A Novel Subgridding Approach with Huygens Surface and Unconditionally Stable Method

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Based upon the equivalent principle and Crank-Nicholson time domain (CNTD) scheme, we present a novel subgridding method for the FDTD. In the proposed method, rather than electric and magnetic fields, the equivalent electric and magnetic currents on Huygens surface are considered as the commuter between coarse and fine grids. The unconditionally stable CNTD method is employed to replace the conventional FDTD method in fine grid, which enables electromagnetic fields be updated synchronously in both coarse and fine grids. As a result, tremendous reduction in the complexity of programming and coding has been achieved. Numerical examples show that this method has two significant advantages: the size ratio between coarse and fine grids can be arbitrarily large and late time instability has been suppressed.

In the traditional methods, the interface between coarse and fine grids is considered the boundary condition by each other. Recently, a new subgridding technique is presented. The physical connection between two areas in that method is realized by means of Huygens surfaces. Equivalent currents instead of the fields become the commuter of the coarse grids and fine grids. Two major advantages of this method is arbitrarily large spatial ratio and no significant numerical reflection from the interface. However, the late time instability is an awkward drawback to this method. In this paper, a new subgridding technique with late time stability is presented. The similar procedure is taken to produce the equivalent currents, but the CNTD method instead of Yee's FDTD is employed in the area with fine grids in this method. The fields in fine grids can be updated with those in coarse grids synchronously due to the feature of CNTD method. At the same time, the advantages of arbitrarily large spatial ratio and no obvious numerical reflection are reserved. More important thing of this method is there is no late time instability phenomenon.