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EDITORIAL

IEEE ACCESS SPECIAL SECTION: INTELLIGENT DATA SENSING, COLLECTION, AND DISSEMINATION IN MOBILE COMPUTING

Data are an important parts of building applications and providing services to users. With the development of modern technology, the requirements for data quantity, quality, and processing capabilities have become more stringent. Sufficient high-quality data are the foundation for most mobile applications. It is important to collect enough data to effectively build your application. In addition to ensure the amount of data collected, the quality of the data collected is also important. Otherwise, a large amount of data redundancy will occur, which will cause trouble for data processing. At the same time, large amounts of data also mean the need for data processing capabilities. Traditional processing methods cannot meet the growing demand for data processing. Mobile computing is a promising solution to meet the growing computing needs of various mobile applications. The advancement and application of mobile computing require more intelligent ways to sense and collect data, which constantly poses new challenges to researchers.

With mobile computing, the scale of data sensing, collection, and dissemination is far greater than ever. Various smart mobile devices are located throughout cities, and mobile computing makes full use of various sensing devices such as smartphones, wireless body sensors, smart sensing devices in manufactory and smart meters. To sense and collect data, which will be on the order of zettabytes in the near future, together with the use of the computing power of those mobile devices, develops a new paradigm for data sensing, collection, and dissemination. Data sensing and collection through smarter methods can effectively reduce the workload of participants. Mobile computing has become a potential computing paradigm, paving the way for the popular computing of mobile and big data applications.

In a popular computing environment, ensuring intelligent data sensing, collection, and processing based on mobile computing is a basic requirement. It is a pity that this long-standing problem has not yet been completely solved. For example, how to implement intelligent data sensing, data collection, and expected performance of data processing in intelligent data collection/dissemination, and how to ensure data quality, data reliability, information security, and privacy are unanswered questions.

In addition, other related aspects are also worth studying, such as computation costs, platforms, tools, service discovery, data management, and analysis for intelligent data collection and dissemination. These unresolved issues have been a major research hotspot for many researchers since they are critical to ensure rigid and efficient applications for edge-computing-based crowdsensing networks.

This Special Section of IEEE Access on Intelligent Data Sensing, Collection, and Dissemination in Mobile Computing aims to solve the above issues and challenges. This Special Section hopes to present innovative solutions and recent advances in the domain of intelligent data sensing, collection, and dissemination in mobile computing, which can provide a good guide for the application and future research on mobile computing.

After the release of the Call for Papers, related researchers showed great enthusiasm and began to actively submit manuscripts. In the end, we received 39 excellent articles, which will be introduced. based on the categories of these articles.

Articles in the first category are dedicated to improving energy utilization, extending network lifetime, and reducing latency.

The article "QSDN-WISE: A new QoS-based routing protocol for software-defined wireless sensor networks," by Tan *et al.*, proposes a hierarchical software-defined network architecture for WSNs, which is more adaptive and enables complex network management. In addition, the authors propose a QoS-based routing protocol called QSDN-WISE, which can provide QoS support for data with different requirements, balance network energy consumption, and extend the lifetime of the network.

The article "A hybrid transmission based data collection scheme with delay and reliability guaranteed for Lossy WSNs," by Zhang *et al.*, proposes a hybrid transmission scheme integrating the packet reproduction (PR) and Hop-by-Hop Automatic Repeat-reQuest (HBH ARQ) schemes to

improve energy efficiency and reduce delays. The network is divided into two parts by a hybrid boundary, where location information is used to help determine routing changes between PR and HBH ARQ schemes. According to the simulation results provided by Zhang *et al.*, the effectiveness of the scheme has been finally proved.

The article ''Mobile intelligent computing in Internet of Things: An optimized data gathering method based on compressive sensing,'' by Sun *et al.*, proposes a mobile intelligent computing based on compressive sensing date gathering (MIC-CSDG) algorithm, which can improve the accuracy of data reconstruction. Through mobile intelligent computing, sparse matrix, and the confirmation mechanism of the data forwarding strategy, multipath routing data between different routers are implemented to achieve reliable data switching. Simulation results confirm the validity and efficiency of the proposed method. Compared with other existing algorithms, the data forwarding time is reduced by 16.36%, and the average network energy consumption is reduced by 23.59%.

The article ''Improving lifetime of cell-edge smart sensing devices by incentive architecture based on dynamic charging,'' by Gui *et al.*, proposes a new incentive architecture based on dynamic charging to improve the lifetime of cell-edge smart sensing devices. In order to solve the problem of motivating smart terminals to plug in chargers and freight forwarders at the same time, the authors proposed a set of noncooperative games for smart terminals.

