IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Digital Object Identifier 10.1109/ACCESS.2021.3105788

EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: EMERGING TRENDS OF ENERGY AND SPECTRUM HARVESTING TECHNOLOGIES

Billions of low-end wireless devices, such as sensors, are permeating into almost every aspect of personal life, such as vehicles, washing machines, and air conditioners. These miniaturized and low-end devices are a promising solution to collect information and assist users in interacting with real-world objects. Frost and Sullivan reported that the global market of miniaturized devices is forecast to increase from 1.4 billion to 3.26 billion from 2014 to 2024. Unfortunately, the performance of miniaturized devices, which generally operate with limited battery power and transmit data over an unlicensed spectrum, is highly deteriorated due to resource scarcity issues in terms of energy and spectrum. The energy scarcity issue limits the longevity of devices and requires the operator to manually replace the depleted battery, which results in considerable maintenance costs. Even with sufficient energy supply, data transmission conflicts with other networks that coexist in the unlicensed spectrum band, leading to spectrum scarcity issues. To alleviate these energy and spectrum scarcity issues, numerous energy and spectrum harvesting technologies have emerged, such as mini solar panels, piezoelectric transducers, and cognitive radio. By embedding these modules, the devices can harvest energy from the ambient energy sources and explore the idle licensed spectrum for data transmission, leading to energy and spectrum harvesting-enabled devices.

This Special Section solicited original research and practical contributions in energy and spectrum harvesting technologies. In total, 54 articles were submitted. After a rigorous peer-review process, 27 articles were accepted for publication in IEEE Access.

In the article "ITSSAKA-MS: An improved three-factor symmetric-key based secure AKA scheme for multi-server environments," by Ali *et al.*, the authors propose an amended three-factor symmetric-key based secure authentication and key agreement scheme for multi-server environments (ITSSAKA-MS). The security of ITSSAKA-MS is proved formally, along with a security feature discussion. The analysis indicates that the proposed scheme withstands several known attacks as compared to recent benchmark schemes.

The article by Adil *et al.*, "An efficient load balancing scheme of energy gauge nodes to maximize the lifespan of constraint oriented networks," presents an energy gauge node (EGN)-based communication infrastructure. The EGN measures the residual energy of the participating nodes. Moreover, EGN nodes advertise hop selection information in the network which is used by ordinary nodes to update their routing tables. The simulation results show that the proposed scheme surpasses the existing schemes in terms of the lifespan of individual nodes, throughput, packet loss ratio (PLR), latency, communication costs, computation costs, and so on.

In the article "Time allocation optimization and trajectory design in UAV-assisted energy and spectrum harvesting network," by Shi *et al.*, the authors propose an unaligned time allocation scheme (UTAS) in which the uplink phase and downlink phase of nearby SUs and remote SUs are unaligned to achieve more flexible time for scheduling. In addition, maximum throughput optimization problems are formulated for nearby SUs and remote SUs, respectively, to find the optimal time allocation. The optimization problem can be divided into three cases according to the relationship between practical data volume and theoretical throughput to avoid wasting time resources. Simulation results show that the proposed UTAS can achieve better performance than traditional time allocation schemes.

The article "Statistical QoS aware for wireless powered cooperative communications in Internet of Things," by Gao *et al.*, aims to maximize the effective capacity (EC) under specified QoS requirements. Also, the statistical QoS-inspired resource allocation policies are investigated for half- /full-duplex (HD/FD) modes to jointly optimize power allocation and power splitting (PS) ratio. To solve the formulated problem, the authors first derive the closed-form solution of the optimal power allocation at the AP and the PS ratio. To gain more insights, the authors further derive the boundary conditions of optimal power allocation and PS ratio. Finally, numerical results validate the theoretical derivations, which highlights the proposed scheme in terms of EC performance in comparison to the benchmark scheme.

