EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: MISSION-CRITICAL SENSORS AND SENSOR NETWORKS (MC-SSN)

Mission-critical sensors and sensor networks (MC-SSN) have been applied to missions such as battlefield, border patrol, search and rescue, critical structure monitoring, and surveillance. To support critical missions, sensors and sensor networks need to be flexible and interactive and continuously work despite limited bandwidth, intermittent connectivity, and with a large number of devices on the network. Sometimes, humans will be the elements within mission-critical sensors and sensor networks that are most vulnerable to deception, and humans will be handicapped when they are concerned about the received information from the network is not trustworthy, even if their concern is misplaced. In MCSSN, the advantages of linking multiple electronic support measures and electronic attack assets to achieve improved capabilities across a networked mission-critical force have yet to be quantified. Algorithms are sought for fused and/or coherent cross-platform radio frequency (RF) sensing. The MC-SSN algorithms should be capable of utilizing RF returns from multiple aspects in time-coordinated sensors and sensor networks. Such adaptation, management, and reorganization of information sources, devices, and networks must be accomplished almost autonomously in order to avoid imposing additional burdens on the humans, and without much reliance on support and maintenance services. Moreover, humans, under extreme cognitive and physical stress, will be strongly challenged by the massive complexity of the MC-SSN and the information it will provide and carry. Advances in technologies that capitalize on the benefits of the MC-SSN have to assist humans in making effective use of this massive, complex, confusing, and potentially deceptive ocean of information while taking into account the ever-changing mission. New approaches and low-complexity algorithms are expected to enable MC-SSN to automatically manage and effect risk and uncertainty in a highly deceptive, mixed cooperative/adversarial, information-centric environment.

This Special Section on mission-critical sensors and sensor networks aimed to publish the most recent results in theories and methods of sensor design, networking, sensing, information management, and decision support analytics. The response to the Call for Papers was overwhelming, with 216 articles submitted from worldwide. During the review process, each paper was assigned to and reviewed by multiple experts in relevant areas, with a rigorous peer-review process. Thanks to the great support from the Editor-in-Chief of IEEE ACCESS, Prof. Derek Abbott, we were able to accept 98 excellent articles covering various aspects of mission-critical sensors and sensor networks.

Image mapping spectrometer (IMS) is a hyperspectral imager that can obtain the spatial and spectral information of an object simultaneously in real time. The cross talk on the pupil array plane results in degradation of the final image contrast, the reduction of the detector dynamic range, and the aliasing of the spatial–spectral information. The article "Modeling and optimization of image mapper for snapshot image mapping spectrometer," by Ding *et al.*, presents a novel approach to designing an image mapper that can be used in IMS to reduce cross talk between adjacent sub-pupils.

Multimodal wireless sensor networks (WSNs) consist of various types of sensor nodes and are capable of many important applications such as environment monitoring, health care, and target tracking. The article "Genetic fuzzy tree-based node moving strategy of target tracking in multimodal wireless sensor networks," by Yu and Liang, utilizes the multimodal WSN to keep track of targets in a 3-D space.

The article "An EMD-based sense-through-foliage target detection UWB radar sensor networks," by Zhao *et al.*, proposes an empirical mode decomposition (EMD)-based approach to ultra wide band radar for sense-through-foliage target detection.

An ultra wide band radar module sensor for soil moisture monitoring field experiments is investigated in the article "Soil moisture retrieval from UWB sensor data by leveraging fuzzy logic" by Liang and Zhu. This type of mission-critical sensor is applied to collect the reflected signals from the subsurface of bare soil and sand with different volumetric water contents (VWCs) data (which are calibrated by a time domain reflectometer).

In the article "Radar HRRP target recognition based on concatenated deep neural networks," by Liao *et al.*, a deep neural network with concatenated structure is created for the recognition of flight targets.

The article "UWB radar target detection based on hidden Markov models," by Zhao *et al.*, proposes an ultra wideband

(UWB) radar target detection approach based on Hidden Markov Models (HMMs). HMMs are used as a classifier to identify signals with the presence of a target in a background clutter and the pure clutter response signal.

Fourier ptychographic microscopy (FPM) is a recently developed microscope that offers wide-field, high-resolution, and quantitative phase imaging. The article "Efficient colorful Fourier ptychographic microscopy reconstruction with wavelet fusion," by Zhang *et al.*, proposes an efficient colorful FPM reconstruction method using multiresolution wavelet color fusion, and an adaptive denoising method by analyzing the noise information of the dark-frame.

In general FPM systems, the LED source is important for the reconstructed quality and is sensitive to the positions of each LED element. The random positional deviations of each LED element can bring errors in reconstructed results. To improve the reconstruction rate and correct random deviations, the article "Random positional deviations correction for each LED via ePIE in Fourier ptychographic microscopy," by Chen *et al.*, combines an initial phase guess and a feedback parameter based on differential phase contrast and extended ptychographical iterative engine to propose an optimized iteration process for FPM.

