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SPECIAL SECTION ON CIRCUIT AND SYSTEM DESIGN AUTOMATION FOR INTERNET OF THINGS

Guest Editorial - Circuit and System Design Automation for Internet of Things

Internet-of-Things (IoT) is the technical backbone of smart cities which are envisioned to cope up with rapid urbanization of human population with limited resources. IoT provides three key features of smart cities such as intelligence, interconnection, and instrumentation. IoT is essentially a system-of-systems which can be considered as a configurable dynamic global network of networks. The main components of IoT include the following: (1) The Things, (2) Internet, (3) LAN, and (4) The Cloud. IoT is built by various diverse components including electronics, sensors, actuators, controllers, networks, firmware, and software. However, the existing electronics, controllers and processors do not meet IoT requirements, such as multiple sensors, communication protocols, and security requirements. The existing Computer-Aided Design (CAD) or Electronic Design Automation (EDA) tools are not enough to meet diverse challenges such as time-to-market, complexity, and cost of IoT. The required electronic circuits and systems need to be developed by handling and solving specific requirements. Real-time and ultra-low power plays a major role since mobile devices in the IoT have to provide a long availability with a relative small energy budget. At the same time, reliability, availability, real-time constraints, and performance requirements pose significant challenges and therefore lead to a high interest in research. In this special issue, different approaches to design novel devices, circuits, and systems for solving the challenges with IoT are targeted. Various novel design automation components including modeling, design flows, simulation methods, and optimizations for designing of modern IoT are targeted, from system level down to device level. The current special issue was envisioned with the above technical considerations. After a rigorous review process, a set of articles were selected for this special issue. These papers are briefly discussed in the rest of the editorial.

In IoT, edge computing paradigm can be useful to reduce the data transmission latency and cost by performing many computations at the edge nodes prior to sending them in the Internet. Adegbija, et al. in "Microprocessor Optimizations for the Internet of Things: A Survey" present an extensive study of microarchitectural characteristics of IoT applications for efficient edge computing.

Multicore computing is useful in mixed-criticality systems in which multiple activities with different certification requirements may happen. Han, et al. in "Multicore Mixed-Criticality Systems: Partitioned Scheduling and Utilization Bound" present a criticality-aware task partitioning algorithm to improve utilization of the multiple cores in the hardware platform.

Artificial Intelligent (AI) technology including machine learning and deep learning is one of the drivers of IoT growth. Hardware accelerators for such technology can be crucial high-speed low-cost computations in the IoT framework. Guo, et al. in "Angel-Eye: A Complete Design Flow for Mapping CNN onto Embedded FPGA" present a programmable and flexible Convolutional Neural Network (CNN) accelerator.

Andri, et al. in "YodaNN: An Architecture for Ultra-Low Power Binary-Weight CNN Acceleration" present a hardware accelerator for binary-weight Convolutional Neural Network (CNN). The proposed accelerator advances the state-of-the-art in terms of energy and area efficiency.

Typical real-life hardware needed for the IoT can be combination of analog and digital components for cost and performance trade-offs. Beaumont, et al. in "High-Level Asynchronous Concepts at The Interface Between Analog and Digital Worlds" introduce novel high-level description language for asynchronous circuits which may serve as interface between analog and digital domains. The key feature of this idea is simplification of capturing the system requirements in the form of a formal specification and to promote behavioral for design reuse.

Chen, et al. in "qSwitch: Dynamical Off-Chip Bandwidth Allocation between Local and Remote Accesses" present an approach for dynamic bandwidth allocation in the multisocket computer systems when there is heavy intersocket communications. The main feature of the proposed method is to increases the physical bandwidth of intersocket communication via switching the function of pins from off-chip memory accesses to achieve an average performance speedup.

Security is of paramount importance in the IoT which are essentially connected devices potentially communicating among themselves all the time. In the context of IoT, security is an umbrella term which may include trust, privacy, information security, system security, privacy, and copyright protection. Wang, et al. in "Enabling Security-enhanced Attestation with Intel SGX for Remote Terminal and IoT" present a security-enhanced attestation for remote terminals which can be useful and Bring Your Own Device (BYOD) approach in IoT.

