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Title

Arbitrary-Order Full-Vectorial Interface Conditions and Higher Order Finite-Difference Analysis of Optical Waveguides

Source

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Abstract

We derive generalized full-vectorial continuity relations of field derivatives across an abrupt curved interface. Using the Helmholtz wave equation, we can extend the interface conditions by two orders. Repeating the process, we obtain interface conditions of even and odd orders from the zeroth- and first-order interface conditions, respectively, which can be extended to arbitrary orders. The interface conditions combined with Taylor series expansion are applied in higher order full-vectorial finite-difference analysis of several waveguide structures. From effective index convergence analysis of optical fiber modes, the 6-, 15-, and 28-point schemes give second-, fourth-, and sixth-order convergence, respectively. The higher order formulation is also applied to guided mode analysis of photonic crystal fibers and terahertz pipe waveguides, where improved accuracy is obtained when using higher order scheme. Our proposed method allows coarser discretization, which can greatly reduce the computation time and memory. The ultimate accuracy can also be higher due to smaller accumulated roundoff error.