The article "Integration convolutional neural network for person re-identification in camera networks," by Zhang *et al.*, proposes a novel deep model named integration convolutional neural network (ICNN) for person re-identification in camera networks, which jointly learns global and local features in a unified framework.

The article "Pedestrian retrieval via part-based gradation regularization in sensor networks," by Liu *et al.*, proposes a novel label distribution approach named part-based gradation regularization (PGR) for pedestrian retrieval in sensor networks.

Modulated wideband converter (MWC) is an attractive alternative among several sub-Nyquist sampling systems. However, most existing reconstruction methods require the sparse information, which is difficult to acquire in practical scenarios. The article "Sub-Nyquist spectrum sensing based on modulated wideband converter in cognitive radio sensor networks," by Wang *et al.*, proposes a blind multiband signal reconstruction method, referred to as the statistics multiple measurement vectors (MMV) iterative algorithm, to bypasses the above problem.

In order to improve the accuracy and efficiency of the precipitation cloud identification, a methodology of precipitation cloud identification based on deep learning is proposed in the article "Identification of precipitation-clouds based on the dual-polarization Doppler weather radar echoes using deep–learning method," by Wang *et al.* The method mainly consists of three major parts, which are constant altitude plan position indicator data inversion, zero-layer bright band identification, and precipitation-cloud classification using the deep learning network model.

The article "High sensitivity temperature sensor with an avoided-crossing-based selective-filling high birefringent photonic crystal fiber sagnac interferometer," by Zuo *et al.*, proposes and demonstrates a high sensitivity temperature sensor in an avoided-crossing-based selective-filling photonic crystal fiber (SFPCF), which was designed by selectively filling two symmetrical air holes around the fiber core of an index-guiding PCF with a kind of high index liquid.

In cognitive radio (CR), the detection performance of traditional spectrum sensing may be decreased due to the multipath fading and shadowing effect. However, unmanned aerial vehicles (UAVs) can receive a higher strength signal without suffering severe fading and shadowing. In the article "Spectrum sensing optimization in an UAV-based cognitive radio," by Liu *et al.*, a UAV-based CR is proposed to improve spectrum sensing performance and access the idle spectrum.

The article "Multi-focus image fusion algorithm in sensor networks," by Tong and Chen, proposes a multi-focus image fusion algorithm in sensor networks. The algorithm combines the advantages of multi-scale analysis and image phase analysis.

White blood cells (WBCs) play a significant role in the human immune system; therefore, WBC detection is a meaningful work. The article "SO-YOLO-based WBC detection with Fourier ptychographic microscopy," by Wang *et al.*, proposes a novel framework which combines Fourier ptychographic microscopy (FPM) and SO-you only look once (YOLO) for WCB detection.

In the wireless sensor networks (WSNs), designing an optimal tour path for sink is a challenging task because topology is time-varying and needs to consider latency. The article "A Bayesian compressive data gathering scheme in wireless sensor networks with one mobile sink," by Gu *et al.*, studies the compressive data gathering problem in terms of Bayesian theory for WSNs with a mobile sink and provides a modified shuffled frog leaping algorithm with a delay constraint.

Direction-of-Arrival (DOA) estimation capability of sensor arrays is greatly influenced by the geometric configuration of arrays. The article "Two-dimensional direction of arrival estimation for improved Archimedean spiral array with MUSIC algorithm," by Chen *et al.*, proposes a new type of 2-D planar array, improved Archimedean spiral array (IASA), to arrange sensor elements and enhance the array performance through Archimedean curves. The 2-D MUSIC algorithm is used to estimate the spatial spectrum of signals.

Aiming at the problem of how to use two different position image sensors to measure the coordinates of target points, the article "Plane-space algorithm based on binocular stereo vision with its estimation of range and measurement boundary," by Zhang and Wang, proposes the plane-space algorithm. According to the structural characteristics of the photosensitive element of the image sensor, the method of how to calculate the plane-space algorithm is proposed.

State-of-the-art nano-sensor and actuator technology enables diagnostics and treatment on the scale of biological cells. An action potential propagation through an axon or a special cell activity might be sensed and suppressed by an actuator through voltage stimulation or chemical agent

delivery. Such a complex procedure calls for building a communication network between sensors and actuators, despite challenged with issues. The article "Wireless sensor-actuator network for cell-level treatment based on protocol of collision segregation via learning," by Zhao and Blick, proposes a collision segregation method and the protocol of collision segregation via learning.

