

Andrew Seagar

# Application of Geometric Algebra to Electromagnetic Scattering

The Clifford–Cauchy–Dirac Technique

# Application Of Geometric Algebra To Electromagnetic Scattering The Clifford Cauchy Dirac Technique

**Yijin Wang**

## **Application Of Geometric Algebra To Electromagnetic Scattering The Clifford Cauchy Dirac Technique:**

**Application of Geometric Algebra to Electromagnetic Scattering** Andrew Seagar,2015-11-12 This work presents the Clifford Cauchy Dirac CCD technique for solving problems involving the scattering of electromagnetic radiation from materials of all kinds It allows anyone who is interested to master techniques that lead to simpler and more efficient solutions to problems of electromagnetic scattering than are currently in use The technique is formulated in terms of the Cauchy kernel single integrals Clifford algebra and a whole field approach This is in contrast to many conventional techniques that are formulated in terms of Green's functions double integrals vector calculus and the combined field integral equation CFIE Whereas these conventional techniques lead to an implementation using the method of moments MoM the CCD technique is implemented as alternating projections onto convex sets in a Banach space The ultimate outcome is an integral formulation that lends itself to a more direct and efficient solution than conventionally is the case and applies without exception to all types of materials On any particular machine it results in either a faster solution for a given problem or the ability to solve problems of greater complexity The Clifford Cauchy Dirac technique offers very real and significant advantages in uniformity complexity speed storage stability consistency and accuracy

**Numerical Calculations in Clifford Algebra** Andrew Seagar,2023-05-30 NUMERICAL CALCULATIONS IN CLIFFORD ALGEBRA An intuitive combination of the theory of Clifford algebra with numerous worked and computed examples and calculations Numerical Calculations in Clifford Algebra A Practical Guide for Engineers and Scientists is an accessible and practical introduction to Clifford algebra with comprehensive coverage of the theory and calculations The book offers many worked and computed examples at a variety of levels of complexity and over a range of different applications making extensive use of diagrams to maintain clarity The author introduces and documents the Clifford Numerical Suite developed to overcome the limitations of existing computational packages and to enable the rapid creation and deployment of sophisticated and efficient code Applications of the suite include Fourier transforms for arrays of any types of Clifford numbers and the solution of linear systems in which the coefficients are Clifford numbers of particular types including scalars bicomplex numbers quaternions Pauli matrices and extended electromagnetic fields Readers will find A thorough introduction to Clifford algebra with a combination of theory and practical implementation in a range of engineering problems Comprehensive explorations of a variety of worked and computed examples at various levels of complexity Practical discussions of the conceptual and computational tools for solving common engineering problems Detailed documentation on the deployment and application of the Clifford Numerical Suite Perfect for engineers researchers and academics with an interest in Clifford algebra Numerical Calculations in Clifford Algebra A Practical Guide for Engineers and Scientists will particularly benefit professionals in the areas of antenna design digital image processing theoretical physics and geometry

**Mathematical Reviews** ,2004 [Nuclear Science Abstracts](#),1974 [The Linear Sampling Method in Inverse Electromagnetic Scattering](#) Fioralba Cakoni,David Colton,Peter

Monk,2011-01-01 The linear sampling method is the oldest and most developed of the qualitative methods in inverse scattering theory It is based on solving a linear integral equation and then using the equation s solution as an indicator function for the determination of the support of the scattering object This book describes the linear sampling method for a variety of electromagnetic scattering problems It presents uniqueness theorems and the derivation of various inequalities on the material properties of the scattering object from a knowledge of the far field pattern of the scattered wave

### **Development and Application of Differential-equation Based Numerical Techniques to Electromagnetic Scattering and Radiation Problems**

Neil R. S. Simons,1994      Method of Moments for 2D Scattering Problems

Christophe Bourlier,Nicolas Pinel,Gildas Kubické,2013-08-05 Electromagnetic wave scattering from randomly rough surfaces in the presence of scatterers is an active interdisciplinary area of research with myriad practical applications in fields such as optics acoustics geoscience and remote sensing In this book the Method of Moments MoM is applied to compute the field scattered by scatterers such as canonical objects cylinder or plate or a randomly rough surface and also by an object above or below a random rough surface Since the problem is considered to be 2D the integral equations IEs are scalar and only the TE transverse electric and TM transverse magnetic polarizations are addressed no cross polarizations occur In Chapter 1 the MoM is applied to convert the IEs into a linear system while Chapter 2 compares the MoM with the exact solution of the field scattered by a cylinder in free space and with the Physical Optics PO approximation for the scattering from a plate in free space Chapter 3 presents numerical results obtained from the MoM of the coherent and incoherent intensities scattered by a random rough surface and an object below a random rough surface The final chapter presents the same results as in Chapter 3 but for an object above a random rough surface In these last two chapters the coupling between the two scatterers is also studied in detail by inverting the impedance matrix by blocks

Application of Integral Equation and Finite-difference Methods to Electromagnetic Scattering by Two-dimensional and Body of Revolution Geometries James Joseph Kattoor,1990