The article ''A two-stage RPSO-ACS based protocol: A new method for sensor network clustering and routing in mobile computing,'' by Wang *et al.*, introduces the resampling particle swarm optimization algorithm (RPSO). The cluster head node uses multihop transmission, and ant colony optimization (ACO) is used to select the relay node between the cluster head and the base station. The authors propose a protocol based on two-phase RPSO-ACS to improve energy efficiency and network operation quality during data transmission, as well as extend network life.

The article ''An edge computing platform for intelligent operational monitoring in Internet data centers,'' by Jiang *et al.*, proposes an edge computing platform for data center intelligent operation monitoring. The platform integrates wireless sensors and onboard built-in sensors to collect data during data center operation and maintenance.

The article ''Adding duty cycle only in connected dominating sets for energy efficient and fast data collection,'' by Shi *et al.*, proposed an Adding Duty Cycle Only in Connected Dominating Sets (ADCOCDS) approach, which can effectively reduce network energy consumption and delay.

To reduce service latency and ensure high service efficiency, researchers have developed task offloading using Mobile Edge Computing (MobEC). However, most existing solutions focus only on one offload, and task dependencies are considered less. The article ''Dependency-aware computation offloading in mobile edge computing: A reinforcement learning approach,'' by Pan *et al.*, proposes a model-free approach based on reinforcement learning (RL). A Q-learning approach that adaptively learns to optimize the offloading, decision, and energy consumption jointly by interacting with the network environment is used.

The article ''An energy-efficient multi-ring-based routing scheme for WSNs,'' by He *et al.*, proposes a novel scheme named Energy-efficient Routing Scheme, based on Multi-Ring (ERSMR). The core idea of this scheme is to collect as many data packets as possible from the nodes in the peripheral area so as to realize the full use of energy.

The article ''Data collection through mobile vehicles in edge network of smart city,'' by Luo *et al.*, proposes a cluster head rotation joint mobile vehicle data collection (CHR) scheme. The authors first propose a single cluster head rotation joint mobile vehicle data collection (SCHR) scheme to balance in-network energy consumption. Then, a multiple cluster head rotation joint mobile vehicle data collection (MCHR) scheme is proposed to further balance the energy consumption.

Multiaccess edge computing (MEC) provides a cloud-like service. However, implementation reliability is rarely considered in current MEC studies. The article ''A fast algorithm for energy-saving offloading with reliability and latency requirements in multi-access edge computing,'' by Liu *et al.*, considers energy-saving offloading to satisfy the reliability and latency requirements of the application. Simulation results demonstrate that the proposed algorithm obtains lower energy consumption compared with local execution and random assignment and costs less runtime compared with the greedy algorithm.

The article ''A reliable hybrid routing strategy for durability monitoring of concrete structures in wireless sensor networks,'' by Hu and Li, focuses on the problem of multi-objective data transmission. The goal is to achieve a trade-off among low energy consumption, low latency, and high reliability. The authors combine the reproduction mechanism and retransmission mechanism and propose a hybrid routing strategy named HRRS based on packet retransmission and packet reproduction, which achieved the expected research results.

In addition to the aforementioned articles, there are also several studies that focus on data collection methods and accuracy.

In the process of city design, real-time itinerary planning, activity monitoring, and personal transportation modes for daily travel can provide useful information. At present, in the existing systems, accelerometer and GPS are mainly used as signal sources, which rapidly exhaust the limited battery life of wearable devices. In the article ''Energy harvesting-based smart transportation mode detection system via attention-based LSTM,'' by Xu *et al.*, the authors propose an alternative method for fine-grained transport mode detection using kinetic energy harvester (KEH) and design a transportation detection framework based on attention-based long short-term memory (LSTM) to implement fine-grained transport mode detection. According to their research, the method can detect fine-grained transportation modalities, and the overall

accuracy is more than 97%. In addition, the power consumption of sampling the KEH signal is only 460 uW.

The article "Multi-step data prediction in wireless sensor networks based on one-dimensional CNN and bidirectional LSTM," by Cheng *et al.*, proposes a new multi-step sensory data prediction model for wireless sensor networks. This model makes full use of the spatial–temporal correlation between wireless sensor nodes to recover abnormal/lost data through data prediction. This multistep prediction model can predict multi-step (short-term and medium-term) sensory data, and its performance is better than other related methods.