Since the appearance of clouds is always changing, ground-based cloud classification is still in urgent need for development in weather station networks. The article "Salient dual activations aggregation for ground-based cloud classification in weather station networks," by Zhang *et al.*, proposes a novel method named salient dual activations aggregation (SDA2) to extract ground-based cloud features from different convolutional layers, which could learn the structural, textural, and high-level semantic information for ground-based cloud representation simultaneously.

The article "Through wall human detection under small samples based on deep learning algorithm," by Li *et al.*, focuses on studying the detection of a human target's status behind walls in small sample conditions. In the deep learning network model, the autoencoder algorithm is chosen here to classify and identify human targets behind walls.

Influenced by various factors, there are a lot of scenes that the data collected from Internet of Things (IoT) devices are in the distribution-based form. Therefore, the study of classification for the distribution-based data is very valuable in the field of IoT. To speed up the training process, the article "Efficient classification of distribution-based data for Internet of Things," by Huang *et al.*, proposes a new general approach when the types and parameters of distributions are known.

Aiming at the serious effects of coverage holes caused by poor deployment environments and the limited energy of wireless sensor networks (WSN) on network lifetimes, an optimized and lightweight energy-efficient connected coverage heuristic (OECCH) algorithm is proposed in the article "Study on connected target coverage algorithm for wireless sensor network," by Qin *et al.*

In the article "Study on a cylindrical sensor network for intelligent health monitoring and prognosis," by Li and Zhang, intelligent body healthcare management based on body-centric wireless communications (BCWCs) is considered, and a wearable sensor network is studied.

En-route filtering is a mechanism where intermediate forwarding nodes identify and drop false reports while they are being forwarded toward the sink. Most of the existing en-route filtering schemes are probabilistic, where sensor nodes in each cell share secret keys with a fixed probability with intermediate nodes. Thus, forwarded reports are verified probabilistically by intermediate nodes, because of which false reports can travel several hops before being dropped. Few deterministic en-route filtering schemes have also been proposed in the literature, but all such schemes require a source to send the reports through a fixed path to reach the sink. The article "Deterministic en-route filtering of false reports: A combinatorial design based approach," by Kumar and Pais, proposes a novel deterministic en-route filtering scheme based on a combinatorial design to overcome the above-mentioned limitations of the existing schemes.

In the article "Research on an automatic tracking strategy based on CCD image sensor in micromanipulation," by Yin *et al.*, an automatic tracking strategy based on a CCD image sensor is proposed to achieve real-time tracking of embryonic cells with the MR-6 micromanipulator.

One of the major problems in WSN networks is imprecise SN localization. The article "Optimized hop angle relativity for DV-Hop localization in wireless sensor networks," by Phoemphon *et al.*, proposes a range-free WSN position estimation approach to improve the DV-Hop technique.

Most of the current machine learning models for processing big data belong to the static learning model. The batch learning method makes it impossible to analyze data streams in real time, and the learning ability of dynamic data streams is poor. This article "Online real-time analysis of data streams based on an incremental high-order deep learning model," by Li *et al.*, proposes an incremental high-order deep learning model to extend the data from the vector space to the tensor space and update the parameters and structure of the network model in the high-order tensor space.

The article "Soil moisture retrieval algorithm based on TFA and CNN," by Wang *et al.*, proposes a soil moisture retrieval algorithm with time–frequency analysis and convolutional neural network (CNN) based on ultrawideband radar echoes, which do not need to build a feature database in advance. The algorithm transforms the soil echoes into time–frequency (TF) distribution patterns and utilizes the CNN algorithm to classify soil echoes with different soil volumetric water contents (VWCs).

Accurate recognition of gestures based on surface EMG signals is of great importance in the study of human prosthetic interaction. The article "Research on recognition of nine kinds of fine gestures based on adaptive AdaBoost algorithm and multi-feature combination," by Liang *et al.*, proposes multi-feature combination and adaptive AdaBoost algorithm used to identify nine kinds of fine gestures.

The article "Plug-and-play prior based on Gaussian mixture model learning for image restoration in sensor network," by Shi and Feng, proposes a method to use Gaussian mixture model (GMM) as a plug-and-play prior for image restoration in sensor networks. The "plug-and-play" concept as an image prior is extended to image restoration.

Multi-robot exploration is a search of uncertainty in restricted space seeking to build a finite map by a group of robots. It has the main task of distributing the search assignments among robots in real time. The article "Hybrid stochastic exploration using grey wolf optimizer and coordinated multi-robot exploration algorithms," by Albina and Lee, proposes a stochastic optimization for multi-robot exploration that mimics the coordinated predatory behavior of grey wolves via simulation.

