Microwave Imaging for the Detection and Classification of Early Stage Breast Cancer

Dr. Martin O'Halloran

Electrical and Electronic Engineering, National University of Ireland Galway

Background

The current de-facto method for detecting non-palpable early stage breast cancer is X-Ray mammography. Despite the fact that X-rays provide high-resolution images, its limitations are well documented. In the U.S., up to 75% of all malignancies identified by X-ray mammography are later found to be benign after biopsies. These false positive conclusions result in unnecessary biopsies, causing considerable distress to the patient and an unnecessary financial burden on the health service. Much more worrying is the fact that approximately 15% of all breast cancers are missed by conventional mammography, often delaying treatment to the point where it's no longer effective.

One of the most promising alternative imaging modalities is Microwave Imaging. The rationale for using Microwave Imaging to detect breast cancer is the dielectric contrast that exists between normal and cancerous breast tissue at microwave frequencies. Furthermore, the dielectric properties of tumours show no significant variation with age, suggesting that the dielectric contrast exists at the earliest stage of tumour development. Therefore, when a microwave pulse illuminates the breast, the dielectric contrast between healthy and cancerous tissue in the breast tissue will ensure that a reflected wave is generated, which can be used to detect, localise and classify tumours, as shown in Figure 1. Microwave imaging is non-ionising, non-invasive, does not require uncomfortable breast compression, and is potentially low cost.

This four-year project will involve the development of a prototype Microwave Breast Imaging hardware system (similar to the system shown in Figure 2) and the evaluation of the imaging and classification methods developed by the applicant using realistic breast phantoms and ultimately clinical trials. This microwave breast cancer detection system will allow for the detection of early-stage breast cancer specifically in women with dense breast tissue, which would otherwise by missed using conventional X-ray mammography.

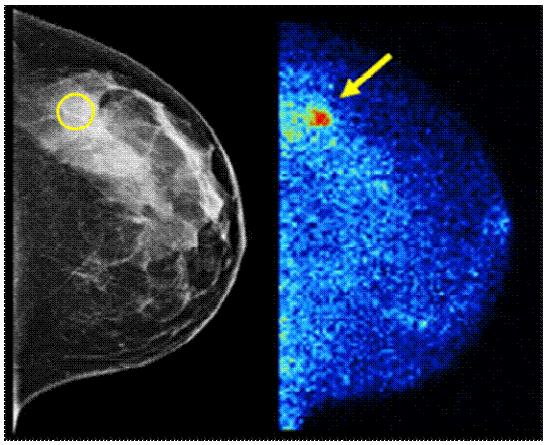

Figure 1: Comparison of X-ray and Microwave Breast Image. The tumour is much more clearly visible in the microwave tomographic image

Figure 2: Prototype Microwave Breast Imaging System developed at the University of Calgary

PhD Candidate

This project can be divided into several distinct tasks, centred on algorithm refinement, hardware development and clinical evaluation. The PhD candidate's research will focus primarily on the development and refinement of the imaging and classification algorithms for application to "real-world" scenarios, while assisting in the development of the required microwave hardware and resultant clinical trials. The PhD candidate will be responsible for the following:

1. Assisting in the development and refinement of the microwave prototype imaging system at NUIG.

2. Integration of Microwave Imaging and classification algorithms.

3. Evaluation and refinement of the integrated system using anatomically and dielectrically accurate breast phantoms, across a range of potential clinical scenarios.

4. Refinement and optimisation of the imaging and classification system based on the initial results of clinical trials. This refinement will focus on making the system more robust to normal variation in the size and density of the breast, variations in the patient-specific dielectric properties and dielectric heterogeneity.

For more information, contact Dr. Martin O'Halloran (martin.ohalloran@nuigalway.ie)