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Special section

RECENT ADVANCES IN MODELLING, ANALYSIS AND IMPLEMENTATION OF CYBER-PHYSICAL SYSTEMS

Guest editors

Remigiusz WIŚNIEWSKI
Luis GOMES
Shaohua WAN

University of Zielona Góra Press, Poland

Profile

About

The *International Journal of Applied Mathematics and Computer Science* is a quarterly published in Poland since 1991 by the University of Zielona Góra in partnership with De Gruyter Poland (Sciendo) and historically with Lubuskie Scientific Society, under the auspices of the Committee on Automatic Control and Robotics of the Polish Academy of Sciences. It strives to meet the demand for the presentation of interdisciplinary research in various fields related to control theory, applied mathematics, scientific computing, and computer science.

In particular, *AMCS* publishes original, high-quality full-length research papers in the following areas: *modern control theory and practice; artificial intelligence methods and their applications; applied mathematics and mathematical optimisation techniques; and mathematical methods in engineering, computer science and biology.*

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AIMS & SCOPE

The *International Journal of Applied Mathematics and Computer Science* strives to meet the demand for the presentation of interdisciplinary research in various fields related to control theory, applied mathematics, scientific computing, and computer science. In particular, it publishes high quality original research results in the following areas:

- modern control theory and practice
- artificial intelligence methods and their applications
- applied mathematics and mathematical optimisation techniques
- mathematical methods in engineering, computer science, and biology.

We are primarily interested in presenting theoretical and application-oriented full-length research papers dealing with the following topics:

- control theory, including optimal control, system identification, adaptive and robust control, multivariable control, and non-linear systems
- dynamical systems, including spatiotemporal processes, control problems, state and parameter estimation, and sensor networks
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- classification and pattern recognition
- biomedical engineering and biomathematics
- applications in engineering and medicine.

The editors welcome proposals for exchange between similar journals. Also, all persons interested in bringing out special issues of *AMCS* are encouraged to contact the Editor-in-Chief. Such issues may be published on any important and timely subject within the scope of the journal. All papers proposed for specials should be refereed and meet the same criteria for scientific quality as articles presented in regular issues.

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PREFACE

Special section on

Recent Advances in Modelling, Analysis and Implementation of Cyber-Physical Systems

A cyber-physical system (CPS) is an integration of computation with physical processes, whose behaviour is defined by cyber and physical parts of the system. Rapid development of cyber-physical systems results in a huge impact on human life. The design methodology of such systems includes the joint dynamics of computers, software, networks and physical processes. The physical part refers to the real world and is prone to environmental influences, while the control (cyber) part controls the objects and makes decisions.

This special section presents five papers related to the recent advances in the modelling, analysis, and application merits of cyber-physical systems. The authors focus on the new aspects, algorithms and systems related to the prototyping flow of cyber-physical systems. Their papers include novel techniques, algorithms, and theoretical results oriented towards the modelling and analysis of CPSs, as well as propositions of new design methodologies, including cybersecurity aspects.

The paper entitled *Modelling information for the burnishing process in a cyber–physical production system* proposes a framework to collect data and information from the burnishing production process, in order to monitor real-time deviations from the correct course of the process. Such an operation allows reducing the number of defective products within the manufacturing process. The main contribution of the paper consists in constructing a predictive model, based on the Hellwig method for errors in the production process, which relies on indications of a machine's status. The presented technique is supported by experimental research based on the implementation of the system in a real-life environment.

The authors of the article *Edge computing in IOT-enabled honeybee monitoring for the detection of Varroa destructor* introduce a solution for the global monitoring of apiaries and the detection of *Varroa destructor* mites in beehives. In particular, the proposed solution is based on capturing and processing video streams from camera-based IoT devices. Such streams are further analysed with the use of edge computing in order to construct a global collection of cases within the cloud. The presented method is supported by experimental results, which show that the detection process can be run in real time.

The paper *Application of fuzzy logic in a secure beacon-based guidance system for public transportation* aims at the problems of guiding passengers within a public transport infrastructure. The proposed solution is based on a digital personal travel companion application, including outdoor location and event detection. The number of necessary interactions between the user and the application is reduced by employing an alerting system based on personalization through the preferences and characteristics of the user. The proposed solution includes an event detection system based on beacons and is supported by a fuzzy logic algorithm which makes it possible to determine the user's most likely actions during the journey. The techniques proposed in the work are supported by experimental research of two different case-studies.

