Guest Editorial: Special Section on Social and Cognitive Mobile Computing in Industrial Internet of Things

INTERNET of Thing (IoT) technology has attracted intensive interest in the automotive industry to meet the new demands in the market while continuing to achieve their conservative goals [item 1) in the Appendix]. As for Industrial Internet of Things (IIoT), randomly moving wireless nodes are often carried by humans and communicate with each other when they are in close proximity. The interaction between nodes shows strong regularity or sociality, i.e., a wireless node always communicates with several social-closed or distance-closed nodes. Furthermore, with thousands of industrial sensors across physical and man-made environments, the IIoT generates vast amounts of real-time data complexes in scale, form, and meaning [items 2) and 3) in the Appendix]. Particularly, cognitive IIoT learns from interactions with people and their experiences with industrial environments via cognitive mobile computing, which enables them to keep pace with the volume, complexity, and unpredictability of information generated by the IIoT. Different from usual mesh networks whose main feature lies in its unpredictable topology structure, the intrinsic properties of social and cognitive IIoT are social metrics guiding data in a predictable way and intelligently understanding and judging social values of massive data. In this context, social and cognitive mobility modeling, routing protocol, energy allocation, mobile computing, cognitive computing, etc., in the IIoT environment especially with stochastic layout shapes deserve more comprehensive investigations. Such characteristics call for a deep fusion of social characteristics, user experiences, edge computing, trust probability, cognitive communication, and information sharing in IIoT. Motivated by this, taking social and cognitive mobile computing into account when designing the IIoT mechanism in industry aggregation areas has been a promising trend.

This special section collects the latest ideas and research on the social and cognitive mobile computing in IIoT. Particularly, 15 original articles are accepted and included in the collection on the following pages. The topics of these articles are mainly concerned with social and cognitive mobility modeling, routing protocol, resource allocation, and so forth. We believe that these articles will play a role in inspiring our readers.

Summaries of Accepted Articles

The first article entitled "NOMA-based Resource Allocation for Cluster-based Cognitive Industrial Internet of Things" authored by Liu *et al.* proposes a cluster-based cognitive IIoT, wherein the cluster heads perform cooperative spectrum sensing to improve the detection performance and the nodes use nonorthogonal multiple access to improve the transmission performance. A joint optimization problem involves allocation of sensing time, the number of clusters, and node powers is solved, aiming to maximize the average total throughput.

The second article entitled "Manipulation with Domino Effect for Cache-and Buffer-Enabled Social IIoT: Preserving Stability in Tripartite Graphs" authored by Sun *et al.* investigates how to maximize the quality of experience while minimizing the energy consumption in Social IoT. Specifically, they first design a proactive cache placement scheme for cost minimization, and then, they conceive the content sharing procedure with the framework of tripartite graph and propose a ternary stable matching algorithm to let the devices self-organize the content sharing.

The third article entitled "Cooperative-Evolution-Based WPT Resource Allocation for Large-Scale Cognitive Industrial IOT" authored by Sun *et al.* considers a new wireless power transfer system consisting of a rechargeable wireless sensor network and multiple mobile chargers, where a decomposition strategy is proposed and the decomposed subcomponents are cooperatively evolved by adopting a cooperative evolutionary algorithm.

The fourth article entitled "Energy Minimization in D2D-Assisted Cache-Enabled Internet of Things: A Deep Reinforcement Learning Approach" authored by Tang *et al.* presents a joint framework consisting of MEC and cache-enabled device-to-device (D2D) communications to minimize the energy cost of the systematic traffic transmission. Under this framework, a novel scheme based on reinforcement learning is proposed, in which a systematic traffic transmission energy cost minimization problem is investigated.

The fifth article entitled "A Novel Framework of Three-Hierarchical Offloading Optimization for MEC in Industrial IoT Networks" authored by Zhao *et al.* proposes a novel three-hierarchical offloading optimization strategy, which incorporates the bandwidth allocation, offloading strategy, and relay selection for the IIoT industrial IoT to reduce the system latency and energy consumption.

