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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: GREEN SIGNAL PROCESSING FOR WIRELESS COMMUNICATIONSAND NETWORKING

Wireless devices, including smartphones/PDAs and the network equipment that connects them, consume a significant amount of power. The global greenhouse gas emissions produced by the operation of information and communication technology (ICT) infrastructure is comparable to that produced by the aviation industry. This situation is getting worse since billions of wireless devices, such as the Internet of Things devices, are expected to be newly added to the Internet in the coming decade. Consequently, there are multiple research and development projects that aim at addressing this issue, including some IEEE standards intended to reduce the environmental impact of the ICT industry. These standards include energy-efficient communications and networking. Although these emerging techniques have attracted considerable attention and have been studied recently, there are still many open research challenges to be addressed.

The goal of this Special Section is to bring together researchers from academia, industry, and governmental agencies to cover the most recent research and development about signal processing techniques, to improve the sustainability of wireless communications and networking. The articles in this feature topic focus on cutting-edge research in various aspects of the green-oriented and environmentally aware signal processing for 4G/5G systems, cognitive radio networks, and other types of advanced wireless communication networks.

Our Call for Papers received an enthusiastic response with 48 high-quality submissions. Per IEEE ACCESS policy, it was ensured that handling editors did not have any potential conflict of interest with the authors of submitted articles. All articles were reviewed by at least two independent referees. The articles were evaluated for their rigor and quality, and also for their relevance to the theme of our Special Section. After a rigorous review process, we accepted seven articles to form the Special Section.

1) The article ''Identifying influential nodes based on community structure to speed up the dissemination of information in complex network,'' authored by Tulu *et al.*, proposed new methods to identify important nodes in a complex network for energy-efficient communication. Recently, in a complex network, finding a powerful leader of the community to spread information quickly throughout the network was the concern of many researchers.

In this article, a Community-based Mediator (CbM) is proposed as a metric to identify influential nodes in a large and complex network. The CbM considers the entropy of a random walk from a node to each community.

The performance of CbM was evaluated by susceptible-infected-recovered (SIR) model. Simulation results showed that the proposed method performs better than the existing methods to spread information quickly and can also introduce new influential nodes that other methods failed to identify.

2) In the article ''Energy efficient space-time line coded regenerative two-way relay under per-antenna power constraints,'' Joung proposed a new space-time line code (STLC)-based two-way relay (TWR) method to improve the energy-efficiency (EE). In multiple-input multiple-output (MIMO) systems, per-antenna power constraint (PAPC) has been considered to enhance the power efficiency of the multiple power amplifiers. However, under PAPC, the conventional space-division multiple access (SDMA)-based TWR method suffers a significant bit-error-rate performance degradation, leading to EE degradation as well. The author demonstrated that the proposed STLC-based TWR system achieves higher EE than the conventional SDMA-based TWR when the maximum transmit power is low. Furthermore, the author also presented that, compared with the SDMA-based TWR, the proposed approach can reduce computational complexity and readily extend to a TWR system with a large number of antennas, e.g., a massive MIMO system.

3) In the article ''Integrating distributed grids with green cellular Backhaul: From competition to cooperation,'' Li *et al.*, addressed a comprehensive study on a green cellular backhaul system which is powered by distributed microgrids and faces the price-sensitive end-users. Most notably, the price competition between multiple renewable power suppliers (RPSs) and wireless operator is formulated in a two-stage Stackelberg game from which interesting characteristics regarding the price competition are found. Moreover, the cooperative scenario of RPSs is also considered using coalitions game. The authors provided valuable intuition regarding the operation of a green cellular backhaul based on the distributed energy sources in a decentralized market setting.