The ultra wide band (UWB) radar sensor is useful in the field of mission-critical sensors and sensor networks due to its short detection time, high penetration, and low energy consumption. To support critical missions such as search and rescue, the article "Non-contact detection of vital signs using a UWB radar sensor," by Duan and Liang, designs a non-contact detection system based on a UWB radar sensor module to obtain vital signs of human beings.

For the direction-of-arrival (DOA) estimators based on sparse signal representation, the feasibility and precision are greatly restricted by the inherent limitation of the predefined spatial discrete grids. The article "Off-grid DOA estimation for wideband LFM signals in FRFT domain using the sensor arrays," by Wang *et al.*, based on the high aggregation characteristic of wideband linear frequency modulation signals, derives the modified fractional domain sparse model (MFDSM) in DOA estimation and proposes a novel off-grid DOA estimation method via alternating descent iteration (OGDEADI).

The article "Software defined mission-critical wireless sensor network: Architecture and edge offloading strategy," by Xu *et al.*, proposes a software-defined mission-critical wireless sensor network (MC-SDWSN) which can solve the existing challenging issues in traditional WSNs, such as resource utilization, data processing, system compatibility, and strict latency requirements.

The media access control (MAC) layer of the vehicular ad-hoc network (VANET) is designed to provide fast and reliable vehicle-to-vehicle (V2V) or vehicle-to-infrastructures (V2I) access. In the article "Distributed multichannel MAC protocol for VANET: An adaptive frame structure scheme," by Lin and Tang, the authors adopt an adaptive frame scheme on the control channel and the service channels, which mainly improves two aspects of channel access performance: improved time slot utilization of the broadcasting period as much as possible while ensuring the vehicle can access the control channel quickly; and increasing the throughput of the service channels without generating excessive overhead.

In many mission-critical systems, a number of sensors are deployed to track ground targets with linear or nonlinear constraints on their motion dynamics. These sensors generate state estimates to be sent over long-haul links to a remote fusion center. The article "Projection-based constrained state estimation and fusion for tracking over long-haul links," by Liu and Rao, proposes a closed-form projection-based method to incorporate known constraints into the estimation and fusion process.

Sequentially training based on a series of datasets with gradually added training samples belonging to new classes is called incremental learning. The article "Learning automata, based incremental learning method for deep neural networks," by Guo *et al.*, proposes an effective incremental training method based on learning automata for deep neural networks.

Radio over fiber (RoF) systems are promising for low latency and flexible systems of high efficiency in mission-critical sensors and sensor networks (MC-SSN). The article "A joint scheduling and beamforming scheme for RoF-aided MC-SSN," by Chen *et al.*, proposes an RoF-aided MCSSN system serving the sensors with massive multiple-input multiple-output (MIMO) equipped.

Hyperspectral transmission imaging may provide a means for rapid screening of breast tumors, but tissue has a strong nature of scattering, thus causing great difficulties in identifying heterogeneity. The article "Multispectral heterogeneity detection based on frame accumulation and deep learning," by Zhang *et al.*, proposes a combination of frame accumulation and deep learning to detect heterogeneity.

In the article "Study on the electromagnetic field distribution of an implantable antenna for an intelligent health monitoring system," by Li *et al.*, an intelligent health monitoring system based on body-centric wireless communications and an implantable antenna is investigated.

For the flange end of the internal combustion engine crankshaft, the position of threaded holes and pinholes relative to the journal reference plane affects the dynamic balance and thermal efficiency of the engine, and therefore, this parameter measurement has a positive significance in crankshaft manufacturing. The article "The fast measurement for the relative position of flange-end holes," by Wang *et al.*, proposes a system for quickly measuring the relative position of the flange-end holes.

Due to the randomness of the node distribution, the equal clustering mechanism obviously cannot reduce energy consumption in wireless sensor networks (WSNs). The article "An energy aware adaptive kernel density estimation approach to unequal clustering in wireless sensor networks," by Liu and Chang, proposes a new unequal clustering algorithm, an energy-aware adaptive kernel density estimation algorithm (EAKDE), which aims to balance the energy dissipation among the Cluster Head (CH).

The article "An implantable antenna design for an intelligent health monitoring system considering the relative permittivity and conductivity of the human body," by Li *et al.*, investigates an intelligent health monitoring system based on body-centric wireless communications and implantable antennas.

The article "Energy-efficient multilevel heterogeneous routing protocol for wireless sensor networks," by Zhang *et al.*, proposes an enhanced balanced energy efficient network-integrated super-heterogeneous (E-BEENISH) routing protocol, by analyzing communication energy consumption of the clusters and a large range of energy levels in heterogeneous wireless sensor networks (WSNs).

Snapshot image mapping spectrometer (IMS) can capture the spatial and spectral information of an object simultaneously in a single integral time. The article "Geometric optical model of the snapshot image mapping spectrometer for data cube recovery," by Ding and Yuan, presents a geometric optical model of the IMS and proposes a reconstruction method for 3-D data cube based on this model.

