Guest Editorial: Special Issue on Toward Positioning, Navigation, and Location-Based Services (PNLBS) for Internet of Things

IN THE past decade, technological advancements have facilitated the manufacturing of compact, inexpensive, and low-power consuming receivers and sensors for smart devices (e.g., GPS, WiFi, MEMS sensors, RFID, UWB, BLE, etc.). This led to the fast development of positioning, navigation, and location-based services (PNLBS), and much broader new applications than just providing a location or navigation.

These new applications include, for example, asset tracking, autonomous parking, context awareness, virtual reality, condition monitoring, smart manufacturing, geolocation, as well as smart cities. In fact, PNLBS have become indispensable to the future of Internet of Things (IoT). On the other hand, IoT systems create limitless possibilities for PNLBS, due to their sophisticated cloud computing technologies, powerful big data analytics, and embedded multisensors.

The aim of IoT architectures for provisioning of PNLBS is to design an accurate, low-cost, low-power, reliable, and scalable solution for cutting-edge applications. To achieve this goal, several challenges should be addressed, such as improving the positioning accuracy, reducing the power cost, handling the tracking of millions of devices, as well as transmitting and processing big data. Therefore, research need to focus on many important aspects, including innovative PNLBS algorithms, new IoT architectures, and low-power chip design technologies. Toward these goals, this Special Issue is focused on the latest unpublished work on PNLBS for IoT. The Calls for Papers was issued in May 2017 with the submission deadline set as September 1, 2017. We have received 55 submissions and ultimately 15 high-quality papers have been selected.

The paper "PSOTrack: A RFID-Based System for Random Moving Objects Tracking in Unconstrained Indoor Environment" by Li *et al.*, proposed a continuous RFID-based tracking system, which used an optimized particle swarm optimization to determine the initial position and a dynamic correction method to predict trajectory for continuous tracking, for random moving targets in unconstrained indoor environments.

The paper "MapSense: Mitigating Inconsistent WiFi Signals Using Signal Patterns and Pathway Map for Indoor Positioning" by Du *et al.*, defined the WiFi sibling signal pattern to generate Beacon APs, which had higher confidence in positioning, used the feature of spatial signal patterns over pathway map to reduce the search space of WiFi positioning, and eventually improved the positioning accuracy.

The paper "Indoor Localization by Fusing a Group of Fingerprints Based on Random Forests" by Guo *et al.*, proposed a sliding window aided mode-based fusion algorithm to balance the localization accuracy and efficiency, which first adopted windowing and sliding techniques to improve the localization efficiency, and then obtained a more accurate estimate by minimizing the entropy of multiple classifiers or multiple samples, and finally, guaranteed the estimator to be robust to a changing environment and larger noise level.

The paper "A Pervasive Integration Platform of Low-Cost MEMS Sensors and Wireless Signals for Indoor Localization" by Zhuang *et al.*, proposed an innovative integrated platform for indoor localization by integrating low-cost MEMS sensors with different kinds of wireless singles (e.g., WiFi, Bluetooth Low Energy, and RFID) and using a multilevel quality control mechanism. This proposed platform consists of wireless AP localization engine and sensor fusion engine, which provides a robust localization solution for both dense and sparse deployments of wireless base stations.

The paper "Multi-Antenna GNSS and Inertial Sensors/Odometer Coupling for Robust Vehicular Navigation" by Vagle *et al.*, focused on multiantenna GNSS and inertial navigation system (INS)–odometer integration to improve robustness, security, and privacy of navigation solutions. In this paper, the performance of single and multiantenna GPS receivers integrated with INS and odometer data was investigated under spoofing, jamming, and GPS outage cases for vehicular navigation.

The paper "Cooperative Localization Algorithm Based on Hybrid Topology Architecture for Multiple Mobile Robot System" by Sun *et al.*, proposed a novel cooperative localization algorithm based on hybrid topology architecture under the framework of extended Kalman filter to enhance the accuracy for multiple mobile robots system and adopted a hybrid topology architecture based on the relative position measurement graph method to enhance the usage efficiency of observations.

