Guest Editorial—ISCAS 2014 Special Issue

THIS special issue of the IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS highlights a selection of biomedical related research papers from the 2014 IEEE International Symposium on Circuits and Systems (ISCAS 2014), in Melbourne, Australia, from June 1–5, 2014. These papers were selected based on technical review scores from independent experts worldwide who reviewed these papers for the conference program. The authors of the 17 most highly ranked papers were invited to submit extended versions for consideration in the special issue. A second round of peer review in the TRANSACTIONS resulted in the following 10 papers in this special issue. The papers cover four broad topical categories, which are briefly outlined below.

A. *Microfluidic Design*

In "Reconfigurable Prototyping Microfluidic Platform for DEP Manipulation and Capacitive Sensing," Miled *et al.* present a new rapid prototyping platform dedicated to dielectrophoretic microfluidic manipulation and capacitive cell sensing. The authors also present a new assembly technique for reusable microfluidic chips based on anisotropic adhesive conductive film, epoxy and PDMS. The main advantage of the proposed platform is to provide a versatile tool for research purpose to study and analyze lab-on-chip behavior.

B. *Neuromorphic Circuits and Systems*

In "Spin-Transfer Torque Magnetic Memory as a Stochastic Memristive Synapse for Neuromorphic Systems," Vincent *et al.* introduce fundamental concepts relating to spin-transfer torque magnetic tunnel junction (STT-MTJ, the STT-MRAM cell) behavior and its possible use to implement learning-capable synapses. Three programming regimes (low, intermediate and high current) are identified and compared. System-level simulations on the task of vehicle counting highlight the potential of the technology for learning systems. These results open a new way to explore applications of STT-MTJs in robust, low power, cognitive-type systems.

In "Astrocyte on Neuronal Phase Synchrony in CMOS," Irizarry-Valle *et al.* present a CMOS neuromorphic circuit to emulate the role of astrocytes in phase synchronization of neuronal activity. They also show possible implications of phase synchronization on the firing of neurons and show that the way the astrocytes interact with each other could potentially elicit synchronization at different locations in a group of unrelated neurons. Using neuromorphic circuits, the authors show the role of astrocytes in the integration of neuronal activity leading to a conscious episode.

In "Turn Down that Noise: Synaptic Encoding of Afferent SNR in a Single Spiking Neuron," Afshar *et al.* introduce the Synapto-dendritic Kernel Adapting Neuron as a simplified neuromorphic model of Spike Time Dependent Plasticity. The resulting neuron model is the first to perform synaptic encoding of afferent signal-to-noise ratio in addition to the unsupervised learning of spatio-temporal spike patterns. The results show that simultaneously learning common patterns in input data is possible while dynamically weighing individual afferents based on their signal to noise ratio.

In "Memristive Hebbian Plasticity: Device Requirements for the Emulation of Hebbian Plasticity Based on Memristive Devices," Ziegler *et al.* discuss the requirements of individual memristive devices for the emulation of Hebbian plasticity in neuromorphic applications. The paper also presents a plasticity model suitable for memristive devices based on advanced novel learning rules, which provide Hebbian plasticity in accordance to the Bienenstock-Cooper-Munro (BCM) rule.

C. *Visual Circuits*

In "1 kHz 2D Visual Motion Sensor Using 20×20 Silicon Retina Optical Sensor and DSP Microcontroller," Liu *et al.* present a flexible and compact hardware motion system consisting of a custom retina vision sensor and a microcontroller. The system can compute global translational motion vectors at a sample rate of 1 kHz, for speeds up to ± 1000 pixels/s, using less than 5 k instruction cycles (12 instructions per pixel) per frame. At 1 kHz sample rate the DSP is 12% occupied with motion computation. The sensor is implemented as a 6 g PCB consuming 170 mW of power.

D. *Health Monitoring Circuits*

In "Self-powered Monitoring of Repeated Head Impacts Using Time-Dilation Energy Measurement Circuit," Feng *et al.* present a helmet-sensor technology based on self-powered piezo floating-gate injectors for sports-related concussion detection. The array of sensors embedded in the helmet allows for sensing of both direct and rotational impact using 0.5 micron technology. The field experiments presented in the paper indicate that concussions during the course of normal play can be reliably detected using this low cost technology.

In "A Visual-Aided Wireless Monitoring System Design for Total Hip Replacement Surgery," Chen *et al.* present a sensory technology for determining the position of hip implants during total hip replacement surgery. The proposed system measures and displays the contact distribution and estimates the relative pose between femoral head and acetabulum prosthesis during the surgery to help surgeons obtain accurate position of implants. The signal conditioning circuits of the system are implemented in 180 nm technology and operate under a 1.2–3.6 V supply voltage with 116–160 μA current consumption. The measured relative error of the hip rotation and translation is less than 10%.

In "A Low Voltage Chopper-Stabilized Amplifier for Fetal ECG Monitoring with a 1.41 Power Efficiency Factor," Song

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et al. present a low-voltage current-reuse chopper-stabilized frontend amplifier achieving 0.34 μVrms noise level at 1 μW power consumption. Power management circuitry is also integrated to achieve improved system efficiency.

