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Embracing a New Golden Age of Signal Processing

Signal processing has created a significant effect on our information society. Signal processing can be found everywhere: in cell phones, TVs, automobiles, GPSs, modems, scanners, and all kinds of communication systems and electronic devices. Modern cell phones are indeed a most typical example—within these small wonders, voice, audio, image, video, and graphics are processed and enhanced based on decades of media signal processing research that have appeared in our *IEEE Signal Processing Magazine (SPM)*.

Technological advancement in recent years has heralded a new golden age for signal processing. Many exciting directions, such as bioinformatics, human language, networking, and security, are emerging from the traditional field of signal processing on raw information content. The challenge in the new era is to transcend from the conventional role of processing the low-level, waveform-like signal to the new role of understanding and mining the high-level, human-centric semantic signal and information. Such a fundamental shift has already taken place in limited areas of signal processing and is expected to become more pervasive in coming years of research in more areas of signal processing.

SPM educates our readers in new trends of signal processing, in addition to the traditional areas such as coding, analysis, enhancement, synthesis, and recognition of common media and communication signals. The new technological development requires nontraditional signal processing tasks including understanding, mining, and retrieving of high-level information sources and contents often embedded in low-level signals. To create greater societal impact encompassing new technological trends, we need stronger interactions than ever before between academic and industrial research communities, and between signal processing and other related disciplines. *SPM* especially promotes these interactions.

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Digital Object Identifier 10.1109/MSP.2008.930482

discussed are from classical signal processing theory and also employ number and frame theoretic ideas, which naturally arise in this framework.

Sixty years ago, efforts by Golay to improve the sensitivity of far infrared spectrometry led to the discovery of pairs of complementary sequences. Shortly thereafter, Welti proposed to use Golay sequences in radar, but they have found very limited application to date. In "Waveform Diversity in Radar Signal Processing," Calderbank, Howard, and Moran demonstrate that suitably transmitted and processed radar waveforms based on Golay sequences provide new primitives for adaptive waveform transmission. The adaptive transmission enables improved detection and finer resolution, while managing computational complexity at the receiver.

Polarization diversity provides meaningful information to discriminate targets from clutter. Hurtado, Xiao, and Nehorai review the concept of polarimetric diversity and discuss methods for the optimal adaptive design of radar polarization in their article, "Target Estimation, Detection, and Tracking." A closed-loop system is considered that sequentially estimates the target and clutter scattering parameters and then uses the estimates to optimally select the polarization of subsequent waveforms. This adaptive system is shown to significantly improve radar capabilities when compared with fixed-polarization schemes, as it can achieve optimal performance in several operating modes, including detection, estimation, and tracking.

The choice of agile waveform in sensing can be affected by many factors, including whether the sensing environment is narrowband or wideband, is immersed in heavy clutter or strong noise. In their article, "Waveform-Agile Sensing for Tracking," Sira, Li, Papandreou-Suppappola, Morrell, Cochran, and Rangaswamy discuss how tracking can exploit the optimization of waveform-dependent cost or objective functions, such as tracking errors and information retrieval, to update the transmitted waveform for the next time step. Waveforms with nonlinear time-frequency signatures have been found to be more conducive to adverse environmental conditions and these waveforms are shown to better match the bio-sonar mechanism of mammals.

The first five articles provide overviews on waveform agility in sensing. Vespe, Jones, and Baker, in their article "Lessons for Radar," provide an overview on the echolocating world of mammals and how it relates to waveform agility. They show that bats employ various strategies for survival or communication that could provide critical insight into autonomous navigation, collision avoidance, and automatic target classification. After a discussion on how bats vary their emitted waveforms, the bat echolocation behavior is related to exploiting waveform diversity in radar. The authors also investigate how bats perform autonomous orientation and relate it to potentially more reliable and robust autonomous systems.

We hope you find the reading as exciting for you as the research is for us! To view a more extensive reference list, visit the WASPer (waveform-agile sensing and processing e-resources) Web site at http://www.fulton.asu.edu/~apapand/WASPer. We conclude by thanking the reviewers, authors, and Prof. Williams (special issue area editor) for their guidance. In the future, we look to see the research presented here realize the promise of bat-like agility in man-made systems for active sensing. SP

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Under the leadership of former Editor-in-Chief, Prof. Shih-Fu Chang, and through the diligent work of his editorial team as well as the foundational work of our society's Vice-President for Publications, Prof. Ray Liu, *SPM* is in excellent condition as testified by its top ranking among over 200 electrical engineering publications worldwide. During the transition period, I received Prof. Chang's and Prof. Liu's invaluable guidance and support, for which I am wholeheartedly grateful. I am also fortunate to have Profs. Antonio Ortega, Dan Schonfeld, Ghassan AlRegib, and Min Wu, who agreed to shoulder the responsibility of area editors for feature articles, special issues, columns/forums, and e-newsletter, respectively. They will work closely with me and the editorial board to fulfill the expectations of you, our readers.

Different from other publications that focus on new research results, the magazine includes tutorial articles with comprehensive surveys of important theories, algorithms, tools, and applications related to signal processing. *SPM* is received bimonthly by every member of the IEEE Signal Processing Society. Each issue includes articles from three main categories—special issue articles, feature articles, and columns/forums articles. The recently introduced *Inside Signal Processing E-Newsletter* is a monthly electronic publication of *SPM* serving all Society members.

It is not easy to meet the grand challenges in the new golden age of signal processing. We seek your active involvement and participation in shaping *SPM* to one reflecting our whole community's interests, both long term and short term. Contact me for any ideas you may have for improving any section in *SPM*. I welcome you to be an *SPM* author, columnist, guest editor, and/or a reviewer, and to share the optimistic spirit of the community in anticipating the new, exciting era of signal and information processing. SP