



Editorial

Innovative circuit and system design methodologies for green cyber-physical systems



With the development and expansion of automation and intelligence, there are still all sorts of challenges (e.g., energy consumption, heterogeneity problems, and integration methodology) for the design of green Cyber-Physical Systems (CPS). Recently, the popularity of CPS (e.g., intelligent manufacturing, intelligent transportation systems, and smart home) has brought about some epoch-making industrial revolution. The design problems of green CPS should be considered from the perspective of the innovative circuit and system design methodologies.

This “Special Issue on Innovative Circuit and System Design Methodologies for Green Cyber-Physical Systems” presents a collection of high quality papers from the CPS and its related research community. The 9 accepted papers were selected from a total of 21 submissions. Each accepted paper has gone through at least one revision to enhance the paper quality. The authors have done an excellent job of presenting their research materials.

In “CPSiCGF: A Code Generation Framework for CPS Integration Modeling”, S. Li et al. present a multi-view code generation framework for CPS modeling language to supplement the model-integrated developing approach for CPS. As we know, CPS has become a feasible paradigm in solving complex problems faced in industrial applications, however, several drawbacks of traditional developing methodologies for CPS may be the obstacles of its further application. Therefore, a multi-view-integrated model-driven approach is adopted for efficient design and implementation of CPS and the proposed code generation framework, CPSiCGF, completes the whole tool chain for this approach. Details of the proposed framework are also introduced.

In the paper “A Standardized Design Methodology for Complex Digital Logic Components of Cyber-Physical Systems” by F. Chen et al., the authors propose a standardized design methodology for complex digital logic components to help developers to understand the design intent preferably, and make design activities be carried out under a convenient modeling methodology. Also, a precise verification solution is designed for completing the design cycle so as to speed up the development process, and improve the development quality and efficiency.

In the third paper, “Improvement of Type Declaration of the IEC 61499 Basic Function Block for Developing Applications of Cyber-Physical System”, S. Wang et al. present an improved type declaration for basic function block of the IEC 61499 standard. The authors point out that the function block network defined by the IEC 61499 standard suits well for building distributed applications and managing complexity for green cyber-physical systems. While the function block network can be built and managed in a single

computer, different blocks can be allocated to different devices. However, semantic ambiguity exists in the function block architecture due to the incomplete definition of the standard leading to inconsistency in different implementations. In this paper, the authors propose a compact interface model and a strict execution control chart model to successfully reduce semantic ambiguity and simplify block development and application process.

The paper, entitled “Cloud-Assisted Industrial Cyber-Physical Systems: An Insight”, introduces and compares the traditional industrial manufacturing mode and the cloud-assisted industrial production mode. The topic of this paper highlights the importance of cloud and industrial cyber-physical systems (ICPS), which can increase the efficiency of industrial manufacturing, and enhance the flexibility of production line. Also, the authors especially present the model of service-oriented cloud-assisted ICPS, which is aimed to realize sustainability and green business. This will take great contribution to our life and industrial manufacturing. Particularly, the authors explain the mode of implementing cloud-assisted ICPS, talk about some essential enabling technologies, and discuss some challenges.

G. Han et al. in their paper entitled “Impacts of Traveling Paths on Energy Provisioning for Industrial Wireless Rechargeable Sensor Networks” introduce and compare the performance of four traveling paths in charging performance comprehensively, analyze and conclude the characteristics that an effective traveling path should possess from the simulation results. The four traveling paths are SCAN, HILBERT, S-CURVES (ad) and Z-curve respectively, which are all space-filling curves and suitable for industrial wireless sensor networks. The authors aim to establish a solid foundation for traveling path planning of mobile chargers and provide guidance on designing more advanced charging traveling paths.

In the sixth paper “LTE-based Humanoid Robotics System”, Y. Ma et al. present a LTE-based robotics system integrated with cloud computing to enhance the capability of data transmissions and intelligence for providing higher quality and more friendly services. This paper indicates that although the robots integrated with communication module can provide various functions, there are some intrinsic limitations because of the instable wireless connection, restricted bandwidth and limited coverage of the network. Fortunately, assisted by LTE (Long Term Evolution) techniques, the robots can be deployed more widely to support bandwidth-intensive applications for green cyber-physical systems. Details of the proposed robotic system architecture are introduced. Furthermore, the authors develop a robot with emotional recognition and feedback for improving the quality of service and quality of

experience, and design a testbed for verifying system's feasibility and performance.

