A Water-based 3-D Breast Imaging System: Modelling and Use of Prior Information

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Breast cancer is one of the most common types of cancer amongst women around the world. Early detection of breast tumors is crucial in increasing the patients' survival rate. An emerging modality being investigated worldwide for early detection of breast cancer is microwave imaging (MWI). This technique offers several advantages such as the use of non-ionizing radiation, its relatively low cost with respect to other modalities, and its portability.

In this work, we investigate the inversion of scattered-field data obtained from a recently developed 3-D full-vectorial water-based MWI system for breast imaging applications (M. OstadRahimi, *et. al.*, USNC-URSI, 54, 2014). This system supports up to 120 microwave sources and receivers points; further it uses water as the medium in which a patient's breast is submerged. An FEM-CSI inversion algorithm (A. Zakaria *et. al.*, Prog. In Electromagn. Res., 142, 463-483, 2013), developed at the Electromagnetic Imaging Lab (EIL) at the University of Manitoba, is used to produce quantitative images of the complex permittivity of the tissues throughout the breast from measurements taken using the aforementioned system. For successful inversions, the algorithm requires an accurate numerical model of the imaging system that resembles the physical measurement configuration; this is known as modeling error reduction. Furthermore, the utilized algorithm allows the use of an inhomogeneous dielectric region as a numerical background material within which the contrast is defined. This form of prior information reduces the magnitude of the contrast variable being optimized and effectively deals with the ill-posedness of the inverse problem (A. Baran *et. al.*, Pier, 149, 161-171, 2014).

Using water as the immersion medium does not provide an ideal electromagnetic match at the boundary of the breast. We show that the amount of interrogative energy that penetrates the interior of the breast and propagates back to the receiving antennas has sufficient data for the reconstruction algorithm. In addition to an accurate FEM-based system model being incorporated in the inversion algorithm, proper calibration techniques are necessary to effectively reduce the modeling error. The prior information used in the reconstructions can be obtained using alternate modalities, such as radar processing techniques and laser range-finding methods; these methods localize the breast's surface within the imaging domain, and will be discussed during the presentation.