

Higher Order FDTD Schemes for Waveguide and Antenna Structures

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Higher Order FDTD Schemes for Waveguide and Antenna Structures

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SYNTHESIS LECTURES ON COMPUTATIONAL ELECTROMAGNETICS #3

ABSTRACT

This publication provides a comprehensive and systematically organized coverage of higher order *finite-difference time-domain* or FDTD schemes, demonstrating their potential role as a powerful modeling tool in computational electromagnetics. Special emphasis is drawn on the analysis of contemporary waveguide and antenna structures. Acknowledged as a significant breakthrough in the evolution of the original Yee's algorithm, the higher order FDTD operators remain the subject of an ongoing scientific research. Among their indisputable merits, one can distinguish the enhanced levels of accuracy even for coarse grid resolutions, the fast convergence rates, and the adjustable stability. In fact, as the fabrication standards of modern systems get stricter, it is apparent that such properties become very appealing for the accomplishment of elaborate and credible designs.

KEYWORDS

finite-difference time-domain methods, FDTD, computational electromagnetics, Yee's algorithm, waveguide and antenna structure and analysis, electromagnetic modeling,

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Preface

The present book provides a comprehensive and systematically organized coverage of higher order FDTD schemes, demonstrating their potential role as a powerful modeling tool in computational electromagnetics. Special emphasis is drawn on the analysis of contemporary waveguide and antenna structures. Acknowledged as a significant breakthrough in the evolution of the original Yee's algorithm, the higher order FDTD operators remain the subject of an ongoing scientific research. Among their indisputable merits, one can distinguish the enhanced levels of accuracy even for coarse grid resolutions, the fast convergence rates, and the adjustable stability. In fact, as the fabrication standards of modern systems get stricter, it is apparent that such properties become very appealing for the accomplishment of elaborate and credible designs.

In Chapter 1, the book begins with a brief, yet informative, introduction on time-domain algorithms, the most characteristic shortcomings of Yee's technique, and the classification of higher order FDTD schemes in conventional and nonstandard counterparts. The investigation of the former – both explicit and implicit – along with a thorough analysis of interface treatment and dispersion-error optimization is conducted in Chapter 2. Chapter 3 covers the theoretical formulation of higher order nonstandard operators and introduces a generalized curvilinear covariant/contravariant methodology for broadband simulations. The topic of absorbing boundary conditions for open-region termination is carefully examined in Chapter 4, which also presents several techniques for the manipulation of the inevitably widened spatial stencils near dissimilar material interfaces or lattice ends. Chapter 5 discusses diverse structural extensions and temporal integration approaches focusing on lossy, frequency-dependent and dispersion-reduction approaches. Moreover, the hybridization of higher order FDTD forms with other efficient algorithms and the possibility of increasing the order of accuracy of several alternative methods are explored in Chapter 6. Finally, Chapters 7 and 8 are devoted to the numerical modeling of up-to-date waveguides and antennas, respectively. A lot of indicative examples are presented and various complicated configurations are successfully solved. All applications are realistic, while most of the results are compared with measurements or reference data. It is stressed that every chapter closes with an extensive list of references that offer additional evidence and details on the competence of higher order schemes to the more interested reader.

Conclusively, the flavor of the book is the profitable link between the underlying physical background and the computational practice of the higher order FDTD method. Therefore, it is

the hope of the authors that it will be contributive as a basis to the researcher pursuing effective substitutes to traditional ideas or serve as a state-of-the-art review for this rapidly growing numerical technique.

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