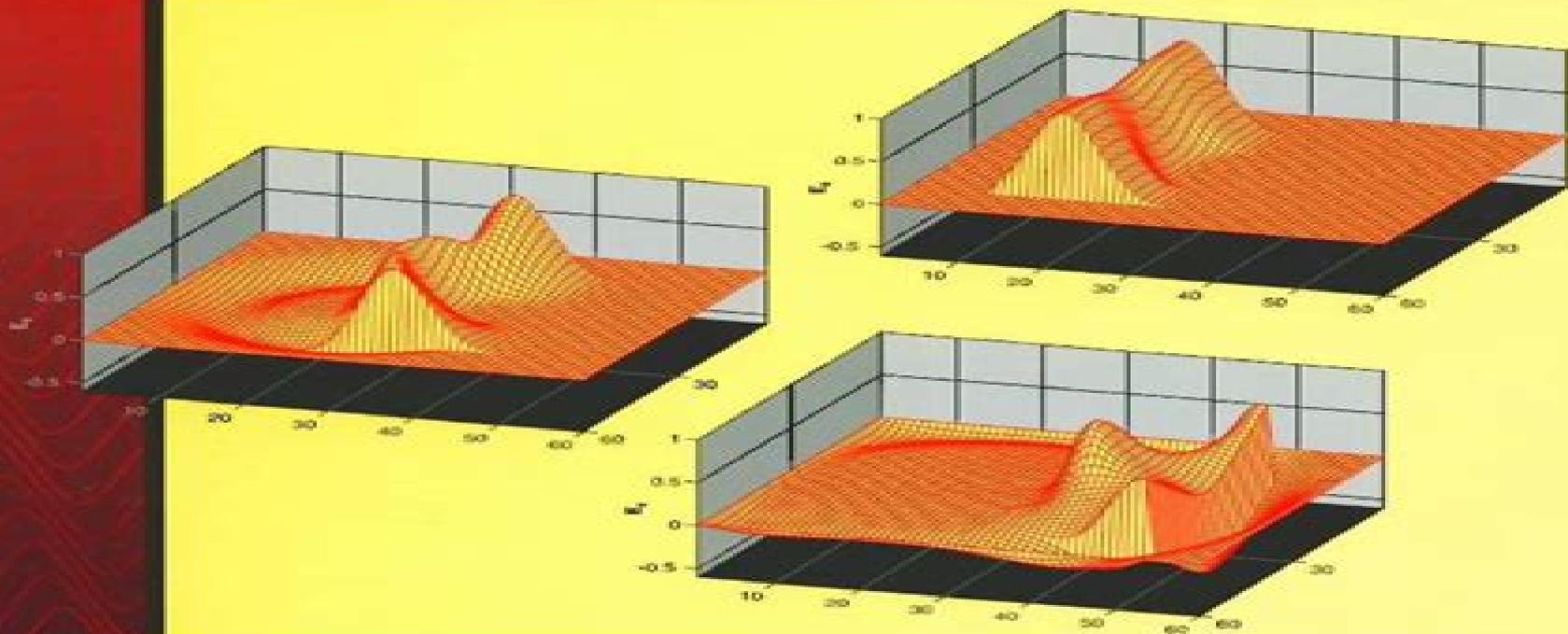


ELECTROMAGNETIC SIMULATION USING THE FDTD METHOD

DENNIS M. SULLIVAN



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Electromagnetic Simulation Using The Fdtd Method

George W. Pan



Electromagnetic Simulation Using The FDTD Method:

Electromagnetic Simulation Using the FDTD Method with Python Jennifer E. Houle, Dennis M. Sullivan, 2020-01-15
Provides an introduction to the Finite Difference Time Domain method and shows how Python code can be used to implement various simulations. This book allows engineering students and practicing engineers to learn the finite difference time domain FDTD method and properly apply it toward their electromagnetic simulation projects. Each chapter contains a concise explanation of an essential concept and instruction on its implementation into computer code. Included projects increase in complexity ranging from simulations in free space to propagation in dispersive media. This third edition utilizes the Python programming language which is becoming the preferred computer language for the engineering and scientific community.

