Department of Electrical Engineering
香港城市大學
City University of Hong Kong

CityU Architecture Lab for Arithmetic and Security (CALAS) Seminar Series

Accelerated Bioelectric Interfaces for Healthcare: Secure, Low-Latency Edge AI from Sensing to Stimulation

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Abstract:

The combination of bioelectric medicine and advanced hardware design offers a chance to create faster, safer, and more reliable platforms for healthcare. Bioelectric signals such as those from triboelectric nanogenerators (TENGs), brain activity (EEG), muscle activity (EMG), and wound healing processes carry valuable clinical information. However, normal software processing can be too slow, power-hungry, and sometimes not secure. This seminar introduces a hardware-based approach for bioelectric interfaces that brings sensing, analysis, and stimulation together in one system. At the sensing stage, self-powered TENGs and standard electrodes collect continuous signals. These are handled on specialized hardware chips called FPGA/SoC boards, which allow filtering, compression, and feature extraction in real time while using very little power. Lightweight artificial intelligence models, such as compact convolutional neural networks or binary neural networks, can then classify signal patterns e.g., related to pain, inflammation, or healing quickly and efficiently. To ensure both safety and security, the system also includes built-in safety checks and cryptographic modules that protect the authenticity of data. By combining biomedical signal generation from BME with secure and efficient hardware computing from EE/CALAS, this platform targets three key needs: (i) real-time closed-loop bioelectric stimulation, (ii) fast and efficient signal analysis at the edge, and (iii) secure, trustworthy data handling. This work aligns with CALAS expertise in reconfigurable computing and security while opening pathways toward clinically reliable bioelectronic healthcare systems.

Biography:

Saira Iqbal received her Bachelor's degree in Mechatronics and Control Engineering from the University of Engineering and Technology, Lahore, Pakistan (2016), and a Master's degree in Mechatronics Engineering from the Harbin Institute of Technology, China (2019). She is currently pursuing a Ph.D. at the School of Biomedical Engineering, City University of Hong Kong, under the supervision of Prof. Jinlian Hu. Her research focuses on energy-harvesting devices, triboelectric nanogenerators, and wearable bioelectronic systems for healthcare applications. She has published in high-impact journal and is interested in cross-disciplinary collaboration bridging biomedical engineering and reconfigurable computing.

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