Abstracts

Dispersion of homogeneous and inhomogeneous waves in the Yee finite-difference time-domain grid

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The numerical dispersion relation governing the propagation of homogeneous plane waves in a finite-difference time-domain (FDTD) grid is well known. However, homogeneous plane waves, by themselves, do not form a complete basis set capable of representing all valid field distributions. A complete basis set is obtained by including inhomogeneous waves, where, in the physical world, constant phase planes must be orthogonal to constant amplitude planes for lossless media. In this paper, me present a dispersion analysis for both homogeneous and inhomogeneous plane waves in the Yee FDTD grid. We show that, in general, the constant amplitude and constant phase planes of inhomogeneous plane waves are not orthogonal, but they approach orthogonality for fine discretization. The dispersion analysis also shows that, for very coarsely resolved fields, homogeneous waves will experience exponential decay as they propagate and they may propagate faster than the speed of light. Bounds are established for the speed of propagation within the grid, as well as the highest frequency and the shortest wavelength that can be coupled into the grid. Analysis is restricted to the classic Yee algorithm, but a similar approach can be used to analyze other time-domain finite-difference methods.

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