Electromagnetic Simulation Using the FDTD Method with Python Third Edition is written with the goal of enabling readers to learn the FDTD method in a manageable amount of time. Some basic applications of signal processing theory are explained to enhance the effectiveness of FDTD simulation. Topics covered include one dimensional simulation with the FDTD method, two dimensional simulation, and three dimensional simulation. The book also covers advanced Python features and deep regional hyperthermia treatment planning.

Electromagnetic Simulation Using the FDTD Method with Python Guides the reader from basic programs to complex three dimensional programs in a tutorial fashion. Includes a rewritten fifth chapter that illustrates the most interesting applications in FDTD and the advanced graphics techniques of Python. Covers peripheral topics pertinent to time domain simulation such as Z transforms and the discrete Fourier transform. Provides Python simulation programs on an accompanying website. An ideal book for senior undergraduate engineering students studying FDTD.

Electromagnetic Simulation Using the FDTD Method with Python will also benefit scientists and engineers interested in the subject.

Electromagnetic Simulation Using the FDTD Method Dennis M. Sullivan, 2013-05-17 A straightforward easy to read introduction to the finite difference time domain FDTD method. Finite difference time domain FDTD is one of the primary computational electrodynamics modeling techniques available. Since it is a time domain method FDTD solutions can cover a wide frequency range with a single simulation run and treat nonlinear material properties in a natural way. Written in a tutorial fashion starting with the simplest programs and guiding the reader up from one dimensional to the more complex three dimensional programs this book provides a simple yet comprehensive introduction to the most widely used method for electromagnetic simulation. This fully updated edition presents many new applications including the FDTD method being used in the design and analysis of highly resonant radio frequency RF coils often used for MRI. Each chapter contains a concise explanation of an essential concept and instruction on its implementation into computer code. Projects that increase in complexity are included ranging from simulations in free space to propagation in dispersive media. Additionally the text offers downloadable MATLAB and C programming languages from the book support site <http://booksupport.wiley.com>. Simple to read and classroom tested.

Electromagnetic Simulation Using the FDTD Method is a useful reference for practicing engineers as

well as undergraduate and graduate engineering students Electromagnetic Simulation Techniques Based on the FDTD Method W. Yu, 2009-09-15 Bridges the gap between FDTD theory and the implementation of practical simulation techniques This is the first publication that guides readers step by step through the implementation of electromagnetic simulation techniques based on FDTD methods These simulation techniques serve as an essential bridge between FDTD methods and their applications Moreover the book helps readers better understand the underlying logic of FDTD methods so that they can design FDTD projects using either commercial electromagnetic software packages or their own codes in order to solve practical engineering problems The book begins with two chapters that introduce the basic concepts of the 3 D Cartesian FDTD method followed by discussions of advanced FDTD methods such as conformal techniques dispersive media circuit elements and near to far field transformation Next the book Presents basic concepts of parallel processing techniques and systems including parallel FDTD techniques and systems Explores simulation techniques based on FDTD methods Illustrates practical simulation techniques using engineering applications Introduces advanced simulation techniques Each chapter concludes with references to help readers investigate particular topics in greater depth Each chapter also includes problem sets that challenge readers to put their new FDTD and simulation skills into practice By bridging the gap between FDTD theory and practical simulation techniques this publication is an invaluable guide for students and engineers who need to solve a wide range of design problems in RF antenna and microwave engineering *Numerical Electromagnetics* Umran S. Inan, Robert A. Marshall, 2011-04-07 Beginning with the development of finite difference equations and leading to the complete FDTD algorithm this is a coherent introduction to the FDTD method the method of choice for modeling Maxwell s equations It provides students and professional engineers with everything they need to know to begin writing FDTD simulations from scratch and to develop a thorough understanding of the inner workings of commercial FDTD software Stability numerical dispersion sources and boundary conditions are all discussed in detail as are dispersive and anisotropic materials A comparative introduction of the finite volume and finite element methods is also provided All concepts are introduced from first principles so no prior modeling experience is required and they are made easier to understand through numerous illustrative examples and the inclusion of both intuitive explanations and mathematical derivations

