IEEE Women in Engineering (WIE) Montreal Section

Monday, 11 June 2018, 11:00 – 12:00 , McConnell Engineering Building ENGMC 603, McGill University

Microwave radar reconstruction algorithm for breast cancer detection: adapting the maximum-likelihood expectation-maximization (MLEM) algorithm used in positron emission tomography

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Breast cancer is responsible for 25% of all new cancers in Canadian women and is a growing global health concern. While x-ray mammography is the current standard for breast imaging and has benefits for managing local control in women over the age of 50, its false positive rate of up to 20%, inability to reduce mortality, particularly in younger women and its tendency for overdiagnosis, provides opportunities for complementary techniques. Breast microwave imaging is an emerging imaging modality that uses non-ionizing microwave signals to image the breast. Radar-based systems are popular because of their simplicity, but the quality of the images reconstructed from these systems is often low.

This talk will present an iterative microwave radar reconstruction algorithm for breast cancer detection based on the maximum-likelihood expectation-maximization (MLEM) algorithm used in positron emission tomography. The iterative nature of this algorithm allows for the implementation of various correction factors into the signal model. Corrections for the antennas beam pattern and frequency-dependent gain, and for the inhomogeneous propagation speed of the signal in the scan region were implemented. Experimental scans of an array of 3D-printed MRI-based anthropomorphic breast phantoms were used to test and validate the reconstruction algorithm, and the reconstructed images were compared to those produced by a published holographic reconstruction algorithm.

The monostatic MLEM-based radar algorithm produced images with greater signal-to-clutter ratios than those of the holographic algorithm, particularly in the reconstruction of dense breast phantoms, as large as 16 dB in reconstructions of a 3 cm lesion. A multistatic version of the MLEM-based algorithm will also be described, and the images and quality metrics of these reconstructions will be compared with those of experimental monostatic and bistatic scans. The impact of breast density on the visibility of the tumor response in reconstructed images produced by the MLEM-based algorithms and the holographic method will be explored.

The MLEM-based algorithm has demonstrated improvements in both image quality and the identification of the tumor response compared to holographic reconstruction. This talk will demonstrate the advantages of the MLEM-based algorithm, particularly in the reconstructions of dense breasts.

About the speaker:

Tyson received his B.Sc. (Hons) in Medical & Biological Physics from the University of Manitoba in 2018. He has worked in the non-ionizing imaging laboratory at the University of Manitoba under the supervision of Dr. Stephen Pistorius in the summers of 2016 & 2017 and completed the requirements of the undergraduate thesis course at the University of Manitoba in this laboratory. Tyson has worked on the development of anthropomorphic breast phantoms for breast microwave imaging (2016) and the development and validation of a novel reconstruction algorithm for use in breast microwave imaging.