Guest Editorial: Special Issue on Computational Intelligence for Communications and Sensing

AS BILLIONS of phones, appliances, drones, traffic lights, security systems, environmental sensors, radars, and other radio-connected sensing and communication devices sum into a rapidly growing Internet of Things (IoT), many challenges such as spectrum allocation and efficiency, energy efficiency, security, have emerged as urgent topics to be solved. For example, 5G wireless communications will be deployed in the 28 GHz, 37 GHz, 39 GHz frequency band, which may co-exist with radars and other sensing devices. Quite often, researchers often handle these challenges using traditional approaches such as game theory, convex optimization, etc. Computational intelligences techniques such as fuzzy systems, evolutionary computing, neural networks and learning systems are capable of handling resources allocation, decision making, where uncertainties abound, so it is very natural to apply computational intelligence to the above challenges in communications and sensing.

The goal of this special issue is to publish the recent results in Computational Intelligence for Communications and Sensing. The response to our Call for Papers on this special issue was overwhelming. During the review process, each paper was assigned to and reviewed by multiple experts in the relevant areas, with a rigorous two or three rounds of review process. Thanks to the great support from the Editor-in-Chief of IEEE Transactions on Emerging Topics in Computational Intelligence, Prof. Yew-Soon Ong, we are able to accept 9 excellent papers covering various aspects of Computational Intelligence for Communications and Sensing.

In conventional cognitive radio (CR), only when a primary user (PU) is detected to be absent, the idle spectrum can be accessed by a secondary user (SU), and the allocation processes for spectrum resources of CR such as sensing time and transmission power are often independent. In the first paper, Intelligent Spectrum Resource Allocation based on Joint Optimization in Heterogeneous Cognitive Radio, an intelligent spectrum resource allocation based on joint optimization is proposed. The proposal allows the SU to access the PU spectrum not only in overlay but also in underlay modes. The SU accesses the spectrum with full power when PU is absent and with controlled power when PU is present.

Signal processing based higher-order statistics(HOS) has been acted a potential important tool on variety of target identification and information sensing fields. While a concise or compact expression of HOS is needed to ease the burden of data acquisition and computational complexity, sparse representation of HOS could be the optimum solution to this problem. In the second paper, Sparse Learning of Higher-order Statistics for Communications and Sensing the issue of sparse representation of HOS by categorizing them into three cases according to the discriminative sparsity: strictly sparse, structure-based sparse and structure-based compressible is formulated. The corresponding algorithms of sparse representation for the three types of HOS are designed individually.

In the third paper, Pedestrian Retrieval using Generated Samples and Multi-stream Layer in Sensor Networks, it proposes a novel loss function named the hybrid quadruplet loss (HQL) to utilize the generated samples for pedestrian retrieval in sensor networks. The proposed HQL employs a set of quadruplets in order to maintain an appropriate margin between the real sample and the generated sample, reduce the intra-class variations and enlarge the interclass variations. Furthermore, to identify the extremely similar pedestrians, it proposes a novel multi-stream layer to mine imperceptible information from different aspects. The proposed multi-stream layer utilizes various filters with different morphologies to capture discriminative features in multiple scales, and it is flexible to follow any convolutional layer.

With the rapid evolvement of the Internet and data acquisition technology as well as the continuous advancement of science and technology, the amount of data in many fields has reached the level of terabyte or petabyte and most data collection comes from the Internet of Things (IoT). However, most of the IoT big data are presented as heterogeneous data, with high dimensions, different forms of expression, and a lot of redundant information. The current machine learning model works in vector space, which makes it impossible to gain big data features because vectors cannot simulate the highly nonlinear distribution of IoT big data. The fourth paper, Tensor Deep Learning Model for Heterogeneous Data Fusion in Internet of Things, presents a deep learning calculation model called tensor deep learning (TDL), which further improves big data feature learning and high-level feature fusion.

Spectrum allocation problem in cellular network scenarios is studied in the fifth paper, Utility and fairness based spectrum allocation of cellular networks by an adaptive particle swarm optimization algorithm. The network utility performance is assessed by two forms. One is no fairness consideration for linked users in the network, and the other is considering fairness for linked users. The spectrum allocation problem is represented

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as a maximization optimization problem. To solve the utility and fairness based spectrum allocation optimization, an adaptive particle swarm optimization is proposed based on sawtooth wave propagation technique.

In the sixth paper, Person Re-identification based on Heterogeneous Part-based Deep Network in Camera Networks," it proposes a new deep learning model named heterogeneous part-based deep network (HPDN) for person re-identification in camera networks, which simultaneously learns the alignment and discrimination for parts of pedestrian images. Concretely, several parts are obtained through the uniform partition on the convolutional layer for each pedestrian image. Then, it presents part-aligned distances to perform alignment by searching the shortest local distances between image parts in a certain range.

Indoor target intrusion sensing technique has been used in many fields such as smart home management, security monitoring, counter-terrorism, and disaster relief. However, the existing indoor WLAN target intrusion sensing approaches usually depend on the radio map construction with huge labor and time cost, which is the major barrier of current systems. In response to this compelling problem, in the seventh paper, Indoor WLAN Intelligent Target Intrusion Sensing Using Ray-aided Generative Adversarial Network, it proposes the new Ray-aided Generative Adversarial Model (RaGAM) to automatically construct the radio map which is used for the indoor WLAN intelligent target intrusion sensing and localization.

Soil quality is vital in agriculture. People often use sensor networks to obtain the soil data of a piece of land. Sometimes, people detect soil data by using one-dimensional ultrawideband (UWB) signals, which is too energy-consuming. Compressed sensing is a feasible model to save energy. Unfortunately, soil data are always changing because of the variance of weather and environment. Therefore, if there is a computational intelligent compressed sensing algorithm which is suitable for variant signals, the problem is solved. In the eighth paper, Soil PH Measurement based on Compressive Sensing and Deep Image Prior, it proposes a deep learning model of compressed sensing which can avoid designing a sparse dictionary.

To meet the extremely stringent but diverse requirements of 5G, cost-effective network deployment and traffic-aware adaptive utilization of network resources are becoming essential. In the ninth paper, Deep Learning Based Hotspot Prediction and Beam Management for Adaptive Virtual Small Cell in 5G Networks, a hotspot prediction based virtual small cell (VSC) operation scheme is adopted to improve both the cost efficiency and operational efficiency of 5G networks. It first leverages the feature extraction capabilities of deep learning and exploit use of a long short term memory (LSTM) neural network to achieve hotspot prediction for the potential formation of the VSCs.

We express our gratitude to the authors for their excellent contributions to this SI. We are also thankful for all reviewers dedicating their efforts in reviewing these papers, and for their valuable comments and suggestions that significantly improve the quality of the articles. We hope that this SI will serve as good reference for researches, scientists, engineers and academicians in the field of Computational Intelligence for Communications and Sensing.

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