The seventh paper "STETS: A Novel Energy-efficient Time Synchronization Scheme based on Embedded Networking Devices", T. Qiu et al. explore system design methodologies and propose an effective solution for time synchronization in large-scale sensor networks. In the proposed approach, the backbone sensor nodes form a spanning tree and they get synchronized layer by layer through SRP (Sender to Receiver Protocol). Other nodes get synchronized through RRP (Receiver to Receiver Protocol) by only listening to the communication between backbone sensor nodes. The authors also evaluate the performances by simulating the approach on NS-2 and implementing it on embedded networking devices STM32W108 with simple MAC protocol stack.

In the paper "An Integrated Framework of Formal Methods for Interaction Behaviors among Industrial Equipments", P. Deng, et al. propose a formal framework for modeling and analysis of interaction behaviors among industrial equipments. This framework, which combines pi-calculus, a famous process algebra, and NuSMV, a well-known model checker, can be used in modeling and analysis of GCPs and help practicing engineers to ensure system temporal correctness and reliability. This framework is applied to the specification and verification of scheduling of road emergency services. The results show the framework is practical and effective.

Finally, in the paper entitled "Metaheuristics for the Deployment Problem of WSN: A Review", C. Tsai, et al. review the deployment problem (DP) of WSN. This work begins with an overview of WSN and the deployment problem, followed by discussions on metaheuristics and how to use them to solve the DP. Then, a comprehensive comparison between metaheuristics for the DP is given. Finally, the open issues and future trends of this field are addressed. This paper attempts to provide not only a systematic survey of metaheuristics for solving the deployment problem but also a roadmap for researchers working on WSN and metaheuristics to further save the energy of a WSN.

We would like to thank all the reviewers for their efforts and constructive comments. We would in particular like to thank Professor L. Jozwiak, the Editor-in-Chief, for his support and helpful suggestions. We thank all authors who contributed to this Special Issue for submitting their manuscript and sharing their latest research results.



Jiafu Wan is an Associate Professor in School of Mechanical & Automotive Engineering, South China University of Technology (SCUT), Guangzhou, China. He has directed 10 research projects, including the National Natural Science Foundation of China (NSFC), the High-level Talent Project of Guangdong Province, the Natural Science Foundation of Guangdong Province, etc. Thus far, he has authored/co-authored one book and 80+ scientific papers (with 30+ indexed by ISI SCIE, 40+ indexed by EI Compendex) cited over 1150 times. His research results were published in several famous journals, such as IEEE Communications Surveys and

Tutorials, IEEE Communications Magazine, IEEE Network, IEEE Wireless Communications, ACM Transactions on Embedded Computing Systems, IEEE Systems Journal, and Journal of Power Sources. He is a Guest Editor for IEEE Systems Journal, IEEE Access, Elsevier Computer Networks, ACM/Springer Mobile Networks & Applications (MONET), Microprocessors and Microsystems, etc. He is a Managing Editor for IJAACS (Ei Compendex) and IJART (Ei Compendex). He is General Chair for

2016 International Conference on Industrial IoT Technologies and Applications (IndustrialIoT 2016). His research interests include Cyber-Physical Systems (CPS), Internet of Things (IoT), Industrial Wireless Networks, Cloud Computing, Embedded Systems, and Industrial Robotics. He is a CCF and CMES senior member, and a member of IEEE and ACM.



Chin-Feng Lai is an associate professor at Department of Computer Science and Information Engineering, National Chung Cheng University since 2014. He received the Ph.D. degree in department of engineering science from the National Cheng Kung University, Taiwan, in 2008. He received Best Paper Award from IEEE 17th CCSE, 2014 International Conference on Cloud Computing, IEEE 10th EUC, IEEE 12th CIT. He has more than 100 paper publications. He is an associate editor-in-chief for Journal of Internet Technology and serves as editor or associate editor for IET Networks, International Journal of Internet Protocol Technology, KSII Transactions

on Internet, Information Systems and Journal of Internet Technology. He is TPC Co-Chair for FCST2014, ICS2014, ICESS2013, FC2013, EmbeddedCom-2012, CIT 2012 and the Interest Group on Multimedia Services and Applications over Emerging Networks of the IEEE Multimedia Communication Technical Committee during 2012–2017. His research focuses on Internet of Things, Body Sensor Networks, E-healthcare, Mobile Cloud Computing, Cloud-Assisted Multimedia Network, Embedded Systems, etc. He is an IEEE Senior Member since 2014.