Introduction to the Finite-Difference Time-Domain (FDTD) Method for Electromagnetics Stephen Gedney, 2022-05-31 Introduction to the Finite Difference Time Domain FDTD Method for Electromagnetics provides a comprehensive tutorial of the most widely used method for solving Maxwell s equations the Finite Difference Time Domain Method This book is an essential guide for students researchers and professional engineers who want to gain a fundamental knowledge of the FDTD method It can accompany an undergraduate or entry level graduate course or be used for self study The book provides all the background required to either research or apply the FDTD method for the solution of Maxwell s equations to practical problems in engineering and science Introduction to the Finite Difference Time Domain FDTD Method for Electromagnetics

guides the reader through the foundational theory of the FDTD method starting with the one dimensional transmission line problem and then progressing to the solution of Maxwell s equations in three dimensions It also provides step by step guides to modeling physical sources lumped circuit components absorbing boundary conditions perfectly matched layer absorbers and sub cell structures Post processing methods such as network parameter extraction and far field transformations are also detailed Efficient implementations of the FDTD method in a high level language are also provided Table of Contents Introduction 1D FDTD Modeling of the Transmission Line Equations Yee Algorithm for Maxwell s Equations Source Excitations Absorbing Boundary Conditions The Perfectly Matched Layer PML Absorbing Medium Subcell Modeling Post Processing

Computational Electromagnetics Raj Mittra,2013-08-20 Emerging Topics in Computational Electromagnetics in Computational Electromagnetics presents advances in Computational Electromagnetics This book is designed to fill the existing gap in current CEM literature that only cover the conventional numerical techniques for solving traditional EM problems The book examines new algorithms and applications of these algorithms for solving problems of current interest that are not readily amenable to efficient treatment by using the existing techniques The authors discuss solution techniques for problems arising in nanotechnology bioEM metamaterials as well as multiscale problems They present techniques that utilize recent advances in computer technology such as parallel architectures and the increasing need to solve large and complex problems in a time efficient manner by using highly scalable algorithms

Electromagnetic Computation Methods for Lightning Surge Protection Studies Yoshihiro Baba,Vladimir A. Rakov,2016-02-02 Presents current research into electromagnetic computation theories with particular emphasis on Finite Difference Time Domain Method This book is the first to consolidate current research and to examine the theories of electromagnetic computation methods in relation to lightning surge protection The authors introduce and compare existing electromagnetic computation methods such as the method of moments MOM the partial element equivalent circuit PEEC the finite element method FEM the transmission line modeling TLM method and the finite difference time domain FDTD method The application of FDTD method to lightning protection studies is a topic that has matured through many practical applications in the past decade and the authors explain the derivation of Maxwell s equations required by the FDTD and modeling of various electrical components needed in computing lightning electromagnetic fields and surges with the FDTD method The book describes the application of FDTD method to current and emerging problems of lightning surge protection of continuously more complex installations particularly in critical infrastructures of energy and information such as overhead power lines air insulated sub stations wind turbine generator towers and telecommunication towers Both authors are internationally recognized experts in the area of lightning study and this is the first book to present current research in lightning surge protection Examines in detail why lightning surges occur and what can be done to protect against them Includes theories of electromagnetic computation methods and many examples of their application Accompanied by a sample printed program based on the finite difference