Physical Unclonable Function (PUF) has been explored as a security primitive for last decade which relies on the features of the underneath hardware to provide robust security. Marchand, et al. "Implementation and Characterization of a Physical Unclonable Function for IoT: A Case Study with the TERO-PUF" introduce a transient effect ring oscillator (TERO) PUF which has been demonstrated in FPGA platform.

Physical side channels attacks such as Differential Power Analysis (DPA) extract information from the cryptographic hardware characteristics instead of defeating the algorithms. Kumar, et al. in "FinSAL: FinFET Based Secure Adiabatic Logic for Energy-Efficient and DPA Resistant IoT Devices" present a FinFET based Secure Adiabatic Logic (FinSAL) which is claimed to be energy-efficient and DPA-resistant.

Geng, et al. in "On Random Dynamic Voltage Scaling for Internet-of-Things: A Game-Theoretic Approach" investigate a method based on random dynamic voltage scaling (RDVS) technology for side channel attack resilient cryptosystems. The key idea is to monitor the off-chip power supply voltage and trigger an alarm to protect valued information once the power supply voltage is lower than a threshold value.

Smart building is a concrete example of the application of IoT. In IoT based smart buildings safety, indoor localization are important issues. Cirigliano, et al. in "Towards Smart Building Design Automation: Extensible CAD Framework for Indoor Localization Systems Deployment" present a solution for indoor localization. The key idea is the cost-effective deployment of wireless localization systems in order to maximize the localization accuracy.

Various forms of wired and wireless connectivity is crucial for IoT. Li, et al. in "A Novel Fully Synthesizable All-Digital RF Transmitter for IoT Applications" present fully synthesizable design of all-digital RF transmitter for improving high-frequency communications.

The guest editors sincerely believe that this special issue on IoT will be a great reading for the contemporary researchers worldwide. The guest editors would like to thank the editor-in-chief (EiC) Dr. Vijaykrishnan Narayanan and the deputy EiC Charles J. Alpert of IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD) for the opportunity of this special issue. The guest editors are thankful to the many reviewers around the globe for their timely reviews without which this successful special issue would not have been possible. The guest editors thank the authors for their patience and dedication at all stages of the review process. The guest editors are also thankful to the IEEE staffs for their help during this special issue.

- Saraju P. Mohanty**,** University of North Texas, saraju.mohanty@unt.edu
- Michael Huebner**,** Ruhr University Bochum, Germany, Michael.Huebner@ruhr-uni-bochum.de
- Jason Xue, City University of Hong Kong, China, jasonxue@cityu.edu.hk
- Xin Li, Duke University, xinli.ece@duke.edu
- Hai (Helen) Li, Duke University, hai.li@duke.edu

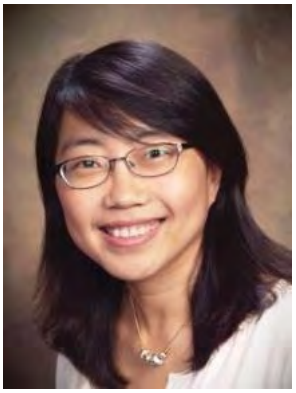
Guest Editors' Bio

Saraju P. Mohanty (SM'08) is a Professor at the Department of Computer Science and Engineering (CSE), University of North Texas (UNT). He obtained a Ph.D. in Computer Engineering from the University of South Florida (USF) in 2003 and a Master's degree in Systems Science and Automation (SSA) from the Indian Institute of Science (IISc), Bangalore, India in 1999. Prof. Mohanty's research is in "Smart Electronic Systems". Prof. Mohanty's research has been funded by National Science Foundation (NSF), Semiconductor Research Corporation (SRC), and Air Force. Dr. Mohanty is an inventor of 4 US patents. Prof. Mohanty is an author of 220 peer-reviewed journal and conference articles, and 3 books. His Google Scholar h-index is 28 and i10-index is 83. Prof. Mohanty was conferred the Glorious India Award in 2017 for his exemplary contributions to the discipline. He received Society for Technical Communication (STC) 2017 Award of Merit for his outstanding contributions to IEEE Consumer Electronics Magazine. He was the recipient of 2016 PROSE Award for best Textbook in Physical Sciences & Mathematics from the Association of American Publishers for his Mixed-Signal System Design book. He was conferred 2016-17 UNT Toulouse Scholars Award for sustained excellent scholarship and teaching achievements. Prof. Mohanty has been serving on the editorial board of several peer-reviewed journals and transactions, including IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD) and ACM Journal on Emerging Technologies in Computing Systems (JETC). He is currently the Editor-in-Chief (EiC) of the IEEE Consumer Electronics Magazine. Prof. Mohanty currently serves as the Chair of Technical Committee on Very Large Scale Integration (TCVLSI), IEEE Computer Society (IEEE-CS) to oversee a dozen of IEEE conferences. He serves on the steering, organizing, and program committees of several international conferences including IEEE-CS Symposium on VLSI (ISVLSI) and IEEE International Conference on 172 Consumer Electronics (ICCE). Prof. Mohanty has supervised 8 Ph.D. dissertations and 26 M.S. theses; eight of these advisees have received outstanding student awards at UNT. More about his biography, research, education, and outreach activities can be obtained from his website: http://www.smohanty.org.

