Guest Editorial
ISCAS 2017 Special Issue

THIS Special Issue of the IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS highlights a selection of biomedical related research papers from the 2017 IEEE International Symposium on Circuits and Systems (ISCAS 2017), in Baltimore, MD, USA, from May 28–31, 2017. ISCAS 2017 featured interdisciplinarity and innovation inspired by the theme "From Dreams to Innovation," which is aligned with the focus of this Special Issue.

These papers were selected based on technical review scores provided by independent reviewers worldwide for the conference program. The authors of the 18 most highly ranked papers were invited to submit extended versions for consideration in the Special Issue. A second round of peer review resulted in the following 11 papers presented in this Special Issue, covering a spectrum of research themes including the areas of Lab-on-a-Chip, Wireless/Implantable Circuits, Integrated Biomedical Systems, and Brain Machine Interfaces.

In "Towards an Integrated QR Code Biosensor: Light-Driven Sample Acquisition and Bacterial Cellulose Paper Substrate," Yuan *et al.* describe a paper-based QR code biosensor for food supply chain monitoring. The researchers optimized the substrate material and developed a new technique based on a light trigger that causes a temperature gradient due to the absorption of infrared light to drive the reaction. The proposed system demonstrated higher flow rate with a graphite heating layer and analyte detection down to 4 nM.

In "Toward Wireless Health Monitoring via an Analog Signal Compression-Based Biosensing Platform," Zhao *et al.* introduce a new low-power wireless biosensing platform, combining microfluidic impedance sensing of molecular markers, sensing of physiological signals and compression concurrently, through the use of AJSCC encoded circuits. This is setting the scene for the future of wireless, continuous health monitoring systems, whereby hybrid monitoring platforms will be collecting data from a network of body sensors, evaluating physical and biochemical data.

In "Continuous-Time Acquisition of Biosignals Using a Charge-Based ADC Topology," Maslik *et al.* report an activity-based, non-uniform sampling ADC for biosignal acquisition. Compression ratios of $5\times$ and $26\times$ were demonstrated for ECG and action potential measurements, respectively. The prototype ADC was designed in 0.35 μm CMOS and has 8-bit resolution with a 4 kHz bandwidth while consuming only 3.75 μW and 1.39 pJ per activity event. This work demonstrates that using non-uniform sampling can lead to significant power savings when digitizing sparse biological signals.

In "High-Pass $\Sigma\Delta$ Converter Design Using a State-Space Approach and Its Application to Cardiac Signal Acquisition," Rout *et al.* report a design technique to realize high linearity data converters with high accuracy of the high-pass filter corner. The authors propose a design strategy and compare different topologies to implement the modulator. Finally, they apply their technique for an ECG application with a sub-Hz high-pass corner to remove baseline wander artefacts.

In "A Wireless Fiber Photometry System Based on a High-Precision CMOS Biosensor with Embedded Continuous-Time $\Sigma\Delta$ Modulation," Khiarak *et al.* present an optoelectronic neural interface, comprised of a CMOS-based biophotometry sensor incorporated within a head mountable fiber photometry device, and includes a wireless transceiver and a diffuse excitation light source. The proposed system integrates a low-noise sensing front-end and a 2nd order $\Sigma\Delta$ modulator in CMOS, demonstrating the capability to suppress excitation light leakage to the CMOS detector, improving the system's SNR, while reducing the power consumption to 41 μW.

In "Real-Time Measurements of Cell Proliferation Using a Lab-on-CMOS Capacitance Sensor Array," Senevirathna *et al.* present a CMOS capacitance sensor array incorporated into a lab-on-CMOS system for monitoring cell viability and cell growth rate quantification. The system presented allows for live cell monitoring through the integration of multiple chips recording in parallel, offering significant advantages for high-throughput assays, while demonstrating the potential of use of such a set-up for applications in emerging areas such as drug efficacy monitoring and medical diagnostics.

In "The Microbead: A Highly Miniaturized Wirelessly Powered Implantable Neural Stimulating System," Khalifa *et al.* present a fully integrated and *in vivo* validated prototype 'microbead' system for spatially selective neural stimulation. The authors propose a 200 μm $\times$ 200 μm all-in-ASIC system, as the smallest remotely powered neural stimulator reported, adopting the pulsed power transmission scheme to reduce the time duration of transmission, and a phased array to allow localisation of the energy beam. The proposed packaging and insertion mechanism allows for the 'microbead' to be seen as a big step closer to the development of a fully encapsulated stand-alone implant.