Shiwen Mao received Ph.D. in electrical and computer engineering from Polytechnic University, Brooklyn, NY in 2004. He was the McWane Associate Professor in the Department of Electrical and Computer Engineering from 2012 to 2015, and is the Samuel Ginn Endowed Professor since 2015 at Auburn University, Auburn, AL, USA. His research interests include wireless networks and multimedia communications. He is a Distinguished Lecturer of the IEEE Vehicular Technology Society in the Class of 2014, and the Vice Chair–Letters and Member Communications of IEEE Communications Society Multimedia Communications Technical Committee. He is on

the Editorial Board of IEEE Transactions on Multimedia, IEEE Internet of Things Journal, IEEE Communications Surveys and Tutorials, and IEEE Multimedia, among others. He serves as Steering Committee Member for IEEE ICME and AdhocNets, Area TPC Chair of IEEE INFOCOM 2016 and Technical Program Vice Chair for Information Systems of IEEE INFOCOM 2015, symposium co-chairs for many conferences, including IEEE ICC, IEEE GLOBECOM, ICCCN, et al. He received the 2013 IEEE ComSoc MMTC Outstanding Leadership Award and the NSF CAREER Award in 2010. He is a co-recipient of The IEEE WCNC 2015 Best Paper Award, The IEEE ICC 2013 Best Paper Award, and the 2004 IEEE Communications Society Leonard G. Abraham Prize in the Field of Communications Systems.



Prof. Eugenio Villar got his Ph.D. in Electronics from the University of Cantabria in 1984. Since 1992 is Full Professor at the Electronics Technology, Automatics and Systems Engineering Department of the University of Cantabria where he is currently the responsible for the area of HW/SW Embedded Systems Design at the Microelectronics Engineering Group. His research activity has been always related with system specification and modeling. His current research interests cover system specification and design, MpSoC modeling and performance estimation using SystemC and UML/MARTE of mixed-critical, distributed embedded systems.

He is author of more than 130 papers in international conferences, journals and books in the area of specification and design of electronic systems. Prof. Villar served in several technical committees of international conferences like the VHDL Forum, Euro-VHDL, EuroDAC, DATE, VLSI-SoC, FDL and EuroMicro DSD. He has participated in several international projects in electronic system design under the FP5, FP6 and FP7, ITEA, Medea-Catrene and Artemis programs. He is the representative of the University of Cantabria in the ECSEL.



Subhas Mukhopadhyay (M'97, SM'02, F'11) graduated from the Department of Electrical Engineering, Jadavpur University, Calcutta, India with a Gold medal and received the Master of Electrical Engineering degree from Indian Institute of Science, Bangalore, India. He has PhD (Eng.) degree from Jadavpur University, India and Doctor of Engineering degree from Kanazawa University, Japan. Currently he is working as a Professor of Sensing Technology with the School of Engineering and Advanced Technology, Massey University, Palmerston North, New Zealand. He has over 25 years of teaching and research experiences. His fields of interest include Sensors and Sensing Technology, Smart Home and Environment, Internet of Things, Instrumentation and Measurements, Wireless Sensor Networks, Electromagnetics, Control, Electrical machines and Numerical Field Calculation etc. He has authored/co-authored four books and over 320 papers in different international journals, conferences and book chapter. He has edited twelve conference proceedings. He has also edited twelve special issues of international journals as lead guest editor and twenty-five books out of which twenty three are with Springer-Verlag. He has delivered 246 seminars as keynote, invited, tutorial and special lectures in 24 countries. He was awarded numerous awards throughout his career and attracted over NZ \$3.8M on different research projects. He is a Fellow of IEEE (USA), a Fellow of IET (UK) and a Fellow of IETE (India).

Guest Editors

Jiafu Wan

South China University of Technology, China

E-mail address: jiafuwan_76@163.com

Chin-Feng Lai

National Chung Cheng University, Taiwan

E-mail address: cinfon@ieee.org

Shiwen Mao

Auburn University, USA

E-mail address: smao@ieee.org

Eugenio Villar

University of Cantabria, Spain

E-mail address: evillar@teisa.unican.es

Subhas Mukhopadhyay

Massey University, New Zealand

E-mail address: S.C.Mukhopadhyay@massey.ac.nz