Prof. Dr.-Ing. habil. Michael Hübner is the Chair for Embedded Systems for Information Technology (ESIT) at the Ruhr-University of Bochum (RUB) since April 2012. He received his diploma degree in electrical engineering and information technology in 2003 and his PhD degree in 2007 from the University of Karlsruhe (TH). Prof. Hübner did his habilitation in 2011 at the Karlsruhe Institute of Technology (KIT) in the domain of reconfigurable computing systems. His research interests are in reconfigurable computing and particularly new technologies for adaptive FPGA run-time reconfiguration and on-chip network structures with application in automotive systems, incl. the integration into high-level design and programming environments.

Chun Jason Xue (SM'16) received the B.S. degree in computer science and engineering from the University of Texas at Arlington, Arlington, TX, USA, in 1997, and the M.S. and Ph.D. degrees in computer Science from the University of Texas at Dallas, Dallas, TX, USA, in 2002 and 2007, respectively. He is currently an Associate Professor with the Department of Computer Science, City University of Hong Kong.. His current research interests include non-volatile memories, embedded systems, and software/hardware co-design. He is currently Associate Editor for ACM Transactions on Embedded Computing Systems, ACM Transactions on CPS, ACM Transactions on Storage. He was TPC co-chair for ACM LCTES 2015, IEEE RTCSA 2010. He has served as TPC members for premier conferences such as DAC, DATE, RTSS, RTAS, EMSOFT. He received best paper award in ICCD 2016 and best student paper award in RTCSA 2015.

Xin Li (F'17) is currently a Professor in the Department of Electrical and Computer Engineering at Duke University and is leading the Institute of Applied Physical Sciences and Engineering at Duke Kunshan University. From 2007 to 2016, he was a faculty in the Department of Electrical and Computer Engineering, Carnegie Mellon University, Pittsburgh, PA. In 2005, he co-founded Xigmix Inc. to commercialize his PhD research, and served as the Chief Technical Officer until the company was acquired by Extreme DA in 2007. In 2011, Extreme DA was further acquired by Synopsis (Nasdaq: SNPS). From 2009 to 2012, he was the Assistant Director for FCRP Focus Research Center for Circuit & System Solutions (C2S2), a national consortium of 13 research universities (CMU, MIT, Stanford, Berkeley, UIUC, UMich, Columbia, UCLA, among others) chartered by the U.S. semiconductor industry and U.S. Department of Defense to work on next-generation integrated circuit design challenges. From 2014 to 2015, he was the Assistant Director for the Center for Silicon System Implementation (CSSI), a CMU research center with 20 faculty members working on integrated circuits and systems. His research interests include integrated circuit, signal processing and data analytics. Dr. Xin Li was an Associate Editor of IEEE Trans. on Biomedical Engineering (TBME), IEEE Trans. on Computer-Aided Design of Integrated Circuits and Systems (TCAD), ACM Trans. on Design Automation of Electronic Systems (TODAES), IEEE Design & Test (D&T), and Journal of Low Power Electronics (JOLPE). He was the Guest Editor for IEEE TCAD, IEEE TNANO, IEEE TBD, IEEE D&T, IEEE JETCAS, ACM TCPS, ACM JETC and VLSI Integration. He served on the Executive Committee of ACM Special Interest Group on Design Automation (SIGDA), IEEE Systems, Man, and Cybernetics Society Technical Committee on Cybernetics for Cyber-Physical Systems (TCCCPS), and IEEE Computer Society Technical Committee on VLSI (TCVLSI). He was the General Chair of ISVLSI, iNIS and FAC, and the Technical Program Chair of CAD/Graphics. He also served on the ACM/SIGDA Outstanding PhD Dissertation Award Selection Committee, the IEEE TTTC E. J. McCluskey Best Doctoral Thesis Selection Committee, the IEEE Outstanding Young Author Award Selection Committee, the Executive Committee of ISVLSI, GLSVLSI and iNIS, and the Technical Program Committee of DAC, ICCAD, ITC, ISVLSI, FAC, CAD/Graphics, ASICON and VLSI. He received the NSF Faculty Early Career Development Award (CAREER) in 2012, two IEEE Donald O. Pederson Best Paper Awards in 2013 and 2016, the Best Paper Award from Design Automation Conference (DAC) in 2010, two IEEE/ACM William J. McCalla ICCAD Best Paper Awards in 2004 and 2011, and the Best Paper Award from International Symposium on Integrated Circuits (ISIC) in 2014. In addition to these awards, he also received six Best Paper Nominations from Design Automation Conference (DAC), International Conference on Computer-Aided Design (ICCAD) and Custom Integrated Circuits Conference (CICC).



