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Accuracy Enhanced Contrast Source Inversion Algorithm for Microwave Breast Tumor Detection

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Contrast source inversion (CSI) based microwave quantitative imaging scheme is presented in this paper, which is promising for microwave breast tumor detection applications. Many reports revealed that a breast cancer is one of the most diagnosed cancers in worldwide. X-ray mammography, an existing screening technique, has a risk for radiation exposure to normal cells. As a promising alternative modality, microwave based tumor detection system has a great potential to achieve more frequent, safe, and reliable screening because of the number of advantages such as non-harmful exposure, non-contact measurement, and low cost and compact equipment. There are a large number of studies that demonstrated that a cancer tissues has higher dielectric property, compared with adipose or fibro-glandular tissues, and it is the physical basis of the microwave imaging modality of cancer detection [1].

This paper focuses on the tomographic approach, *i.e.* inverse scattering analysis, provides a quantitative reconstruction of complex permittivity. However, the above inverse problem is ill-posed in most case, and is non-linear, and it usually requires much expensive computational cost by the iterative use of the forward solver. As an approach with much less computational cost, we focus on the contrast source inversion (CSI) method [2], which minimizes the residuals between the measured and reconstructed scattered field both the data and state equations, instead of the use of forward solver. However, the CSI also suffers from inaccuracy due to the ill-posed feature of the problem, that is, the number of measured data is considerably smaller than that of unknowns. To address with the above problem, this paper proposes the ROI limited CSI algorithm, where the number of unknowns judged as adipose tissues are eliminated from the ROI, and the CSI focuses on the reconstruction within the ROI including only the fibro-glandular and cancer tissue regions. Figure 1 shows the two-dimensional (2-D) FDTD numerical simulation, using a realistic MRI-derived breast phantoms [3], and it demonstrated that the ROI limited approach further enhances the reconstruction accuracy in any cases, by alleviating the ill-posed feature of inverse scattering problem.

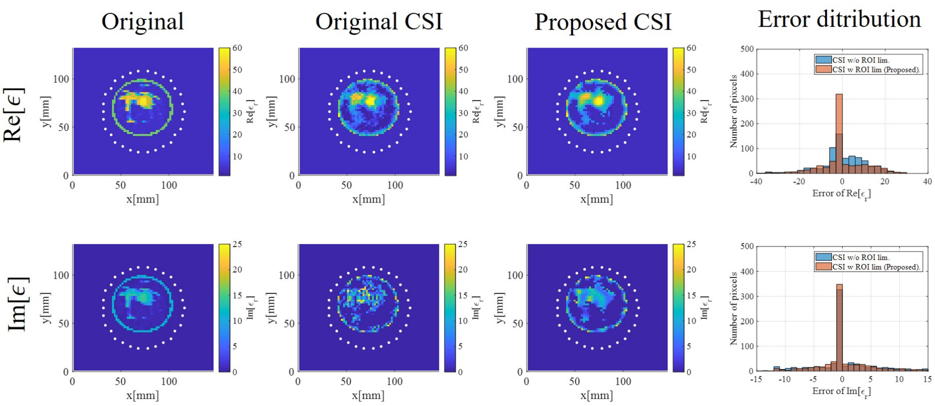

Figure 1. Reconstruction results for real and imaginary part of complex permittivity at each method. Histogram of errors.

References

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