time domain FDTD method written in C program *Electromagnetic Pulse Simulations Using Finite-Difference Time-Domain Method* Shahid Ahmed,2021-04-13 Electromagnetic Pulse Simulations Using Finite Difference Time Domain Method Discover the utility of the FDTD approach to solving electromagnetic problems with this powerful new resource Electromagnetic Pulse Simulations Using Finite Difference Time Domain Method delivers a comprehensive overview of the generation and propagation of ultra wideband electromagnetic pulses The book provides a broad cross section of studies of electromagnetic waves and their propagation in free space dielectric media complex media and within guiding structures like waveguide lines transmission lines and antennae The distinguished author offers readers a fresh new approach for analyzing electromagnetic modes for pulsed electromagnetic systems designed to improve the reader s understanding of the electromagnetic modes responsible for radiating far fields The book also provides a wide variety of computer programs data analysis techniques and visualization tools with state of the art packages in MATLAB and Octave Following an introduction and clarification of basic electromagnetics and the frequency and time domain approach the book delivers explanations of different numerical methods frequently used in computational electromagnetics and the necessity for the time domain treatment In addition to a discussion of the Finite difference Time domain FDTD approach readers will also enjoy A thorough introduction to electromagnetic pulses EMPs and basic electromagnetics including common applications of electromagnetics and EMP coupling and its effects An exploration of time and frequency domain analysis in electromagnetics including Maxwell s equations and their practical implications A discussion of electromagnetic waves and propagation including waves in free space dielectric mediums complex mediums and guiding structures A treatment of computational electromagnetics including an explanation of why we need modeling and simulations Perfect for undergraduate and graduate students taking courses in physics and electrical and electronic engineering *Electromagnetic Pulse Simulations Using Finite Difference Time Domain Method* will also earn a place in the libraries of scientists and engineers working in electromagnetic research RF and microwave design and electromagnetic interference *Parallel Finite-difference Time-domain Method* Wenhua Yu,2006 The finite difference time domain FTDT method has revolutionized antenna design and electromagnetics engineering This book raises the FDTD method to the next level by empowering it with the vast capabilities of parallel computing It shows engineers how to exploit the natural parallel properties of FDTD to improve the existing FDTD method and to efficiently solve more complex and large problem sets Professionals learn how to apply open source software to develop parallel software and hardware to run FDTD in parallel for their projects The book features hands on examples that illustrate th **Silicon Photonics Design** Lukas Chrostowski,Michael Hochberg,2015-03-12 From design and simulation through to testing and fabrication this hands on introduction to silicon photonics engineering equips students with everything they need to begin creating foundry ready designs In depth discussion of real world issues and fabrication challenges ensures that students are fully equipped for careers in industry Step by step tutorials straightforward examples and illustrative source code fragments

guide students through every aspect of the design process providing a practical framework for developing and refining key skills Offering industry ready expertise the text supports existing PDKs for CMOS UV lithography foundry services OpSIS ePIXfab imec LETI IME and CMC and the development of new kits for proprietary processes and clean room based research Accompanied by additional online resources to support students this is the perfect learning package for senior undergraduate and graduate students studying silicon photonics design and academic and industrial researchers involved in the development and manufacture of new silicon photonics systems

Modern EMC Analysis Techniques Volume I
 Nikolaos V. Kantartzis,Theodoros D. Tsiboukis,2022-05-31 The objective of this two volume book is the systematic and comprehensive description of the most competitive time domain computational methods for the efficient modeling and accurate solution of contemporary real world EMC problems Intended to be self contained it performs a detailed presentation of all well known algorithms elucidating on their merits or weaknesses and accompanies the theoretical content with a variety of applications Outlining the present volume the analysis covers the theory of the finite difference time domain the transmission line matrix modeling and the finite integration technique Moreover alternative schemes such as the finite element the finitevolume the multiresolution time domain methods and many others are presented while particular attention is drawn to hybrid approaches To this aim the general aspects for the correct implementation of the previous algorithms are also exemplified At the end of every section an elaborate reference on the prominent pros and possible cons always in the light of EMC modeling assists the reader to retrieve the gist of each formulation and decide on his her best possible selection according to the problem under investigation Table of Contents Fundamental Time Domain Methodologies for EMC Analysis Alternative Time Domain Techniques in EMC Modeling Principal Implementation Issues of Time Domain EMC Simulation

Advanced Computational Electromagnetic Methods Wenhua Yu,Wenxing Li,Atef Elsherbeni,Yahya Rahmat-Samii,2015-03-01 This new resource covers the latest developments in computational electromagnetic methods with emphasis on cutting edge applications This book is designed to extend existing literature to the latest development in computational electromagnetic methods which are of interest to readers in both academic and industrial areas The topics include advanced techniques in MoM FEM and FDTD spectral domain method GPU and Phi hardware acceleration metamaterials frequency and time domain integral equations and statistics methods in bio electromagnetics