Hai (Helen) Li (SM'16) received the B.S. and M.S. degrees from Tsinghua University, Beijing, China, and the Ph.D. degree from the Department of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA. She is a Clare Boothe Luce Associate Professor with the Department of Electrical and Computer Engineering at Duke University, Durham, NC, USA. She was with Qualcomm Inc., San Diego, CA, USA, Intel Corporation, Santa Clara, CA, Seagate Technology, Bloomington, MN, USA, the Polytechnic Institute of New York University, Brooklyn, NY, USA, and the University of Pittsburgh, Pittsburgh, PA, USA. She has authored or co-authored over 180 technical papers published in peer-reviewed journals and a book entitled Nonvolatile Memory Design: Magnetic, Resistive, and Phase Changing (CRC Press, 2011). Her research interests include memory design and architecture, neuromorphic architecture for brain-inspired computing systems, and architecture/circuit/device cross-layer optimization for low power and high performance. Dr. Hai Li serves as Associate Editor of IEEE Transactions on Computer Aided Design (TCAD), IEEE Transactions on Multi-Scale Computing Systems (TMSCS), IEEE Transactions on Very Large Scale Integration (TVLSI) Systems, the IEEE Consumer Electronics Magazine (CEM), ACM Transactions on

Design Automation of Electronic Systems (TODAES), and IET Cyber-Physical Systems: Theory & Applications (IET-CPS). She was the Guest Editor for IEEE TCAD, IEEE TNANO, IEEE JETCAS, ACM JETC, IET CPS, and VLSI Integration. She was the General Chair of ISVLSI, ICCE, ISQED and GLSVLSI, and the Technical Program Chair of SoCC, iNIS, GLSVLSI. She also served on the ACM/SIGDA Outstanding PhD Dissertation Award Selection Committee, the Program chair for ACM SIGDA summer school (DASS), the Executive Committee of ISVLSI, GLSVLSI and iNIS, and the Technical Program Committee members of over 20 international conference series. She received the NSF Faculty Early Career Development Award (CAREER) in 2012, the DARPA Young Faculty Award (YFA) in 2013, TUM-IAS Hans Fisher Fellowship in 2017, two Best Paper Awards from Asia and South Pacific Design Automation Conference (ASPDAC) in 2017 and 2015, the Best Paper Award from IEEE Computer Society Annual Symposium on VLSI (ISVLSI) in 2014, the Best Paper Award from Proceedings of ACM International Conference on Great Lakes Symposium on VLSI (GLSVLSI) in 2013, the Best Paper Award from ACM/IEEE International Symposium on Low Power Electronics and Design (ISLPED) in 2010, and the Best Paper Award from International Symposium on Quality Electronic Design (ISQED) in 2008. In addition to these awards, she also received seven Best Paper Nominations from Design Automation Conference (DAC), International Conference on Computer-Aided Design (ICCAD), International Symposium on Low Power Electronics and Design (ISLPED), Asia and South Pacific Design Automation Conference (ASPDAC), Design, Automation & Test in Europe Conference and Exhibition (DATE), and International Symposium on Quality Electronic Design (ISQED). She is a senior member of IEEE and ACM.