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论文

基于非零散度关系的交替方向隐式减缩FDTD算法

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摘要
该文证明了即使在无源区域，交替方向隐式时域有限差分法(ADI-FDTD)所给出的电磁场量不满足零散度关系，同时推导出了该散度关系的具体表达式。基于该非零散度关系，将不受Courant稳定条件限制的ADI-FDTD法和能节约最多达1/3内存的减缩时域有限差分(R-FDTD)法结合，提出了一种新的交替方向隐式减缩FDTD算法。该算法保留了ADI-FDTD能增大时间步长，缩短计算时间的优点，同时与ADI-FDTD相比节约了最多达1/3(三维)或2/5(二维)的内存。与基于零散度关系的ADI/R-FDTD相比，该算法避免了采用长时间步长计算时的发散现象。应用所提出的ADI/R-FDTD算法计算了二维自由空间波的传播及一维频率选择表面垂直入射的问题，计算结果与ADI-FDTD计算结果完全一致，验证了ADI/R-FDTD的正确性和有效性。

关键词 FDTD 减缩时域有限差分法(R-FDTD) 交替方向隐式(ADI)技术

分类号 O441

An Algorithm of ADI-FDTD and R-FDTD Based on Non-zero Divergence Relationship

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Abstract
In this paper, it is proven that the divergence relationship of electric-field and magnetic-field is non-zero even in charge-free regions, when the electric-field and magnetic-field are calculated with Alternating Direction Implicit Finite-Difference Time-Domain (ADI-FDTD) method, and the concrete expression of the divergence relationship is derived. Based on the non-zero divergence relationship, the ADI-FDTD which is unconditionally stable is combined with the Reduced Finite-Difference Time-Domain(R-FDTD). In the proposed method (ADI/R-FDTD), the merit of ADI-FDTD, e.g. increasing time step size and decreasing calculation time, is kept, at the same time, the memory requirement is reduced by 1/3(3-D) or 2/5(2-D) of the memory requirement of ADI-FDTD. Compare to the ADI/R-FDTD based on regular zero divergence relationship, the proposed algorithm is more stable when lager time step size is used. Wave propagation in 2-D free space and the scattered field of a 1-D Frequency Selective Surface(FSS) is simulated by the proposed hybrid method. Compared with ADI-FDTD，perfect agreement of numerical results indicates that ADI/R-FDTD method is correct and efficient.

Key words FDTD Reduced Finite-Difference Time-Domain (R-FDTD) Alternating Direction Implicit(ADI) technique

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