Increasing the Amount of Data for Microwave Imaging System Using Field Perturbing Elements

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When designing microwave imaging (MWI) systems, two of the most important considerations are the amount of independent data, and the accuracy of the numerical model used in the inversion algorithm. One method to increase the amount of data is using the modulated scattering technique (MST) (Bolomey, *et. al.* IEEE Transactions on Antennas and Propagation, vol. 36, 1988) or the differential scattering technique (DST)(Asefi, *et. al.* IEEE Transactions on Microwave Theory and Techniques, vol. 62, 2014). However, MST/DST probes can only be used to increase the number of spatial sampling points and not the amount of interrogating fields. Increasing the number of interrogating fields usually increases the accuracy of the reconstructed image (Bucci, *et. al.* IEEE Transactions on Biomedical Engineering, vol. 62, 2015). This can be obtained by increasing the number of coresident antennas which is limited by the tolerable mutual coupling between coresident antennas and the increase in the overall cost of the system.

Interest in using MWI within conducting boundaries has been increasing in different industrial applications such as agriculture (Asefi, et. al. Computers and Electronics in Agriculture, vol. 119, 2015). To increase the amount of data for imaging within conducting boundaries, herein, we introduce field perturbing elements (FPEs).

Presence of conducting objects can significantly perturb the field distribution within a conducting enclosure. We have previously shown that the use of reconfigurable antennas (RAs), instead of thin-wire monopoles, can reduce the perturbations due to the non-active antennas inside a metallic enclosure (Asefi, *et. al.* IEEE Transactions on Microwave Theory and Techniques, vol. 62, 2014). This is due to change in the effective length of the RAs when set in different modes. We show that using FPEs to perturb the interrogating fields in a predefined way, effectively increases the number of independent sources and enhances the inversion results.

We also show that because FPEs are small structures compared to the size of the chamber, in the finite-element method (FEM) grid only a small subset of the tetrahedra are affected when the FPE is turned on or off which is advantageous in the numerical inversion algorithm wherein the part of matrix-model corresponding to the mesh that does not change can be separately inverted only once. Experimental data from simple breast phantom will be used to show the effectiveness of this technique.