

EFFICIENT INVERSION OF THE IMPEDANCE MATRIX IN AN OVERLAPPING, LOCALIZING BASIS

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Numerical solutions of integral equation formulations of time-harmonic electromagnetic phenomena involve solving linear systems of the form

$$ZJ = E^i \quad (1)$$

where Z is the impedance matrix. The use of integral equations to determine (1) usually leads to a full impedance matrix. This has led to the development of a large number of fast iterative solution strategies. Iterative methods, however, have certain well known limitations restricting the class of problems to which they can be usefully applied.

It has recently been shown for scalar problems in two dimensions that a reduced-complexity, error-controllable direct solution of (1) is obtained by expanding and inverting the impedance matrix in a complete set of nonradiating local-global solution (LOGOS) modes. A nonradiating LOGOS mode consists of an excitation/solution pairing, (E_m^i, J_m) , for which the current and the incident field are both localized to a (usually) small region of a larger simulation domain. Unfortunately, the relative computational efficiencies of previously reported LOGOS representations is approximately $O(N^{1.5})$ in 2-D and $O(N^2)$ in 3-D. Such limitations are directly related to the non-overlapping nature of the nonradiating LOGOS modes.

This paper summarizes an improved LOGOS direct solution algorithm for PEC scattering problems in 2-D. It is shown that the solution algorithm requires $O(N \log N)$ floating point operations to determine an $O(N)$ factored representation of the inverse of the impedance matrix. These reduced complexities are obtained using an overlapping basis of LOGOS modes defined on a dual-grid multilevel quad tree.

The direct solution algorithm proceeds by projecting the sparse, $O(N)$, MLSSM representation of the impedance matrix (Zhu *et. al.*, 2005) onto overlapped LOGOS modes defined at successively coarser levels of the dual-grid quad tree. Interactions between the main and offset grids of the dual-grid tree are minimized by imposing an appropriate orthogonality condition on the LOGOS modes defined on the main and offset grids. The latter condition is efficiently enforced using a so-called $R\Theta$ factorization of the MLSSM representation of the impedance matrix.

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