The article "Information freshness-guaranteed and energy-efficient data generation control system in energy harvesting Internet of Things," by Ko *et al.*, designs an information freshness-guaranteed and energy-efficient data generation control system (IFE-DGCS) where an IoT gateway with a directional antenna determines the polling frequency for each sector. When polling data, the IoT gateway transfers the RF

energy to IoT devices in the polling sector by means of simultaneous wireless information and power transfer (SWIPT). To minimize the energy outage probability while maintaining the AoI below a certain level, a constrained Markov decision process (CMDP) is formulated and the optimal stochastic policy on the polling sector is obtained by linear programming (LP). To resolve the dimensionality problem in CMDP, a greedy IFE-DGCS is developed and its performance is extensively studied. Evaluation results demonstrate that IFE-DGCS with the optimal policy achieves a comparable energy outage probability to the conventional energy-oriented scheme while guaranteeing a sufficiently low AoI.

In the article "Privacy protection and energy optimization for 5G-aided industrial Internet of Things," by Humayun *et al*., the authors provide a comprehensive framework that will help researchers and practitioners to better understand 5G-aided industry 4.0 infrastructure and energy resource optimization by improving privacy. The proposed framework is evaluated using case studies and mathematical modeling.

The article by Din *et al*., "Beaconless traffic-aware geographical routing protocol for intelligent transportation system," designs a beaconless traffic-aware geographical routing protocol (BTA-GRP) by considering traffic density, distance, and direction for the next forwarder node and route selection. The protocol is feasible for urban, dense, and sparse traffic conditions, and addresses delay, disconnection, and packet dropping issues. The proposed protocol is simulated with state-of-the-art routing protocols. The simulation results indicate that the proposed protocol has higher performance in VANETs.

In the article "Analytical modeling and performance study of a piezoelectric laminated annular plate for rotary energy harvesting," by Guo *et al*., the authors propose to convert rotary energy into standing wave vibration energy of the piezoelectric laminated annular plate, which then can be directly converted to electrical energy through the direct piezoelectric effect of piezoelectric ceramics. The proposed structure is particularly suitable for rotating mechanical energy harvesting for its simple structure, convenient installation, and high power density. The analytical modeling is established to predict the steady-state output features of the energy harvester, and is verified by the finite element analysis results as well.

The article by Wu *et al*., "A lightweight secure management scheme for energy harvesting dynamic wireless charging system," proposes a lightweight secure management scheme for energy harvesting dynamic wireless charging systems. The proposed scheme can achieve effective authentication, secure communication, privacy protection, and reliable payment for the system. Moreover, considering that there is weather that is not conducive to harvesting energy, the scheme divides the system into three different working states to ensure safe operation. Finally, the security analysis and performance evolution prove that the scheme is secure and efficient.

The article by Fan "Frequency-hopping sequences with optimal average hamming correlation and their applications in energy and spectrum harvesting technologies area," proposes a class of frequency hopping sequence set with the best average Hamming correlation.

The article by Saleem *et al*., "Bio-inspired network security for 5G-enabled IoT applications," first surveys the 5G network layer security for IoT applications and lists the network layer security vulnerabilities and requirements in wireless sensor networks, IoT, and 5G-enabled IoT. Second, a detailed literature review is conducted with the current network layer security methods and the bio-inspired techniques for IoT applications exchanging data packets over 5G. Finally, the bio-inspired algorithms are analyzed in the context of providing a secure network layer for IoT applications connected over 5G and beyond networks.

In the article "Real-time energy harvesting aided scheduling in UAV-assisted D2D networks relying on deep reinforcement learning," by Nguyen *et al*., the authors propose a novel model based on deep reinforcement learning in order to find the optimal solution for energy-harvesting time scheduling in UAV-assisted D2D communications. The numerical results demonstrate that the proposed schemes outperform the existing solutions. The associated energy efficiency game can be solved in less than one millisecond by an off-the-shelf processor using trained neural networks.

