A Novel Unconditionally Stable FDTD Scheme with UUPML for Structures with Curved Surfaces

Z. Huang and G. Pan
Arizona State University, Tempe, AZ, 85281

Combining the universally applicable uniaxial perfectly matched layers (UUPML) formulation and simple anisotropic affective medium method (SAEM), we present a novel unconditionally stable FDTD for structures with curved surfaces. Rather than to approximate the curved boundary with staircase, the unit cell with partial material fulfillment is treated by the SAEM method as the equivalent permittivity and permeability variations. These cells are then embedded into the existing unconditionally stable FDTD schemes naturally, with little additional effort using the UUPML formulation. Numerical cases show that the new scheme is unconditionally stable, and it improves the numerical accuracy tremendously for structures with curved surfaces comparing with the conventional USTD schemes.

SAEM was developed to overcome the inaccuracy of staircase approximation for curved surfaces in Yee's FDTD. By considering the partially filled cell as its permittivity and permeability variation, this method can achieve high numerical accuracy using relative low grid resolution. Only one time calculation for equivalent permittivity and permeability is needed. UUPML was developed to truncate computational boundaries for all kinds advanced FDTD methods without changing theirs original updating equations. It treats material parameters as the updating coefficient differences for both PML and normal computational regions. Therefore, the idea of SAEM is readily applicable for unconditionally stable FDTD methods with the aid of UUPML. Combining these two ideas, a novel unconditionally stable method is presented here, which is ready to simulate the numerical cases with curved surfaces. This method can obtain high numerical accuracy with low grid resolution and keep the unconditional stability at the same time.