Multilevel Field Interpolation Algorithm for MoM

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Multilevel and fast iterative techniques for solving electromagnetic wave scattering problems involving large complex bodies have been developed for the efficient performance of matrix-vector product, providing considerably reduced computational requirements.

These techniques require a number of operations per iteration, for very large objects, of the order of $O(N\log N)$ for a problem with N degrees of freedom, which is much less than the $O(N^2)$ operation count required by direct matrix-vector multiplication.

In this paper, we develop an algorithm that allows for the numerically efficient evaluation of fields produced by given current distributions. It is applied to the fast solution of 2-D problems discretized by the Method of Moments. The generalization to 3-D problems is straightforward.

The proposed algorithm is based on a recursive procedure where the 2-D scatterer surface is decomposed into a set of subdomain cells. The cell enclosing the object is subdivided into smaller cells at multiple levels, in the form of an octal tree. The field produced by each of them is computed separately by means of the interaction between source and observation cells.

For the near cell interaction (touching cells) at the finest level, the field is evaluated through direct integration of the Electric Field Integral Equation, while for the far cell interaction the field of each non-touching subdomain cell is evaluated at a small number of samples surrounding it.

The phase common to all source points in the subdomain cell is removed to cancel rapid oscillations due to the Green function of the EFIE. Subsequently the fields of each observation cell are interpolated at a small number of samples and the phase is then redistributed. Finally the fields evaluated in every subdomain cell are aggregated into the total field.

In the paper, we outline the proposed algorithm, demonstrate its $N\log N$ operation count both theoretically and numerically, and assess its accuracy as a function of the governing parameters.