The paper "Towards a Practical Crowdsensing System for Road Surface Conditions Monitoring" by El-Wakeel *et al.*, proposed a robust framework for road anomaly detection based on experimental activities, in which a wavelet packet de-noising technique was applied to all sensed data to decrease

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the noise effects, feature extraction techniques were adopted to describe the effects of the road irregularities on the sensed data, and a multilevel SVM classifier was used to detect and classify multiple anomalies with varying levels of severity.

The paper "A Localization Database Establishment Method Based on Crowdsourcing Inertial Sensor Data and Quality Assessment Criteria" by Zhang *et al.*, proposed an anchor point-based forward–backward smoothing method to obtain reliable localization solutions and a quantitative framework to automatically evaluate the quality of smartphone-based inertial sensor data for localization database establishment.

The paper "SoundMark: Accurate Indoor Localization via Peer-Assisted Dead Reckoning" by Chen *et al.*, proposed an accurate peer-assisted localization system on a smartphone with no prior infrastructure or fingerprinting. SoundMark also applied a mobility-induced time-difference-of-arrival-based audio ranging to extract the location constraints between the peers for localization.

The paper "Fuzzy Weighted Centroid Localization With Virtual Node Approximation in Wireless Sensor Networks" by Phoemphon *et al.*, proposed a low-cost technique to determine the number of virtual anchor nodes or virtual nodes together with their positions. It also addressed estimations of unknown node locations by applying a fuzzy-based centroid localization method to prioritize anchor nodes by assigning different fine-tuned weighted factors.

The paper "A Scalable Algorithm for Network Localization and Synchronization" by Meyer *et al.*, proposed a cooperative, scalable, and time-recursive algorithm based on time measurements, to support heterogeneous devices with limited computation and communication resources, time-varying clock and location parameters, arbitrary state-evolution models, and time-varying network connectivity. It also used belief propagation for an efficient marginalization of the joint posterior distribution.

The paper "Unsupervised Crowd-Assisted Learning Enabling Location-Aware Facilities" by Sikeridis *et al.*, developed a probabilistic cell-based model that was constructed by an unsupervised learning algorithm. The black-box approach maintained the positioning accuracy regardless of changes in the underlying hardware or indoor environment.

The paper "Fuzzy-Based Channel Selection for Location Oriented Services in Multichannel VCPS Environments" by Kasana *et al.*, proposed a fuzzy-based channel selection framework for location-oriented services in multichannel VCPS environments. The channel quality was estimated using channel access delay (CAD) and signal-to-interference ratio (SIR). Besides, the fuzzy logic-based channel selection framework was developed considering fuzzification and defuzzification of CAD and SIR.

The paper "DTCS: An Integrated Strategy for Enhancing Data Trustworthiness in Mobile Crowdsourcing" by Hu *et al.*, proposed an integrated strategy to enhance data trustworthiness and defend against the internal threats for mobile crowdsourcing. The solution integrated effective methods, including an evaluation scheme for the attribute relevancy and familiarity of participants, a trust relationship establishment method, a group division strategy based on attributes and metagraph, and a core-selecting based incentive mechanism.

The paper "Security and Privacy in Location-Based Services for Vehicular and Mobile Communications: An Overview, Challenges and Countermeasures" by Asuquo *et al.*, analyzed the security and privacy requirements for location-based services in vehicular and mobile networks. This paper also covered privacy enhancing technologies and cryptographic approaches that provide location privacy in vehicular and mobile networks.

