Fast MoM Solutions for Large Arrays Via Green's Function Interpolation and Physical Preconditioning

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This presentation focuses on numerical procedures that address the difficulties of dealing with large, finite arrays while preserving the generality and robustness of full-wave methods. First we review a method presented recently [F. Capolino, D. R. Wilton, D. R. Jackson, *URSI General Assembly,* Maastricht, 2002] that uses a physically-based preconditioner to accelerate the iterative solution process, generally reducing to a handful the number of iterations required. There, a preconditioner was obtained based on an identity relating the impedance and admittance operators for infinite and finite periodic structures. In particular, the identity relates the inverse of the impedance operator for the actual array problem to a windowed admittance operator for the infinite array and an operator representing mutual coupling between the array and a virtual array formed by extending the actual array to form an infinite array. Here we propose an alternative way to construct the preconditioner based on an FFT transform applied to blocks of the original impedance matrix; comparisons between the two methods will be provided. In many practical cases the preconditioning is sufficiently effective that the preconditioned right hand side alone serves as an excellent approximation to the solution of the full MoM system.

Secondly, we examine a fast method for solving array problems. We present a method based on approximating interactions between sufficiently separated array elements via a relatively coarse interpolation of the Green's function on a uniform grid commensurate with the array's periodicity. The interaction between the basis and testing functions is reduced to a three-stage process. The first stage is a projection of standard (e.g., RWG) subdomain bases onto a set of interpolation functions that interpolate the Green's function on the array face. This projection, which is used in a matrix/vector product for each array cell in an iterative solution process, need only be carried out once for a single cell, and results in a low-rank matrix. An intermediate stage matrix/vector product involving the uniformly sampled Green's function is of convolutional form in the lateral directions so that a 2D FFT may be used. The final stage is a third matrix/vector product involving a matrix resulting from projecting testing functions onto the Green's function interpolation functions; the matrix is the same (Galerkin's method) or a similar low-rank matrix as for the bases projection. Insertion of the physical preconditioner discussed above into this fast solution scheme and its effect on overall matrix/vector product construction time will be analyzed.