Guest Editorial Introduction to the Special Section on Advanced Networking Technologies in the Battle Against the Outbreak of Epidemic Diseases

At present, COVID-19 is a major global public health challenge. Worse, this epidemic could last for 2 years, according to US experts. To address it, scientific research institutions attempt to actively leveraged networking technologies to fight the epidemic disease, which have effectively improved the efficiency of epidemic monitoring, virus tracking, prevention, control and treatment, and resource allocation. For example, to make full use of the resources of medical experts, the remote consultation system, supporting live-streaming video and telemedicine by 5G, cloud computing, blockchain and other networking-related technologies, has been quickly implemented in many hospitals all over the world.

Although networking technologies have played an important role in the epidemic prevention and control, new challenges arise when billions of people around the world have been ordered to stay at home to help curb the epidemic disease. As the virus spread, the networking demand for HD video conferencing and online teaching has skyrocketed. Moreover, many streaming services — like Netflix, Amazon Prime Video and YouTube, have reduced the quality of their streams to reduce strain on the Internet. Therefore, more advanced networking technologies should be deeply investigated and implemented to help us with fighting CVOID-19.

This special section aimed to explore recent advances and disseminate state-of-the-art research on advanced networking technologies for epidemic monitoring, virus tracking, prevention, control and treatment, and resource allocation. Thanks to the extensive efforts of the reviewers and the great support from the Editor-in-Chief, Dr. Jianwei Huang, we were able to accept 8 contributed articles covering several important topics, from the system design, to the blockchain perspective, to the edge networks and other novel networks. A brief review follows:

Li *et al.* in "Adjuvant Therapy System of COVID-19 Patient: Integrating Warning, Therapy, Post-therapy Psychological Intervention" proposed a novel adjuvant therapy system, including warning, treatment and post-treatment psychological intervention. For the first time, they designed a framework to guide the treatment of COVID-19 patients by combining data analytics, communication networks, and artificial intelligence. It is of great significance to further provide more reasonable and intelligent medical service for patients by utilizing communication network.

Motivated by the emerging evolution of 5G networks toward dense heterogeneous network (HetNet), Chkirbene *et al.* presented in "Deep Reinforcement Learning for Network Selection over Heterogeneous Health Systems" a novel Deep Reinforcement Learning (DRL) model for optimizing network selection decisions over 5G HetNet to provide seamless connectivity for smart healthcare systems. Their formulated optimization model integrated diverse networks' characteristics along with adaptive compression capabilities at the network edge to optimize medical data delivery, while meeting diverse healthcare Quality of service (QoS) requirements. The proposed DRL model could outperform the state-of-the-art techniques in solving the formulated optimization problem, especially for highly dynamic environments.

To address the security and privacy issues in the medical cloud platform, L. Tan *et al.* in "Towards Secure and Privacy-Preserving Data Sharing for COVID-19 Medical Records: A Blockchain-Empowered Approach" proposed a blockchain-empowered security and privacy protection scheme with traceable and direct revocation for COVID-19 medical records. The security analysis demonstrated that the proposed scheme is indicated to be safe under the Decision Bilinear Diffie-Hellman (DBDH) assumption and can resist many attacks.

In "Towards Large-Scale and Privacy-Preserving Contact Tracing in COVID-19 pandemic: A Blockchain Perspective," W. Lv *et al.* proposed a decentralized and permissionless blockchain protocol, named Bychain. Specifically, a privacy-preserving SRC protocol for activity-tracking and corresponding generalized block structure was developed, by connecting an interactive zero-knowledge proof protocol and the key escrow mechanism. An artificial potential field-based incentive allocation mechanism was proposed to incentivize IoT witnesses to pursue the maximum monitoring coverage deployment.

Various wearable devices based on smart new fabrics can collect life-relevant data from patients on a continuous basis. However, the computing capacity and battery energy of wearable devices are limited. In "WearNet: Medical-Emergency Response Wearable Networking Powered by UAV-Assisted Computing Offloading and WPT," Y. Jiang *et al.* proposed Medical-Emergency Response Wearable Networking Powered by UAV-assisted (unmanned aerial vehicle) computing offloading and wireless power transfer (WPT), known as MER-WearNet. It established a joint optimization model of charging time allocation, wearable computing offloading sequence and hovering position of UAV.

In "COVID-19 Networking Demand: An Auction-based Mechanism for Automated Selection of Edge Computing Services," A. Yassine and M. S. Hossain *et al.* investigated and proposed a novel auction mechanism by which network service brokers would be able to automate the selection of edge computing offers to support their end-users. It also proposed a multi-attribute decision-making model that allows the

Digital Object Identifier 10.1109/TNSE.2021.3134379

broker to maximize its utility when several bids from edge-network providers were present.

W. Sun *et al.* in "Dynamic Digital Twin and Federated Learning with Incentives for Air-Ground Networks" designed incentives for federated learning based on Stackelberg game, in which the digital twin of the drone acted as the leader to set preferences for clients, and clients as followers choose the global training rounds after weighing benefits and costs. Furthermore, considering the varying digital twin deviations and network dynamics during the federated learning process, it designed a dynamic incentive scheme to adaptively adjust the selection of the optimal clients and their participation level.

