Iterative Preconditioned Solvers In Electromagnetic Computations

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The application of fast methods for calculating electromagnetic behavior of large structures promises to yield significant speed-ups and memory savings [e.g., FASTSCAT by Wandzura, et al., FISC by Chew, et al., AIM by Bleszynski, et al.]. While iterative methods are the basis of all fast methods, a priori knowledge of the best iterative solver to use or the best preconditioner to use is normally not available. Such information is difficult to come by for the average user and specific algorithms with preconditioners that work well are usually closely held by their developers. Also, adding someone else's "black box" preconditioners to existing iterative code is often not practical due to the inability of any one preconditioner to handle all geometries and wide dynamic ranges in calculations. Finally, there has been little discussion on the practicalities of adding fast solvers to existing MOM codes. Although, it can be done with almost any existing MOM code, the amount work involved is difficult to estimate since most fast codes to date have evolved from research codes.

This paper discusses choices of iterative method and guidelines for selecting or developing preconditioners for the MOM/FMM. Results from numerical experiments are presented on convergence for changes in geometry as well as preconditioning. These results also show the sensitivity of these factors to wide dynamic range calculations.

The paper opens with a discussion of the common thread in all fast methods, i.e., the iterative solution of sparse, complex systems of simultaneous equations. The approach is straight forward and it seems ideally suited for a quick jump to fast methods. However, experiments have indicated that the performance and accuracy of a given method and preconditioner often fall short when geometry and dynamic range requirements change. Convergence and preconditioning issues are described for scattering analysis of simple PEC tip shapes (cone) and more complex structures (duct). This investigation is limited to EFIE in order to remain compatible with existing model descriptions using open (thin) surfaces.