The Radon Transform And Some Of Its Applications

Updating the original, Transforms and Applications Handbook, Third Edition solidifies its place as the complete resource on those mathematical transforms most frequently used by engineers, scientists, and mathematicians. Highlighting the use of transforms and their properties, this latest edition of the bestseller begins with a solid introduction to signals and systems, including properties of the delta function and some classical orthogonal functions. It then goes on to detail different transforms, including lapped, Mellin, wavelet, and Hartley varieties. Written by top experts, each chapter provides numerous examples and applications that clearly demonstrate the unique purpose and properties of each type. The material is presented in a way that makes it easy for readers from different backgrounds to familiarize themselves with the wide range of transform applications. Revisiting transforms previously covered, this book adds information on other important ones, including: Finite Hankel, Legendre, Jacobi, Gengenbauer, Laguerre, and Hermite Fraction Fourier Zak Continuous and discrete Chirp-Fourier Multidimensional discrete unitary Hilbert-Huang Most comparable books cover only a few of the transforms addressed here, making this text by far the most useful for anyone involved in signal processing—including electrical and communication engineers, mathematicians, and any other scientist working in this field.

This Proceedings volume contains a selection of invited and other papers by international scientists which were presented at the VIth International Vilnius Conference on Probability Theory and Mathematical Statistics, held in Vilnius, Lithuania, 28 June--3 July, 1993. The main topics of the conference were: limit theorems, stochastic analysis and stochastic physics, quantum probability theory, statistics, change detection in random processes, and probabilistic number theory.

The Radon transform is an important topic in integral geometry which deals with the problem of expressing a function on a manifold in terms of its integrals over certain submanifolds. Solutions to such problems have a wide range of applications, namely to partial differential equations, group representations, X-ray technology, nuclear magnetic resonance scanning, and tomography. This second edition, significantly expanded and updated, presents new material taking into account some of the progress made in the field since 1980. Aimed at beginning graduate students, this monograph will be useful in the classroom or as a resource for self-study. Readers will find here an accessible introduction to Radon transform theory, an elegant topic in integral geometry.

This book provides a unified view of tomographic techniques and an in-depth treatment of reconstruction algorithms.

Written by a leading scholar in mathematics, this monograph discusses the Radon transform, a field that has wide ranging applications to X-ray technology, partial differential equations, nuclear magnetic resonance scanning, and tomography. In this book, Ehrenpreis focuses on recent research and highlights the strong relationship between high-level pure mathematics and applications of the Radon transform to areas such as medical imaging. The first part of the book discusses parametricand nonparametric Radon transforms, Harmonic Functions and Radon transform on Algebraic Varieties, nonlinear Radon and Fourier transforms, Radon transform on groups, and Radon transform as the interrelation of geometry and analysis. The later parts discuss the extension of solutions of differential equations, Periods of Eisenstein and Poincare, and some problems of integral geometry arising in tomography. Examples and proofs are provided throughout the book to aid the reader's understanding.This is the latest title in the Oxford Mathematical Monographs, which includes texts and monographs covering many topics of current research interest in pure and applied mathematics. Other titles include: Carbone and Semmes: A graphic apology for symmetry and implicitness; Higson and Roe: Analytic K-Homology; Iwaniec and Martin: Geometric Function Theory and Nonlinear Analysis; Lyons and Qian: System Control and Rough Paths. Also new in paperback Johnson and Lapidus: The Feynman Integral andFeynman's Operational Calculus; Donaldson and Kronheimer: The geometry of four-manifolds.

"This thesis focuses on a practical application of some mathematical theory. In particular, how Radon's transform and its inverse play a key role in computerized tomography. The first part of this paper develops the theoretical underpinnings of this imaging process. Secondly, numerical methods used in the computer program are briefly described. Thirdly, a specific algorithm is devised and some examples are provided. Finally, some comparisons and results are discussed"--Document.

This collection is designed to acquaint readers with advances in Radon transforms carried out in the former Soviet Union. The papers focus on mathematical problems related to applications of Radon transforms. Some of the problems arose from practical tomography, while others are theoretical problems originating in tomography. The book should be of use to mathematicians working in integral geometry and mathematical problems of tomography, as well as scientists who work on inverse problems and their computer realization.