In "The PennBMBI: Design of a General Purpose Wireless Brain-Machine-Brain Interface System," Liu *et al.* the authors present a general-purpose wireless Brain-Machine-Brain Interface (BMBI) system. The system integrates four battery-powered wireless devices for the implementation of a closed-loop sensorimotor neural interface, including a neural signal analyzer, a neural stimulator, a body-area sensor node and a graphic user interface implemented on a PC.

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JIE CHEN, *Guest Editor*
University of Alberta, AB, Canada

VIKTOR GRUEV, *Guest Editor*
Washington University in Saint Louis
St. Louis, USA

GUOXING WANG, *Guest Editor*
Shanghai Jiao Tong University,
Shanghai, China

Jie Chen received the Ph.D. degree in electrical and computer engineering (ECE) from the University of Maryland, College Park, MD, USA, in 1998.

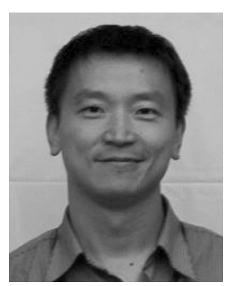
He is a Professor in the Faculty of Engineering at the University of Alberta, Edmonton, AB, Canada, as well as a Research Officer of the Canadian National Research Council at the National Institute for Nanotechnology. He has more than 2,650 citations and an H-index of 25. He has served as either PI or co-PI of $10.5 million worth of grants over the past 10 years. His research on designing a miniaturized ultrasound device for intra-oral dental tissue formation was listed by *Reader's Digest* as a major medical breakthrough in Canada in 2006. In partnership with the University of Toronto, the device is in the Phase II clinical trial. He also helped establish a Bell-Lab spin-off company (focused on developing 4th generation wireless networks), which was acquired by QUALCOMM in San Diego, CA, USA, in 2005. He has many awarded patents, several of which have been either used in production or licensed by various companies. His current interdisciplinary research interests are impedance-based portable devices for metabolic sensing, low-intensity pulsed ultrasound device for cell therapy and increasing renewable biofuel production, and functional nanomaterials for gene/drug delivery and targeted cancer imaging/treatment.

Dr. Chen is a Fellow of the Engineering Institute of Canada. He has been the recipient of numerous awards such as the Canada Foundation for Innovation Leaders' Opportunity Award, Local Innovation and Global Impact Award by TEC Edmonton, and Member of the Year Award by the Association of Chinese Canadian Professors. He was also an IEEE Distinguished Lecturer of the Circuits and Systems Society. His supervised students have received awards, including the 2013 Best Poster Award at the International Union of Crystallography's Conference of Biology and Synchrotron Radiation, Hamburg, the 2007 Best Student Paper Award at the IEEE/National Institutes for Health's (NIH) Life Science Systems and Applications Workshop, and the 2008 Taiwan Chip Implementation Center's Annual Best Chip Award.

Viktor Gruev received the M.S. and Ph.D. degrees in electrical and computer engineering from Johns Hopkins University, Baltimore, MD, USA, in 2000 and 2005, respectively.

He is an Associate Professor in the Department of Computer Science and Engineering at Washington University in St. Louis (WUSTL), St. Louis, MO, USA, and has secondary appointments in the Department of Electrical and Systems Engineering and Department of Biomedical Engineering. He is also a core faculty member of the Institute for Materials Science at WUSTL. After completing his doctoral studies, he was a Postdoctoral Researcher at the University of Pennsylvania, Philadelphia, PA, USA. His expertise is in polarization imaging technology, bio-inspired optical systems, and multimodal imaging devices. He has authored more than 200 journals and conference papers and has been awarded five patents related to imaging technologies. Several imaging technologies developed in his lab have successfully undergone clinical translation and are licensed to several medical companies.

Dr. Gruev is an Associate Editor for the IEEE SENSORS JOURNAL and has been a Guest Editor for several journals including IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS and IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—I: REGULAR PAPERS.



Guoxing Wang (M'06–SM'13) received the Ph.D. degree in electrical engineering from the University of California at Santa Cruz, Santa Cruz, CA, USA, in 2006.

From 2006–2007, he was a Technical Staff Member at Agere Systems, San Jose, CA, USA. From 2007–2009, he was with Second Sight Medical Products, Sylmar, CA, USA, where he designed the integrated circuits chip that went into the eyes of patients to restore vision. Currently, he is an Associate Professor in the School of Microelectronics, Shanghai Jiao Tong University, Shanghai, China. He has authored more than 40 peer-reviewed journal and conference papers. His current research interests include wireless technologies and biomedical electronics.

Dr. Wang is a member of the IEEE Biomedical Circuits Systems (BioCAS) Technical Committee. He serves as an Associate Editor for IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—II: EXPRESS BRIEFS, Guest Editor for the IEEE JOURNAL ON EMERGING AND SELECTED TOPICS IN CIRCUITS AND SYSTEMS, and Guest Editor for IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS. He was the local chair for the first IEEE Green Circuits and Systems (ICGCS) and for the second Asia Pacific Conference on Postgraduate Research in Microelectronics and Electronics (PrimeAsia).