Guest Editorial—Selected Papers From the 2022 IEEE International Symposium on Circuits and Systems

THE IEEE International Symposium on Circuits and Systems (ISCAS) is the flagship conference of the IEEE Circuits and Systems (CAS) Society and the world's premiere forum for researchers in the fields of theory, design and implementation of circuits and systems. The IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS (TBioCAS) highlights selected papers from ISCAS on topics related to biological and healthcare applications. This special section features four selected papers from ISCAS 2022, held in Austin, Texas, USA from May 28 to June 1, 2022.

The ISCAS 2022 technical committee invited original work in all areas of circuits and systems, including topics such as circuits and systems for analog, mixed-signal, digital, power/energy, sensory, communication, and biomedical applications, as well as digital signal processing and intelligent sensors and systems. The TBioCAS received a total of nine papers from ISCAS 2022, out of which four papers were accepted, resulting in an acceptance rate of 44%. The selection of these papers was based on a thorough peer review process (we acknowledge the TBioCAS Editor-in-Chief, Prof. Kea-Tiong Tang for his support). The selected papers cover several topics and can be combined broadly in the category of intelligent sensors and systems.

The article by Wangdong Xie et al. from the Institute of Microelectronic Circuits and Systems, East China Normal University, Shanghai (China) describes a concentric circle (CC) model for indoor WiFi sensing. By setting the transmitter and receiver together, the perception model becomes concentric circles with equal spacing, which eliminates the blind zone and unequal radial sensitivity problems of the Fresnel zone (FZ) model. A human respiratory monitoring system is developed based on this model, where the components related to human activities are extracted by a pre-processing with Principal component analysis (PCA) applied to the channel state information ratio (CSIR), human presence detection and respiratory signal detection are adopted to improve monitoring accuracy and the Doppler frequency of respiratory is extracted to calculate the respiratory rate. Experimental results show that the CC model achieves high accuracy in velocity measurement with an error of less than 0.4 cm/s and the respiration monitoring system can accurately monitor human respiration with an error of less than 0.7 bpm within 6 m.

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The article by Zhe Chen et al. from the University of California, Los Angeles (USA) reports the first real-time calcium image processing and position decoding based on an FPGA design for closed-loop feedback applications. It aims at offering a miniaturized calcium imaging solution for monitoring neural activity at large scale at a specific brain region of a rodent. Most calcium-image analysis pipelines operate offline with long processing latency, which is not optimal for closed-loop feedback stimulation. The proposed design in this article can perform real-time calcium image motion correction, enhancement, and fast trace extraction based on predefined cell contours and tiles. A variety of machine learning methods have been evaluated to decode positions from the extracted traces. The proposed system has achieved position decoding with less than 1 ms latency, when implemented in an FPGA at 300 MHz, for a variety of mainstream 1-photon mini-scope sensors. When the position decoding accuracy has been benchmarked on open-sourced datasets collected from six different rats, the decoding accuracy has consistently been improved without any overhead on hardware implementation and runtime across the subjects by taking advantage of the ordinal encoding in the decoding task.

The article by Di Wu et al. from the Westlake University, Hangzhou (China) reports software-hardware co-design for energy-efficient continuous health monitoring via task-aware compression. The design and development of accurate and reliable wearable systems for continuous monitoring of real-time human body health conditions are crucial for preventive and diagnostic ubiquitous healthcare. It is critical that such systems consume low power while collecting, analysing, and transmitting data, to mitigate frequent battery replacement or recharging. Existing compression approaches such as compressive sensing are task-agnostic causing a discard of task-relevant information. This article proposes a new monitoring framework where the acquired signal is compressed in a task-aware manner to preserve task-relevant information at the sensor end with a low computation cost, which also reduces the transmission bandwidth. This framework has been validated by showcasing a seizure prediction system, in which the prediction accuracy, sensitivity, false prediction rate, and signal reconstruction quality have been reported under different compression ratios. Experimental results have shown a seizure prediction accuracy of 89.7% (signal compression ratio of 1/16). A dedicated hardware architecture with sparse Booth encoding multiplication and 1-D convolution pipeline has also been implemented for this framework on an

FPGA, consuming 207 mW of power at a clock frequency of 100 MHz.

The article by Satyapreet Singh Yadav et al. from the Indian Institute of Science, Bangalore (India) and the Texas Instruments, Bangalore (India) reports a contactless framework (tinyRadar) for edge computing as a personalized healthcare technology. Although modern fitness trackers are lightweight, wearable, and real time in monitoring users' health for long periods of time, they require prolonged skin contact causing discomfort and privacy issues. To mitigate these issues, this article proposes tinyRadar, which is a new on-edge millimeter wave (mmWave) radar-based fitness tracker. The Texas Instruments IWR1843 mmWave radar board has been used to recognize the exercise type and measure its repetition counts, using on-board signal processing and convolutional neural network (CNN). The dataset used in this paper has comprised of eight exercises generalized over ten subjects. In measurements, the system has provided real-time repetition counts with 96% average accuracy and has an overall subject-independent classification accuracy of 97%.

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Hong Chen received the Ph.D. degree from the Department of Electronic Engineering, Tsinghua University, Beijing, China, in 2005. From 2005 to 2007, she was with the Institute of Microelectronics, Tsinghua University, Beijing, China, as a Postdoctoral Fellow. From Febuary to June 2006, she was with the Medical Center, Nebraska University, Lincoln, NE, USA. In 2007, she joined the Faculty of the School of Integrated Circuits, Tsinghua University. From March 2016 to April 2017, she was a Visiting Scholar in Gatech Tech. Her research interests include bio-inspired on-chip learning asynchronous neuromorphic circuits, and biomedical prosthetic circuits and systems. This has resulted in more than 110 refereed publications, and 30 issued or pending patents. Dr. Chen's work on monitoring systems during TKR/THR surgery has been undergoing commercialization by Yiemed Inc since 2014, and was approved a certification by the China Food & Drug Administration in 2022. Dr. Chen was the recipient of Best Demo of IEEE International Symposium on Circuits and Systems, and Best Paper Nominee of IEEE International Symposium on Asynchronous Circuits and Systems. She is the General Chair of the 2023 IEEE ASYNC Conference, and is currently an Associate Editor-in-Chief for the IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS and the Guest Editor of *Tsinghua Science and Technology*, and is also the Technical Program Committee Member of the IEEE ASYNC and IEEE ISCAS.

Marco Carminati received B.S., M.S., and Ph.D. degrees (*summa cum laude*) from the Politecnico di Milano, Milan, Italy, in 2003, 2005 and 2010 respectively. In 2008, he was a Visiting Student with MIT, USA. In 2016, he was an Assistant Professor with DEIB, Politecnico di Milano, where he has been an Associate Professor since 2021. He is also affiliated with the National Italian Institute of Nuclear Physics, where he is national coordinator of the TRISTAN experiment. He has coauthored more than 250 peer reviewed papers (3200 citations, h-index of 28). His research interests include low-noise analog electronics and instrumentation for miniaturized solid-state sensors and radiation detectors with application to healthcare and the environment. He was the recipient of the Best Paper Award at IEEE conferences ICECS 2012, SSD 2014 and ISCAS 2019. He was tutorial speaker at BioCAS 2019, MeMeA 2021 and ISCAS 2023. He is an Associate Editor for IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS (TBioCAS) and IEEE TRANSACTIONS ON AGRIFOOD ELECTRONICS and the Secretary of the Italy Chapter of the IEEE Nuclear and Plasma Science Society and Member of the TPC of several IEEE conferences (ICECS, BioCAS).