In 1917, Johann Radon published his fundamental work, where he introduced what is now called the Radon transform. Including important contributions by several experts, this book reports on ground-breaking developments related to the Radon transform throughout these years, and also discusses novel mathematical research topics and applications for the next century.

This multi-volume handbook is the most up-to-date and comprehensive reference work in the field of fractional calculus and its numerous applications. This first volume collects authoritative chapters covering the mathematical theory of fractional calculus, including fractional-order operators, integral transforms and equations, special functions, calculus of variations, and probabilistic and other aspects.

Over the past decade, the field of image processing has made tremendous advances. One type of image processing that is currently of particular interest is "tomographic imaging," a technique for computing the density function of a body, or discontinuity surfaces of this function. Today, tomography is widely used, and has applications in such fields as medicine, engineering, physics, geophysics, and security. The Radon Transform and Local Tomography clearly explains the theoretical, computational, and practical aspects of applied tomography. It includes sufficient background information to make it essentially self-contained for most readers.

One of the most exciting features of the fields of Radon transforms and tomography is the strong relationship between high-level pure mathematics and applications to areas such as medical imaging and industrial nondestructive evaluation. The proceedings featured in this volume bring together fundamental research articles in the major areas of Radon transforms and tomography. This volume includes expository papers that are of special interest to beginners as well as advanced researchers. Topics include local tomography and wavelets, Lambda tomography and related methods, tomographic methods in RADAR, ultrasound, Radon transforms and differential equations, and the Pompeiu problem. The major themes in Radon transforms and tomography are represented among the research articles.Pure mathematical themes include vector tomography, microlocal analysis, twistor theory, Lie theory, wavelets, harmonic analysis, and distribution theory. The applied articles employ high-quality pure mathematics

to solve important practical problems. Effective scanning geometries are developed and tested for a NASA wind tunnel. Algorithms for limited electromagnetic tomographic data and for impedance imaging are developed and tested. Range theorems are proposed to diagnose problems with tomography scanners. Principles are given for the design of X-ray tomography reconstruction algorithms, and numerical examples are provided. This volume offers readers a comprehensive source of fundamental research useful to both beginners and advanced researchers in the fields.

This book surveys the main mathematical ideas and techniques behind some well-established imaging modalities such as X-ray CT and emission tomography, as well as a variety of newly developing coupled-physics or hybrid techniques, including thermoacoustic tomography. The Radon Transform and Medical Imaging emphasizes mathematical techniques and ideas arising across the spectrum of medical imaging modalities and explains important concepts concerning inversion, stability, incomplete data effects, the role of interior information, and other issues critical to all medical imaging methods. For nonexperts, the author provides appendices that cover background information on notation, Fourier analysis, geometric rays, and linear operators. The vast bibliography, with over 825 entries, directs readers to a wide array of additional information sources on medical imaging for further study.

At the heart of every medical imaging technology is a sophisticated mathematical model of the measurement process and an algorithm to reconstruct an image from the measured data. This book provides a firm foundation in the mathematical tools used to model the measurements and derive the reconstruction algorithms used in most of these modalities. The text uses X-ray computed tomography (X-ray CT) as a 'pedagogical machine' to illustrate important ideas and its extensive discussion of background material makes the more advanced mathematical topics accessible to people with a less formal mathematical education. This new edition contains a chapter on magnetic resonance imaging (MRI), a revised section on the relationship between the continuum and discrete Fourier transforms, an improved description of the gridding method, and new sections on both Grangreat's formula and noise analysis in MR-imaging. Mathematical concepts are illuminated with over 200 illustrations and numerous exercises.

In this text, integral geometry deals with Radon’s problem of representing a function on a manifold in terms of its integrals over certain submanifolds—hence the term the Radon transform. Examples and far-reaching generalizations lead to fundamental problems such as: (i) injectivity, (ii) inversion formulas, (iii) support questions, (iv) applications (e.g., to tomography, partial di erential equations and group representations). For the case of the plane, the inversion theorem and the support theorem have had major applications in medicine through tomography and CAT scanning. While containing some recent research, the book is aimed at beginning graduate students for classroom use or self-study. A number of exercises point to further results with documentation. From the reviews: “Integral Geometry is a fascinating area, where numerous branches of mathematics meet together. the contents of the book is concentrated around the duality and double vibration, which is realized through the masterful treatment of a variety of examples. the book is written by an expert, who has made fundamental contributions to the area.” —Boris Rubin, Louisiana State University

"At the senior level, mathematics students are exposed to many theoretical exercises, but it is rare that they see a practical application of the theory. Without concrete examples, the connection between theory and practice is difficult to make. This paper seeks to examine the Radon transform and its inverse and how these are related to Computerized Tomography at a level which is readily available to senior undergraduates"--Document.

