Higher Stability Limits for the Symplectic FDTD Method by Making Use of Chebyshev Polynomials

Authors: M. Kusaf ; A.Y. Oztoprak

Abstract:
A new scheme is introduced for obtaining higher stability performance for the symplectic finite-difference time-domain (FDTD) method. Both the stability limit and the numerical dispersion of the symplectic FDTD are determined by a function zeta. It is shown that when the zeta function is a Chebyshev polynomial the stability limit is linearly proportional to the number of the exponential operators. Thus, the stability limit can be increased as much as possible at the cost of increased number of operators. For example, the stability limit of the four-exponential operator scheme is 0.989 and of the eight-exponential operator scheme it is 1.979 for fourth-order space discretization in three dimensions, which is almost three times the stability limit of previously published symplectic FDTD schemes with a similar number of operators. This study also shows that the numerical dispersion errors for this new scheme are less than those of the previously reported symplectic FDTD schemes

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