A Novel Hybrid FDTD Technique for Efficient Solution of Multiscale Problems

K. Sharma[(1)], K. Panayappan[(1)], C. Pelletti[(1)] and R. Mittra* [(1,2)]
[(1)] EMC Lab, Pennsylvania State University, University Park, USA
[(2)] University of Central Florida, Orlando, USA

Numerical simulation of electromagnetic models with multiscale features is highly challenging due to the fact that electrically large as well as small features are simultaneously present in the model, which in turn requires that the computational domain be discretized such that the number of degrees of freedom (DOF) is very large and hence, levies a heavy burden on computational resources.

Recently (C. Pelletti, K. Panayappan, R. Mittra and A. Monorchio, Electromagnetic Theory Symposium (EMTS), 850-852, 2010), geometries with multiscale features have been simulated by using the dipole moment (DM) approach to handle the fine features wherein the dipole moment method has been combined with the FDTD algorithm in the frequency domain. However, when the size of the scatterer becomes larger in terms of the wavelength so that the quasi-static assumption becomes invalid, repeated Fourier transformations on separation domains are usually required to achieve convergent results, increasing the computational burden.

In this paper, a novel hybrid FDTD technique is introduced which combines the MOM and FDTD techniques directly in the time domain circumventing the frequency transform calculations. The proposed technique utilizes piecewise sinusoidal basis functions to represent the currents on wire-like geometries with fine features. As a first step, the fields scattered by the object with fine features are computed in the frequency domain and then, transformed to the time domain on a planar interface as shown in Fig. 1. The time domain fields obtained at the planar interface are then combined with the FDTD update equations. In contrast to the existing techniques for handling this type of problems, the proposed technique is both efficient as well as stable.

Numerical results obtained by using the novel technique, both in terms of solution time and accuracy, will be included and discussed in the presentation.

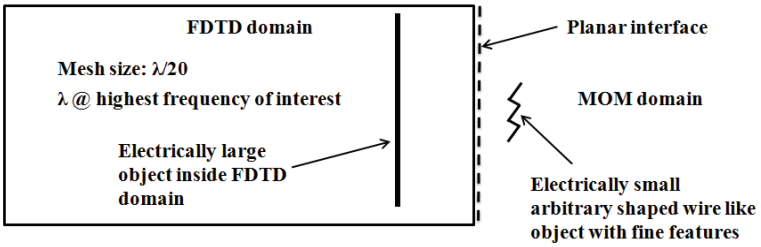

Fig. 1: Problem definition for the proposed novel hybrid FDTD technique.