin, Jan Knobloch, Petr Prochazka, and Ivo Pazdera

**Induction Machine Models and Equivalent Circuits Based on Hybrid Parameters of Two-Port Network** ..... 202  
 Ivo Pazdera, Petr Prochazka, Jiri Ctibor, Petr Hutak, Radoslav Cipin, and Miroslav Patocka

**Push–Pull Converter Transformer Maximum Efficiency Optimization** ..... 211  
 Jan Martis

**Synchronous Machine Model Including Damper** ..... 219  
 Bohumil Skala and Vladimir Kindl

**Reduction of Pulsating Torque of the Synchronous Motor Using Magnetic Wedges** ..... 227  
 Jiri Sika, Vladimir Kindl, Roman Pechanek, and Tomas Kavalir

**Calculation of a Lap Winding Coil Geometry** ..... 236  
 Karel Hruska and Pavel Dvorak

**Equivalent Magnetic Circuit Method Usage in the Synchronous Reluctance Machine Rotor Design** ..... 248  
 Jan Laksar, Pavel Svetlik, and Lukas Veg

**Analysis of Rotor Ventilation System of Air Cooled Synchronous Machine Through Computational Fluid Dynamics** ..... 257  
 Jiří Franc and Roman Pechanek

**High-Speed Electrical Machines: Review of Concepts and Currently Used Solutions with Synchronous Machines with Permanent Magnets** ..... 265  
 Lukas Veg, Pavel Svetlik, and Jan Laksar

**Control and Design of a High Power Density PMSM** ..... 273  
 Omur Aydogmus and Gullu Boztas



<b>Magnetic Measurements of Solid Material</b> . . . . .	281
Tomas Bulin and Cestmir Ondrusek	
<b>Identification of Induction Machine Electromagnetic Parameters for a Wide Range of Frequency and Flux Density</b> . . . . .	289
Marek Toman, Radoslav Cipin, Martin Mach, and Pavel Vorel	
<b>Modification of Frame for Synchronous Machine with Permanent Magnet</b> . . . . .	296
Rostislav Huzlík, Petr Lošák, Jiří Kurfürst, and Čestmír Ondrůšek	
<b>Mechatronic System with a Turbo-Generator of Two Different Frequencies</b> . . . . .	302
Boris Skvortsov, Tarek Nahdi, and Dusan Maga	
<b>Test Rig for Determination of Performance Characteristics of High Speed Linear Actuators</b> . . . . .	311
Karol Bagiński, Maciej Bodnicki, Wojciech Credo, and Leszek Wawrzyniuk	
<b>Modelling and Simulation</b>	
<b>Dynamic Analysis of Multispindle Lathe</b> . . . . .	321
Petr Hadraba and Zdeněk Hadaš	
<b>Numerical and Experimental Solution of Friction Stir Welding of Plates</b> . . . . .	330
Roland Jančo, Pavel Élesztós, and Ladislav Écsi	
<b>Universal HIL Test Platform for Mechatronic Systems</b> . . . . .	338
Peter Talian, Daniela Perduková, and Pavol Fedor	
<b>A Dynamic Feedback Neural Model for Identification of the Robot Manipulator</b> . . . . .	347
Mustafa Ay and Gonca Ozmen Koca	
<b>Innovative Model of Radial Fluid Bearing for Simulations of Turbocharger Rotordynamics</b> . . . . .	356
Pavel Novotný and Jozef Dluhoš	
<b>The Model of Non-stationary Heat Conduction in a Metal Mould</b> . . . . .	364
Jaroslav Mlýnek and Roman Knobloch	
<b>The Possibility of Applying Neural Networks to Influence Vehicle Energy Consumption by Eco Driving</b> . . . . .	372
Tomáš Milesich, Jozef Bucha, Ladislav Gulán, and Ján Danko	
<b>Parametric Model of Human Body for Orthotic Robot Simulation Study</b> . . . . .	380
Dymitr Osiński and Danuta Jasińska-Choromańska	

**Evaluation of Gait and Standing Posture by Software Based on SimMechanics** . . . . . 387  
 Patrik Kutilek, Slavka Viteckova, Petr Volf, Jan Hejda, Veronika Kotolova, Vaclav Krivanek, Zdenek Svoboda, Radek Dorskocil, and Alexandr Stefek

