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High-Order Accurate FDTD Schemes for Dispersive Maxwell's Equations in Second-Order Form Using Recursive Convolutions

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Abstract

We propose a novel finite-difference time-domain (FDTD) scheme for the solution of the Maxwell's equations in which linear dispersive effects are present. The method uses high-order accurate approximations in space and time for the dispersive Maxwell's equations written as a second-order vector wave equation with a time-history convolution term. The modified equation approach is combined with the recursive convolution (RC) method to develop high-order approximations accurate to any desired order in space and time. High-order-accurate centered approximations of the physical Maxwell interface conditions are derived for the dispersive setting in order to fully restore accuracy at discontinuous material interfaces. Second- and fourth-order accurate versions of the scheme are presented and implemented in two spatial dimensions for the case of the Drude linear dispersion model. The stability of these schemes is analyzed. Finally, our approach is also amenable to curvilinear numerical grids if used with appropriate generalized Laplace operator.

Keywords: Dispersive Maxwell, FDTD, Recursive Convolution, Wave Equations

Contents

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