The article "Drift calibration using constrained extreme learning machine and Kalman filter in clustered wireless sensor networks," by Wu and Li, presents a novel algorithm using constrained extreme learning machine and Kalman filter (CELM-KF) for tracking and calibrating drift of sensor data. According to their study, through training phase and calibrating phase, CELM-KF can successfully calibrate sensor data drift.

The existing WIFI-based indoor localization methods mainly obtain channel state information (CSI) through a personal computer, or coarse-grained received signal strength (RSS) through a smartphone, to complete the positioning. In the article "Smartphone-based indoor fingerprinting localization using channel state information," by Chen *et al.*, the authors use smartphones to collect fine-grained CSI that is more convenient and applicable and propose an indoor fingerprinting localization. The authors use a Google Nexus 5 smartphone to conduct experiments in two typical indoor environments. The localization accuracy is 91% and 86%, respectively, and both average localization errors are less than 0.5 m. The proposed algorithm has higher localization accuracy compared with the typical algorithms.

Traditional data collection protocols, such as growth codes, cannot distinguish the importance of data, which increases the risk of losing important data. The article "RTDCM: A coding preemption collection system for key data prioritization with hierarchical probability exchange mechanism in mobile computing," by Zhang *et al.*, analyzes the impact of growth codes on the "fair" processing of all data. From the perspective of distinguishing the importance of data, a real-time data collection model (RTDCM) is proposed. Experiments show that the data recovery characteristics of RTDCM-based data acquisition protocols are mainly concentrated on important data and have high recovery efficiency for ordinary data.

The article "Time-dependent ad-hoc routing structure for delivering delay-sensitive data using UAVs," by Yoon *et al.*, proposes a hybrid data delivery mechanism that exploits the load-carry-and-delivery by UAVs with a mixture of localized ad-hoc routing over partially connected terrestrial networks through the following three steps: 1) localized network construction, 2) network probing by UAVs, and 3) localized ad-hoc routing based on a dynamic depth routing tree depending on the data urgency. With the premise of keeping routing costs low, the authors achieved reliable on-time data delivery to target nodes.

The article "Artificial intelligence based mobile tracking and antenna pointing in satellite-terrestrial network," by Liu *et al.*, addresses the problem of having to accurately locate mobile terminals and quickly process collected data to reduce communication pressure. The authors study a pointing and tracking method based on artificial intelligence for mobile stations and terminals in satellite-terrestrial networks. This method can ensure that the mobile station and terminal can obtain the optimal antenna signal under the guarantee of minimal communication interference.

The article "Random forest algorithm-based lightweight comprehensive evaluation for wireless user perception," by Zhang *et al.*, proposes a lightweight comprehensive evaluation method. The method first selects indicators through the random forest algorithm, then weighs those selected indicators by the entropy weight method, and finally calculates the weighted scores of all cells. The experimental results show that the higher scoring units perform better in actual situations.

Security is another key research issue, and we have also included some related articles.

In the study of Mobile Crowd Sensing (MCS) for the problem of information orientation, existing research has lacked task bidding and task assignment. The article "Location privacy-aware task bidding and assignment for mobile crowdsensing," by Yan *et al.*, proposes two task selection strategies: Minimize Total Cost (MTC) and Minimize Average Cost (MAC). The authors prove both strategies through theoretical analysis.

Security monitoring big data has begun to emerge, providing favorable support for smart city construction and city-scale and investment expansion. When using existing clusters to train distributed machine learning models, problems such as load imbalances and network transmission delays can lead to inefficient model training. The article "Parameter communication consistency model for large-scale security monitoring based on mobile computing," by Yang *et al.*, proposes a distributed machine learning parameter communication consistency model based on the parameter server idea, which is called the limited synchronous parallel model. The implementation of cluster dynamic load balancing experiments shows that the model can fully utilize the cluster performance during the training of distributed machine learning models to ensure the accuracy of the model and improve the training speed.

Face pose analysis usually uses traditional deep learning methods, which are mainly based on public data set training and are not robust or suitable for specific application scenarios. The process of trimming the facial area in the early stage also takes a portion of time. In response to this problem, the article "Fusion learning model for mobile face safe detection and facial gesture analysis," by Ni and Li, proposes a joint learning network model for mobile face safe detection and pose analysis. The method is implemented by a cloud-service assisted semi-automated image annotation method, the cascaded multitask network and the fusion loss function,

classified training data, and Online Hard Example Mining (OHEM) training strategies together.

Among these 39 articles, another subset researched some practical application scenarios.