The article "QoS-aware energy management and node scheduling schemes for sensor network-based surveillance applications," by Thomas *et al*., discusses the energy management techniques of WSN with a particular emphasis on node scheduling and proposes an energy management life-cycle model and an energy conservation pyramid to extend the network lifetime of WSNs. The authors provided a detailed classification and evaluation of various node scheduling schemes in terms of their ability to fulfill essential QoS requirements, namely, coverage, connectivity, fault tolerance, and security.

In the article "A survey of energy and spectrum harvesting technologies and protocols for next generation wireless networks," by Padhy *et al*., the authors present the historical background of EH and SH techniques and their development over several decades. Specifically, they focus on EH-SH communication technologies and protocols for a wide range of systems and networks. The authors present a detailed survey of the various harvesting techniques and protocols from recent literature. Finally, the authors describe exciting, open, intra-disciplinary, and inter-disciplinary challenges for further research on EH-SH communication technologies.

The article by Nguyen *et al*., "Spectrum-sharing UAV-assisted mission-critical communication: Learning-aided real-time optimisation," proposes an unmanned aerial vehicle (UAV) communications scheme with a spectrum-sharing mechanism to provide mission-critical services such as disaster recovery and public safety. Specifically, the UAVs can serve as flying base stations to provide extended network coverage for the affected area under spectrum-sharing

cognitive radio networks (CRNs). To cope with the effects of network destruction in a disaster, the authors proposed a real-time optimization framework for resource allocation (e.g., power and number of UAVs) for CRNs assisted by UAV relays. The proposed optimization scheme aims at improving the network throughput of primary and secondary networks under the stringent constraint of maximum tolerable interference impinged on the primary users. The authors also propose a deep neural network model to reduce the execution time under real-time solutions of mixed-integer UAV deployment problems.

In the article ''Transmission power rate control for EHD with temporal and complete deaths,'' by Li *et al*., the authors formulate an equivalent piece-deterministic Markov process (PDMP) based on the embedded discrete-time decision epoch sequence of the system model. The authors show the existence of the stationary deterministic optimal transmission power rate (TPR) policy, and an algorithm for computing the TPR policy.

In the article ''Data collection mechanism based on wavelet multi-resolution for opportunistic social networks,'' by Chen *et al*., the authors establish an efficient data collection mechanism based on wavelet multi-resolution to improve the efficiency of data collection from the source, which mainly studies the multi-resolution compression storage method of node data, the spatial multi-resolution data hierarchical storage framework, and the multi-resolution data management mechanism of mobile nodes. The experimental results show that the multi-resolution communication mode based on integer wavelet transform can greatly reduce the amount of data in the network and the energy consumption of nodes.

In the article ''Energy-efficient task offloading based on differential evolution in edge computing system with energy harvesting,'' by Sun *et al*., the authors propose an energy-efficient task offloading method optimized by differential evolution. First, a wireless edge computing network model is established to analyze the energy harvesting, task offloading, and task calculation of the system, as well as the total number of calculated bits and total energy consumption of the system. Second, according to the total number of calculated bits and total energy consumption of the system, an objective function is established to optimize the energy efficiency of the system, and a differential evolution based optimization method is proposed, with which the optimal energy efficiency of system calculation, offloading time, calculation time, and frequency are obtained. Experimental results show that the proposed method not only achieves better convergence effect, but also effectively solves the energy shortage problem of the micro-equipment and extends the service life of the equipment.

The article ''Adaptive contention window MAC protocol in a global view for emerging trends networks,'' by Li *et al*., gives an optimization algorithm for the size of the contention window through theoretical analysis, which can achieve a compromise between energy consumption (i.e., alternative energy harvesting) and delay. Then, a global view based adaptive contention window (GV-ACW) MAC protocol is proposed to further reduce latency and improve alternative energy harvesting. The GV-ACW MAC protocol adopts the optimized size of contention window in the near sink area to meet the functional requirements of data forwarding. The theoretical analysis and experimental results show that, compared with previous MAC protocol, GV-ACW protocol can realize effective alternative energy harvesting which increases the network lifetime by 6% and reduces the network delay by 15%.