4) In the article ''Secure analog network coding with wireless energy harvesting under multiple eavesdroppers,'' Lee *et al.*, proposed a two-way relay system in which two users exchange data via a relay based on analog network coding (ANC) when multiple eavesdroppers exist. The relay can replenish energy from the two users' signals and utilize it to forward the ANC signal to users. Each user eliminates their own signal from the received signal through self-interference cancellation and decodes the desired signal. On the other hand, the eavesdroppers overhear the relaying signal and attempt to recover the data between two users. For this ANC-based network with multiple eavesdroppers, the authors proposed two secure ANC protocols: Power splitting-ANC (PS-ANC) and time switching-ANC (TS-ANC), in which the relay respectively determines the power splitting ratio and time switching ratio, in order to balance between the energy harvesting and the data reception. The optimal ratios are obtained analytically to maximize the minimum achievable secrecy rate. The authors demonstrated that both the PS-ANC and TS-ANC protocols can achieve near-optimal achievable secrecy rate irrespective of the locations and number of eavesdroppers. The comparison of these two protocols in various network environments showed that PS-ANC has a better performance than TS-ANC when the network conditions are unfavorable for wiretapping by the eavesdroppers.

5) The article ''Cognitive heterogeneous networks with multiple primary users and unreliable backhaul connections,'' by Yin *et al.*, presented a practical model including a heterogeneous underlay cognitive network with small cells also acting as multiple secondary users, multiple primary users, and unreliable wireless backhaul. A Bernoulli process was adopted to model the backhaul reliability. A selection combining protocol was used at the secondary receiver side to maximize the received signal-to-noise ratio as well. The authors investigated the impact of the number of secondary transmitters, the number of primary users, as well as the backhaul reliability on the system performance in Rayleigh fading channels under two key constraints: 1) maximum transmit power at the secondary transmitters and 2) peak interference power at the primary users caused by secondary transmitters. Moreover, closed-form expressions for outage probability, ergodic capacity, and symbol error rate, and the asymptotic expressions for outage probability and symbol error rate were derived.

6) The article ''Strategy-based gain ratio power allocation in non-orthogonal multiple access for indoor visible light communication networks,'' authored by Tao *et al.*, investigated the power allocation of visible light communication (VLC). VLC is an evolving green communication technology for indoor wireless communication networks. VLC utilizes light-emitting diodes (LEDs) for both illumination and communication. To achieve economic and energy-efficient communications, non-orthogonal multiple access (NOMA) improves the system throughput by enhancing spectral efficiency. In indoor VLC networks, the gain ratio power allocation (GRPA) of NOMA allocates greater signal power to the users of poor channels to achieve both fairness and high data rate. However, current GRPA strategies developed for radio frequency channels are not necessarily effective in all VLC channel and illumination cases. The authors proposed a GRPA strategy based on VLC channels and compared the lower-bound throughput with other competing methods. Finally, the experimental results demonstrated the compactness of the proposed alternate lower bound and the advantages of the proposed strategy.

7) The article ''Energy efficiency beamforming design for UAV communications with broadband hybrid polarization antenna arrays,'' by Zhou, studied the problem of energy-efficient wireless communications for Unmanned Aerial Vehicles (UAVs). In this work, the energy-efficient communication of UAVs is improved while considering the physical resources constraints on UAVs by introducing the use of a new hybrid polarized antenna array combined with filter-and-forward relaying. For this system, the author presented an algorithm that optimizes the beamforming parameters to maximize the energy-efficient information transmit rate.

To conclude, we would like to sincerely thank all the reviewers who kindly volunteered their precious time and expertise for helping us handle the review process successfully. Moreover, we appreciate all the authors who submitted high-quality and timely articles to our Special Section as well. We would also like to thank the former IEEE Access Editor-in-Chief, Professor Michael Pecht, present IEEE Access Editor-in-Chief, Professor Derek Abbott, and other staff members of IEEE Access for their continuous support and guidance.

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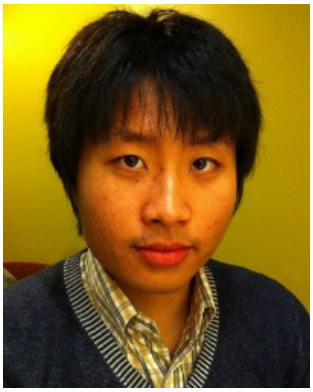

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