In usual circumstances, the peaks of spectrum-like waveforms carry critical information, and accurately identifying peak location is of great significance. To improve the resolution performance without upgrading the hardware, a weighted centroid algorithm is proposed in the article "A partial-dip observation mechanism for the resolution improvement of spectrum-like surface plasmon resonance waveforms," by Wang.

The article "Microfluidic approaches toward the isolation and detection of exosome nanovesicles," by Jia *et al.*, compiled a thorough review that includes the latest works on using microfluidic technologies to isolate and detect exosomes in different bodily fluids and comments on their advantages and disadvantages.

Compressive sensing (CS) plays a pivotal role in signal processing. The article "Information theoretic bounds for sparse reconstruction in random noise," by Chen *et al.*, addresses information-theoretic analysis of CS under random noise with an aim to provide a precise reconstruction of the source signal.

The article "Discrimination-aware integration for person re-identification in camera networks," by Si *et al.*, proposes a novel method named discrimination-aware integration (DAI) for person re-identification (re-ID) in camera networks, which not only integrates multiple reID models but also adaptively learns integration weights for different feature dimensions.

The article "Representation learning and nature encoded fusion for heterogeneous sensor networks," by Wang and Liang, proposes a two-stage fusion method to solve the heterogeneous data fusion problem. Target detection based on heterogeneous sensor networks is considered in this scenario.

In object detection using deep convolutional neural networks, the informative annotations of the training data obtained from enormous human effort are mainly used in the last stage of the network for producing supervisions, thus being under-explored. The article "Foreground feature enhancement for object detection," by Jiang *et al.*, proposes to take further advantage of bounding box annotations in order to highlight the feature map of foreground objects by erasing background noise with a novel Mask loss, in which process L2 norm is further incorporated to avoid degenerated features.

As a mission-critical sensor, SAR has been applied in environmental monitoring and battlefield surveillance; moreover, SAR target recognition is one of the most important applications of SAR technology. The article "Image data augmentation for SAR sensor via generative adversarial nets," by Cui *et al.*, presents a SAR image data augmentation method via Generative Adversarial Nets (GAN).

The article "A fuzzy c-means and hierarchical voting-based RSSI quantify localization method for wireless sensor network," by Cheng *et al.*, proposes a received signal strength indicator (RSSI)-based positioning scheme and a hierarchical voting-based positioning scheme for calculating the position of the mobile node.

A novel framework called domain transfer multiple kernel boosting (DTMKB) is investigated in the article "Domain transfer multiple kernel boosting for classification of EEG motor imagery signals," by Dai *et al.* For this type of framework, it extends the DTMKL algorithms by applying boosting techniques for learning kernel-based classifiers with the transfer of multiple kernels.

Face recognition (FR) with a single sample per person (SSPP) is one of the most challenging problems in computer vision. The development of the FR system with only a small number of training samples is hindered. The article "Single-sample face recognition based on feature expansion," by Min *et al.*, proposes a scheme combining transfer learning and sample expansion in feature space.

Wireless body area networks (WBANs) are composed of several tiny sensor devices which are embedded on or implanted in the human body and are designed to continuously transmit sensed physiological data and act as key infrastructures for remote healthcare monitoring and treatment. The article "An efficient and reliable directed diffusion routing protocol in wireless body area networks," by Mu *et al.*, derives a directional diffusion routing protocol for WBANs.

A novel loss function named dual-guided loss (DGL) for ground-based cloud classification in weather station networks is proposed in the article "Dual-guided loss for ground-based cloud classification in weather station networks," by Li *et al.* The proposed DGL can integrate the knowledge of different convolutional neural networks (CNNs) in the process of optimization, which improves the discriminative ability of ground-based cloud feature representations.

The article "Coarse-fine convolutional neural network for person re-identification in camera sensor networks," by Zhang *et al.*, proposes a novel deep model named coarse-fine convolutional neural network (CFCNN) for person re-identification in camera sensor networks.

A novel medium access control (MAC) layer protocol is introduced for unmanned aerial vehicle (UAV)-based mission critical wireless sensor networks (MC-WSN) in the article "Medium access control for unmanned aerial vehicle-based mission-critical wireless sensor networks in 3-D monitoring networks," by Yang *et al.* It is an important application of mission-critical sensors and sensor networks (MC-SSN).

Wireless body area networks (WBANs) have become a forward-looking technology that is regarded as a potential solution for the remote collecting of physical and symptoms information. The article "Simplified energy-balanced alternative-aware routing algorithm for wireless body area networks," by Mu *et al.*, presents a simplified energy-balanced alternative-aware routing algorithm (SEAR) for WBANs.