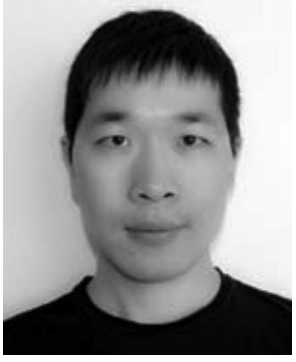
To conclude, we would like to thank all the authors for their contributions to this Special Issue, and all the reviewers for their great efforts and excellent reviews. We also would like to give special thanks to and Dr. Sherman Shen, the Editor-in-Chief of this JOURNAL, and all the JOURNAL's staff for their help in the publication process. We hope you will enjoy this Special Issue!

YUAN ZHUANG, *Guest Editor*
Location Services Team
Bluvision
Fort Lauderdale, FL 33334 USA

YUE CAO, *Guest Editor*
Department of Computer and Information Sciences
Northumbria University
Newcastle upon Tyne NE1 8ST, U.K.

NASER EL-SHEIMY, *Guest Editor*
Department of Geomatics Engineering
University of Calgary
Calgary, AB T2N 1N4, Canada

JUN YANG, *Guest Editor*
National ASIC Center
Southeast University
Nanjing 210096, China



Yuan Zhuang (M'16) received the Ph.D. degree in geomatics engineering from the University of Calgary, Calgary, AB, Canada, in 2015.

Since 2015, he has been a Lead Scientist with Bluvision, part of HID Global, Fort Lauderdale, FL, USA. He was a Baseband Engineer with CSR Technology, Shanghai, China, and an Algorithm Designer with Trusted Positioning Inc., Calgary. He has co-authored 39 academic papers and 11 patents. His current research interests include real-time location system, personal navigation system, wireless positioning, multisensors integration, Internet of Things, and machine learning for navigation applications.

Dr. Zhuang was a recipient of Ten Academic Awards. He is a Reviewer of several IEEE journals and the Guest Editor for the IEEE INTERNET OF THINGS JOURNAL and IEEE ACCESS.

Yue Cao (M'16) received the Ph.D. degree from the Institute for Communication Systems (ICS), 5G Innovation Centre, University of Surrey, Guildford, U.K., in 2013.

He was a Research Fellow with ICS until 2016, and a Lecturer with the Department of Computer and Information Sciences, Northumbria University, Newcastle upon Tyne, U.K. until 2017, where he has been a Senior Lecturer since 2017. His current research interest includes intelligent mobility, including transportation and energy, network communication and computation, and security and privacy.

Dr. Cao is an Associate Editor of IEEE ACCESS.

Naser El-Sheimy is a Professor and a former Head of the Department of Geomatics Engineering, University of Calgary, Calgary, AB, Canada, where he holds a Canada Research Chair in Geomatics Multisensor Systems. He has had 2 books, 6 book chapters, and over 450 papers published in academic journals, conference, and workshop proceedings. His current research interests include geomatics multisensor systems, GPS/INS integration, and mobile mapping systems.

Dr. El-Sheimy was a recipient of 30 National and International Paper Awards and many National and International Awards, including the ASTech "Leadership in Alberta Technology" Award and the Association of Professional Engineers, Geologists, and Geophysicists of Alberta Educational Excellence Award. He was the President of Commission I on "Sensors and Platforms" of the International Society for Photogrammetry and Remote Sensing from 2008 to 2012. He is currently an Editorial Board member of the *Journal of Survey Review*, the *Journal of Applied Geodesy*, and *Coordinates*.

Jun Yang (GS'11–M'11–SM'18) received the bachelor's, master's, and Ph.D. degrees from Southeast University, Nanjing, China, in 1999, 2001, and 2004, respectively.

He is a Professor with National ASIC Center, Southeast University. He is currently collaborating with SMIC and TSMC to develop near threshold IP, such as embedded memories, standard cell library, and other RF components. He has supervised and graduated over 30 master's and Ph.D. students. He has holds 3 U.S. patents, 1 EU patent, over 30 Chinese patents, and has co-authored over 30 academic papers. His current research interests include near threshold circuit design and ultralow power indoor/outdoor position algorithms and chips.

Dr. Yang was a recipient of several national awards including the National Science and Technology Progress Award.