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## 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 allocated to different devices. However, semantic ambiguity exists in the function block architecture due to the incomplete definition of the standard leading to inconsistence 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 aim 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 GCPSs 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.



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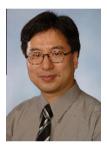
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