Special Issue on Device-Free Sensing for Human Behavior Recognition II

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In 2018, we organized a special issue of *Personal and Ubiquitous Computing* titled Device-Free Sensing for Human Behavior Recognition, which was published in 2019. After that, a number of researchers contacted us, asking if it is possible to arrange another issue of this topic. With the approval of the Editor in Chief, we organized the special issue on Device-Free Sensing for Human Behavior Recognition II, aiming at further investigating the recent development of new frameworks, mechanisms, and algorithms that are able to support device-free behavior recognition systems.

Following an open call for papers, we received a total number of 26 submissions. All the submissions have undergone rigorous peer-review according to the journal's high standards. Based on recommendations from the reviewers, the guest editors selected 8 contributions (with a accept rate of 31%) which cover different topics within this theme, ranging from device-free human sensing to position and orientation estimation, from activity identification to gesture recognition, from environment independent sensing to user independent sensing.

The first article, by Gong et al. on “Device-Free Near-Field Human Sensing Using Wi-Fi Signals,” proposes a novel system for device-free near-field human sensing without site-survey fingerprints. Specifically, a Gaussian mixture model is developed to cluster the signal fading features of different antennas, and a cluster identification algorithm is designed to identify clusters in correspondence to different near-field subareas of

human appearance. Based on the cluster characteristic, near-field human presence can be recognized with online sensing.

In “LIPO: Indoor Position and Orientation Estimation via Superposed Reflected Light,” the authors propose to estimate the user's 3D location and heading direction by exploring the signal strengths of reflections from the user's chest. In particular, a set of modulation, sampling and signal recovery algorithms are designed to resolve the received signal strength (RSS).

Liao et al. in “Understanding and Visualizing Passengers' Travel Behaviours: A Device-Free Sensing Way Leveraging Taxi Trajectory Data” proposes a device-free sensing approach to understand the passenger's travel behavior, which leverages the taxi trajectory data left when passengers taking taxis. Specifically, a visual analytics system is established to understand taxi trip purposes by fusing the taxi trajectory data and human check-in data.

In “Passive Wi-Fi Monitoring in the wild: A long term study across multiple location typologies,” the authors developed a passive Wi-Fi tracking system and deployed it across different location typologies, aiming to perform systematic analysis of large-scale human mobility patterns. Meanwhile, an automatic classification technique is proposed to identify location types based on collected data.

Ghosh et al. in “HumanSense: A Framework for Collective Human Activity Identification using Heterogeneous Sensor Grid in Multi-inhabitant Smart Environments” present a device-free and non-intrusive sensing framework called HumanSense, which uses an array of ultrasonic and sound sensors for human activity monitoring. In particular, the proposed system not only senses a stream of events as the occupants perform different activities (e.g., sitting and walking) but also tracks person-person verbal interactions (e.g., monologue and discussion), aiming to understand the overall behavioral scenario of the indoor environment.

In “Deep Transfer Learning for Gesture Recognition with Wi-Fi Signals,” the authors propose to apply deep transfer learning techniques to recognize gestures based on Wi-Fi CSI. In particular, the CSI-based gesture recognition problem

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is innovatively converted to an image classification problem by expressing CSI streams as an image matrix. After that, two deep transfer learning methods are applied to recognize gestures using high-level features extracted by deep CNN and fine-tuned CNN models.

Bu et al. in “TransferSense: Towards Environment Independent and One-shot Wi-Fi Sensing” presents an environment independent and one-shot Wi-Fi sensing framework. Specifically, both low-level and high-level semantic features of CSI data are extracted using a pre-trained convolutional neural network, based on which a transfer learning method is developed to reduce the data collection cost in the target domain.

In “Dual Layer Transfer Learning for sEMG based User-Independent Gesture Recognition,” to achieve sEMG based user-independent gesture recognition, the authors propose a dual layer transfer learning framework. In particular, the proposed framework is composed of two layers, where the first

layer leverages the correlations of sEMG signal among different users to label partial gestures with high confidence from new users, and the second layer labels the rest gestures based on the consistencies of sEMG signal from the same users.

The guest editors believe the papers appearing in this issue form an accurate representation of current research topics in device-free sensing for human behavior recognition and hope these articles will stimulate further development in this area. The guest editors express their appreciation to the authors and reviewers for contributing to this special issue. We also would like to express our appreciation to the Editor in Chief and the staff of the *Personal and Ubiquitous Computing* Journal for their kind help in accomplishing this special issue.

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