Editorial to the Special Issue on Smart Cities based on the Efforts of the Systems, Man, and Cybernetics Society

I. Introduction

To achieve net zero emissions economy, the transition to online entertainment and retail, ageing populations, urban population growth and pressures on public finance have created huge interests for human to run cities differently and smartly. A term titled smart city is created which is considered as an idealistic city, where the quality of life for citizens is greatly improved by utilizing information and communication technology (ICT), new services and new city infrastructures to efficiently achieve the value such as sustainable and resilient development. The eco-sustainable method has to be used in several aspects such as energy, mobility, environment, and social services. Research and development in smart cities is expanding exponentially. SMC is one of the core sponsors of the IEEE Smart Cities.

The SMC Society has a number of Technical Committees (TCs) on System Science and Engineering, Cybernetics and Human Machine Systems. Presently, there are 62 TCs in the field of system engineering related to issue formulation, analysis and modelling, decision making, and problem interpretation for any of the systems engineering lifecycle phases, and deployment of large systems between different scientific, engineering, and social disciplines [1,2].

This special issue aims to report the high-quality work supported and published by IEEE Systems, Man and Cybernetics Society in the theory, engineering, case study, policy, and other fields under the smart city domain including energy, health, industry and services. Due to the page limitation, the guest editors could only select 15 papers to demonstrate the significant contributions made.

II. Selected SMC Areas and Articles

A smart city may be described by six fundamental pillars, namely, smart economy for competitiveness, smart people related to social and human capital, smart governance deal with decision making in running a society, smart mobility with integration of transport and ICT to minimize fatality and maximize comfortability, smart environment to achieve net zero emission with the utilization of natural resources and smart living to improve quality of life and life expectancy [3].

To demonstrate the SMC efforts on smart cities research and deployment with a long-lasting impact, in this special issue, some papers are selected to give a coverage of few main smart city areas including (i) smart energy, (ii) smart health, and (iii) smart manufacturing systems, (iv) smart services and (v) smart transportation.

A. Energy

Energy is very important in our daily lives because it is a basic human need. There is a strong link between the availability of energy and the growth of a city.

Cheng et al. [4] proposed a resilient distributed scheme by integrating load-frequency control (LFC) with virtual inertia control (VIC) to obtain power system resilience performance under low inertia and hybrid attacks. A linear matrix inequality (LMI) technique was adopted to design the distributed resilient control gains. A novel deception attack model was proposed on the basis of a sign function, which describes the malicious intention to damage negative feedback control.

Zhang et al. [5] proposed a demand–response mechanism with two noncooperative games, in which dynamic pricing is applied for suppliers. The proposed energy trading system was prototyped on a cluster network, with a coordinator running as a smart contract in a Hyperledger blockchain. Both on-chain and off-chain processing modes were implemented to investigate the system performance. Experimental results indicated that the proposed demand–response games have a large effect in reducing the net peak load, and at the same time, the off-chain processing mode provides lower latency and overhead.

Yang et al. [6] studied the energy operation problem based on a novel full-duplex model named We-Energy (WE). A multi-objective optimization model proposed realizes the economic and security of WE. The model can respond to the changing needs based on various environment and operating situations. A two-channel Human-in-the-loop method was proposed to achieve real-time regulation under abnormal conditions and online evaluation. The capabilities of autonomous learning and self-adaptation can be improved through human–machine interaction and collaboration. This can also better avoid decision making risks but to ensure economic and security operation.

Lai et al. [7] proposed a resilient distributed multiagent control scheme for AC microgrid networks with additive noise and time-delay disturbances taking into account. The proposed multiagent control scheme is composed of three distributed consensus protocols, which is able to synchronize the output voltages and frequencies of inverter-based distributed energy resources to their reference values and achieve the optimal active power-sharing property by a low bandwidth communication network.

Jalali et al. [8] introduced a deep learning-based multistep ahead approach to improve the forecasting performance of global horizontal irradiance (GHI). A deep convolutional long short-term memory is applied to extract optimal features for accurate prediction of the GHI. The performance of such deep neural networks directly depends on their architectures. To deal with this, a swarm evolutionary optimization method, called the sine-cosine algorithm, was adopted and advanced to spontaneously

optimize the network architecture. A three-phase modification model was proposed to increase the diversity of population and avoid premature convergence in the optimization mechanism. The performance of the proposed method was evaluated with three datasets collected from three solar stations in the United States. The experimental results demonstrated the superiority of the proposed method in comparison to other forecasting models.

B. Health

Health is at the center of human life. Good health is essential to human happiness and contributes importantly to prosperity and economic progress.

Guo et al. [9] designed and analyzed a prediction system about influenza-like illness (ILI) from the latent temporal and spatial information. In this system 1) Gaussian function model and multivariate polynomial regression were employed to study the temporal and spatial distribution of ILI data; 2) the phase space reconstructed by delay-coordinate embedding was applied to explore the dynamical evolution behavior of the 1-D ILI series; and 3) a dynamical radial basis function neural network method which is the kernel of the system, was adopted to predict the ILI values based on the correlations between the observations space and reconstructed phase space. The prediction system can be used to a model-free control schemes, i.e., there are no restriction equations between the multivariable inputs and outputs.

Gazda et al. [10] presented a method based on a convolutional neural network (CNN) to diagnose Parkinson's disease (PD) from handwriting images. This eliminates any need for specialized devices or feature engineering. To improve the performance of the proposed pretrained CNN, the authors proposed the idea of multiple fine tuning to bridge the gap between semantically different source and target datasets to facilitate more efficient transfer learning.