This dissertation deals with several types of imaging: radio tomography, single scattering optical tomography, photoacoustic tomography, and Compton camera imaging. Each of these tomographic techniques leads to a Radon-type transform: radio tomography brings about an elliptical Radon transform, single scattering optical tomography reduces to the V-line Radon transform, and photoacoustic tomography with line detectors boils down to a cylindrical Radon transform. We also introduce a different Radon-type transform arising in photo acoustic tomography with circular detectors, and study mathematically similar object, a toroidal Radon transform. We also consider the cone transform arising in Compton camera imaging as well as the windowed ray transform. We provide inversion formulas for all these transforms. When given some Radon-type transform, we are interested not only in inversion formulas, but also in range conditions, and stability. We thus address range conditions, a stability estimate for some of the Radon-type transforms above. The electronic version of this dissertation is accessible from http://hdl.handle.net/1969.1/151692

This volume is based on two special sessions held at the AMS Annual Meeting in New Orleans in January 2007, and a satellite workshop held in Baton Rouge on January 4-5, 2007. It consists of invited expositions that together represent a broad spectrum of fields, stressing surprising interactions and connections between areas that are normally thought of as disparate. The main topics are geometry and integral transforms. On the one side are harmonic analysis, symmetric spaces, representation theory (the groups include continuous and discrete, finite and infinite, compact and non-compact), operator theory, PDE, and mathematical probability. Moving in the applied direction we encounter wavelets, fractals, and engineering topics such as frames and signal and image processing. The subjects covered in this book form a unified whole, and they stand at the crossroads of pure and applied mathematics. The articles cover a broad range in harmonic analysis, with the main themes related to integral geometry, the Radon transform, wavelets and frame theory.These themes can loosely be grouped together as follows: Frame Theory and Applications Harmonic Analysis and Function Spaces Harmonic Analysis and Number Theory Integral Geometry and Radon Transforms Multiresolution Analysis, Wavelets, and Applications

Fourier Methods in Imaging introduces the mathematical tools for modeling linear imaging systems to predict the action of the system or for solving for the input. The chapters are grouped into five sections, the first introduces the imaging “tasks” (direct, inverse, and system analysis), the basic concepts of linear algebra for vectors and functions, including complex-valued vectors, and inner products of vectors and functions. The second section defines "special" functions, mathematical operations, and transformations that are useful for describing imaging systems. Among these are the Fourier transforms of 1-D and 2-D function, and the Hankel and Radon transforms. This section also considers approximations of the Fourier transform. The third and fourth sections examine the discrete Fourier transform and the description of imaging systems as linear "filters", including the inverse, matched, Wiener and Wiener-Helstrom filters. The final section examines applications of linear system models to optical imaging systems, including holography. Provides a unified mathematical description of imaging systems. Develops a consistent mathematical formalism for characterizing imaging systems. Helps the reader develop an intuitive grasp of the most common mathematical methods, useful for describing the action of general linear systems on signals of one or more spatial dimensions. Offers parallel descriptions of continuous and discrete cases. Includes many graphical and pictorial examples to illustrate the concepts. This book helps students develop an understanding of mathematical tools for describing general one- and two-dimensional linear imaging systems, and will also serve as a reference for engineers and scientists

The first edition of this book has been out of print for some time and I have decided to follow the publisher's kind suggestion to prepare a new edition. Many examples with explicit inversion formulas and range theo rems have been added, and the group-theoretic viewpoint emphasized. For example, the integral geometric viewpoint of the Poisson integral for the disk leads to interesting analogies with the X-ray transform in Euclidean 3-space. To preserve the introductory flavor of the book the short and self-contained Chapter Von Schwartz' distributions has been added. Here §5 provides proofs of the needed results about the Riesz potentials while §§3-4 develop the tools from Fourier analysis following closely the account in Hormander's books (1963] and [1983]. There is some overlap with my books (1984] and [1994b] which however rely heavily on Lie group theory. The present book is much more elementary. I am indebted to Sine

Jensen for a critical reading of parts of the manuscript and to Hilgert and Schlichtkrull for concrete contributions men tioned at specific places in the text. Finally I thank Jan Wetzel and Bonnie Friedman for their patient and skillful preparation of the manuscript.