Unmanned surface vehicle (USV), as a flexible, lightweight, and intelligent device deployment integration platform, is the main tool for the development of water containers. How to monitor the real-time navigation status information of the USV, integrate the information, and finally distribute it to the ground control center is an urgent problem. The article ''Joint communication and control for small underactuated USV based on mobile computing technology,'' by Yang *et al.*, proposes an integrated space–air–ground–sea communication control system based on mobile computing technology to rescue water tanks. The authors carried out three aspects of research: USV information collection, information fusion, and data distribution to the ground control center. The proposed scheme can reduce the surge of ships and meet the needs of ship navigation.

The Industrial Internet of Things (IIoT) can be used to sense public safety hazards and provide early warning of potential accidents. It is often used for mine disaster monitoring. Existing methods focus on processing on a single data or cloud platform, and rarely consider the correlation of time and space. The article ''Hierarchical edge computing: A novel multi-source multi-dimensional data anomaly detection scheme for Industrial Internet of Things,'' by Peng *et al.*, proposes a novel multi-source multidimensional data anomaly detection scheme based on hierarchical edge computing model. Compared with the traditional scheme, this scheme has higher detection accuracy and lower processing delay.

The article ''Fatigue EEG feature extraction based on tasks with different physiological states for ubiquitous edge computing,'' by Xu *et al.*, proposes two groups of stroop tasks with different critical levels to cause fatigue, which is evaluated by electroencephalography (EEG). The wavelet packet decomposition and sample entropy algorithm were used to analyze the EEG signals in both sober and fatigue state, respectively. Through analysis, parameters for potential indicators of reasonable mental fatigue were found, which were α/β and $(\alpha+\theta)/\beta$, respectively.

The article ''An effective digital system for intelligent financial environments,'' by Zhang *et al.*, proposes an enhanced system that can quickly make early responses and avoid potential bad debt risks. The system ensures the selection of reliable customers and avoids the potential risk of bad debts due to loose credit lines. The preventive control of the corresponding collection management was strengthened, and the potential risk of bad debt was detected in earlier system alerts.

In order to solve the apparent contradiction between the existing resolution requirements of marine monitoring data (MMD) and the cost of sensor network deployment, the article ''Efficient acquisition method for marine monitoring data based on compressed sensing,'' by Tian *et al.*, proposes an MMD acquisition and reconstruction scheme based on compressed sensing theory (CS-MMD). The simulation results show that CS-MMD can save a lot of acquisition resources and accurately reconstruct data. The accuracy rate reached 99% under the premise of saving up to 99% of sampling resources.

The article ''An intelligent video tag recommendation method for improving video popularity in mobile computing environment,'' by Zhou *et al.*, focuses on the question of how to improve the popularity of video sharing on websites like YouTube in a mobile computing environment. The authors propose a novel hybrid method based on multi-modal content analysis, which recommends keywords for video uploaders to compose titles and tags for their videos, and then gain higher popularity.

Red tide is caused by a variety of complex marine environmental factors. In order to initiate a systematic study of the interaction analysis between these factors, the article ''Machine learning based dynamic correlation on marine environmental data using cross-recurrence strategy,'' by Li *et al.*, developed a novel framework based on machine learning for marine environment sequence analysis. It combines a cross recurrence plot (CRP), a cross recurrence quantification analysis (CRQA), and a statistical analysis. Finally, the representative factors in each field are statistically determined by a boxplot. Experimental results show that the framework is competent to perform the visualization of marine time series.

The article ''Design and analysis of a strengthen internal control scheme for smart trust financial service,'' by Xiao *et al.*, designs a set of intelligent ERP financial modules for multinational corporations that could comply with SOX 404, strengthen internal controls, and improve the security and convenience of the financial module.

Some articles are focused on resource allocation issues.

With the rapid development of mobile networks and the development of the sharing economy model, spatio-temporal crowdsourcing technology has become a research hotspot. Task allocation is one of the core issues of spatio-temporal crowdsourcing technology. All three existing algorithms ignore the cost and fairness of the distance between task requesters and workers. The article ''An online task assignment based on quality constraint for spatio-temporal crowdsourcing,'' by Pan *et al.*, proposes a quality constraint algorithm (QCA), which quantifies the fairness between task requesters and workers as the quality of matching, and adopts a matching strategy of task reward auto-negotiation to improve average matching quality. QCA not only has higher average match quality and higher overall utility but also optimizes average distance cost.

In order to maximize system throughput and consider energy harvesting constraints and cellular user equipment (CUE) service quality, the article ''Mode selection and resource allocation algorithm in energy-harvesting D2D heterogeneous network,'' by Yan *et al.*, investigates mode selection and resource allocation problem with D2D User Equipment (DUE) multiplexing CUE uplink spectrum

resources for EH-DHNs. The authors propose a Mode Selection and Resource Allocation (MSRA) algorithm, which can effectively improve the throughput.

