Abstracts

A new 3D FDTD multigrid technique with dielectric traverse capabilities

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The finite-difference time-domain (FDTD) technique has become increasingly popular and is being used to model extremely complex and electrically large structures. These simulations are computationally demanding and often exceed available limits on computer resources. In this paper, we present an FDTD sub-gridding technique that allows for increased resolution in regions of interest without increasing the overall computational requirements beyond the available resources. Furthermore, the formulation presented here allows for traversing dielectric boundaries using any integer refinement factor and the maximum Courant number. By allowing the coarse-/fine-grid boundary to traverse dielectric boundaries, numerical simulations that were previously either extremely difficult or impossible to perform are now possible. The technique presented here uses a weighted current value from the coarse region at the boundary between the fine- and coarse-grid regions to update the fine-region tangential fields on that boundary. The weighting function depends on the material properties and the relative position of the fine-region electric field within the current contour at the boundary. The complete formulation of this new technique is described and some results of simulation cases are presented to validate the accuracy and stability of the newly developed FDTD code. Simulations include simple cases where the analytical solution exists and more complex cases, which were impossible to model using a uniform-grid FDTD code. In some simulation examples, computer memory savings as high as 70 times what would have been necessary with a uniform-grid code were achieved. It is shown that errors of less than 2% are achievable with ratios of coarse-to-fine grid sizes exceeding ten. The new technique is expected to be used in simulating many electrically large and complex structures in the biomedical microwave processing of materials and the wireless communications areas.

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