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Recent Advances in the Iterative Multizooming Reconstruction of Nonmeasurable Equivalent Current Densities for Non-Invasive Diagnostic Applications

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In the framework of the inversion of electromagnetic data, several methodologies consider the introduction of an equivalent current density defined into the dielectric domain to be reconstructed. However, even though the above methods looks attractive, they present a number of drawbacks clearly pointed out in [*Chew et al.*, 1994] and ranging from the existence of non-radiating sources (thus of the dimension of the kernel of the integral scattering equation) up to the low-pass filtering behavior of the Green operator. In order to overcome these drawbacks, starting from the theoretical considerations presented by [*Habashy et al.*, 1994] and taking into account the two-step methodology presented in [*Gragnani et al.*, 1999], Donelli and colleagues proposed in [*Donelli et al.*, 2006] an integrated strategy based on an innovative stochastic method and on a multizooming procedure. In order to fully exploit the reduction of the null-space enhancing the achievable spatial resolution, starting from a coarse representation, the method iteratively defines a subgridding of the support of the equivalent current density successively improving the representation (in terms of spatial accuracy) of the non-radiating currents (i.e., their components with respect to a suitable set of basis functions) as well as the scatterer profile by minimizing a suitable nonlinear cost function.
In such a contribution, a more detailed study as well as a comparative analysys on the representation of the nonradiating currents is carried out since their impact on the effectiveness of the reconstruction procedure. Starting from the result that nonradiating sources and the fields they generate within the source domain are simultaneous solutions of the "reduced wave equation" subject to specified boundary conditions [*Gamliel et al.*, 1989], a new complete (in the finite element sense) set of basis functions is determined and integrated in the iterative multiresolution scheme.
The results of a selected set of numerical experiments are presented for pointing out the sensitivity of the reconstruction on the choice of the expansion functions as well as for further analyzing the potentialities and current limitations of the source-based multi-resolution methodology.

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