The theoretical and numerical studies of electromagnetic scattering and radiation from perfectly conducting as well as dielectric bodies are of great importance in the design of various systems such as airborne targets and antennas This thesis is an attempt to investigate integral equation and partial differential equation techniques as tools for numerical solution of such problems These techniques are analyzed and some improvements to existing methods are presented Some scattering problems involving two dimensional and body of revolution geometries are solved using these techniques to demonstrate their capabilities and to point out their limitations The first topic that this thesis addresses is the method of moments technique To demonstrate the techniques developed electromagnetic scattering from perfectly conducting as well as dielectric bodies of revolution is considered There are two major issues addressed in this thesis in this context First the use of quasi entire domain basis functions as an alternative to the more traditional sub sectional basis functions is considered It is shown that using the quasi entire domain basis functions results in a reduction in the size of the matrix that needs to be

solved. The second major topic that Chapter 2 considers is the problem of electromagnetic scattering from layered and partially coated bodies of revolution. The formulation used to solve these problems as well as some results are presented. The partial differential equation technique that this thesis considers is the finite difference method. Chapter 3 discusses the finite difference method in the frequency domain while Chapter 4 focuses on the solution of Maxwell's equations in the time domain. Chapter 3 solves the problem of scattering by a conducting body of revolution using the finite difference method in the frequency domain. The procedure outlined uses the coupled azimuthal potentials introduced by Morgan Chang and Mei 20 to obtain two coupled partial differential equations. These equations are then solved over a domain discretized using a boundary fitted curvilinear coordinate system. The main contribution of this thesis in this respect is the application of the boundary fitted curvilinear coordinate system to this class of problems. It is demonstrated that using this system eliminates the need for using the staircase approximation that is typically required in the finite difference methods. Chapter 4 focuses on circumventing the problem of staircase approximation that is traditionally used to model material boundaries in finite difference time domain algorithms. In this context two methods are presented. The first one referred to in this thesis as the modified stencil approach allows the use of arbitrarily shaped quadrilateral grids. The second is similar to the boundary fitted curvilinear coordinate approach presented in Chapter 3. The methods are compared and contrasted and the advantages and disadvantages of each method are pointed out. [Electromagnetic Scattering from Random Media](#) Timothy R. Field, 2008-12-18. The book develops the dynamical theory of scattering from random media from first principles. Its key findings are to characterize the time evolution of the scattered field in terms of stochastic differential equations and to illustrate this framework in simulation and experimental data analysis. The physical models contain all correlation information and higher order statistics which enables radar and laser scattering experiments to be interpreted. An emphasis is placed on the statistical character of the instantaneous fluctuations as opposed to ensemble average properties. This leads to various means for detection which have important consequences in radar signal processing and statistical optics. The book is also significant also because it illustrates how ideas in mathematical finance can be applied to physics problems in which non Gaussian noise processes play an essential role. This pioneering book represents a significant advance in this field and should prove valuable to leading edge researchers and practitioners at the postgraduate level and above.

[Analytical and Computational Methods in Scattering and Applied Mathematics](#) Fadil Santosa, Ivar Stakgold, 2019-05-07. Professor Ralph Kleinman was director of the Center for the Mathematics of Waves and held the UNIDEL Professorship of the University of Delaware. Before his death in 1998 he made major scientific contributions in the areas of electromagnetic scattering, wave propagation and inverse problems. He was instrumental in bringing together the mathematician **Geometric Scattering Theory** Richard B. Melrose, 1995-07-28. These lecture notes are intended as a non technical overview of scattering theory.

[Acoustic and Electromagnetic Scattering Analysis Using Discrete Sources](#) Adrian Doicu, Yuri A. Eremin, Thomas

Wriedt,2000-07-06 The discrete sources method is an efficient and powerful tool for solving a large class of boundary value problems in scattering theory A variety of numerical methods for discrete sources now exist In this book the authors unify these formulations in the context of the so called discrete sources method Comprehensive presentation of the discrete sources method Original theory an extension of the conventional null field method using discrete sources Practical examples that demonstrate the efficiency and flexibility of elaborated methods scattering by particles with high aspect ratio rough particles nonaxisymmetric particles multiple scattering List of discrete sources programmes available via the Internet *An Integral Equation Method for Electromagnetic Scattering Problems* Arthur K. Jordan,NAVAL RESEARCH LAB WASHINGTON D C.,1975 The purpose of this memorandum report is to document the analysis which was performed to obtain the matrix equation which represents the electromagnetic fields scattered from axially symmetric targets Although these results are not new the analysis is presented in a concise logical manner which is suitable for computer programming and which provides the foundation for the solution of diverse transient electromagnetic scattering problems by the newer methods of natural mode representations and singularity expansion techniques The motivation for this study was to formulate in an understandable manner the necessarily complicated and tedious electromagnetic scattering calculations Even relatively simple targets e g missiles and torpedoes require lengthy calculations The integral equation for electromagnetic scattering from axially symmetric targets is derived The boundary conditions for the case of metallic perfectly conducting and for the case of lossy dielectric targets are applied The integral equation is reduced to matrix form by application of the method of moments The scattering cross section is derived A typical target geometry sphere cone sphere is used as an example The detailed calculations are documented for reference with future computer calculations *The Application of the Lanczos Method of Minimized Iterations to Electromagnetic Scattering Problems* Ronald George Riechers,Cornelius Lanczos,1988

**Application of the Finite Integral Technique and the Measured Equation of Invariance to Electromagnetic Scattering Problems Involving Three-dimensional, Arbitrarily-shaped, Inhomogeneous Bodies** John Hubert Henderson,1997 **Fictitious Domain Method for Unsteady Problems** F. Collino,P. Joly,F. Millot,1996

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