Advanced FDTD Methods Wenhua Yu,2011 Advanced FDTD Methods Parallelization Acceleration and Engineering Applications
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Electromagnetics and Device Modeling George W. Pan,2003-02-05 Equally valuable as a beginning engineer s guide or as
 a reference for experienced engineers and scientists Wavelets in Electromagnetics and Device Modeling offers a quick
 introduction to the basics of wavelets and then without overly complex or abstract mathematics outlines applications of
 wavelets in real world engineering problems Book Jacket Electromagnetic Shielding Salvatore Celozzi,Rodolfo
 Araneo,Giampiero Lovat,2008-04-18 This reference provides a survey of options for the reduction of the electromagnetic field
 levels in prescribed areas This is a resource for practicing telecommunications and electrical engineers as well as
 researchers in industry and academia who are involved in the design and analysis of electromagnetic shielding structures
 Jacket **Journal of the Korean Physical Society** ,2004 **FDTD-based Full Wave Co-simulation Model for Hybrid**
Electromagnetic Systems Tong Li,1999 In high frequency ranges the present electronic design automation software has
 limited capabilities to model electromagnetic EM systems where there are strong field effects influencing their
 characteristics In this situation a full wave simulation tool is desired for the analysis and design of high speed and non linear
 EM systems It is necessary to explore the interaction between the field and electronic components during a transient process
 when field effects are more significant The finite difference time domain FDTD technique receives growing attention in the
 area of EM system analysis and simulation due to its simplicity flexibility and robustness It is a full wave simulation method
 that solves the Maxwell s equations in time domain directly Decades of research and development and rapid growth in
 computer capability have built up a firm foundation for FDTD techniques to be applied to many practical problems Based on
 FDTD this dissertation develops a stable CO simulation method to perform a full wave simulation of a hybrid EM system
 consisting of lumped elements and distributed structures In this method FDTD is used to solve the EM field problems
 associated with distributed structures and a circuit simulator solves the response of lumped elements A field circuit model

proposed in the dissertation serves as the interface between the two simulation tools Compared with previous methods the FDTD method based on this model is much more flexible and stable for linear and nonlinear lumped elements under both small and large signal conditions Because of its flexibility and robustness this model is a promising approach to integrate a field solver and a circuit simulator in the simulations of practical EM systems In order to improve the simulation accuracy some problems related to FDTD simulation are studied Based on the numerical dispersion in homogeneous media uniform grids the FDTD numerical reflection and transmission on the boundary of media which are discretized by a non uniform grid are investigated This investigation provides for the first time an estimation of FDTD numerical error in inhomogeneous media and non uniform grids Perfectly matched layer PML was previously utilized the homogeneous media or uniform grids This dissertation extends the PML boundary conditions to handle the inhomogeneous media and non uniform grid Techniques extracting S parameters from FDTD simulation are also discussed Two and three dimensional CO simulation software written in C has been derived developed and verified in this dissertation The simulation results agree well with results from other simulation methods like SPICE for many test circuits Taking data sampling and interpolation into account simulation results generally fit well to measurement and other simulation results for complicated three dimensional structures With further improvements of the FDTD technique and circuit simulation field circuit CO simulation model will widen its application to general EM systems

The Finite-Difference Time-Domain Method for Electromagnetics with MATLAB® Simulations Atef Z. Elsherbeni, Veysel Demir, 2015-11-25 This is one of the best books on computational electromagnetics both for graduate students focusing on electromagnetics problems and for practicing engineering professionals in industry and government It is designed as an advanced textbook and self study guide to the FDTD method of solving EM problems and simulations This latest edition has been expanded to include 5 entirely new chapters on advanced topics in the mainstream of FDTD practice In addition to advanced techniques it also includes applications and examples and some tricks and traps of using MATLAB to achieve them Compared to the previous version the second edition is more complete and is a good reference for someone who is performing FDTD research This book is part of the ACES Series on Computational Electromagnetics and Engineering Supplementary material can be found at the IET's ebook page Supplementary materials for professors are available upon request via email to books@iet.org

Optical Microlithography, 1999 *Metrology, Inspection, and Process Control for Microlithography XVIII*, 2004

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