Guest Editorial
Flexible Sensing and Medical Imaging for Cerebro-Cardiovascular Health

HEALTHCARE and disease management are receiving increasing attention. Cerebro-cardiovascular diseases (CCVDs) are the leading cause of death globally. Cerebro-cardiovascular diseases include a variety of medical conditions that affect the blood vessels of the brain, the cerebral circulation, and the heart. The common presentations of CCVDs include an ischemic stroke or mini-stroke and sometimes a hemorrhagic stroke, heart failure, hypertensive heart disease, etc. The important contributing risk factors include high blood pressure, smoking, diabetes, lack of exercise, obesity, high blood cholesterol, and excessive alcohol consumption, among others. A rapidly-growing field, biomedical and health engineering research for CCVDs is unique in that it involves a variety of specialties such as neurology, surgery, cardiology, psychology and rehabilitation, and must meet the growing need for sophisticated, up-to-date biomedical and health informatics on clinical data, diagnostic testing, and therapeutic issues.

To address the grand challenges of cerebro-cardiovascular health, this special issue aims to publish the latest technology advancement in flexible sensing and medical imaging for cerebro-cardiovascular health, and focus on the cross-disciplinary approaches, solutions, and initiatives in imaging informatics, sensor informatics, and medical informatics. The application scenarios can cover single or multiple scenarios of health engineering such as unobtrusive physiological sensing, preventive care, multi-modal fast biomedical imaging and processing, health informatics for precision medicine.

After a rigorous review process, 3 papers have been selected for publication in this special issue. Some papers are extensions of contributions to the 13th IEEE-EMBS International Summer School and Symposium on Medical Devices and Biosensors in conjunction with the 11th International School and Symposium on Biomedical and Health Engineering (MDBS-BHE 2019) held in Chengdu, China (http://mdbs-bhe2019.medmeeting.org/en). The selected papers are briefly discussed below.

As a consequence of a cerebrovascular accident, aphasia is an acquired neurogenic language disorder in which an individual's ability to produce or comprehend language is compromised. Aphasia occurs in about one-third of the stroke patients, and may cause impairments in both expressive and receptive language skills. Speech assessment is an important part of the rehabilitation process for patients with aphasia. In the first paper, entitled "An Efficient Deep Learning Based Method for Speech Assessment of Mandarin-Speaking Aphasic Patients," Mahmoud *et al.* presented a standardized automatic speech lucidity assessment method for Mandarin-speaking aphasic patients using a machine learning based technique. Results showed significant correlations between the output of the convolutional neural network (CNN) model and aphasic patients' articulation, fluency, and tone scores, which may provide feedback to aphasic patients about their verbal output during the rehabilitation procedure.

Sensing biological acoustic signals has been enabling various intelligent medical applications. Auscultation is one of the most efficient ways to diagnose cardiovascular and respiratory diseases; however, its clinical applications heavily rely on the accurate recognition of heart and lung sounds from the mixed chest sounds recorded under various clinical situations. Recent development of supervised machine learning methods enables effective separation of heart and lung sounds, but requires paired mixed sounds and individual pure sounds for model training, which are difficult to obtain in real scenarios. In the second paper, entitled "Blind Monaural Source Separation on Heart and Lung Sounds Based on Periodic-Coded Deep Autoencoder," Tsai *et al.* proposed a novel unsupervised model to separate mixed heart-lung sounds, and the method was developed based on the assumption of different periodicities between heart rate and respiration rate. They evaluated the performance of the proposed method on two datasets, including chest sounds recorded in real-world conditions. Experimental results indicated that the developed method outperformed several well-known sound separation methods in objective evaluations with standardized metrics, and the heart sound recognition accuracies could be notably boosted.

Semantic segmentation has important applications in the field of medical image analysis. In the third paper, entitled "Multi-Receptive-Field CNN for Semantic Segmentation of Medical Images", Liu *et al.* proposed a novel CNN model to extract rich and useful context information from complex and changeable medical images. They evaluated the performance of the proposed CNN model on the task of semantic segmentation using 3 public medical image datasets, and achieved the outstanding performance on all 3 datasets.

The papers presented in this special issue provide a snapshot of the latest technology advancement and valuable applications in the areas of flexible sensing and medical imaging for cerebro-cardiovascular health. We believe that the special issue provides an interdisciplinary forum for researchers working in

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the fields of biomedical engineering, medical physics, computational neuroscience, and integrative physiology to present the most recent ideas for understanding, diagnosing, and treatment of cerebro-cardiovascular health.

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