Some articles focused on indicators used to measure special performance.

Dempster–Shafer (DS) evidence theory, as an important method for uncertainty modeling, has been widely used in practical applications. When fusing different sources of highly conflicting evidence with Dempster's merger rules, it often produces counterintuitive results. To this end, some researchers have proposed several different methods of measuring conflicts of evidence. However, these methods show only one criterion to measure contradictory evidence. The article ''Multi-sensor data fusion based on improved analytic hierarchy process,'' by Deng and Wang, uses multiple criteria factors to measure the degree of conflict between the evidence. The results show that the method is more effective and feasible in managing conflict evidence.

The article ''Multi-level two-sided rating protocol design for service exchange contest dilemma in crowdsensing,'' by Lu *et al.*, proposes a game-theoretic framework of a multilevel two-sided rating protocol using all-pay contests to balance service requests and service provision between users in which a user is tagged with a multilevel rating to represent their social status and is encouraged to take the initiative to be a server and provide high-quality services to increase their rating.

Some articles focus on the process of processing the collected data.

Combining fog computing with mobile *ad hoc* networks has formed a new type of network called fog-based vehicle self-organizing networks (VANETs). This is a heterogeneous network, and the clock rates between different nodes are very different. The article ''An extremely accurate time synchronization mechanism in fog-based vehicular *ad hoc* network,'' by Liang and Wu, proposes a precise time synchronization mechanism for fog-based VANETs. This mechanism uses a two-way message exchange method to estimate clock skew by analyzing the mobility of dynamic nodes. Clock skew can be corrected using carrier frequency offset (CFO)-based hardware clock frequency estimation, and by taking into account the Doppler effect.

As we all know, an end-edge-cloud hierarchical storage system (EECHSS) can reliably cache and quickly offload large amounts of data. One of the main challenges posed by edge cloud architectures is consistency issues. It is difficult to ensure that the data from two distributed clusters are consistent through existing consistency protocols. The article ''Grouping-based consistency protocol design for end-edge-cloud hierarchical storage system,'' by Gu *et al.*, focuses on designing grouping-based consistency protocols with adaptively selecting consistency level in EECHSS. After the authors analyze the internal structure and workflow of EECHSS, they devise two modified adaptive grouping-based consistency protocols (GM-Paxos and GEPaxos) with efficient grouping algorithms. Then, based on the characteristics of frequently offloaded data, they design two synchronization strategies to ensure the consistency of the data cached in the cloud. Experiments show that the protocol can ensure data consistency and maximize usability.

There are two articles summarizing research that has been done on a topic.

Discovering social relationships among people and detecting the development of communities have become hot topics in mobile social networks (MSNs). The common description of people's social relationships based on static networks is inaccurate because one of the main characteristics of MSNs is that the network topology will change over time. The article ''Exploiting mobile social networks from temporal perspective: A survey,'' by Zhou *et al.*, presents a survey of this emerging field from a temporal perspective by focusing on four aspects: social property, time-varying graph, temporal social property, and temporal social properties-based applications. In addition, the authors discuss some important open issues about MSNs.

Recently, power spatio-temporal big data (PSTBD) technology for smart grids based on mobile computing has experienced explosive growth. The article ''Review of power spatio-temporal big data technologies for mobile computing in smart grid,'' by Ma *et al.*, emphasizes the specific requirements, technologies, applications, and challenges of the current PSTBD for mobile computing in smart grids.

Finally, the Lead Editor and Guest Editors of the Special Section express their great gratitude to the authors for their contributions, to the volunteering reviewers for their dedication, and to the whole IEEE Access editorial staff for their invaluable support.

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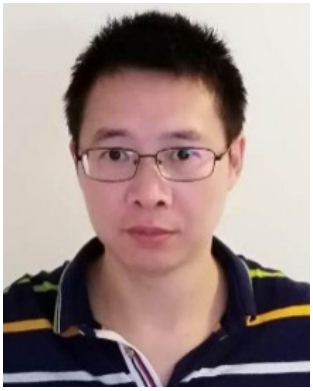

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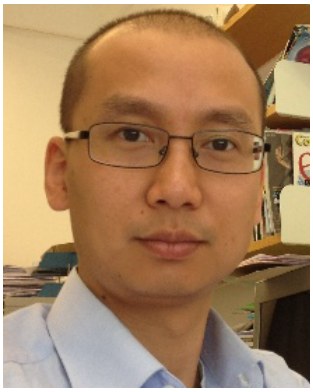

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