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Increasing Data Variation Using Dynamic Boundaries

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1 Extended Abstract

When designing microwave imaging (MWI) systems, it is important to consider the amount of independent data that can be collected by the system. The number of independent measurements can be increased by using randomly distributed antennas in a non-symmetric imaging chamber. However, the total number of antennas in an imaging system is limited by the size of the chamber and mutual coupling between the antennas. Problems associated with mutual coupling of the antennas can be avoided using techniques such as the modulated scattering technique (MST) [1] or the differential scattering technique (DST) [2], but MST/DST probes can only be used to increase the number of spatial sampling points and not the amount of interrogating fields. This limitation can have a significant effect on the accuracy of the image reconstructed from these field data [3].

The effect of using conducting boundaries has previously been shown to enhance the performance of an imaging system by increasing the amount of interrogating fields [4]. A novel technique to increase both the amount of data and the field variation within an imaging system is the use of dynamic boundaries. A Dynamic Model Contrast Source Inversion (DMCSI) algorithm is developed which is a generalization of the CSI algorithm described in [5]. In the DMCSI algorithm, the boundary conditions of the Finite Element (FE) model are no longer assumed to be static. Using this technique, conducting boundaries mixed with non-conducting boundaries allow one to control the distribution of the fields in an imaging system. These boundaries allow the system to have two or more boundary conditions for each transmitter/receiver pair. For example, some of the facets in a flat-faceted chamber can be made dynamic to allow their properties to change from conducting to non-conducting.

We have shown that using a small active field perturbing element inside a fully conducting imaging chamber can enhance the imaging performance by removing the symmetry of the field distribution [6]. In this work we investigate the effect of using dynamic boundaries which can have more significant impact on changing the distribution of the fields inside a chamber. Additionally, their effect on increasing the amount of independent interrogating fields and reducing the overall system cost will be investigated. Numerical and experimental results from a simple breast phantom will be used to show the effectiveness of this technique.

References

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