In "A Synchronous Neural Recording Platform for Multiple High-Resolution CMOS Probes and Passive Electrode Arrays," Angotzi *et al.* demonstrate an electrode-based neural recording system capable for simultaneous and synchronous recording of neural activity for improving the spatiotemporal resolution

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of electrophysiological signals generated from multiple probes. The authors present a neural recording platform combining a 36-channel CMOS headstage and up to four implantable CMOS neural probes for low- and high-density recordings respectively, allowing for a wide range of electrode arrays to be interfaced.

In "A 16-Channel CMOS Chopper-Stabilized Analog Front-End ECoG Acquisition Circuit for a Closed-Loop Epileptic Seizure Control System," Wu *et al.* present a CMOS-based 16-channel low-noise amplifier for acquisition of ECoG signals as part of a closed-loop epileptic seizure control system. The authors propose the use of an improved offset reduction loop to compensate the effect of chopper modulation, significantly reducing the input-referred noise. The closed-loop system, validated *in vivo*, demonstrate ECoG signal acquisition using a programmable mid-band gain, with a total power consumption of 3.26 μW per channel and an NEF of 3.36 for a 117 Hz signal bandwidth.

In "A CMOS-Based Bidirectional Brain Machine Interface System with Integrated fdNIRS and tDCS for Closed-Loop Brain Stimulation," Miao *et al.* present a system that focuses on the combination of analog/optical design for the integration of fdNIRS and tDCS in CMOS, to enable non-invasive closed-loop brain stimulation for treatment of neural disorders. The authors propose a system that offers significant improvements towards further miniaturization of bidirectional brain machine interfaces, taking into consideration the need to adjust tDCS dosage based on the brain's hemodynamics and intra-subject variability, while offering a solution to overcome the incompatibility between EEG and fdNIRS in the spatial and time domains.

In "A Multimodal Adaptive Wireless Control Interface for People With Upper-Body Disabilities," Fall *et al.* describe a body-machine interface for individuals with upper-limb disabilities. The system utilizes an inertial headset and supports up to six wearable sensors that measure motion and muscular activity. The algorithms run on a Raspberry Pi and controlled a 6-degree of freedom robotic arm used to test the system. The reported performance was almost as fast as able-bodied individuals using a joystick controller.

The Guest Editors would like to thank all the authors, the 2017 ISCAS Technical Program Committee members, and the reviewers. We would also like to express our thanks to the IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS Editorial Board and particularly to Professor Mohamad Sawan, Editor-in-Chief, as well as the IEEE Biomedical Circuits and Systems Technical Committee (BioCAS-TC), for giving us the opportunity to organize this Special Issue.

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Dr. Hall has been an Associate Editor for the IEEE TRANSACTIONS ON BIOMEDICAL INTEGRATED CIRCUITS since 2015 and has been a member of the CICC Technical Program Committee since 2017. He received the First Place in the Inaugural International IEEE Change the World Competition and First Place in the BME-IDEA invention competition, both in 2009. He was the recipient of the Analog Devices Outstanding Designer Award in 2011, an Undergraduate Teaching Award in 2014, the Hellman Fellowship Award in 2014, and an NSF CAREER Award in 2015. He is also a Tau Beta Pi Fellow.

Melpomeni Kalofonou (S'09–M'13) received the M.Eng. (Hons.) degree in electrical and computer engineering from the University of Patras, Patra, Greece, in 2007, the M.Sc. degree in biomedical engineering from the Department of Bioengineering, in 2009, and the Ph.D. in biomedical engineering from the Department of Electrical and Electronic Engineering, Imperial College London, London, U.K., in 2013.

She continued as a Postdoctoral Researcher with the Centre where she became the Lead for Cancer Engineering and Technologies in 2016, starting a new research theme on the development of Point-of-Care devices for the personalization of cancer therapy. She is a Research Fellow and Cancer Technology Lead with the Centre for Bio-Inspired Technology, Department of Electrical and Electronic Engineering, Imperial College London, London, U.K. She has conducted pioneering work in the application of microchip technology for detection of cancer biomarkers, through design and fabrication of microchip devices, leading to the development of new Lab-on-Chip systems. One of her key research areas is "liquid-biopsy" diagnostics using pH-sensitive microchip technology, enabling detection of breast cancer mutations in circulation, providing a sample-to-result system for cancer patient stratification, and monitoring tumor progression.

Dr. Kalofonou is a member of the IET and ESMO and part of the IEEE Biomedical Circuits and Systems Technical Committee. She is an Advocate for Women in Engineering, promoting the application of biomedical engineering in cancer diagnostics and precision oncology, in addition to being an Ambassador of the EEE profession in schools, outreach events, and industry.