In "Epidemic Risk Assessment By A Novel Communication Station Based Method," Z. Gu *et al.* proposed a novel epidemic risk assessment method based on the granular data collected by communication stations. It first computed the epidemic risk of these stations in different intervals by combining the number of infected persons and the way they passed through the station. Then it calculated the personnel risk in different intervals according to the station trajectory of the queried person. This method could assess people's epidemic risk accurately and efficiently.

In summary, the collected articles not only offer innovative application scenarios but also shed light on the underlying principles of advanced networking technologies in the battle against the outbreak of epidemic diseases. We hope that this timely special section will trigger more future work in the emerging area.

YIN ZHANG, *Guest Editor*
School of Information and Communication Engineering
University of Electronic Science and Technology of China
Chengdu 610056, China
(e-mail: yin.zhang.cn@ieee.org)

ALA AL-FUQAHA, *Guest Editor*
Information and Computing Technologies Division
College of Science and Engineering
Hamad Bin Khalifa University
Doha, Qatar
(e-mail: ala@ieee.org)

GIANCARLO FORTINO, *Guest Editor*
Department of Informatics, Modeling, Electronics, and Systems
University of Calabria
87036 Arcavacata, Italy
(e-mail: giancarlo.fortino@unical.it)

LIMEI PENG, *Guest Editor*
School of Computer Science and Engineering
Kyungpook National University
80 Daegu, South Korea
(e-mail: auroraplm@knu.ac.kr)

IZTOK HUMAR, *Guest Editor*
Faculty of Electrical Engineering
University of Ljubljana
1000 Ljubljana, Slovenia
(e-mail: iztok.humar@fe.uni-lj.si)

HUA WANG, *Guest Editor*
Institute of Sustainable Industries & Liveable Cities
Victoria University
Footscray, 8001 VIC, Australia
(e-mail: hua.wang@vu.edu.au)

Yin Zhang (Senior Member, IEEE) is currently a Full Professor with the School of Information and Communication Engineering, University of Electronic Science and Technology of China, Chengdu, China. His research interests include intelligent mobile services and applications, mobile computing, edge computing, and cognitive wireless communications. He is the Co-Chair of the IEEE Computer Society Big Data STC. He is the Editor or an Associate Editor for the IEEE NETWORK, IEEE ACCESS, and *Journal of Information Processing Systems*.

Ala Al-Fuqaha (Senior Member, IEEE) received the Ph.D. degree in computer engineering and networking from the University of Missouri-Kansas City, Kansas City, MO, USA, in 2004. His research interests include the use of machine learning, in general, and deep learning, in particular, in support of the data- and self-driven management of large-scale deployments of the Internet of Things and smart city infrastructure and services, wireless vehicular networks (VANETs), cooperation and spectrum access etiquette in cognitive radio networks, and management and planning of software-defined networks (SDNs).

Giancarlo Fortino (Fellow, IEEE) is currently a Full Professor of computer engineering with the Department of Informatics, Modeling, Electronics, and Systems, UniCal. He is also an Adjunct Professor with the Wuhan University of Technology, Wuhan, China, and a Senior Research Fellow with Italian National Research Council ICAR Institute. He is also the Co-Founder and the CEO of SenSysCal S.r.l., a Unical spinoff focused on the innovative Internet of Things (IoT) systems. His research interests include agent-based computing, wireless (body) sensor networks, and the IoT. He is also a Member of the IEEE SMCS BoG and the Chair of the IEEE SMCS Italian Chapter.

Limei Peng (Senior Member, IEEE) is currently an Associate Professor with the School of Computer Science and Engineering, Kyungpook National University, Daegu, South Korea. Her research interests include optical communication networks and protocols, datacenter networks, optical fiber sensor networks, wireless sensor networks, IoT, and Big Data. She was the TPC Chair of CloudComp'2015 and the Workshop Co-Chair of CIT'2012, and a Leading Guest Editor of several special issues in some leading journals, such as the *Optical Switching and Networking, Vehcom, and MONET*.

Iztok Humar (Senior Member, IEEE) is currently a Full Professor with the Faculty of Electrical Engineering, University of Ljubljana, Slovenia, where he lecturers on design, management, and modeling of telecommunication networks. His main research interests include the design, planning, and management of communications networks and services, and edge cognitive computing and modeling of networks and traffic for energy efficiency, and QoS/QoE. He has been a Senior Member of IEEE Communication Society since 2009 and a Member of Electrical Association of Slovenia. He was as IEEE Communication Society of Slovenia Chapter Chair for ten years.

Hua Wang is currently a Full-Time Professor with the Institute of Sustainable Industries & Liveable Cities, Victoria University, Footscray, VIC, Australia. He has authored or coauthored more than 350 peer-reviewed research papers mainly in data security, data mining, access control, privacy, and web services, and also their applications in the fields of e-health and e-environment.