**FEM – Based Simulations of Selected Setups of Magnetic Field Tomography** . . . . . 395  
 Paweł Nowak, Paweł Rozum, and Roman Szewczyk

**Modelling and Simulation of Vehicle Boot Door.** . . . . . 402  
 Filip Musil and Martin Brablc

**Advanced Multi-body Modelling in Mechatronics Education** . . . . . 410  
 Lukas Brezina

**Control**

**Unusual Application of the X3STEP Controller** . . . . . 419  
 Michał Bartyś

**Disturbance Compensation and Control Algorithm with Application for Non-linear Twin Rotor MIMO System** . . . . . 428  
 Alexey Margun, Igor Furtat, Dmitry Bazylev, and Artem Kremlev

**Model Reference Control for a Class of MIMO System with Dead-Time.** . . . . . 436  
 Jerzy E. Kurek

**Robust Control of Uncertain MIMO Plants in Conditions of Output Quantization and Time-Delay** . . . . . 444  
 Alexey Margun, Igor Furtat, and Konstantin Zimenko

**Speed Estimator for Low Speed PMSM Aerospace Application** . . . . . 452  
 Ivo Pazdera, Petr Huták, and Petr Procházka

**The New Stepper Driver for Low-Cost Arduino Based 3D Printer with Dynamic Stepper Control.** . . . . . 458  
 Jiri Ctibor and Ivo Pazdera

**Model Based Fault-Tolerant Control for SMA Actuator in Soft Robotics.** . . . . . 467  
 Tien Sy Le, Holger Schlegel, Welf-Guntram Drossel, and Matthias Putz

**Design and Verification of FPGA-Based Real-Time HIL Simulator of Induction Motor Drive** . . . . . 475  
 Tomas Kosan, Jakub Talla, and Antonin Glac

<b>Robust Control of a Robot Arm Using an Optimized PID Controller</b> . . . . .	484
Mustafa Can Bingöl, Zuhtu Hakan Akpolat, and Gonca Ozmen Koca	
<b>PSO Optimized ADRC Motor Speed Controller for Two Mass System with Backlash</b> . . . . .	493
Bartłomiej Wicher and Krzysztof Nowopolski	
<b>Sensors and Measurement</b>	
<b>Separation of Gravitational Acceleration from Acceleration of Human Motion Using Quaternion Based Unscented Kalman Filter</b> . . . . .	503
Pavel Kumpán	
<b>Methods of Motion Data Analysis of Animal's Body on Rotating Platform</b> . . . . .	511
Patrik Kutilek, Jan Hybl, Martin Eberl, Slavka Viteckova, Veronika Kotolova, Daniel Frynta, Eva Landova, Petra Frydlova, Vaclav Krivanek, Radek Dorskocil, and Rudolf Cerny	
<b>Fabrication and Optical-Electrical Characterization of Al/p-Si/CdO/Au Photodiode</b> . . . . .	520
Mehmet Çavaş	
<b>Threshold Selection Based on Extreme Value Theory</b> . . . . .	529
Radek Mařík	
<b>Development of a Time of Flight Laser Scanner 3D</b> . . . . .	538
Francesco Durante and Pierluigi Beomonte Zobel	
<b>Polish Road Signs Detection and Classification System Based on Sign Sketches and ConvNet</b> . . . . .	546
Łukasz Chechliński and Bartłomiej Chechliński	
<b>The Influence of the Learning Set on the Evaluation of Microcalcifications Using Artificial Neural Networks</b> . . . . .	554
Krzysztof Urbaniak and Krzysztof Lewenstein	
<b>Experimental Measurement of Magnetic Field Generated by Neodymium Magnet</b> . . . . .	562
Edyta Ładyżyńska-Kozdraś, Anna Sibilska-Mroziewicz, and Sławomir Czubaj	
<b>Measurement of Power Transistors Dynamic Parameters</b> . . . . .	571
Petr Prochazka, Jan Miklas, Ivo Pazdera, Miroslav Patocka, Jan Knobloch, and Radoslav Cipin	
<b>Measurement of High-Frequency Currents in Power Electronics</b> . . . . .	578
Jan Knobloch, Radoslav Cipin, and Petr Prochazka	

