Guest Editorial
Special Issue on Intelligent Reflecting Surface for Green Communication, Computing, and Sensing

DRIVEN by the emergence of promising Internet-of-Everything (IoE) applications ranging from extended reality and automated systems to the tactile Internet, 6G is expected to provide diverse services including, e.g., communication, computing, and sensing, as well as achieve more ambitious network performance than 5G. To meet the future demands of 6G, an innovative concept referred to as the *smart radio environment* has been recently proposed, which suggests that random and time-varying wireless channels can be dynamically controlled/reconfigured to enhance wireless communication performance, by leveraging digitally-controlled low-cost *intelligent reflecting surface* (IRS) or its various equivalents such as *reconfigurable intelligent surface* (RIS) and others. Besides communication, IRS can also be exploited to improve the computing and sensing performance of future 6G wireless networks. The aim of this special issue is to motivate innovative research on IRS for achieving green communication, computing, and sensing in future 6G wireless networks. The issue attracted 18 high-quality submissions from all over the world, among which 6 original contributions were eventually selected for publication. The special issue covers diverse applications of IRS and various design issues in IRS-aided wireless systems. The novelty and key contributions of these articles are summarized as follows.

In [A1], Zhuang *et al.* study the use of IRS to improve the communication performance of an ambient backscatter communication-enabled non-orthogonal multiple access (NOMA) system. An optimization problem is formulated and solved to maximize the energy efficiency by jointly optimizing the IRS phase shifts and power allocation of the NOMA users.

In [A2], Li *et al.* consider an Internet-of-Things (IoT) network with one access point and multiple IoT devices. The IRS is employed to enhance the performance of both downlink wireless power transfer and uplink NOMA based data transmission. A novel resource allocation scheme is proposed to maximize the sum throughput by jointly optimizing the time allocation factor and IRS phase shift matrices, which is shown to achieve larger sum throughput than the system without IRS.

In [A3], Kawai and Sugiura consider an IRS-aided secure multi-user downlink communication system, where a base station (BS) sends information and artificial noise in the presence of multiple eavesdroppers. To reduce the BS transmit power subject to a constraint on the target secrecy rate, the authors propose an efficient alternating algorithm to jointly optimize the IRS phase shifts, BS beamforming, and jamming matrix.

In [A4], Wang *et al.* study a rate maximization problem in an IRS-aided decode-and-forward (DF) relay system. Three low-complexity yet efficient algorithms are proposed to jointly design the receive beamforming of the relay and passive beamforming of the IRS, which are shown to achieve better rate performance than the existing network with a single-antenna relay. It also reveals that there exist optimal relay and IRS positions that have a substantial impact on the rate performance.

In [A5], Zhou *et al.* propose an efficient scheme to estimate the downlink channel for IRS-assisted massive multi-input multi-output (MIMO) systems. Specifically, the authors present a new sparse recovery problem for channel estimation by exploiting the sparsity of massive MIMO channels and adopting the IRS surface partition scheme, which thus significantly reduces the computational complexity and training overhead. To deal with the coupling in the row-sparse matrix, the authors propose a hybrid approximate message passing (AMP) framework, whose superiority is verified by simulations as well.

In [A6], Bie *et al.* focus on optimizing the RIS deployment in a RIS-assisted relay system. To draw useful insights for practical design, the authors first consider the special case with homogeneous transmit power and noise, and derive a closed-form expression for the optimal RIS deployment. Then, for general system setups, the authors further propose a method to find the optimal RIS deployment and provide theoretical insights. It is discovered that the optimal strategy is to deploy the RIS near the relay, rather than near the source or destination as in traditional RIS-aided systems without relays.

The Guest Editors would like to express their gratitude to all authors for their submissions and all reviewers for their efforts and insightful reviews that have contributed to the high quality of this special issue. The Guest Editors are also very grateful for the strong support provided by Prof. Zhisheng Niu, the Editor-in-Chief of the IEEE TRANSACTIONS ON GREEN COMMUNICATIONS AND NETWORKING (TGCN), as well as the IEEE TGCN staffs.

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APPENDIX: RELATED ARTICLES

[A1] Y. Zhuang, X. Li, H. Ji, and H. Zhang, "Exploiting intelligent reflecting surface for energy efficiency in ambient backscatter communication-enabled NOMA networks," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 163–174, Mar. 2022, doi: 10.1109/TGCN.2022.3144465.

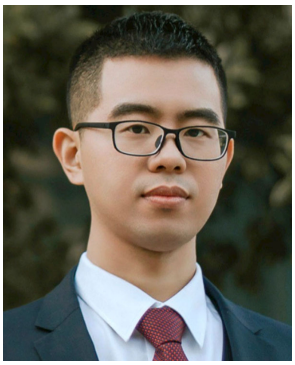
[A2] X. Li, Z. Xie, Z. Chu, V. G. Menon, S. Mumtaz, and J. Zhang, "Exploiting benefits of IRS in wireless powered NOMA networks," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 175–186, Mar. 2022, doi: 10.1109/TGCN.2022.3144744.

[A3] Y. Kawai and S. Sugiura, "QoS-constrained energy-efficient beamforming and jamming with intelligent reflecting surface for secure multi-user downlink," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 187–197, Mar. 2022, doi: 10.1109/TGCN.2022.3144293.

[A4] X. Wang *et al.*, "Beamforming design for IRS-aided decode-and-forward relay wireless network," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 198–207, Mar. 2022, doi: 10.1109/TGCN.2022.3145031.

[A5] L. Zhou, J. Dai, W. Xu, and C. Chang, "Sparse channel estimation for intelligent reflecting surface assisted massive MIMO systems," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 208–220, Mar. 2022, doi: 10.1109/TGCN.2022.3146188.

[A6] Q. Bie, Y. Liu, Y. Wang, X. Zhao, and X. Y. Zhang, "Deployment optimization of reconfigurable intelligent surface for relay systems," *IEEE Trans. Green Commun. Netw.*, vol. 6, no. 1, pp. 221–233, Mar. 2022, doi: 10.1109/TGCN.2022.3145026.



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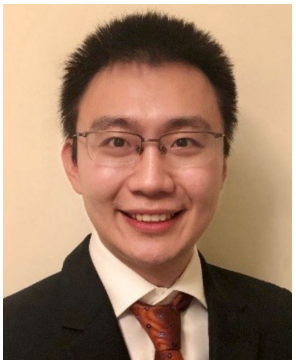

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