Western
Biomedical Imaging
Research Centre

VIRTUAL SEMINAR SERIES

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Mohammad Mehrmohammadi, PhD

Associate Professor Biomedical Engineering
Research Associate Professor of Obstetrics and Gynecology,
Wayne State University, Detroit MI, USA

Title: Light and sound work together to enable the next generation of intelligent theranostic systems

Abstract:

Ultrasound (US) imaging (aka sonography) has been widely used in clinical practice for various screening and diagnostic applications due to its notable advantages such as being non-ionizing, non-invasive, cost effective, portable, real-time, possessing reasonable imaging contrast, and scalable spatial resolution. Conventional US imaging is often used to reveal morphological and structural abnormalities. However, with advancements in the field of medical diagnostics, functional and molecular imaging have also become integral parts of today's medicine. Photoacoustic (PA) and Elasticity (EL) imaging, developed around US scanners, enable US imaging to acquire intricate functional and molecular information from tissues, including molecular composition and biomechanical properties. The advantage of these adjunct-to-US imaging modalities is they can be implemented on a single US-acquisition core without any advanced fusion algorithm to combine the multimodal images. We have been developing various US/PA/EL imaging instruments ranging in sizes from miniaturized endoscopic systems for imaging hard-to-access tissues (such as cervix), to whole tomographic systems for imaging large tissues (such as breast). This talk will cover use of the developed devices in two major applications: more accurate cervical imaging to predict preterm birth, and the US/PA tomographic system for breast cancer theranostics.

Molecular, Functional, and Microstructural Imaging of Cervical Remodeling Biomarkers: Currently, there are no reliable, clinically translatable, and non-invasive imaging instruments capable of acquiring quantitative diagnostic information about the underlying mechanisms of cervical insufficiency and it's associated risk of preterm birth, or for objective assessment of cervical ripening during labor induction. To address this unmet clinical need, we have developed a combined multi-modal imaging instrument that merges PA, EL, and conventional US into a single transvaginal probe. In this instrument, PA imaging provides quantitative measurements of molecular and microstructural mechanistic biomarkers of cervical remodeling (i.e. collagen network organization, water content, microvascular and oxygenation status); EL assesses the changes in tissue biomechanical biomarkers of cervical remodeling (i.e. degree of stiffness/softness and viscosity); and US imaging measures cervical morphology (i.e. cervical length).

Combined Full-Ring Photoacoustic and Ultrasonic Theranostic System for Breast Cancer: Lack of a highly sensitive and specific clinical tool for differential diagnosis of breast cancer has led to a large number of benign biopsies, resulting in unnecessary physical and emotional distress for patients and a substantial national financial health care burden from overdiagnosed or overtreated breast cancer. PA tomography (PAT) has been previously proposed to provide important breast cancer biomarkers such as vascular density and hypoxia. However, the laser light delivery has been a challenge for PAT imaging of clinically important areas close to the chest wall. We have developed a novel ring-illumination system, combined with ring signal acquisition, to overcome the existing limitations. Synergistic combination of UST and PAT allows for further enhancement of PAT images by compensating for tissue inhomogeneities that affect the quantitative measurements of biomarkers.