Introduction to the Special Issue on Signal Processing Systems

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We are pleased to present this special issue of the *Journal of Signal Processing Systems* on Signal Processing Systems. The eight papers in this special issue represent new research directions in the design and implementation of signal processing systems. The topics range from circuits for communication systems to circuits for new applications in machine learning to stochastic computing to healthcare.

The article, titled “Energy Efficient Multi-User Millimeter Wave MIMO Systems Using Tree Search Hybrid Precoding and Few-Bit ADCs,” (<https://doi.org/10.1007/s11265-017-1301-3>) concerns the emerging area of millimeter wave wireless communication systems. The authors propose a low complexity hybrid analog and digital precoding method. This is combined with low resolution analog to digital converters. The analysis in the paper shows the potential to reduce system complexity and improve energy efficiency while maintaining system performance.

In the article, “Canonic Composite Length Real-Valued FFT,” (<https://doi.org/10.1007/s11265-017-1296-9>) a novel algorithm to compute the real-valued fast Fourier transform (RFFT) that is canonic with respect to the number of signal values is presented. The authors discuss several major advantages of the canonic RFFTs including: more regular sub-blocks in the data flow, a reduction in the number of butterfly operations, and architectures that only involve a real valued data path. The authors also discuss the tradeoff that exists in that canonic RFFTs may not be as desirable when

taking the cost of twiddle factor operations as the major consideration.

The article, “Non-Uniform Microphone Arrays for Robust Speech Source Localization for Smartphone-assisted Hearing Aid Devices,” (<https://doi.org/10.1007/s11265-017-1297-8>) concerns an important aspect of hearing aid research. In the paper, the authors analyze a non-uniform nonlinear microphone array (NUNLA) geometry for improving robust speech source localization. They propose the use of an L-shaped three-element microphone array which is available on many modern smartphones. The estimation algorithm presented is intended for use under very low signal to noise ratios and consists of a modified Dictionary-based singular value decomposition method for localizing single speech sources.

In the article, “A Rank Decomposed Statistical Error Compensation Technique for Robust Convolutional Neural Networks in the Near Threshold Voltage Regime,” (<https://doi.org/10.1007/s11265-018-1332-4>) a novel scheme is presented to improve energy efficiency. The authors propose a variation-tolerant architecture that can operate in the near threshold voltage regime. A rank decomposed statistical error compensation method (RD-SEC) is also developed. In order to derive low-cost estimators for error detection and compensation, the paper exploits the inherent redundancy within matrix vector multiplication which is a power-consuming operation in CNNs.

The article, “Adaptive Preconditioned Iterative Linear Detection and Architecture for Massive MU-MIMO Uplink,”

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(<https://doi.org/10.1007/s11265-017-1317-8>) concerns the emerging area of massive MIMO detection for 5G and beyond wireless communication systems. In this paper, the authors first explore the convergence properties of iterative linear solvers, then, they propose an adaptive preconditioning technique for faster convergence. To show the validity and generality of the proposed technique, the authors apply this technique to steepest descent (SD) detection. Also, they further develop a reduced complexity log-likelihood ratio (LLRs) computing method using approximate calculation.

In the article, “TouchSpeaker, a Multi-Sensor Context-Aware Application for Mobile Devices: from Application to Implementation,” (<https://doi.org/10.1007/s11265-017-1302-2>) a novel built-in audio speaker-based finger tap detection method is proposed for applications in mobile devices. The authors show that the joint use of built-in speakers and other built-in sensors can efficiently classify 9 different tap events with very high accuracy up to 98.3%, which outperforms other state-of-the-art methods. The authors also develop a robust version with low false positive rates ($<1\%$). In order to accommodate a very strict limited power budget, the authors further develop a low-power version which only consists of speakers and an accelerometer with an accuracy of 95.2%.

The article, “Molecular Synthesis for Probability Theory and Stochastic Process,” (<https://doi.org/10.1007/s11265-017-1318-7>) concerns the interesting interplay between molecular computing and stochastic processes. Motivated by the advantages of chemical reaction networks (CRN) on inherent parallelism and randomness, the authors investigate efficient CRN-based synthesis for common probability theory and stochastic processes to imitate and explore large-scale complex systems. In addition, the authors further analyze two types of interaction between stochastic processes and CRNs: stochastic model-based CRNs and CRN-based solvers for stochastic problems.

In the article, “Low-complexity, Multi Sub-band Digital Predistortion: Novel Algorithms and SDR Verification,” (<https://doi.org/10.1007/s11265-017-1303-1>) a novel iterative multi sub-band version of sub-band digital predistortion (DPD) is proposed. The authors propose to perform DPD learning iteratively over intermodulation distortion (IMD) sub-bands until achieving satisfactory performance. The authors also propose a low hardware complexity sequential DPD learning procedure for the case of higher order nonlinearities. The authors further implement their proposed DPD using the WARPLab software defined radio testbed and show excellent suppression of the targeted spurious emissions.

We would like to thank all of the authors for their contributions to this special issue and we would like to thank the anonymous reviewers for their efforts in providing comments and suggestions to improve the papers and ensuring the paper quality. We hope that you enjoy reading this special issue.

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