

# Introduction to the Special Issue on Wearable and Flexible Integrated Sensors for Screening, Diagnostics, and Treatment

**T**HIS special issue of the IEEE TRANSACTIONS ON BIOMEDICAL CIRCUITS AND SYSTEMS presents a selection of high quality research papers on wearable and flexible integrated sensors for screening, diagnostics, and treatment. Emerging flexible and wearable physical sensing devices create huge potential for many vital healthcare and biomedical applications including artificial electronic skins, physiological monitoring and assessment systems, therapeutic and drug delivery platforms, etc. Monitoring of vital physiological parameters in hospital and/or home environments has been of tremendous interests to healthcare practitioners for a long time. Robust and reliable sensors with excellent flexibility and stretchability are essential in the development of pervasive health monitoring systems with the capability of continuously tracking physiological signals of human body without conspicuous discomfort and invasiveness. Furthermore, long-term continuous monitoring of health could quantify the impact of treatment at home care. These have resulted in the TBioCAS Special Issue on Wearable and Flexible Integrated Sensors for Screening, Diagnostics, and Treatment 2019 (“**WISEDT19**”). The main objectives of this special issue are to (i) provide a roadmap for integrated circuits and systems for wearable or flexible sensor devices; (ii) enhance cross-disciplinary collaboration in this emerging research field; and (iii) report the state-of-art development of the circuits and devices with translational potential into clinics. A total of 94 manuscripts were received for this special issues, and after multiple rounds of peer review 29 papers are selected, which cover a range of biomedical and healthcare sensors related to the 5 topics that follow:

## 1) **Low-power, Low-noise Circuits and Integrated Microsystems for Wearable Biomedical Sensors:**

- a) Low-Power High-Input-Impedance EEG Signal Acquisition SoC with Fully Integrated IA and Signal-Specific ADC for Wearable Applications.
- b) A 769  $\mu$ W Battery-powered Single-chip SoC with BLE for Multi-modal Vital Sign Health Patches.
- c) A Digital-Enhanced Chip-Scale Photoacoustic Sensor System for Blood Core Temperature Monitoring and In Vivo Imaging.
- d) An Ultrasonically Powered Optogenetic Microstimulator With Power-Efficient Active Rectifier and Charge Reuse Capability.

- e) Real-time Ultra-low Power ECG Anomaly Detection Using an Event-driven Neuromorphic Processor.
- ## 2) **Artificial Intelligence Circuits for Sensor Reasoning, Classification and Decision:**
- a) Low-Power Hardware Implementation of a Support Vector Machine Training and Classification for Neural Seizure Detection.
  - b) ECG Classification Algorithm Based on STDP and R-STDP Neural Networks for Real-time Monitoring on Ultra Low-Power Personal Wearable Devices.
- ## 3) **Flexible Sensor Interface Circuits and Systems:**
- a) Integrated Flexible Hybrid Silicone-Textile Dual-Resonant Sensors and Switching Circuit for Wearable Neurodegeneration Monitoring Systems.
  - b) Fabrication of High-Resolution Flexible Circuits and Sensors based on Liquid Metal Inks by Spraying and Wiping Processing.
  - c) A Multi-Functional Physiological Hybrid-Sensing E-Skin Integrated Interface for Wearable IoT Applications.
  - d) Wearable SiPM-based NIRS Interface Integrated with Pulsed Laser Source.
  - e) Vascular Pressure-Flow Measurement Using CB-PDMS Flexible Strain Sensor.
  - f) Flexible, Skin Coupled Microphone Array for Point of Care Vascular Access Monitoring.
  - g) NFC-powered Flexible Chest Patch for Fast Assessment of Cardiac, Hemodynamic and Endocrine Parameters.
- ## 4) **Portable Biomedical Sensing, Monitoring and Imaging Circuits and Systems:**
- a) A Miniaturized Low-Intensity Ultrasound Device for Wearable Medical Therapeutic Applications.
  - b) CMOS Image Sensor Design and Image Processing Algorithm Implementation for Total Hip Arthroplasty Surgery.
  - c) A Noninvasive, Electromagnetic, Epidermal Sensing Device for Hemodynamics Monitoring.
  - d) Towards Wearable Healthcare: A Miniaturized 3D Imager with Coherent Frequency-domain Photoacoustics.
  - e) Electrocardiogram and Phonocardiogram Monitoring System for Cardiac Auscultation.

- f) Fully Integrated, Automated and Smartphone enabled Point-of-Source Microfluidic Portable Platform for Nitrite Detection.
  - g) Wearable Millimeter-Wave Device for Contactless Measurement of Arterial Pulses.
  - h) Recognizing Hand Gestures with Pressure Sensor based Motion Sensing.
  - i) A Smartphone-only Pulse Transit Time Monitor Based on Cardio-mechanical and Photoplethysmography Modalities.
  - j) Design of a Wearable Smart sEMG Recorder Integrated Gradient Boosting Decision Tree based Hand Gesture Recognition.
  - k) Dual-Band Dual-Polarized Wearable Button Array with Miniaturized Radiator.
  - l) Low-Power Photoplethysmography Sensor using Current Integration Circuit for Heartbeat Interval Acquisition.
  - m) A Personalized Beat-to-Beat Heart Rate Detection System from Ballistocardiogram for Smart Home Applications.
- 5) **Hybrid Biofeedback and Closed-Loop Systems Optimizing Edge Applications:**
- a) Myoelectric Control of a Soft Hand Exoskeleton Using Kinematic Synergies.
  - b) Resource-Aware Distributed Epilepsy Monitoring Using Self-Awareness from Edge to Cloud.

The guest editors would like to thank the associate editors and reviewers for soliciting these high-quality papers. We also

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