In the work *An SFA-HMM performance evaluation method using state difference optimization for running gear systems in high-speed trains*, a health assessment method based on SFA and state transition optimization is developed along with application to running gear systems in high-speed train. In particular, a performance evaluation method based on a combination of slow feature maximum entropy analysis and a hidden Markov probability distribution is proposed. The presented technique is supported by experimental research in order to verify the effectiveness of the method.

Finally, the paper *A holistic study on use of blockchain technology in CPS and IoT architectures maintaining the CIA triad in data communication* is focused on the security aspects of cyber-physical systems. In particular, a holistic study of blockchain technology usage in CPS and IoT architectures is studied by exposing its main advantages and benefits. It is shown that present systems of CPS and IoT architectures are vulnerable to faults in the centralized control. In contrast, blockchain-based technologies of distributed secure systems can make these architectures much more secure and efficient.

Concluding, we would like to thank all the authors who submitted their research papers to our special section. We highly appreciate the contribution of the reviewers with their constructive comments and suggestions. We also wish to acknowledge the journal's Editor-in-Chief, Professor Józef Korbicz, for his acceptance of this special section, as well as his cooperation, support and assistance throughout the process. We also would like to thank Ms. Agnieszka Rożewska of the Editorial Office for her invaluable support and helpful suggestions offered during the managing of this special section.

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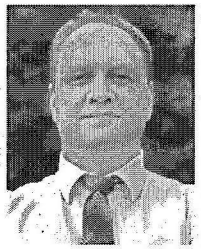
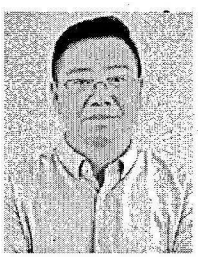
September 2022



Remigiusz Wiśniewski is a professor and the head of the Division of Applied Informatics and Electronics at the University of Zielona Góra, Poland. He received his doctoral degree in computer science from the University of Zielona Góra in 2008, and his DSc degree (habilitation) in computer science from the Silesian University of Technology in 2018. In 2019 he was a visiting professor within an internship at the University of California at Berkeley (Berkeley, CA, USA). His research interests include cryptography and cryptanalysis, design and analysis of cyber-physical systems, control systems, Petri nets, programmable devices, field programmable gate arrays (FPGAs), and partial reconfiguration of FPGAs. In 2022 Prof. Wiśniewski was awarded an individual prize by the Polish Ministry of Science and Higher Education for outstanding scientific achievements. He is an author of over 130 peer-reviewed research papers and books, an associate editor of *IEEE Transactions on Systems, Man, and Cybernetics: Systems, IEEE Transactions on Industrial Informatics*, and *IEEE Access* ("Associate Editor of the Month" of July 2019), and a co-founder and the coordinator of the research project *Hippo* (`www.hippo.issi.uz.zgora.pl`).

Luis Gomes received his electrotechnical engineer degree from the Technical University of Lisbon, Portugal, in 1981, and his PhD degree in digital systems from NOVA University Lisbon, Portugal, in 1997. He is an associate professor with a habilitation at the Electrical and Computer Engineering Department, Faculty of Sciences and Technology, NOVA University Lisbon, and a researcher at the UNINOVA Institute, Portugal. From 1984 to 1987, he was with EID, a Portuguese medium enterprise in the area of electronic system design, at the R&D engineering department. His main interests include the usage of Petri nets and other models of concurrency, applied to reconfigurable and embedded systems co-design, and cyber-physical systems. He was appointed an honorary professor of the Transilvania University of Brasov, Romania, in 2007, as well as an honorary professor of Óbuda University, Budapest, Hungary, in 2014. He received the IEEE Industrial Electronics Society Anthony J. Hornfeck Service Award in 2016. Professor Gomes is an author/co-author of more than 300 papers and chapters published in journals, books and conference proceedings, as well as a co-author of one book and co-editor for three books. He has served as an associate editor for *IEEE Transactions on Industrial Informatics, IEEE Transactions on Industrial Electronics*, and *IEEE Industrial Electronics Magazine*, and as a guest co-editor of several special sections in the referred *IEEE Transactions* as well as *IEEE Access*.



Shaohua Wan received his PhD degree from the School of Computer Science, Wuhan University, in 2010. He is currently a full professor with the Shenzhen Institute for Advanced Study, University of Electronic Science and Technology of China. From 2016 to 2017, he was a visiting professor at the Department of Electrical and Computer Engineering, Technical University of Munich, Germany. His main research interests include deep learning for the Internet of things. He is an author of over 150 peer-reviewed research papers and books, including over 40 *IEEE/ACM Transactions* papers and many top conference papers in the field of edge intelligence. He is a senior member of IEEE.