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Evaluation of a Faceted PEC Air-based Breast Imaging System

Joe LoVetri*, Anastasia Baran, Mohammad Asefi, Kyle Nemez, and Ian Jeffrey
Department of Electrical and Computer Engineering, University of Manitoba, Winnipeg, MB, R3T 5V6, Canada

1 Extended Abstract

Recently we have designed and built a microwave breast imaging system that incorporates a novel flat-faceted PEC chamber. The chamber consists of a total of 44 flat facets approximating a hemi-ellipsoidal shape [1]. The advantages of using chambers with conducting boundaries has previously been shown to enhance the performance of microwave imaging systems [2, 3]. Magnetic field probes are placed on 22 of the chamber's facets and used to introduce the electromagnetic excitation as well as to measure the tangential surface current which forms the data that is subsequently inverted [2]. The magnetic field probes are half-loop coplanar transmission lines with a slotted ground plane that use the boundary of the chamber as the image plane. These can be optimized by loading the termination end of the transmission line. In order to reduce the current flowing on the loops it was found that leaving the terminations open gives optimal results when considering factors related to sensitivity and perturbation of the fields within the chamber due to the co-resident probes [1]. Once the magnetic field data is collected it is inverted using both a fully 3D FEM based Contrast Source Inversion (FEM-CSI) algorithm, as well as a CSI algorithm that uses the Discontinuous Galerkin Method (DGM) [4] to discretize the electromagnetic model (DGM-CSI) [5]. As this is an air-based system, imaging the high contrast breast tissue requires some sort of prior information. We introduce prior information as an inhomogeneous background in CSI [6, 7].

We evaluate this system for breast imaging and tumour detection. The evaluation is performed using MRI-derived synthetically generated breast models as well as simplified 3D breast phantoms. The synthetic study provides a means of choosing optimal frequencies for the inversion. An analysis of using different field components as data is performed as well as a statistical study of collecting data using different configurations of the co-resident antennas. For the experimental investigation different techniques of incorporating prior information are investigated. Comparisons between FEM- and DGM-CSI are shown. The advantages of using the faceted chamber are investigated by comparing with results obtained using a cylindrically shaped chamber.

References

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