Guest Editorial Special Issue on Selected Papers From IEEE ISCAS 2020

THIS Special Issue of the *IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS* highlights a selection of biomedical related research papers from the *2020 IEEE International Symposium on Circuits and Systems* (ISCAS 2020) in Seville, Spain. The ISCAS 2020 due to COVID-19 was organised for the first time virtually from October 10 to 21, 2021. As the flagship international conference/symposium of IEEE Circuits and Systems Society, ISCAS 2020 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 papers in this special issue were selected out from a comprehensive list of papers those presented in the sessions of ISCAS 2020 with strong relation to biomedical applications. Based on technical review scores from independent experts worldwide, 24 highly ranked papers which covered circuits and systems for biomedical applications in ISCAS 2020 were invited to submit their extended versions for consideration in the Special Issue. This Special Issue received 12 contributions and after a thorough peer review process with iteration of manuscript revisions, a final set of 9 papers was accepted to form this Special Issue.

The first paper titled "Light Absorption Measurement with a CMOS Biochip for Quantitative Immunoassay Based Point-of-Care Applications" presented a CMOS biochip-based photometer for quantitative immunoassay diagnostics. Hofmann *et al.* demonstrated the quantification of prostate specific antigen (PSA) with an optoelectronic CMOS biochip using this approach. A PSA immunoassay is performed on the top surface of the CMOS sensor array, enzyme kinetics and PSA concentration are measured within 6 minutes with a limit of detection (LoD) of 0.5 ng/ml, which meets clinical testing requirements. They achieve an overall coefficient of variation (CV) of 7%, which is good compared to other point-of-care (PoC) systems.

The second paper titled "Detection of Multiple Breast Cancer ESR1 mutations on an ISFET based Lab-on-Chip Platform" he efficacy of an ISFET based CMOS integrated Lab-on-Chip (LoC) system, coupled with variant- specific isothermal amplification chemistries, for detection and discrimination of wild type (WT) from mutant (MT) copies of the ESR1 gene. Design and optimization of bespoke primers was carried out and tested on a qPCR instrument and then benchmarked versus the LoC platform. The LoC platform proposed by Alexandrou *et al.*, has the potential to be used at a breast cancer point-of-care testing setting, offering mutational tracking of circulating tumour DNA in liquid biopsies to assist patient stratification and metastatic monitoring.

The third paper titled "A Combined pH-Impedance System Suitable for Portable and Lab-on-Chip Continuous Sensing" presented a combined pH and impedance sensing system suitable for portable measurements. Aslanzadeh *et al.* reported this portable system which is implemented with two chips and an external multi-electrode array into a portable system. Resistance, capacitance, and pH are experimentally measured using buffer solutions to simulate a water quality monitoring application.

The fourth paper titled "A Chopped Neural Front-end featuring Input Impedance Boosting with suppressed offset-induced charge transfer" presented the background and circuit design in detail and presents measurement results of a prototype implemented in a 180nm HV CMOS process. Reich *et al.* reported neural recorder front-end achieves a performance with an area consumption of 0.036mm, an input referred noise of 1.32Vrms (1 Hz to 200 Hz) and 3.36 Vrms (0.2 kHz to 10 kHz), power consumption of 13. W from 1.8 V supply, as well as CMRR and PSRR 83 dB at 50 Hz.

The fifth paper titled "Hardware Acceleration of EEG-based Emotion Classification Systems: A Comprehensive Survey, presented the first hardware-focused critical review of EEG-based wearable classifiers of emotions and survey their implementation perspectives, their algorithmic foundations, and their feature extraction methodologies. Gonzalez *et al.* further provided a neuroscience-based analysis of current hardware accelerators of emotion classifiers and use it to map out several research opportunities, including multi-modal hardware platforms, accelerators with tightly-coupled cores operating robustly in the near/supra-threshold region, and pre-processing libraries for universal EEG-based datasets.

The sixth paper titled "High-Pass SigmaDelta Modulator with Techniques of Operational Amplifier Sharing and Programmable Feedforward Coefficients for ECG Signal Acquisition" presented a high-pass sigmadelta modulator (HPSDM) for electrocardiography (ECG) signal acquisition system. Lee *et al.* fabricated their proposed HPSDM in a 0.18-m standard CMOS process. Measurement results reveal that the proposed HPSDM has a signal-to-noise and distortion ratio (SNDR) of 54.5 dB and a power consumption of 2.25 W under a 1.2 V supply voltage and achieves a figure of merit (FoM) of 12.96 pJ/conv.

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The seventh paper titled "A Super-Sensitivity Photoacoustic Receiver System-on-Chip based on Coherent Detection and Tracking" presented a novel photoacoustic receiver system-on-chip (SoC) with coherent detection (CD) based on the early-and-late acquisition and tracking is developed and first fabricated. Yang *et al.* reported the measurement results that the receiver achieves 0.18Vrms sensitivity at the depth of 1cm with 1mJ/cm^2 laser output fluence. The contrast-to-noise (CNR) of the imaging is improved by about 22.2 dB. The area of the receiver is 5.71 mm^2, and the power consumption of each channel is about 28.8 mW with 1.8V and 1V power supply on the TSMC 65nm CMOS process.

The eighth paper titled "An Imaged-Based Method for Universal Performance Evaluation of Electrical Impedance Tomography Systems" presented a simple and reproducible methodology for universal evaluation of the performance of electrical impedance tomography (EIT) systems using reconstructed images. Wu *et al.* reported a passive 16 electrode EIT system using an application specific integrated circuit front-end. The measured results show both visually and in terms of the proposed FR metrics, the impact on recorded EIT images with different design parameters and non-idealities.

The ninth paper titled "A Noninvasive Miniaturized Transcutaneous Oxygen Monitor" presented a prototype noninvasive, miniaturized transcutaneous oxygen monitor using the luminescent sensing technique. Costanzo *et al.* implemented this design on a printed circuit board with off-the-shelf components. They conducted experiments to understand the temperature and humidity dependence of oxygen-sensitive platinum-porphyrin films. The system resolves changes in oxygen pressure from 0 to 418 mmHg in the lab bench-top testing. Under fixed conditions, the sensor shows a 2% drift over 60 hours. The prototype consumes 9 mW of power from a 2.2 V external DC power supply.

The Guest Editors would like to express their gratitude to all the authors for preparing such high-quality papers and to all the reviewers for their precious time. They also wish to thank the ISCAS 2020 Organising Committee and Technical Program Committee members. We would also like to express our sincere thanks to Prof. Guoxing Wang (Editor-in-Chief), Prof. Timothy Constandinou (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 staff for their efforts in finalizing this special issue.

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