Theme 2-1: Biosensors, Implantable Devices and Bioprocesses - 2023

Title	Name of the PI	List the Names of the Co-Is	Department	Abstract	Starting Date	Ending Date	Funding	Amount of Funding
Development and Design of Biosensor for Real-Time Detection of COVID-19 RNA Sequences	Rana Sabouni	Mehdi Ghommem	CHBE	Objectives: A novel COVID-19 virus (SARS-Co-V2) has raged a global concern since it emerged in Wuhan China in December 2019. It has speeded quickly to over than 200 countries to date. At present, COVID-19 has caused more than four million deaths and over 190 million confirmed cases and the world health organization has declared COVID -19 as a global pandemic. In this current project, we propose the development and fabrication of new metal organic framework (MOF) composite for rapid, sensitive and reliable fluorescence detection of COVID-19 RNA sequences on chip that can be placed in a facemask, which illuminates when exposed to the virus RNA sequences. Furthermore, this proposed new composite is to be incorporated into electrically actuated microbeam for real-time monitoring of COVID-19 RNA sequences concentration in confined environments such as hospitals and workplaces. Methodology: The MOFs composite will be synthesized using facile eco-friendly microwave irradiation technique focusing on the most promising MOFs candidate that would selectively and rapidly detect the COVID-19 RNA and protein sequences. Accordingly, screening for the most suitable probe binds with COVID-19 RNA and protein sequences will be investigated. Then after, parametric study of number of probes will be conducted in order to achieve the most sensitive and reliable one which will be tested in facemask as first application. Furthermore, the electrically actuated microbeam will be developed. In particular, the microbeam dynamic will be studied through frequency responses of the vibrating microbeam in air before and after MOF deposition. Changes in the natural frequency resulting from the mass added by virus RNA sequence immobilization on the detector layer will be tracked and recorded. Potential significance: The new proposed MOF composite will be the new era for rapid and reliable real-time COVID-19 RNA sequences detection and sensing in confined environments for non-clinical studies. This new technology will help in identifying serious infected places and raise a flag for further investigation and isolation for such areas and places. In later stages of the project, more sophisticated biosensors with the capability to detect various viruses simultaneously can be developed and tested.	02/06/2025	02/06/2025	FRG	595000
MEMS Device for Real-time Monitoring of Mercury Concentration in Marine Aquacultures	Mehdi Ghommem	Rana Sabouni	MCE	Aquaculture production contributes significantly to the total world production of aquatic animals. Numerous environmental pollutants may reach coastal waters where marine aquacultures are established via several sources such as coal-burning electric utilities, manufacturing plants, and batteries wastages. Mercury is one of the most hazardous environmental pollutants due to its health implications on humans. As such, there is a need to assess the contamination of sea water to ensure the safety of seafood and effectively prevent health deterioration due to mercury absorption through seafood consumption. Laboratory procedures exist to detect and quantify the mercury content. However, they require the use of sophisticated equipment, the collection of samples from aquacultures on a regular basis, the deployment of expensive solvents and reagents, and a long lead time for sample treatment and analysis. In this project, we propose the development and evaluation of a chemical sensor comprising of electrically-actuated microbeams coated with Metal Organic Frameworks (MOF)-based polyacrylamide composite to selectively sorb mercury. This MEMS device will be deployed for real-time monitoring of mercury concentration in marine aquacultures (open water). First, a multi-physics model coupling the microbeam vibrations, its electrostatic actuation, and the flow of the surrounding fluid will be developed. This model will provide guidance to design the microsensor and will be used to demonstrate the feasibility of the sensing mechanisms in liquid environments by exploiting nonlinear dynamic aspects at the micro scale. The detection concept relies on a dynamic bifurcation of the microsystem resulting from the pull-in instability. The evaluation of the mercury concentration will be obtained from the shift in the natural frequency of the microstructure due to mercury absorption. Then, we will proceed with microfabrication of the microsystem. The microbeam will be coated with novel hybrid MOF-based polyacrylamide composite using different loading percentage. The coated microbeam will be tested for detection of Hg2+ under several conditions including: concentration of Hg2+, pH, temperature and water salinity. The experimental set-up will include submerging the microsensor in water of different salinity levels inside a test enclosure. Drops of MOF- based polyacrylamide composite will be deposited onto the microbeam surface. A laser Doppler vibrometer will be deployed to measure the time and	02/06/2018	02/06/2020	FRG	500000