In the article, ''Scalable Wi-Fi backscatter uplink multiple access for battery-free Internet of Things,'' by Kwon *et al*., the authors present a scalable uplink multiple access (SUMA) protocol for bistatic Wi-Fi backscatter systems, composed of a Wi-Fi reader, Wi-Fi helper, and multiple Wi-Fi backscatter tags. SUMA uses a Wi-Fi reader-initiated dynamic framed slotted ALOHA (DFSA)-based multiple access protocol to minimize collisions caused by simultaneous Wi-Fi backscatter uplink traffic from multiple Wi-Fi backscatter tags. The Wi-Fi helper first estimates the number of tags at the start of network operation and derives an appropriate slot-count parameter (i.e., Q), based on which the frame size is specified. Then, the Wi-Fi helper adaptively adjusts the value of Q to maximize network performance while continuously monitoring the number of remaining Wi-Fi backscatter tags to detect information. An experimental simulation was performed to verify the superiority of SUMA. The results demonstrated that SUMA obtained higher performance in terms of the number of collided and empty slots, delay, and throughput compared with the legacy DFSA approach.

The article, ''Intelligent framework using IoT-based WSNs for wildfire detection,'' by Verma *et al*., proposes an intelligent framework, sleep scheduling-based energy-optimized framework (SEOF) that works in twofold. First, the authors propose an energy-efficient cluster head (CH) selection employing Tunicate Swarm Algorithm (TSA) to optimize the five novel fitness parameters by integrating them into its weighted fitness function. Second, the authors perform a sleep scheduling of closely located sensor nodes based on the distance threshold calculated through a set of experiments. Sleep scheduling methodology plays a pivotal role in abating the number of data transmissions in SEOF. Finally, the authors simulate SEOF in MATLAB under different scenarios to examine its efficacy for the various performance metrics and scalability features. The empirical results prove that SEOF has ameliorated the network stability period for two different scenarios of network parameters by 35.3% and 216%.

The article ''A convergence-accelerated distributed time synchronization algorithm for energy-harvesting wireless sensor networks,'' by Yang *et al*., proposes a novel accelerated time co-synchronization algorithm based on the storage-and-prediction method to improve the convergence rate. In this algorithm, each node in the network first predicts the estimated current time state value according to previous time state values stored in the local node and then adjusts the time

state value according to the estimated time state value deviations between all its adjacent nodes. Theoretical analysis in a more general case shows that the proposed algorithm can improve the convergence rate of distributed time synchronization when selecting the appropriate parameter, and the closed-form solution of the optimal parameter is also given. Finally, the simulation of comparing the classical algorithm with the proposed algorithm based on different scenarios is completed.

In the article "Energy harvesting techniques for Internet of Things (IoT)," by Sanislav *et al.*, the authors review recent advances in energy harvesting techniques for the IoT. The authors demonstrate two energy harvesting techniques using case studies. Finally, the authors discuss some future research challenges that must be addressed to enable the large-scale deployment of energy harvesting solutions for IoT environments.

The article "Deep learning-based approach for detecting trajectory modifications of Cassini-Huygens spacecraft," by Aldabbas *et al.*, provides a sophisticated in-depth learning approach for detecting Cassini spacecraft trajectory modifications in post-processing mode. The proposed model utilizes the ability of long short-term memory (LSTM) neural networks for drawing out useful data and learning the time series inner data pattern, along with the forcefulness of LSTM layers for distinguishing dependencies among the long-short term.

The article "Impacts of nonlinear energy harvesting and residual self-interference on the performance of full-duplex decode-and-forward relay system," by Nguyen *et al.*, designs a clustering optimization anomaly detection algorithm for complex attribute feature data. The algorithm classifies the weighted distance and safety coefficient of the data according to the priority of the traffic attribute features, selects the data with the high safety coefficient as the clustering center, clusters the multi-feature data around the center, and applies it to the attribute anomaly detection. The simulation results show that the traffic frequency detection algorithm based on statistical analysis proposed in this article can quickly detect the traffic frequency anomalies in the network. Moreover, the clustering optimization anomaly detection algorithm based on complex attribute features proposed in this article can effectively detect the malicious attributes contained in network traffic and achieve a high detection rate and a low false detection rate to ensure the safety and reliability of the industrial Internet of Things.