The Gauss-Radon transform is a weighted Radon transform using the Gaussian kernel. First we develop a Gaussian measure on a hyperplane in Rn? , then we use this measure to develop the Gauss-Radon transform. We construct some examples of Gauss-Radon transforms, including the transforms of polynomial functions and exponential functions. We then develop a Support Theorem for the Gauss-Radon transform similar to a previous theorem for the Radon transform. We then derive three explicit inversion formulas for the Gauss-Radon transform using the relationships between it and the Laplace transform, the Fourier transform, and Segal-Bargmann transform, respectively. Finally, we explore the relationship between Gauss-Radon transforms and conditional expectations and use this to recast several results in a probabilistic setting.

Tomography is the mathematical process of imaging an object via a set of finite slices. In medical imaging, these slices are defined by multiple parallel X-ray beams shot through the object at varying angles. The initial and final intensity of each beam is recorded, and the original image is recreated using this data for multiple slices. I will discuss the central role of the Radon transform and its inversion formula in this recovery process.

Of value to mathematicians, physicists, and engineers, this excellent introduction to Radon transform covers both theory and applications, with a rich array of examples and literature that forms a valuable reference. This 1993 edition is a revised and updated version by the author of his pioneering work.

This volume constitutes the refereed proceedings of the Joint IAPR International Workshops on Structural and Syntactic Pattern Recognition (SSPR 2012) and Statistical Techniques in Pattern Recognition (SPR 2012), held in Hiroshima, Japan, in November 2012 as a satellite event of the 21st International Conference on Pattern Recognition, ICPR 2012. The 80 revised full papers presented together with 1 invited paper and the Pierre Devijver award lecture were carefully reviewed and selected from more than 120 initial submissions. The papers are organized in topical sections on structural, syntactical, and statistical pattern recognition, graph and tree methods, randomized methods and image analysis, kernel methods in structural and syntactical pattern recognition, applications of structural and syntactical pattern recognition, clustering, learning, kernel methods in statistical pattern recognition, kernel methods in statistical pattern recognition, as well as applications of structural, syntactical, and statistical methods.

This contributed volume showcases research and survey papers devoted to a broad range of topics on functional equations, ordinary differential equations, partial differential equations, stochastic differential equations, optimization theory, network games, generalized Nash equilibria, critical point theory, calculus of variations, nonlinear functional analysis, convex analysis, variational inequalities, topology, global differential geometry, curvature flows, perturbation theory, numerical analysis, mathematical finance and a variety of applications in interdisciplinary topics. Chapters in this volume investigate compound superquadratic functions, the Hyers-Ulam Stability of functional equations, edge degenerate pseudo-hyperbolic equations, Kirchhoff wave equation, BMO norms of operators on differential forms, equilibrium points of the perturbed R3BP, complex zeros of solutions to second order differential equations, a higher-order Ginzburg-Landau-type equation, multi-symplectic numerical schemes for differential equations, the Erd?os-Rényi network model, strongly m-convex functions, higher order strongly generalized convex functions, factorization and solution of second order differential equations, generalized topologically open sets in relator spaces, graphical mean curvature flow, critical point theory in infinite dimensional spaces using the Leray-Schauder index, non-radial solutions of a supercritical equation in expanding domains, the semi-discrete method for the approximation of the solution of stochastic differential equations, homotopic metric-interval L-contractions in gauge spaces, Rhoades contractions theory, network centrality measures, the Radon transform in three space dimensions via plane integration and applications in positron emission tomography boundary perturbations on medical monitoring and imaging techniques, the KdV-B equation and biomedical applications.

Abstract: "This paper addresses fast parallel methods for the computation of the Radon (or Hough) Transform. The Radon Transform (RT) of an image is a set of projections of the image taken at different angles. Its computation is important in image processing and computer vision, for problems such as pattern recognition and reconstruction of CAT scan images. We present a unique new method for combining partial results which allows us to construct an algorithm which computes a good approximation to the RT. Our Approximate Discrete Radon Transform (ADRT) algorithm computes 4N- 4 projections through an NxN image in time O(N2logN) (previous algorithms require O(N3)). The method is quite simple and easy to parallelize. A parallel version of the ADRT requires only O(log N) parallel steps on O(N2) processors, ignoring communication time. A surprising property of the algorithm is that it can be applied directly to compute the backprojection step of the inverse RT as well."