Development of a Multimodal Imaging System for Peripheral Artery Disease	Amer Zakaria	Nasser Qaddoumi	ELE	Early detection and monitoring of peripheral arterial disease (PAD) progression is important but remains challenging. The proposal focuses on the enormity of the challenges that the UAE faces when addressing diabetic foot syndrome (DFS) and the underlying problems of PAD. PAD is estimated to affect more than 15% of the UAE population above 65 years age group, and the risk of a diabetic person developing DFS is more than 30%. Early treatment of PAD is relatively easy, low-cost, and less invasive. In contrast, untreated PAD eventually prevents blood from reaching the lower extremities and leads to foot ulcerations, infection, tissue loss and, eventually lower limb amputation. Early detection of PAD is crucial but remains difficult using the current technologies. These facts demonstrate the national interest in developing new technologies to early detection of PAD and DFS in diabetic patients. A novel multimodal imaging system that integrates diffuse optical tomography (DOT) and microwave tomography (MWT) will be developed for early diagnosing of PAD. The MWT-DOT imaging system has many advantages over current PAD diagnostic techniques, including the ease of use, being non-invasive, the utilization of low-power non-ionizing radiation, and its relatively low cost. The multimodal approach of combining MWT and DOT is synergistic as MWT provides information about the electrical properties of biological tissue, and DOT provides information about the optical properties. Providing images of electrical properties overlaid onto images of optical properties has great potential to PAD diagnosis. To the best of our knowledge, this is the first work that incorporates MWT and DOT. The goal of this project is to show that multimodal MWT-DOT technology can be employed to detect PAD accurately at its early stages and monitor its treatment. The performance of the MWT-DOT system will be verified using laboratory phantoms. After verification, the MWT-DOT system will be validated by conducting a human study to evaluate the accuracy of detecting PAD. The project can lead to solving the shortcomings of current diagnostic techniques used to diagnose PAD, which will lead to improving healthcare and management of PAD patients.	01/06/2023	31/05/2025	FRG	479,000.00
Mental Stress Management	Hasan Al-Nashash	Dr. Nasir Malik, Dr. Fares Al-Shargie and Dr. Usman Tariq	ELE	Motivation: Mental stress is one of the major emotional health problems in modern societies. Chronic health disorders and loss of productivity are possible negative outcomes of stress. A variety of health problems such as heart disease, obesity, diabetes, stroke and depression can result from long-term exposure to stress. In order to avoid stress and achieve the highest level of performance at work, it is necessary to detect stress in its early stages, i.e., when it is still limited to acute or episodic stress. Goal: Quantify the level of mental stress using a fusion of multiple neuroimaging, machine and deep learning approaches and Investigate the effectiveness of using binaural auditory beat stimulations on vigilance enhancement and stress mitigation. Methods: Develop an experimental protocol to induce stress-related vigilance decrement in the laboratory, Record concurrently the relevant physiological, behavioral and subjective data during the experiment, Use advanced signal processing to enhance the quality of the EEG, ERP, fNIRS and GSR signals from other types of noise and interference, Develop a fusion scheme to discover the relationships between EEG, GSR and fNIRS modalities, Investigate the effectiveness of multi-sensory input on stress reduction in laboratory conditions. Results: The developed stress stimuli successfully induced stress levels on the participants at the workplace. Preliminary results on the multimodal fusion of EEG and fNIRS improved the classification of mental stress by +10% compared to individual EEG and fNIRS modality. In addition, we found that audio stimulation has significantly improved some cognitive abilities by at least 30%.	01/06/2023	01/07/2026	FRG	594,550