A Fast Matlab-based 3D Finite Difference Frequency Domain (FDFD) Method and Its Application to Subsurface Scatterers

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The FDFD electromagnetic model computes wave scattering by directly discretizing Maxwell's equations along with specifying the material characteristics in the scattering volume. No boundary conditions are need except for the outer grid termination absorbing boundary. We use a sparse matrix Matlab code with generalized minimum residue (GMRES) Krylov subspace iterative method to solve the large sparse matrix equation, along with the Perfectly Matched Layer (PML) absorbing boundary condition. The PML conductivity profile employs the empirical optimal value from [1–3].

The sparse Matlab-based model is about 100 times faster than a previous Fortran-based code implemented on the same Alpha-class supercomputer. The 3D FDFD model is easily manipulated; it can handle all types of layer-based geometries if the target region is less than 25% of the total computational space.

Several cases have been investigated. The scattered electromagnetic fields due to spherical and elliptic mine-like TNT targets buried in simulated Bosnian soil are computed and compared to reference solutions. The electric field distribution of a cylindrical air void in soil is computed and compared with analytical models. Multiple buried scatterer problems are easily specified and analyzed with FDFD. This method is particularly well-suited to rough surface and volumetric inhomogeneity applications.

REFERENCES

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