Since their emergence in 1917, tomography and inverse problems remain active and important fields that combine pure and applied mathematics and provide strong interplay between diverse mathematical problems and applications. The applied side is best known for medical and scientific use, in particular, medical imaging, radiotherapy, and industrial non-destructive testing. Doctors use tomography to see the internal structure of the body or to find functional information, such as metabolic processes, noninvasively. Scientists discover defects in objects, the topography of the ocean floor, and geological information using X-rays, geophysical measurements, sonar, or other data.This volume, based on the lectures in the Short Course The Radon Transform and Applications to Inverse Problems at the American Mathematical Society meeting in Atlanta, GA, January 3-4, 2005, brings together articles on mathematical aspects of tomography and related inverse problems. The articles cover introductory material, theoretical problems, and practical issues in 3-D tomography, impedance imaging, local tomography, wavelet methods, regularization and approximate inverse, sampling, and emission tomography. All contributions are written for a general audience, and the authors have included references for further reading.

Geophysical Data Analysis: Discrete Inverse Theory is an introductory text focusing on discrete inverse theory that is concerned with parameters that either are truly discrete or can be adequately approximated as discrete. Organized into 12 chapters, the book’s opening chapters provide a general background of inverse problems and their corresponding solution, as well as some of the basic concepts from probability theory that are applied throughout the text. Chapters 3-7 discuss the solution of the canonical inverse problem, that is, the linear problem with Gaussian statistics, and discussions on problems that are non-Gaussian and nonlinear are covered in Chapters 8 and 9. Chapters 10-12 present examples of the use of inverse theory and a discussion on the numerical algorithms that must be employed to solve inverse problems on a computer. This book is of value to graduate students and many college seniors in the applied sciences.

One of the most methodical treatments of electromagnetic wave propagation, radiation, and scattering—including new applications and ideas Presented in two parts, this book takes an analytical approach on the subject and emphasizes new ideas and applications used today. Part one covers fundamentals of electromagnetic wave propagation, radiation, and scattering. It provides ample end-of-chapter problems

and offers a 90-page solution manual to help readers check and comprehend their work. The second part of the book explores up-to-date applications of electromagnetic waves—including radiometry, geophysical remote sensing and imaging, and biomedical and signal processing applications. Written by a world renowned authority in the field of electromagnetic research, this new edition of Electromagnetic Wave Propagation, Radiation, and Scattering: From Fundamentals to Applications presents detailed applications with useful appendices, including mathematical formulas, Airy function, Abel's equation, Hilbert transform, and Riemann surfaces. The book also features newly revised material that focuses on the following topics: Statistical wave theories—which have been extensively applied to topics such as geophysical remote sensing, bio-electromagnetics, bio-optics, and bio-ultrasound imaging Integration of several distinct yet related disciplines, such as statistical wave theories, communications, signal processing, and time reversal imaging New phenomena of multiple scattering, such as coherent scattering and memory effects Multiphysics applications that combine theories for different physical phenomena, such as seismic coda waves, stochastic wave theory, heat diffusion, and temperature rise in biological and other media Metamaterials and solitons in optical fibers, nonlinear phenomena, and porous media Primarily a textbook for graduate courses in electrical engineering, Electromagnetic Wave Propagation, Radiation, and Scattering is also ideal for graduate students in bioengineering, geophysics, ocean engineering, and geophysical remote sensing. The book is also a useful reference for engineers and scientists working in fields such as geophysical remote sensing, bio–medical engineering in optics and ultrasound, and new materials and integration with signal processing.

This book provides readers with a superior understanding of the mathematical principles behind imaging.

This book contains the notes of five short courses delivered at the "Centro Internazionale Matematico Estivo" session "Integral Geometry, Radon Transforms and Complex Analysis" held in Venice (Italy) in June 1996: three of them deal with various aspects of integral geometry, with a common emphasis on several kinds of Radon transforms, their properties and applications, the other two share a stress on CR manifolds and related problems. All lectures are accessible to a wide audience, and provide self-contained introductions and short surveys on the subjects, as well as detailed expositions of selected results.