**Counting Pedestrians in Inner Spaces Using Optical Flow Algorithm** . . . . . 586  
 Robin Antonič and Vít Ondroušek

**Comparison of Vibration and Noise Measurement of Induction Machine Under Static Eccentricity** . . . . . 592  
 Jan Sobra, Tomas Kavalir, and Jiri Sika

**A Distributed Measurement System for Helium Spill Monitoring** . . . . . 599  
 Artur Jedrusyna, Maciej Grabowski, and Andrzej Noga

**Influence of Measurement Parameters Settings on the Results of the CT Measurement** . . . . . 607  
 Tomasz Kowaluk and Adam Woźniak

**Measurement System for Magnetic Field Sensors Testing with Earth’s Magnetic Field Compensation** . . . . . 613  
 Tomasz Charubin, Michał Nowicki, and Roman Szewczyk

**DeepEMGNet: An Application for Efficient Discrimination of ALS and Normal EMG Signals** . . . . . 619  
 Abdulkadir Sengur, Mehmet Gedikpinar, Yaman Akbulut, Erkan Deniz, Varun Bajaj, and Yanhui Guo

**Comparison of Interpolation Methods for Atmospheric Pressure Determination with Help of TDOA System** . . . . . 626  
 Ladislav Gregor, Libor Drazan, and Jiri Vesely

**Robotics**

**Determination of Optimal Local Path for Mobile Robot** . . . . . 637  
 Jiri Krejsa and Stanislav Vechet

**Development of Dual Wiimote-Based 3D Localization Schemes for Mobile Robot and Quadcopter Integration** . . . . . 644  
 H.-Y. Zhan, T.-H. Li, C.-H. Cheng, S.-H. Kuo, and K.-S. Chen

**Battery-Powered Autonomous Robot for Cleaning of Dusty Photovoltaic Panels in Desert Zones** . . . . . 653  
 Michele Gabrio Antonelli, Pierluigi Beomonte Zobel, Andrea De Marcellis, and Elia Palange

**Design and Control of Diving Mechanism for the Biomimetic Robotic Fish** . . . . . 662  
 Gonca Ozmen Koca, Mustafa Can Bingol, Cafer Bal, Zuhtu Hakan Akpolat, Mustafa Ay, and Deniz Korkmaz

**Standards to Support Military Autonomous System Life Cycle** . . . . . 671  
 Jan Hodicky

<b>Robotic Assistant for the Elderly - Rehabilitation Walker</b> . . . . .	679
Michal Dzurilla, Peter Šolek, Miloš Musil, and Michal Černý	
<b>Motion Control of Three-Rotor Unmanned Underwater Vehicle</b> . . . . .	687
Cafer Bal, Deniz Korkmaz, and Mustafa Can Bingol	
<b>Smart Systems</b>	
<b>From Simulation to Manufacturing of Piezoelectric Micromachined AlN Membrane</b> . . . . .	699
Magdalena A. Ekwińska, Jerzy Zając, Michał Zaborowski, and Dariusz Szmigiel	
<b>Probabilistic Reasoning in Diagnostic Expert System for Smart Homes</b> . . . . .	708
Stanislav Vechet, Jiri Krejsa, Jan Hrbacek, and Kuo-Shen Chen	
<b>Development of Smart and Dynamic Floral Clothing Accessories</b> . . . . .	716
C.H. Pan and H.Y. Pan	
<b>Numerical Wave Tank Analysis for Energy Harvesting with Oscillating Water Column</b> . . . . .	726
Halil İbrahim Yamaç and Ahmet Koca	
<b>Coil Optimization for Linear Electromagnetic Energy Harvesters with Non-uniform Magnetic Field</b> . . . . .	735
Jan Smilek and Zdenek Hadas	
<b>Performance Analysis of Wave Energy Harvesting System with Piezoelectric Element</b> . . . . .	743
Ahmet Koca and Kübra Erdoğan	
<b>Author Index</b> . . . . .	751