The article "An algorithm for detection of traffic attribute exceptions based on cluster algorithm in Industrial Internet of Things," by Fu *et al.*, proposes a hierarchical abnormal traffic detection method for the industrial Internet of Things. It includes two detection methods. The first (crude) one detects traffic frequency based on statistical analysis. The second (sophisticated) one detects traffic attributes based on a clustering algorithm. The hierarchical detection method first detects the abnormal frequency of the network traffic. Property exceptions are then detected for suspected traffic.

In the article "Learn from optimal energy-efficiency beamforming for SWIPT-enabled sensor cloud system based on DNN," by Wang *et al.*, the authors use deep-learning approaches to design the optimal beamforming for sink nodes in the SWIPT-enabled sensor-cloud system. First, the energy-efficiency maximization problem is formulated with a "return/pay" form. Then, a SWIFT-WMMSE algorithm is designed to obtain the optimal beamforming vector. The applicability of the neural network to approximate the SWIPT-WMMSE algorithm is discussed. Furthermore, based on the error propagation in the DNN approaching process, the criteria for the DNN scale design are deduced and the approximation to the SWIPT-WMMSE algorithm is realized through the training of DNN, which is operated as an alternative algorithm to solve the optimal beamforming vectors for sink nodes.

The Guest Editors hope that this Special Section will benefit the scientific community and contribute to the knowledge base and would like to take this opportunity to applaud the contributions of the authors to this Special Section. The efforts of the reviewers to enhance the quality of the manuscripts are also much appreciated.

GUANGJIE HAN, *Lead Editor*
Department of Internet of Things Engineering
Hohai University
Changzhou 213022, China

DEYU ZHANG, *Guest Editor*
School of Software
Central South University
Changsha 410083, China

NING ZHANG, *Guest Editor*
Department of Electrical and Computer Engineering
Texas A&M University-Corpus Christi
Corpus Christi, TX 78412, USA

SONG GUO, *Guest Editor*
Department of Computing
The Hong Kong Polytechnic University
Hong Kong

GEYONG MIN, *Guest Editor*
Department of Computer Science
University of Exeter
Exeter EX4 4PY, U.K.

SHENGRONG BU, *Guest Editor*
School of Engineering
University of Glasgow
Glasgow G12 8QQ, U.K.

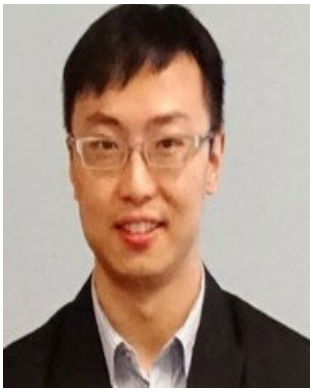
KANKE GAO, *Guest Editor*
Magna International, Inc.
Aurora, ON 48084, Canada

GUANGJIE HAN (Senior Member, IEEE) received the Ph.D. degree from Northeastern University, Shenyang, China, in 2004.

