Guest Editorial Location-Awareness for Radios and Networks, Part II

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IN July 2015, Part I of "Location-Awareness for Radios and Networks" special issue has been published. This second part will continue with the state-of-the-art in technology, regulation, and theory for the emerging field of localization. The remaining fourteen articles are summarized below.

The first article entitled "Sectorized Antenna-based DoA Estimation and Localization: Advanced Algorithms and Measurements" by Werner *et al.* proposes a novel high performance direction-of-arrival (DoA) estimator for sectorized antennas, that does not require cooperation between the transmitter and the localizing network. This DoA estimator is broadly applicable with different sectorized antenna types and signal waveforms, and has low computational complexity. Using computer simulations, authors show that the proposed algorithm approaches the respective Cramér-Rao lower bound for DoA estimation variance if the signal-to-noise ratio (SNR) is moderate to large.

Xiao *et al.* consider the fusion of pedestrian dead reckoning (PDR) with map information, and propose a human motion classification to aid PDR in the second article, "Robust Indoor Positioning with Lifelong Learning." Bi-directional information flow between PDR and map matching is enabled through life-long learning, resulting in sub-meter accuracy.

Van de Velde *et al.*, in the third article "Improved Censoring and NLOS Avoidance for Wireless Localization in Dense Networks," focus on cooperative localization, which can achieve good performance but at the cost of delay and energy. A method is proposed to limit the amount of cooperation, while still achieving good performance. This method relies on a combination of CRB-based censoring and NLOS avoidance.

In the fourth article, "Evaluation of Position-related Information in Multipath Components for Indoor Positioning," Leitinger *et al.* exploit the use of deterministic multipath components to improve positioning accuracy. In order to guide the design of algorithms, the authors propose and validate a framework to quantify this accuracy for different measurement setups.

A scheme for non-invasive detection of a single moving and stationary human using commodity WiFi devices, termed DeMan, is proposed by Wu *et al.* in the fifth article, entitled "Non-invasive Detection of Moving and Stationary Human with WiFi." DeMan takes advantage of both amplitude and phase information of channel state information (CSI) to detect moving targets. Moreover, it considers human breathing as an intrinsic indicator of stationary human presence. It then proposes a way of detecting a particular signal pattern caused by minute chest motions. The overall performance is then validated with experimental data.

In the sixth article, "An Efficient Technique for Locating Multiple Narrow-band Ultrasound Targets in Chorus Mode," Y. Wang *et al.* deal with the challenges associated with location update rate for tracking multiple targets in TOA-based locating systems using narrow band ultrasound (NBU). The authors develop a transmission scheduling method in chorus mode, which allows the location of multiple NBU-targets concurrently transmitting signals. In particular, historical consistence and self-consistence techniques are proposed together with probabilistic particle filter algorithm to detect the targets' IDs. Simulations and prototype testbed validate the effectiveness of the proposed method over exclusive locating ones.

The seventh article considers positioning by means of Global Navigation Satellite Systems (GNSS) in harsh environments. A run-time method to estimate the pseudorange standard deviation based on observable data is proposed with the aim to achieve better User Equivalent Range Error (UERE) estimation. Through simulations, these authors of "A Run-Time Method Based on Observable Data for the Quality Assessment of GNSS Positioning Solutions" further demonstrate that the proposed method could provide better estimation of user environment, and hence extend the applicability of GNSS into harsh environments while keeping the reliability of the obtained position solution.

Kong addresses another challenge in GNSS positioning. The article "SDHT for Fast Detection of Weak GNSS Signals" develops a synthesized Doppler frequency hypothesis testing (SDHT) technique to detect weak GNSS signals in indoor

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environments. The underlying idea is that SDHT would utilize the output of the sparse Doppler frequency search (SDFS) technique, in order to estimate the test results of the whole Doppler frequency hypotheses, which results in faster positioning with lower computational cost. Simulation results verify the performance of the proposed SDHT technique.

"Joint Ranging and Clock Parameter Estimation by Wireless Round Trip Time Measurements" is the ninth article, authored by Dwivedi *et al.* In this article, authors propose a new technique for estimating fine clock errors and range between two nodes simultaneously by using two-way time-of-arrival measurements of impulse-radio ultra-wideband signals. Estimators for clock parameters and the range are proposed that are robust with respect to outliers. They are analyzed numerically and by means of experimental measurement campaigns. The technique and derived estimators achieve accuracies of below 1 Hz for frequency estimation, below 1 ns for phase estimation and 20 cm for range estimation, at 4 m distance using 100 MHz clocks at both nodes.

In the tenth article entitled "A Diffraction Measurement Model and Particle Filter Tracking Method for RSS-based DFL," Z. Wang *et al.* propose a new model based on diffraction theory, in which the target is modeled as a cylinder instead of a point mass. The proposed model can well fit the experimental measurements, especially when the target walks across or along a link. Moreover, as the proposed measurement model is nonlinear, Rao-Blackwellized particle filter (RBPF) tracking method is used to recursively give the approximate Bayesian estimation of the position.

Abrudan *et al.* introduce a magneto-inductive (MI) 3-D positioning system, referred to as MagLoc in the article "Distortion Rejecting Magneto-Inductive 3-D Localization (MagLoc)." To overcome distortions, which are the inherent disadvantage in MI systems, the authors further propose a technique to detect field distortions, and suggest a rotation stabilization technique to deal with receiver rotation. Experiments conducted in various environments demonstrate the advantages of the MagLoc system, e.g., the ability to operate through solid concrete or in heavily distorted environments with high positioning accuracy.

The twelfth article, "Location Fingerprinting with Bluetooth Low Energy Beacons," provides an experimental test of the Bluetooth Low Energy (BLE) positioning using fingerprinting. The test provides results on the high susceptibility of BLE to fast fading, and true power cost of continuous BLE scanning. Key parameters that affect the accuracy of BLE indoor positioning are also discussed. Faragher and Harle further compare the use of BLE beacons and show its improvement over WiFi fingerprinting. Specifically, according to the test, tracking accuracy of BLE beacon was < 2.6 m and < 4.8 m 95% of the time using a dense beacon distribution and a lower density distribution, respectively, where WiFi fingerprinting achieved only < 8.5 m 95% of the time.

Another fingerprinting related article is "Fingerprint-Based Device-Free Localization Performance in Changing Environments" by Mager *et al.* This paper considers the impact of changes in the environment, such as removal or addition of objects, on the performance of fingerprinting-based device-free localization. Furthermore, the paper uses extensive experiments to quantify how the changes in an environment can affect the accuracy, through a repetitive process of randomly moving an item in a residential home and then conducting a localization experiment. The paper also discusses ways to be more robust to environmental change.

Finally, Meyer *et. al.* consider the problem of information-seeking control in multi-agent systems. Their paper "Distributed Estimation with Information-Seeking Control in Agent Networks" provides a framework for controlling cooperative agents to jointly estimate time-varying local and global states, utilizing principles from belief propagation, consensus, and information theory. Simulation results confirm superior estimation performance compared to non-cooperative or non-controlled networks.

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