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Contrast Field and Contrast Source Formulations for Microwave Imaging - A Comparative Analysis

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Inverse scattering techniques are aimed at recovering the profiles, positions and constitutive parameters of unknown objects belonging to an inaccessible region illuminated by known and successive probing fields from the measurements of the scattered field (i.e., the problem data) collected by a set of sensors in an external observation domain. Within such a framework, different methods have been proposed, based either on system matrix inversion or optimization approaches. Since multiple scattering effects cannot be neglegted, full non-linear formulations have to be used. The contrast field inversion (CFI) and the contrast source inversion (CSI) have been widely employed in a lot of practical applications (e.g., biomedical diagnosis or UXO and landmines detection, NDT/NDE, archeology, etc.). CFI-based techniques recast the inversion problem to the minimization of a cost function of two integral terms both non-linear related to the so-called Data and State/Object Equations [1][2]. The goal is to determine the unknown contrast function and total field within the investigation domain. On the other hand, in the CSI algorithm the contrast sources (i.e., the equivalent currents defined in the support of the scatterers) and the contrast itself are iteratively reconstructed [3][4][5]. In such a case, the cost function is still composed by two-terms, but only one is non-linear. This contribution proposes a comparison between the CFI and CSI methods in terms of solution accuracy, robustness to local minima and noise, and computational efficiency. The analysis is aimed at pointing out potentialities and limitations of both the inversion formulations when dealing with synthetic as well as experimental datasets. Towards this end, a set of representative results obtained with different minimization techniques both deterministic [6] and stochastic [7] are reported and compared.

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