In February 2008, he finished his work as a Postdoctoral Researcher with the Department of Computer Science, Chonnam National University, Gwangju, South Korea. From October 2010 to October 2011, he was a Visiting Research Scholar with Osaka University, Suita, Japan. From January 2017 to February 2017, he was a Visiting Professor with the City University of Hong Kong, Hong Kong. From July 2017 to July 2020, he was a Distinguished Professor with Dalian University of Technology, China. He is currently a Professor with the Department of Internet of Things Engineering, Hohai University, Changzhou, China. His current research interests include the Internet of Things, industrial internet, machine learning and artificial intelligence, mobile computing, and security and privacy. He has more than 400 peer-reviewed journals and conference papers, and holds more than 160 granted and pending patents. His current H-index is 46 and i10-index is 172 in Google Citation (Google Scholar). In total, his articles have been cited more than 8800 times. He is a fellow of the U.K. Institution of Engineering and Technology (FIET). He has also served as the chair of organizing and technical committees for many international conferences. He has been awarded the 2020 IEEE SYSTEMS JOURNAL Annual Best Paper Award and the 2017–2019 IEEE Access Outstanding Associate Editor Award. He has served on the Editorial Boards for more than ten international journals, including the *IEEE Network*, IEEE SYSTEMS JOURNAL, IEEE/CAA JOURNAL OF AUTOMATICA SINICA, IEEE ACCESS, and *Telecommunication Systems*. He has guest-edited a number of special issues in IEEE journals and magazines, including the IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, *IEEE Communications Magazine*, *IEEE Wireless Communications*, IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, and *Computer Networks*.

DEYU ZHANG (Member, IEEE) received the B.Sc. degree in communication engineering from PLA Information Engineering University, China, in 2005, and the M.Sc. degree in communication engineering and the Ph.D. degree in computer science from Central South University, China, in 2012 and 2016, respectively.

He was a Visiting Scholar with the Department of Electrical and Computer Engineering, University of Waterloo, Canada, from 2014 to 2016. He is currently an Assistant Professor with the School of Software and a Postdoctoral Fellow with the Transparent Computing Laboratory, School of Information Science and Engineering, Central South University. His research interests include stochastic resource allocation, the Internet of Things, transparent computing, and edge computing. He has published a monograph and more than 30 papers in prestigious international journals and conferences, including IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, IEEE TRANSACTIONS ON MOBILE COMPUTING, IEEE TRANSACTIONS ON WIRELESS COMMUNICATIONS, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, and IEEE GLOBECOM. He has served as an Associate Editor for *KSII Transactions on Internet and Information Systems*, a Guest Editor for IEEE INTERNET OF THINGS JOURNAL, and the Chair of IEEE International Workshop on Sustainable Edge Computing for Internet of Things Systems (SECIoT 2018). He also served as a Technical Program Committee Member of several international conferences, such as VTC 2018 and IEEE GLOBECOM 2017 and 2018. He has served as an active reviewer for over 20 international journals.



NING ZHANG (Senior Member, IEEE) received the Ph.D. degree from the University of Waterloo, Canada, in 2015.

He was a Postdoctoral Research Fellow with the University of Waterloo and the University of Toronto, Canada. Since 2017, he has been an Assistant Professor at Texas A&M University-Corpus Christi, USA. His current research interests include wireless communication and networking, mobile edge computing, machine learning, and physical layer security. He serves as an Associate Editor for IEEE INTERNET OF THINGS JOURNAL, IEEE TRANSACTIONS ON COGNITIVE COMMUNICATIONS AND NETWORKING, IEEE ACCESS, and *IET Communications*, and an Area Editor of *Encyclopedia of Wireless Networks* (Springer) and Cambridge Scholars. He also serves/served as a Guest Editor for several international journals, such as *IEEE Wireless Communications*, IEEE TRANSACTIONS ON COGNITIVE COMMUNICATIONS AND NETWORKING, IEEE ACCESS, and *IET Communications*. He was the Workshop Chair for MobiEdge'18 (in conjunction with IEEE WiMob 2018) and CoopEdge'18 (in conjunction with IEEE EDGE 2018), and 5G&NTN'19 (in conjunction with IEEE EDGE 2019). He received the Best Paper Awards from IEEE GLOBECOM in 2014, IEEE WCSP in 2015, and the *Journal of Communications and Information Networks* in 2018, IEEE ICC in 2019, IEEE Technical Committee on Transmission Access and Optical Systems in 2019, and IEEE ICCC in 2019.