The multimodal information is taken into consideration for ground-based cloud classification in weather station networks. The article "Hierarchical multimodal fusion for ground-based cloud classification in weather station networks," by Liu *et al.*, utilizes a novel approach called

hierarchical multimodal fusion (HMF) for ground-based cloud classification in weather station networks and fuses the deep multimodal features and the deep visual features in different levels.

The article "A novel capture-aware TDMA-based MAC protocol for safety messages broadcast in vehicular *ad hoc* networks," by Wang *et al.*, proposes a novel Capture-aware TDMA-based MAC (CT-MAC) protocol, which can better utilize the channel resource than the existing MAC protocols by setting the optimal frame length while taking capture effect into account.

The article "Compressed sensing image mapping spectrometer," by Ding, derives a novel snapshot imaging spectrometer based on the image mapping and compressed sensing concept named Compressed Sensing Image Mapping Spectrometer (CSIMS).

A direction of arrival (DOA) estimation algorithm based on the reconnaissance plane with multiple array sensors for unmanned aerial vehicles (UAV) is investigated in the article "Localization of unmanned aerial vehicle operators based on reconnaissance plane with multiple array sensors," by Zhen. This algorithm locates numerous radio signals simultaneously and performs well in the circumstance that signals impinge on the sensor array with small-angle intervals.

Feature representation based on the high-resolution range profile (HRRP) is the key technology in radar automatic target recognition (RATR). The article "Radar HRRP target recognition via semi-supervised multi-task deep networks," by Zhao *et al.*, designs a deep-u-blind denoising network (DUBDNet) to extract features with high noise stability.

Quantum cryptography enabling unconditional security is one of the most promising techniques for the internet of things networks deployment. The article "Optimized coherent state based quantum cryptography with high robust for networks deployment," by Li and Wang, presents a coherent state based quantum cryptography protocol, which has highly robust capabilities.

The article "Region-aware proactive routing approaches exploiting energy efficient paths for void hole avoidance in underwater WSNs," by Khan *et al.*, utilizes a proactive routing protocol with three different network types, which is proposed to solve the energy efficient routing protocol issues to maintain a strategic distance from the unexpected failure of the network and to increase the life expectancy of the network.

An algorithm based on deep convolutional generative adversarial networks (DCGANs) to generate typical weather radar base data is proposed in the article "Study on weather radar echo data generation based on DCGAN," by Wang *et al.* This algorithm detects the changes in precipitation clouds for short-term forecasting and improves power spectrum.

The article "PolSAR image speckle reduction based on classification of similarity features between coherency matrices," by Han *et al.*, presents a novel PolSAR image speckle reduction algorithm based on a new definition of similar-ity coefficient. This method is effective not only in speckle suppression but also in polarimetric properties and structure feature preservation.

The target tracking underwater wireless sensor networks (WSNs) is an extension of the terrestrial sensor network with more communication technology and information processing challenges. The article "Sensor-networked underwater target tracking based on grubbs criterion and improved particle filter algorithm," by Zhang and Gao, derives a distributed particle filter-based target tracking algorithm with Grubbs criterion and mutual information entropy weighted fusion (GMIEW).

Through-the-wall radar imaging (TWRI) is a viable technology for providing high-quality imagery of enclosed structures, which makes use of electromagnetic waves below the S-band to penetrate through building wall materials. The article "Dynamic joint reconstruction of walls and targets in through-the-wall radar imaging," by Muqaibel and Albeladi, proposes a dynamic wall pursuit algorithm to simultaneously recover the room geometry and image the scene behind the wall.

The article "Role of UAVs in public safety communications: Energy efficiency perspective," by Shakoor *et al.*, reviews the existing literature for Unmanned aerial vehicle (UAV) communication while taking into account the energy consumption criteria, and proposes a multi-layered network architecture incorporating UAVs for public safety communication.

A novel framework named IdentifyNet which introduces an additional homogeneous task to improve object detection is investigated in the article "IdentifyNet for non-maximum suppression," by Jiang *et al.* This type of framework utilizes further learning to predict whether two different region proposals belong to the same object, thus forcing the network to learn more informative and representative features for different proposals, especially for those from the same object class.

Infrared sensors capture the infrared radiation emitted by objects in the scene. Visible sensors receive the reflected light of the object. The quality of visible images taken under different illumination conditions varies greatly, so the illumination factors will affect infrared and visible image fusion effects inevitably. The article "Infrared and visible image fusion under different illumination conditions based on illumination effective region map," by Tong and Chen, proposes an infrared and visible image fusion algorithm that satisfies poor illumination conditions.

