On Improving the Efficiency of the Use of Wavelet-Like Basis Functions in Finite Element Algorithms

Suppakiat Tuksinvarajan, W. Elliott Hutchcraft, Richard K. Gordon(*)
Department of Electrical Engineering(*)
University of Mississippi
Anderson Hall Box 41
University, MS 38677
Phone: (601) 234-5388
Fax: (601) 232-7231
Email: eegordon@olemiss.edu

Wavelet analysis has recently begun to attract widespread interest in the computational sciences. In computational electromagnetics, wavelet bases have been used in both partial differential equation approaches and integral equation techniques.

In this presentation, techniques for improving the efficiency of the use of wavelet-like basis functions in the finite element method will be discussed. Although the use of wavelet-like functions has advantages such as the lowering of the condition number of the system matrix, there are also some drawbacks related to their use. One of the main disadvantages involves the time required to generate the wavelet-like basis. When wavelet-like basis functions are used, time must first be spent in generating these functions. Orthogonalization is required during the generation of the basis, and the orthogonalization process requires the calculation of the square root of a large matrix. Previously, this has been done using a procedure that requires the determination of the eigenvalues and eigenvectors of the large matrix. However, the square root of this matrix can also be found using an iterative technique. A discussion of the advantages and disadvantages of the utilization of this iterative procedure will be presented.

Another disadvantage of the use of wavelet-like basis functions is that it yields a fully populated system matrix rather than the sparse system matrix that is obtained when traditional finite element basis functions are used. This can lead to an increase in the memory and computational requirements of the solution procedure. An investigation of the deletion of insignificant elements from the system matrix will be presented.

When a convergence study is conducted using wavelet-like basis functions, it is easy to use solutions obtained at earlier steps of the study as starting points for solutions at later steps. This can result in a significant reduction in the amount of time required to conduct the convergence study. This technique will also be discussed in detail.