SONG GUO (Senior Member, IEEE) is currently a Full Professor with the Department of Computing, The Hong Kong Polytechnic University. His research interests include the areas of big data, cloud computing, mobile computing, and distributed systems, with over 400 papers published in major conferences and journals. His work was recognized by the 2016 Annual Best of Computing: Notable Books and Articles in Computing in *ACM Computing Reviews*. He was a recipient of the 2018 IEEE TCGCC Best Magazine Paper Award, the 2017 IEEE SYSTEMS JOURNAL Annual Best Paper Award, and six other Best Paper Awards from IEEE/ACM conferences. He was an IEEE ComSoc Distinguished Lecturer. He also served as the general and program chair for numerous IEEE conferences. He currently serves as the Director and a member of the Board of Governors of the IEEE ComSoc. He is currently an Associate Editor of IEEE TRANSACTIONS ON CLOUD COMPUTING, IEEE TRANSACTIONS ON SUSTAINABLE COMPUTING, IEEE TRANSACTIONS ON GREEN COMMUNICATIONS AND NETWORKING, and *IEEE Network*.

GEYONG MIN received the B.Sc. degree in computer science from Huazhong University of Science and Technology, China, in 1995, and the Ph.D. degree in computing science from the University of Glasgow, U.K., in 2003. He is currently a Professor of high-performance computing and networking with the Department of Computer Science, College of Engineering, Mathematics and Physical Sciences, University of Exeter, U.K. His research interests include future internet, computer networks, wireless communications, multimedia systems, information security, high-performance computing, ubiquitous computing, modeling, and performance engineering. He has served as a Guest Editor for numerous international journals, such as *ACM Transactions on Intelligent Systems and Technology*, IEEE TRANSACTIONS ON SUSTAINABLE COMPUTING, and *ACM Transactions on Embedded Computing*.

SHENGRONG BU received the Ph.D. degree in electrical and computer engineering from Carleton University, Ottawa, ON, Canada, in 2012. She held a research position at Huawei Technologies Canada Inc., Ottawa, as an NSERC Industrial R&D Fellow, until 2014. She is currently a Lecturer (Assistant Professor) with the School of Engineering, University of Glasgow, Glasgow, U.K. Her research interests include big data analytics for wireless networks and smart grids, smart grids communications, vehicular communications, wireless network security, game theory, and stochastic optimization. She was a recipient of three best paper awards at IEEE international conferences. Highlights of her professional activities include duties as a peer reviewer for EPSRC and Carnegie Trust, an Editor for the IEEE Technical Committee on Green Communications and Computing Newsletters, an Associate Editor for *Wireless Networks* (Springer), the TPC Co-Chair for six international workshops or conference symposiums, and duties as the N2Women Mentoring Co-Chair.

KANKE GAO (Member, IEEE) received the B.S. degree in communication engineering from the University of Electronic Science and Technology of China, Chengdu, China, in 2004, and the M.S. and Ph.D. degrees in electrical engineering from the State University of New York at Buffalo, Buffalo, NY, in 2011 and 2007, respectively. He is currently Tech Lead at Magna. He has been an Adjunct Professor with the University of Electronic Science and Technology of China since February 2018. He was a Senior Autonomous Driving Engineer/Tech Lead for Lyft Level 5/Magna from 2018 to 2020. Before that, he was a Principal Algorithms and Signal Processing Engineer for Velodyne Lidar, Inc. from 2017 to 2018. Prior to working for Velodyne, he was a Touch/Display Architecture Engineer for Apple Inc. from 2014 to 2017. Before joining Apple, he worked as a Senior System Engineer at Marvell Semiconductor, Inc. from December 2011 to December 2014. He has published over 20 papers in top conferences and journals. His current research interests include autonomous driving, sensor fusion, SLAM algorithms, cognitive radio communication, cross-layer optimization, and statistical signal processing. He had been awarded the Best Paper Award Runner-Up for IEEE MILCOM 2011 Track 3. He served as a technical program committee member and a reviewer for more than 20 conferences.