A novel Siamese network-based visual tracking method is presented in the article "SVTN: Siamese visual tracking networks with spatially constrained correlation filter and saliency prior context model," by Huang *et al.* This type of network enhances decision-making ability by Spatially Constrained Correlation Filter (SCCF) and Saliency Prior Context (SPC) model.

The article "Person re-identification via contextual region-based metric learning in camera sensor networks," by Zhang *et al.*, proposes a novel metric learning method

named Contextual Region-based Metric Learning (CRML) to learn the distance metric in a local manner for person re-identification in camera sensor networks.

Directional modulation (DM) as a physical layer security technique has been studied from many different aspects recently. The article "Directional modulation design under a constant magnitude constraint for weight coefficients," by Zhang *et al.*, proposes a constant magnitude constraint for the DM design, and the resultant non-convex optimization problem is then transformed into a convex one to facilitate its solution.

Many factors influence the connection states between nodes of wireless sensor networks, such as physical distance and the network load, making the network's edge length dynamic in abundant scenarios. The article "Reinforcement learning-based stochastic shortest path finding in wireless sensor networks," by Xia *et al.*, uses reinforcement learning algorithms to study the stochastic shortest path problem on a directional graph with stochastic edge lengths.

APTEEN is applied to cognitive wireless sensor networks, and an ant colony-based uneven clustering APTEEN algorithm (ACUCAPTEEN) is proposed in the article "Research on uneven clustering APTEEN in CWSN based on ant colony algorithm," by Wang and Wang. The algorithm combines routing and spectrum allocation with cross-layer design method, improves energy-efficient uneven clustering protocol and introduces it to APTEEN, and uses the ant colony algorithm to complete inter-cluster path search.

Target detection is critical in many mission-critical sensors and sensor network (MC-SSN) applications. The article "Two-dimensional direction-of-arrival and polarization parameter estimation using parallel co-prime polarization sensitive array," by Hou *et al.*, proposes the parallel co-prime polarization sensitive array (PCP-PSA) which consists of the co-centered orthogonal dipole triads (CODTs) to estimate two-dimensional direction-of-arrival (2D DOA) and polarization parameters.

Mission-critical sensors and sensor networks (MC-SSN) have been applied to lots of important scenarios, such as battlefield, search and rescue, anti-terrorist, and environment monitoring. The article "Adaptive fuzzy tree system for target tracking in mission-critical sensor networks," by Liu *et al.*, proposes an adaptive fuzzy tree system (AFS) for target tracking in MC-SSN.

An easy-to-calculate mathematical model of alert delivery with RAW is proposed in the article. "Fast and reliable alert delivery in mission-critical Wi-Fi HaLow sensor networks," by Khorov *et al.* The model allows dynamic online reconfiguration of RAW parameters to select such parameters that minimize consumed channel timeshare while providing satisfactory reliability and delivery delay for an alert.

The article "Joint channel and power allocation based on generalized Nash bargaining solution in device-to-device communication," by Wang *et al.*, proposes a new generalized Nash bargaining framework for joint channel and power allo-

cation in device-to-device (D2D) communication underlying cellular networks.

In order to facilitate the flow and explore the economic value of IIoT data, it is crucial to consider data packet transactions (DPTs) and data analytics service transactions (DASTs) simultaneously. The article "Smart contract-based data commodity transactions for industrial Internet of Things," by Jiang *et al.*, presents a new transaction solution based on the smart contract-enabled blockchain technology, which consists of the DPT smart contract and DAST smart contract.

The article "Soil pH value forecasting using UWB echoes based on ensemble methods," by Yang and Liang, proposes a new method to predict soil pH values based on ensemble methods via ultra wideband (UWB) radar echoes, due to the fact that the ensemble method has a fast running speed, fewer parameters, and the amount of data required is not large.

In this era of artificial intelligence (AI), the Internet of things (IoT) with the capability of connecting a great number of heterogeneous terminals and the popularity of mobile devices, which makes more devices available as another pair of eyes for people, such as video surveillance and smart navigation. The article "Image enhancement via indented frame over fusion," by Zhang *et al.*, promotes an image enhancement method and is dedicated to reduce the adverse effects of blurred images on vision systems.

The article "Semantic constraint GAN for person re-identification in camera sensor networks," by Liu *et al.*, proposes a novel data augmentation method named Semantic Constraint Generative Adversarial Network (SCGAN) for person re-identification (Re-ID) in camera sensor networks.

Compressed sensing image mapping spectrometer can acquire the entire three-dimension (3-D) datacube of objects instantaneously in a snapshot. The article "The datacube reconstruction approach for compressed sensing image mapping spectrometer (CSIMS)," by Ding and Wang, establishes the sensing matrix for a novel datacube reconstruction approach, which combines whole sliced parts to make full use of the raw mixture data.

