Integration of the FDTD Method into the Iterative Multi-Region Technique for Scattering from Multiple Three Dimensional Objects

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The integration of the finite-difference time-domain method (FDTD) into the iterative multi region (IMR) technique, an iterative approach used to solve large-scale electromagnetic problems, is presented in this contribution.

Solution of large scale problems has been one of the major challenges of computational electromagnetics. One approach to address this problem is to divide a problem space into smaller subregions and combine the solutions of subregions to achieve the solution for the large domain. Solution of the subregions using frequency domain solvers has been the preferred approach as such solutions using time domain solvers require computationally expensive bookkeeping of time signals. In this contribution we present an algorithm that makes it feasible to use the FDTD method, a time domain numerical technique, in the IMR technique to achieve solutions at a pre-specified number of frequencies.

The idea of the IMR technique is to divide a large computational domain in which several separate objects exist as scatterers into smaller subregions and solve each subregion separately. In each subregion, the scattered electromagnetic near fields are calculated due to the original incident wave. Then, these scattered fields are imposed as the new excitation sources for the opposing subregions leading to a new set of scattered fields identified in a new iteration. This procedure is repeated iteratively until a convergence is achieved.

The IMR technique was first presented as a frequency domain method where numerical methods such as FDFD or method of moments (MoM) are employed to calculate scattered fields in the subregions. In the present contribution, we adapt the use of the FDTD method; as a consequence a problem can be solved at a number of frequencies instead of a single frequency. As in the IMR technique the excitation fields are calculated in the frequency domain, thus a frequency domain to time domain transformation is needed to convert the calculated excitation fields into time domain waveforms and use these waveforms to excite the FDTD problem spaces. A key contribution in this implementation is the waveform construction. We present an algorithm to construct a time waveform that includes in its frequency spectrum the required magnitudes and phases of time-harmonic signals of the desired solution frequencies.