JPL-FEM3D: FULLY SCALABLE S01 .UTIONS TO SCATTERING PROBLEMS

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JPL-FEM3D denotes a mature software system [hat enables users to solve arbitrarily large finite clement scattering problems (up to numerical limitations) on high-performance parallel processing systems, including the Intel Paragon and the Clay T3D. The system has unusual generality, including support for either E or H fields, perfectly conducting boundaries, lossy, lossless, and fully an isotropic dielectric and magnetic materials. Lossless gyrotropic behavior has been validated in modeling resonant cavities. Results arc free of spurious modes and so-called vector parasites.

Preprocessing reduces commercial mesh generator output files to a minimal binary input mesh description appropriate. for the parallel computer. A partitioning step is performed on the parallel computer, which separates the mesh into compact, Iow-surface area sub-meshes, assigned to each of the parallel processors. The technique is inertial partitioning, and is implemented for parallel operation in a fully scalable form; that is, a mesh of arbitrary size may be partitioned in a reasonable time by a proportionate number of processors.

Finite element solution is by complex hi-conjugate gradient iteration using Whitney tetrahedral edge elements for discrete 3-D field representation. Convergence is found to be robust, for well-meshed objects. The scattering object of interest is enclosed in a spherical truncation surface where the Webb-Kanellopoulos sctond-older vector wave absorbing boundary is imposed. The same surface is used to transform the final solution to a compact set of complex spherical harmonic coefficients. These are regarded as the product of the parallel computation. Post-processing uscs the.se coefficients to produce the bistatic RCS on the unit sphere; other far-field display options include the magnitude and phase of each of the two polarizations of the far field. 'l'his solution process is also scalable, due to attention to the rates and forms of input/output, communication patterns at each stage of the iterative solver, and the sparsity of all parts of the matrix system, including the wave absorption boundary. No bottlenecks arise as extremely large problems arc contemplated.

Objects validated to date include conducting spheres up to diameter four wavelengths, conducting cubes to two wavelengths, a composite conductirrg-relative permeability 4 split sphere, and an anisotropic (relative $\varepsilon_x = 4$) dielectric plate with dimension 1 x 1 x 0,25 wavelengths. Also, more than 20 modes of an idealized gyrotropic cylinder have been produced and validated by a variant of JPL-FEM3D.