A BEAM TRANSFORM METHOD FOR PLANE WAVE RESPONSE MATRICES

Robert J. Adams[1], Francis Canning[2], Faisal Mev[1]
[1]Electrical Computer Engineering, University of Kentucky
[2]Simply Sparse Technologies, Morgantown, WV

Abstract Submission Form

2004 National Radio Science Meeting

Abstract: adams7600

Date Received: September 24, 2004

1. (a) Robert Adams
453 FPAT
Electrical
Computer Engineering
University of Kentucky
Lexington, KY
40506 USA
rjadams@uky.edu

(b) 859-257-1775

(c) 859-257-3092

2. B - Fields and Waves

3. (a)

4. C - Contributed Paper

5. No special instructions

Numerical solutions of surface integral equation formulations of time-harmonic electromagnetic radiation and scattering from perfectly conducting targets involve solving linear systems of the form

$$ZJ = M^i \tag{1}$$

where Z is the impedance matrix.

The use of surface integral equations to determine (1) usually leads to a full impedance matrix. As a result, the computational costs associated with standard solutions of (1) are often prohibitive for electrically large problems, and it is often necessary to solve (1) iteratively using compression algorithms for Z. However, the computational costs of fast iterative solvers can be significant when the impedance matrix is poorly conditioned, and when solutions are required for a large number of linearly independent excitations.

A general scheme for addressing the limitations associated with fast iterative solvers for electrically large problems should have two properties. First, it should provide a computationally efficient representation for the inverse of the impedance matrix, Z^{-1}. To be generally applicable, such a scheme should also provide an efficient procedure to determine the compressed representation of the inverse from more directly available information, such as that contained in (1).

In this paper we restrict our attention to the first of these requirements. Furthermore, instead of working directly with the inverse of the impedance matrix, we outline a compression algorithm for a related problem. The algorithm we report compresses the plane wave response matrix (P-matrix) which specifies the currents excited on the surface of a target by a spectrum of incident plane waves. The motivation for working with spectrally forced representations of the scattering problem instead of working directly with the spatial domain representation indicated by (1) follows from the physical characteristics of wave phenomena. In particular, for many electrically large scattering problems, with proper weighting, it is possible to group plane wave sources originating from a small spread of angular directions in order to form incident beams which excite surface currents that are nonzero over a small fraction of a large obstacle. Using this principle, we demonstrate that it is possible to determine a sequence of linear transformations in the domain of the P-matrix which yield sparse representations for electrically large problems.