BRIEF DESCRIPTION OF RESEARCH ACTIVITIES

Name: Mohamad Sawan **Affiliation:** 1) Polytechnique Montreal, Canada, Emeritus Professor
2) Westlake University, China, Chair Professor

Keywords, expertise (Up to10): Microelectronics, Biomedical, Biosensors, Brain-machine interfaces, Neurodegeneration, Neurotechnology, Implantable microsystems, Wearable devices, Analog-signal processing, Artificial Intelligence circuits and systems.

Introduction & Research program:

I am combining microelectronics with biomedical engineering to develop smart medical devices. The latter are dedicated to improving the quality of human life. For almost three decades, I was focusing on designing and validating wearable and wireless implantable systems-on-chip to restore lost sensory abilities and mitigate malfunctioning organs through monitoring healthcare parameters (signals, images, pressure, etc.) and neuromuscular electrical/optic stimulation. The resulting medical applications have led to worldwide recognition, with multiple honors and awards. Information can be found at this URL: www.mohamadsawan.org

Main undertaken research projects:

Nowadays, I am leading a group of 25 researchers conducting the following main projects:

Project 1: Due the present pandemic, we are focusing on the design, implementation, fabrication and tests of a novel biosensor to quickly detect COVID-19. The device is intended for point-of-care and personal use, where screening should be achieved via a smart mobile phone. Optical, capacitive and/or impedance measurement are used to detect the virus. Miniaturization, achieved via a silicon die and custom system-in-package device, allows the detector to be used one-time only. Also, the project includes optical imaging equipment to detect changes at the lungs level, and a respiration monitor and subsequent stimulation to avoid apnea.

Project 2: Epileptic seizures localization, onset detection, onset abortion, and prediction. For the localization of seizures foci, we are applying non-invasive functional near-infra red spectrometer imaging technique combined with regular or cortical EEGs to monitor the oxygenation rate of the brain neural activities. As a second method, we are using magnetic nanoparticles that aggregate when a seizure emerges. For the seizure onset detection, an implantable device is used to monitor the changes of cortical EEG intensity. Then, if a seizure is emerging, a feedback is activated to stimulate the nearby neural tissues to abort the seizures. Finally, predication task is being done via deep learning using latest various algorithms of neural networks.

Project 3: Recover the vision to the blind. This project requires a group of researchers from various fundamental and applied sciences was started a while ago. We keep the focus in developing a visual intracortical stimulator. Also, we are developing a cap based closed loop system, which monitor the brain activities and activate transcutaneous magnetic stimulator to eradicate the addicted people to various needs.

Recently Completed Research Projects

1) Smart Brain-Microsystem Interfaces for Efficient Diagnostic and Treatment of Neurodegenerative diseases; 2) We proposed techniques to enhance or recover the bladder voiding functions, and to avoid incontinence. Several versions of these implantable devices have been proposed, assembled, packaged, and tested in vivo; 3) Equilibrium Propagation Framework: Analog Implementation, this project is hardware oriented to build machine learning algorithms based on detecting the minimum energy level.

SUPPORT (GRANTS AND CONTRACTS)

Mohamad Sawan has been the Principal Investigator of sponsored research, primarily with NSERC, CIHR, MITACS and FRQNT, and CFI in Canada.
Presently, in China he is receiving support from Westlake University, Bright Dream Institute and Tencent Foundation, and from government agencies such as Zhejiang Key project, and Zhejiang Innovation Team.