The article "Patch-based nonlocal adaptive gradient regularization for image restoration in sensor networks," by Shi, proposes a novel patch-based adaptive nonlocal gradient regularization method for image restoration in sensor networks, which formulates the hyper-Laplacian distribution to regularize the global gradient distribution.

Wireless sensor networks are generally used to assist in collecting and transmitting data where humans cannot directly explore. The article "Power control and trajectory planning based interference management for UAV-assisted wireless sensor networks," by Zhang *et al.*, manages interference by optimizing the transmit power of all communication nodes and planning the trajectory of UAV to achieve the goal of maximizing the sum throughput of the target sensor.

Sparse code multiple access (SCMA) combined with spectrally efficient frequency division multiplexing (SEFDM) is a wireless air-interface technology with dual non-orthogonal characteristics which can meet the high spectral efficiency

requirements of the future Internet of Things (IoT). The article "Iterative multiuser detection and decoding for sparse code multiple access combined with spectrally efficient frequency division multiplexing," by Li *et al.*, proposes an iterative multiuser detection/decoder (IMUDD) method for SCMA-SEFDM, which performs soft information iteration in a turbo style. IMUDD can effectively achieve the multiple-access interference (MAI), inter-symbol interference (ISI), and inter-carrier interference (ICI) cancellation through an external iteration and three internal iterative processes.

Mobile target tracking-oriented sensor networks are a special kind of mission-critical sensor network (MCSN), in which various missions with diverse priorities exist. However, it is challenging to achieve real-time tracking while keeping the MCSN a long life time with limited energy provision in a complicated environment. In the article "Intelligent resource collaboration in mobile target tracking oriented mission-critical sensor networks," by Zhou *et al.*, the authors develop a collaborative perception and intelligent scheduling scheme, which jointly optimizes the system responding latency and tracking accuracy with the constraint of the available energy.

Unmanned aerial vehicles, also known as drones, are becoming popular enabling technology for several applications including monitoring, surveillance, and shipping. The article "Leveraging jamming to help drones complete their mission," by Tedeschi *et al.*, proposes e JAM-ME, an autonomous jamming-assisted navigation system that allows a drone to accomplish its mission even in the presence of an anti-drone jamming protection system.

Continuous-variable quantum key distribution (CV-QKD) over air quantum channel enables the ability to provide unconditional information security, which is one of the most promising techniques for information wireless transfer. The article "Continuous-variable quantum key distribution over air quantum channel with phase shift," by Li and Wang, studies the secret key rate of CV-QKD over the air quantum channel, which is characterized by beam wandering and phase distortion under weak air turbulence conditions.

Most of the traditional classification algorithms are based on the uniform distribution of samples, and the effect is not ideal when dealing with such data, which mainly shows that the classification results incline to the majority class. The article "Imbalanced data classification for multi-source heterogeneous sensor networks," by Wang *et al.*, proposes imbalanced multi-source heterogeneous data classification algorithms, which are mainly based on the expansion and extension of support vector machines.

With the advantages of large piezoelectric constant, wide frequency response range and good flexibility, poly(vinylidine fluoride) (PVDF) is receiving heightened attention as a promising alternative to traditional piezoelec-

tric materials. The article "Magnetic field sensing based on magnetoelectric coupling of ampere force effect with piezoelectric effect in silver/poly(vinylidine fluoride)/silver laminated composite," by Qi *et al.*, focuses on investigating the magnetoelectric effect of a three-layer composite consisting of a core layer of PVDF and two layers of silver-plated electrodes under the action of AC and DC magnetic fields.

We express our gratitude to the authors for their excellent contributions to this Special Section. We are also thankful for all reviewers dedicating their efforts in reviewing these articles and for their valuable comments and suggestions that significantly improved the quality of the articles. We hope that this Special Section will serve as a good reference for researchers, scientists, engineers, and academicians in the field of mission-critical sensors and sensor networks.

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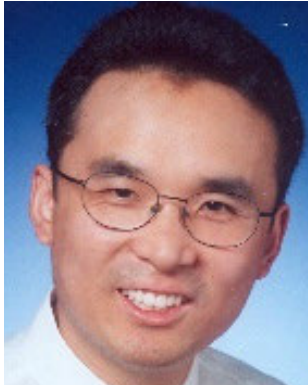**JING LIANG,** *Guest Editor*
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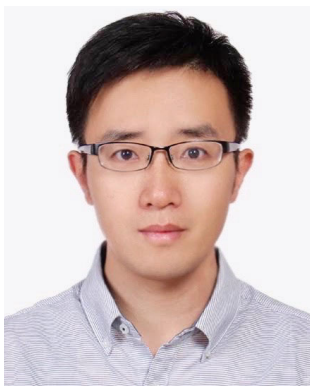
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