The sixth article entitled "Multivehicle Coordinated Lane Change Strategy in the Roundabout under Internet of Vehicle based on Game Theory and Cognitive Computing" authored by Ding et al. investigates the mandatory lane change decision of vehicles in roundabouts under Internet of Vehicles, which

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combines MPC and Stackelberg equilibrium to meet the speed and comfort needs of the vehicle.

The seventh article entitled "Stackelberg Game Based Computation Offloading in Social and Cognitive IIoT" authored by Li *et al.* designs a computation offloading mechanism based on two-stage Stackelberg game to analyze the interaction between multiple edge clouds and multiple IIoT devices. Specifically, the edge clouds are denoted as leaders who set the appropriate price for their computation resource.

The eighth article entitled "Cost-Driven Offloading for DNN-based Applications over Cloud, Edge and End Devices" authored by Lin *et al.* proposes a cost-driven offloading strategy based on particle swarm optimization algorithm using the genetic algorithm operators to optimize the system cost while offloading deep neural network layers with deadline constraints.

The nine article entitled "Deep Reinforcement Learning for Social-Aware Edge Computing and Caching in Urban Informatics" authored by Zhang *et al.* develops a social-aware vehicular edge networks, where computation offloading, data caching, and content transmission are jointly optimized to maximize the content dispatch utility under strict delay constraints in complex vehicular networks with cross-area content coupling and diverse social characteristics.

The tenth article entitled "Signal Estimation in Underlay Cognitive Networks for Industrial Internet of Things" authored by Liu *et al.* proposes two different signal-to-noise-ratio (SNR) estimation methods to further improve the performance of nondata-aided SNR estimations. Furthermore, the Cramer–Rao lower bound of the SNR estimation for time-frequency overlapped signal is also analyzed.

The 11th article entitled "Advances and Emerging Challenges in Cognitive Internet-of-Things" authored by Li *et al.* focuses on the investigation and discussion of applications, standardization, spectrum-related functions, and security-oriented issues of cognitive IoT. In addition, the spectrum-function-related cognitive technology in IoT is summarized and the research challenges and potential applications for cognitive IoT are analyzed as well.

The 12th article entitled "Design of Binary Erasure Code with Triple Simultaneous Objectives for Distributed Edge Caching in Industrial IoT Networks" authored by Dai *et al.* designs a novel erasure property binary zigzag decoding storage code (base-shift) for edge caching, which can be distributively deployed at multiple IoT devices.

The 13th article entitled "Joint Computation and Communication Design for UAV-Assisted Mobile Edge Computing in IoT" authored by Zhang *et al.* proposes a new energy consumption minimization problem by optimizing the bits allocation, time slot scheduling, and power allocation as well as UAV trajectory. Particularly, the nonconvex problem is decomposed into two parts that are solved by the Lagrangian duality method and successive convex approximation technique, respectively.

The 14th article entitled "Social-Aware Incentive Mechanisms for D2D Resource Sharing in IIoT" authored by Sun *et al.* proposes two social-aware incentive mechanisms for D2D resource sharing in IIoT to improve the resource sharing efficiency, namely one hop based social-aware incentive mechanism and relay-based social-aware incentive mechanism.

The 15th article entitled "A Dynamic Multipath Scheme for Protecting Source-Location Privacy Using Multiple Sinks in WSNs Intended for IIoT" authored by Han *et al.* presents a dynamic multipath privacy-preserving routing scheme based on multiple sinks to protect the source location, which is verified to increase the privacy protection and balance the energy consumption by simulations.

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APPENDIX
RELATED WORK

1) D. Moongilan, "5G Internet of Things (IOT) near and far-fields and regulatory compliance intricacies," in *Proc. IEEE 5th World Forum Internet Things,* 2019, pp. 894–898.
2) S. Emiliano, S. Abusayeed, H. Song, J. Ulf, and G. Mikael, "Industrial Internet of Things: Challenges, opportunities, and directions," *IEEE Trans. Ind. Informat.*, vol. 14, no. 11, pp. 4724–4734, Nov. 2018.
3) H. Li and A. V. Savkin, "Wireless sensor network based navigation of micro flying robots in the industrial internet of things," *IEEE Trans. Ind. Informat.*, vol. 14, no. 8, pp. 3524–3533, Aug. 2018.

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