On the Use of the Source Reconstruction Method to Estimate Incident Field Distributions in Microwave Imaging

Chaitanya Narendra*, Ian Jeffrey, and Puyan Mojabi
University of Manitoba, Winnipeg, MB, Canada,
http://www.umanitoba.ca/ece

Microwave Imaging (MWI) is a modality that attempts to obtain the dielectric profile of an object of interest (OI) by exposing it to successive interrogation from a number of co-resident antennas. MWI is advantageous because it is non-invasive and non-ionizing, and consequently it is being used in areas such as biomedical imaging and industrial non-destructive testing. The performance of MWI is dependent, in part, on accurate knowledge of the incident field used to interrogate the OI. The antennas used in MWI systems are usually approximated by simple models, such as point sources, in order to reduce the cost of the numerical model (M. Ostadrahimi et. al., IEEE Antennas Wireless Propag. Lett., 10, 900-903, 2011). This results in the incident field being approximated, and thus, calibration techniques are necessary to compensate for the modelling error. This can lead to degraded reconstructed image quality or additional time consuming measurements needed for calibration.

This research investigates obtaining incident field estimates using the source reconstruction method (SRM) (Y. Alvarez et. al., IEEE Trans. Antennas Propag., 55(12), 3460-3468, 2007). The SRM reconstructs an equivalent source from measured incident field data by solving the associated inverse source problem. The equivalent source distribution is then used to calculate the incident field at locations required to reconstruct the dielectric profile of the OI.

Herein, we synthetically investigate the feasibility of this approach for an open air, near-field MWI configuration. To this end, an antenna element, e.g. the Vivaldi antenna used by the University of Manitoba's Electromagnetic Imaging Laboratory (Gilmore et. al., IEEE Trans. Biomed. Eng., 57(4), 894-904, 2010) is simulated. The equivalent currents representing the simulated antenna are reconstructed using synthetic field measurements at the receiving sites. That is, the data used by the SRM is limited to the locations and polarizations of the MWI transceivers. The true incident fields and those reconstructed from the SRM equivalent currents are compared, and the limitations of the algorithm are explored.