Fourth-Order Finite Difference Methods for Diffraction Gratings

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For diffraction grating problems [1], the Fourier modal method (FMM) [2] is widely used. In the two-dimensional case, the structure is periodic in one direction and is layered in the other direction. In each layer, the wave field is expanded in the eigenmodes, and the eigenmodes are calculated by a discretization based on Fourier series. In this paper, we develop two finite difference (FD) methods using a compact fourth order FD approximation [3] in the periodic direction. The 4th order FD modal method calculates the eigenmodes in each layer as in FMM. Since the matrix is complex for absorbing media, it is expensive to calculate the eigenmodes in each layer. The 4th order FD Dirichlet-to-Neumann (DtN) map method avoids the eigenvalue problem in each layer by computing the DtN map of the layer. We compare the two FD methods with FMM and demonstrate the improvement in efficiency and accuracy.

References

