Guest Editorial: Special Issue on Selected Papers From IEEE ISCAS 2019

THIS Special Issue of the *IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS* highlights a selection of biomedical related research papers from the 2019 *IEEE International Symposium on Circuits and Systems* (ISCAS 2019), in Sapporo, Hokkaido, Japan from May 26 to 29, 2019. As the flagship international conference/symposium of *IEEE Circuits and Systems Society*, ISCAS 2019 had a special focus on circuits and systems for sustainable society in harmony with nature, and sought to address multidisciplinary challenges in circuits and systems, including biomedical applications. The Technical Program Committee of ISCAS 2019 received 1,161 submissions, from which 620 papers were accepted after review with an acceptance rate of 53.4%.

The papers in this special issue were selected out from a comprehensive list of papers those presented in the sessions of ISCAS 2019 with strong relation to biomedical applications. Based on technical review scores from independent experts worldwide, 14 highly ranked papers which covered circuits and systems for biomedical applications in ISCAS 2019 were invited to submit their extended versions for consideration in the Special Issue. After a thorough peer review process with iteration of manuscript revisions, a final set of 8 papers was accepted to form this Special Issue.

The first paper titled "Correlation of Capacitance and Microscopy Measurements Using Image Processing for a Lab-on-CMOS Microsystem" presented a capacitance sensor chip developed in a 0.35 μm CMOS process for monitoring biological cell viability and proliferation. Image processing was performed to detect cells and estimate the coverage of the sensor electrodes. Verified with two cancer cells *in vitro* experiments, the sensor can detect single cell binding events and changes in cell morphology.

The second paper titled "A Data-Compressive Wired-OR Readout for Massively Parallel Neural Recording" presented a data-compressive readout strategy for the large-scale digitization of neural action potentials. The strategy exploits the sparsity and diversity of neural signals, through a wired-OR competition between single-slope ADCs. The proposed design substantially reduces bandwidth requirements relative to traditional designs, and maintains sufficient performance. Based on the spatio-temporal sparsity of the neural signal, the proposed architecture is scalable to a large number of channels ($>$1,000), which enabling the next generation of neural interfaces.

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The third paper titled "A 9.2-gram Fully-Flexible Wireless Ambulatory EEG Monitoring and Diagnostics Headband with Analog Motion Artifact Detection and Compensation" presented an 8-channel wearable wireless device for ambulatory surface EEG monitoring and analysis. The whole multi-channel recording, quantization, and motion artifact removal circuitries were integrated on a polyimide flexible substrate with the recording electrodes together. A fully-analog method for motion artifact detection and removal was described, as well as the corresponding analog circuit had been implemented. The entire wearable device with the battery only weighted 9.2 grams.

The fourth paper titled "A Microwatt Dual-Mode Electrochemical Sensing Current Readout with Current-Reducer Ramp Waveform Generation" presented an integrated circuit platform for electrochemical cell readout. A current-mirror potentiostat architecture with chopper stabilization provides low-noise current readout from the electrochemical cell, and an on-chip ramp generator supports both cyclic voltammetry and fixed-potential voltammetry to provide a single-chip sensor interface system. The design is fabricated in 0.18 μm CMOS, and results include CV measurements using a commercial three-electrode electrochemical cell. The approach demonstrates a single-chip, low-noise electrochemical readout approach for use in biosensor and point-of-care diagnostic applications.

The fifth paper titled "A Low-Power, Single-Chip Electronic Skin Interface for Prosthetic Applications" presented a low-power, single-chip electronic skin interface. The single-chip electronic skin system consumes 7.0 μW per channel and 76.5 μW in the reference application, making it suitable for use with battery-powered prosthetics. The chip functionality has been experimentally demonstrated by interfacing the chip to a prototype electronic skin based on polyvinylidene fluoride (PVDF) piezoelectric sensors.

The sixth paper titled "A Resource-Optimized VLSI Implementation of a Patient-Specific Seizure Detection Algorithm on a Custom-Made 2.2 cm^2 Wireless Device for Ambulatory Epilepsy Diagnostics" presented a wireless wearable ambulatory device for patient-specific epilepsy diagnostic. The device incorporates the embedded, low power, real time FPGA implementation of a novel algorithm, which uses only EEG signals from the frontal lobe electrodes. The measurement results from the FPGA implementation on data from 23 patients accounts for the algorithm yielding a seizure detection sensitivity and specificity competitive to the standard full EEG systems.

The seventh paper titled "Ultrafast Large-Scale Chemical Sensing with CMOS ISFETs: A Level-Crossing Time-Domain Approach" presented an ISFET based pH-to-time readout using an inverter in the time-domain as a level-crossing detector and a 32 × 32 array with in-pixel digitization for pH sensing. The system has been implemented in a standard 0.18 μm CMOS technology, with a pixel size of 26 μm × 26 μm and a time-to digital converter area of 26 μm × 180 μm. Presented experimental results showed a resolution of 0.013 pH, an integrated noise of 0.08 pH within 2-500 Hz, an SFDR of 42.6 dB and a total power consumption of 11.286mW when operating at a high frame rate of 1 KFPS.

The eighth paper titled "Design of a Self-Controlled Dual-Oscillator-Based Supply Voltage Monitor for Biofuel-Cell-Combined Biosensing Systems in 65-nm CMOS and 55-nm DDC CMOS" presented a low power voltage supply monitor architecture for use in biofuel cell (BFC) sensors and BFC-powered electronic systems. The approach uses two integrated oscillators with different voltage sensitivities, where the difference between oscillation frequencies estimates the common supply rail voltage. The design is self-starting and provides a digital output. It is implemented in both 65 nm and 55 nm CMOS processes, where measured results demonstrate utility for future BFC-based sensor systems and future applications in low-voltage supply monitoring.

The Guest Editors would like to thank all the authors, the 2019 ISCAS Technical Program Committee members, and the reviewers. We would also like to express our sincere thanks to Prof. Mohamad Sawan (Editor-in-Chief), Prof. Guoxing Wang (Deputy Editor-in-Chief), and the Technical Committee (TC) of Biomedical and Life Science Circuits and Systems, for giving us the opportunity to organize this Special Issue. We also wish to thank the IEEE support staffs for their efforts in finalizing this special issue.

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