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Perspectives in Signal Processing for Communications and Networking

Spotlight on the IEEE Signal Processing Society Technical Committees

The Signal Processing for Communications and Networking Technical Committee (SPCOM-TC) is one of the 12 technical committees (TCs) in the IEEE Signal Processing Society (SPS). Our mandate covers all technical areas in communication engineering and network science, including

- information transmission and reception
- channel modeling and estimation
- source and channel coding
- multicarrier and multiple-access communications
- array signal processing
- synchronization
- localization

as well as security; privacy; signal processing aspects of sensor and ad-hoc networks; cognitive radio systems; and distributed sensing, detection, estimation, and inference problems over the networks. The application areas range from terrestrial wireless systems to wireline, underwater, satellite, backscattering, and visible light communications, as well as on futuristic areas such as molecular, chemical, biological, and quantum communications. Our technical interests are tightly intertwined with that of the IEEE Communications Society and the IEEE Information Theory Society. We are committed to exploring the connections and cross-fertilization between these rapidly growing fields.

The SPCOM-TC organizes the IEEE International Workshop on Signal Processing Advances in Wireless Communications (SPAWC) each year in a unique all-poster format together with plenary and invited talks. The workshop has attracted increasing interest from the research community in recent years. The record of 268 attendees set at the last year's workshop in Sapporo, Japan, was almost matched by this year's SPAWC in Kalamata, Greece. In 2019, SPAWC will be held in Nice, France, and in 2020 in Atlanta, Georgia, United States.

Many of the classical topics of the TC, such as optimization-based solutions for the physical layer of wireless networks, are still gathering interest and producing novel theoretical results. However, it is their applications to newer settings such as millimeter-wave (mmWave) communication in the high-frequency band; massive multiple-input, multiple-output (MIMO) systems; and cooperative cloud radio-access networks that are now inspiring the most significant innovations. Much of these recent research activities have been driven by the emerging fifth generation (5G) wireless cellular standardization process with enhanced mobile broadband at target peak rates beyond tens of gigabits per second as its first stated goal. Efforts in utilizing the significantly larger bandwidth in the mmWave frequency band, in taking advantage of the potentially hundreds of spatial dimensions brought by the massive MIMO systems while accounting for their hardware limitations, and in cooperative signal processing to mitigate and cancel the dominant intercell interference, are the keys for the successful realization of 5G.

The 5G evolution is much more than just enhancing the data rate. The future Internet of Things calls for new use cases involving machine-type communications, particularly for meeting the challenges of connecting the large number of sensors and actuators, and for providing ultra-reliability and low-latency communications. These new requirements are driven by myriad vertical markets for the wireless technology, from industrial automation to remote health care, robotics, and autonomous driving, extending further to, e.g., communications and control of unmanned aerial vehicles and high-speed Internet service provision via high altitude platforms. These exciting new applications will provide fertile ground for the development of new signal processing techniques.

Some of these new signal processing techniques will undoubtedly involve data-driven machine learning (ML), which is very much becoming a reality within the scope of the TC. The SPCOM area has traditionally been blessed with well-established generative models for point-to-point communication and with the existence of fundamental information theoretical limits for these models. Further, the TC has always placed high value on mathematically provable optimality of the methods that we develop. In spite of this, the adoption of data-driven methods is now moving beyond the initial

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Digital Object Identifier 10.1109/MSP.2018.2841413
Date of publication: 28 August 2018

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skepticism and is very much on the way, and fast.

The current rush for low-hanging fruits that are ripe for ML will eventually slow. When it does, a general consensus of where—and for what purpose—the data-driven ML techniques are appropriate will emerge. Already, and even more so at that stage, it is and will be important to innovate in the space between the established communication system models with provably optimal solutions and purely data-driven methods. One advantage of the SPCOM area is that well-developed models exist based on the physics of electromagnetic propagation. Our research community has historically invested significant efforts to refine stochastic channel models and develop software packages for simulating the full communication chain, including the more complex ray-tracing simulators of the wireless environment. Yet, we are all keenly aware that all models have their limitations; thus an interesting future direction will be to make use of these models in conjunction with the data-driven approaches, not only for the testing and evaluation of proposed solutions but also for data generation.

The SPCOM-TC very much welcomes SPS members from diverse backgrounds to participate in our technical activities. In particular, research within many signal processing research communities has been accelerated by the creation of open and easily accessible software tools. The SPCOM community could be similarly helped by common and open simulators of complex communication systems, with a number of predefined scenarios that make it easy to get research started and allow for ready comparisons of competing solutions. While this need has existed previously, it will be exacerbated by the proliferation of data-driven approaches. It will also be necessary to raise the scientific quality of such works, in particular when it comes to reproducibility.

We invite SPS members to get involved by signing up as affiliated members of SPCOM-TC from the SPS website (https://signalprocessingsociety.org/get-involved/signal-processing-communications-and-networking). The TC membership election takes place in October every year. We sincerely hope to continue this discussion on the future technical directions of our TC with many of you in an intellectually stimulating environment at our annual workshop SPAWC or at the next IEEE International Conference on Acoustics, Speech, and Signal Processing.

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Highlights from the Sensor Array and Multichannel Technical Committee

Spotlight on the IEEE Signal Processing Society Technical Committees

The IEEE Signal Processing Society Sensor Array and Multichannel Technical Committee (SAM TC) promotes activities within the technical areas of sensor array processing and multichannel statistical signal processing, including

- beamforming
- direction-of-arrival estimation
- source localization
- multiple-input multiple-output (MIMO) systems
- compressed sensing
- sparse modeling
- tensor-based signal processing
- deep neural networks
- machine learning for sensor arrays
- signal processing for sensor networks
- network beamforming
- blind source separation
- channel identification
- array processing for radar, sonar, communications, microphone arrays, and biomedical applications.

Digital Object Identifier 10.1109/MSP.2018.2835718
Date of publication: 28 August 2018