Wu et al. [11] proposed a four-dimensional brain mapping method in the form of image frames in a space-time range to represent the continuous process of a person's fatigue state. This work couples 3-D-convolutional neural networks and long-short-term memory networks to develop a cognitive detection model of brain fatigue dynamics to simulate the continuous process of brain fatigue dynamics and accurately identify different cognitive fatigue states. This work produced an effective fusion visualization of the whole brain electrode position information and electroencephalogram signal.

Reddy et al. [12] proposed a novel complex network (CN) based broad learning system (CNBLS) to realize an electroencephalogram (EEG)-based fatigue detection. First, a simulated driving experiment was conducted to obtain EEG recordings under alert and fatigue state. Then, the CN theory was applied to facilitate the broad learning system for producing an EEG-based fatigue detection. The results demonstrate that the proposed CNBLS can accurately differentiate the fatigue state from an alert state with high accuracy. Driver fatigue detection is of great importance to guarantee traffic safety and further reducing economic as well as societal loss of the society.

C. Manufacturing Systems and Smart Industry

As manufacturing systems become more complex, the smooth operation strongly depends on good robustness which is reflected in the collaborative and coherent effects among the components of the system and the ability of the system to maintain the expected external behavior. Process anomalies and unexpected failures in manufacturing systems can lead to poor quality of process and products. The effective method of anomaly detection is a crucial factor to guarantee service quality. Internet of Things (IoT) realizes the interconnection of devices through wireless and mobile communication. IoT can make a real positive difference to the outcome.

Yin et al. [13] proposed an integrated model of the convolutional neural network (CNN) and recurrent autoencoder for anomaly detection. Spatial and temporal features are extracted in CNN and recurrent autoencoder is for the classification in fully connected networks. It shows that the proposed model can achieve better performance on multiple classification metrics and preferable effect on anomaly detection can be produced.

Wang et al. [14] presented a comparative study of two robust control methods, through the combination of neighborhood constraints (NHCs) & modified Banker's Algorithm (BA) and the proposed method is based on critical places, for handling system blocking issues caused by unpredictable failure of resources. The applicability is demonstrated using a basic class of automated manufacturing systems (AMSs), which appear as a set of highly complex and numerically controlled machines with or without human intervention to upgrade products. It was shown that the algorithm based on critical places is more effective and efficient given the same system and is applicable to more complex scenarios. The algorithm resolves not only the problem of blocking due to a failed resource but also the problem of deadlocks.

Ge et al. [15] proposed a search pattern privacy system for approximate shortest distance query of encrypted graphs in Industrial Internet of Things (IIoT). To realize search pattern privacy, two non-colluded cloud servers were adopted to accomplish different tasks. The first server was leveraged to store the encrypted data and perform query operations, while the second one was used to rerandomize the contents and shuffle the locations of the queried records. Before queries, the trapdoors were generated by using different random numbers. After queries, the second server was asked to rerandomize the contents of the records that the first server touched. To enhance the efficiency on the user side, the system was further improved by moving some heavy workloads from the user to the cloud. The security analysis and the performance evaluation show that the work is secure and efficient.

D. Social Networks

A social network is a network of social interactions and relationships that should go well between individuals, groups, and institutions.

Esposito, Moscato, and Sperlí [16] proposed a solution against mendacious reviews that combines fuzzy logic and the theory of evidence by modeling trust management as a multicriteria multi-expert decision making and exploiting the novel concept of time-dependent and content-dependent crown consensus. It was proved empirically that the approach outperforms other approaches, in dealing with sock puppet attacks on reviewing systems.

Mumin et al. [17] proposed an approach for item recommendation with the diffusion method by combining user relationships in social networks with user-item relationships derived from the Internet of People. A resource redistribution process

was explored in the user-object network that gives mass diffusion with a higher recommendation accuracy. A tuning parameter was introduced to adjust the weight of resources that the objects finally receive from users based on their social relationships. Extensive experiments conducted on the real-world datasets which contain friendship relationships, demonstrate the efficiencies of the proposed method in achieving higher performance improvements in terms of the recommendation accuracy, service diversity, and practical dependability.

E. Transportation

The importance of transportation is that it enables trade, services, movement of people and communication that establish civilization. Transportation enables the link between production centers with consumption centers. It plays an important part in economic growth and globalization.

Chen and Wang [18] developed a cooperative fleet cruise control (CFCC) framework for collision avoidance and lane changing based on vehicular sensor networks. CFCC is the first fleet cruise control system to come up with the features such as extending the car following risk of individual vehicles to the fleet following risk of fleet vehicles; minimizing the acceleration and deceleration of fleet vehicles by reducing the speed recovery time; and coordinating individual cars and fleet vehicles in providing enough lane changing space as soon as possible.

III. Summary and Conclusion

Fifteen high-quality papers have been selected in this special issue to show the hot topics in some smart city domains such as energy, health, manufacturing system, industry, social network and transportation. Clearly, SMC covers many technical areas which are essential to the development of cities with the sustainable, marketable, affordable, renewable and technical abilities, that is SMART!

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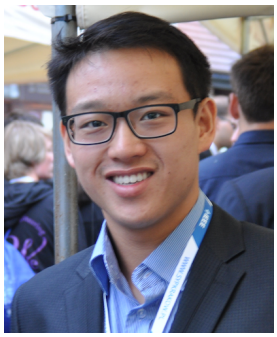

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