2nd URSI AT-RASC, Gran Canaria, 28 May – 1 June 2018

An Electric and Magnetic Field Transceiver Configuration Study for a Biomedical Microwave Imaging System

Kevin Brown(1), Mohammad Asefi(1), Nicholas Geddert(1), Ian Jeffrey(1), and Joe LoVetri*(1)
(1) Department of Electrical and Computer Engineering,
University of Manitoba, Winnipeg, MB, Canada, R3T 5V6

1 Extended Abstract

A challenge when designing experimental microwave imaging (MWI) systems is determining what data to collect. The measurement data may be specified by transmitter and receiver locations, polarizations, and field types, i.e., electric fields, magnetic fields, or both. The choice of data, in addition to choices of calibration technique, numerical forward model, imaging algorithm, and prior information, contribute to the overall quality of generated images. Significant previous work in the MWI community has been devoted to improving calibration techniques, numerical models, algorithms, and the use of prior information. In addition, some work has focused on selecting optimal transmitter and receiver locations for some common imaging configurations using electric field measurements only or magnetic field measurements only [1, 2, 3]. Of potential interest is a study that seeks to gain insight into the choice of electric and/or magnetic field measurements in a custom imaging system.

Herein we present a study of 3D synthetic and experimental inversion results for microwave breast cancer imaging using a variety of different measured field configurations. The imaging system consists of a flat-faceted air-filled metallic chamber [4]. Transceiver configurations include normal electric field components and/or tangential magnetic field components, collected at the chamber boundary. Normal electric field data is collected using monopole probes, and tangential magnetic field data is collected using coaxial half-loop probes. In the experimental system up to 24 transceivers are considered, with data collected from 0.9-1.6 GHz. The object of interest is a breast phantom with realistic permittivity values for fat, fibroglandular, and tumour regions [5]. Both the real and imaginary parts of the complex permittivity are reconstructed using fully parallelized 3D Finite Element Method Contrast Source Inversion (FEM-CSI) [6] and Discontinuous Galerkin Method Contrast Source Inversion (DGM-CSI) [7]. Results demonstrate the benefits of including tangential magnetic fields in the measurement data.

References

[1] O. M. Bucci, L. Crocco, and R. Scapaticci, "On the optimal measurement configuration for magnetic nanoparticles-enhanced breast cancer microwave imaging," *IEEE Transactions on Biomedical Engineering* **62**(2), 2015, pp. 407-414.

[2] M. Asefi, A. Zakaria, and J. LoVetri, "Microwave imaging using normal electric-field components inside metallic resonant chambers," *IEEE Transactions on Microwave Theory and Techniques* **65**(3), 2017, pp. 923-933.

[3] M. Asefi, G. Faucher, and J. LoVetri, "Surface-current measurements as data for electromagnetic imaging within metallic enclosures," *IEEE Transactions on Microwave Theory and Techniques* **64**(11), 2016, pp. 4039-4047.

[4] K. Nemez, A. Baran, M. Asefi, and J. LoVetri, "Modeling error and calibration techniques for a faceted metallic chamber for magnetic field microwave imaging," *IEEE Transactions on Microwave Theory and Techniques* **65**(11), 2017, pp. 4347-4356.

[5] J. LoVetri, *et al.*, "Phantom study of a flat-faceted air-based microwave breast imaging system," *Antennas and Propagation (EuCAP), London, UK, April 9-13*, 2018 (Accepted).

[6] A. Zakaria, I. Jeffrey, and J. LoVetri, "Full-vectorial parallel finite-element contrast source inversion method," *Progress In Electromagnetics Research* **142**, 2013, pp. 463-483.

[7] K. Brown, *et al.*, "3D microwave imaging using the time-harmonic discontinuous Galerkin method - contrast source inversion," *USNC-URSI Radio Science Meeting, San Diego, California, July 9-14*, 2017.