A Spectral Integral Method for Layered Media

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In order to solve layered-medium problems in areas such as interconnect simulations and subsurface sensing, various numerical methods such as finite difference time domain methods, finite element methods, the method of moments (MoM), and the fast multipole method (FMM), have been developed. In this work, we are concerned with piecewise homogeneous objects embedded in a layered medium. As such, the surface integral equation (SIE) can be used to reduce the number of the unknowns compared with the volume integral equation.

The SIE has been solved first with MOM and then with FMM to calculate the scattered electromagnetic fields from a homogeneous scatter with arbitrary geometry in a free space. Liu *et.al.* developed a spectral integral method (SIM) as an alternative way of solving the surface integral equation more efficiently than MOM (J. Liu and Q. H. Liu, IEEE Micro. and Wire. Comp. Lett., 14, 3, 97-99, 2004) for arbitrarily-shaped smooth dielectric cylinders in a free space.

In this work we extend this method to arbitrarily-shaped smooth perfect electrical conductor (PEC) and dielectric cylinders in a multilayer medium. The main ingredients of this method are the use of fast Fourier transform (FFT) algorithm and the subtraction of singularities in Green's functions to achieve a spectral accuracy in the integral. 2D Green's functions for layered media are computed via numerical integration of a Sommerfeld type integral. To obtain spectral accuracy in the SIM, it is important that the Sommerfeld integration is obtained with high precision through singularity subtraction. We have demonstrated the spectral accuracy of this method and the reduced computational cost from the MOM. This method can also be extended to three dimensions.

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