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Digital Spectral Analysis
Second Edition

COLLINS GARRETT

Spectral Analysis for Univariate Time Series Springer Science & Business Media
Signal Processing for Neuroscientists introduces analysis techniques primarily aimed at neuroscientists and biomedical engineering students with a reasonable but modest background in mathematics, physics, and computer programming. The focus of this text is on what can be considered the ‘golden trio’ in the signal processing field: averaging, Fourier analysis, and filtering. Techniques such as convolution, correlation, coherence, and wavelet analysis are considered in the context of time and frequency domain analysis. The whole spectrum of signal analysis is covered, ranging from data acquisition to data processing; and from the mathematical background of the analysis to the practical application of processing algorithms. Overall, the approach to the mathematics is informal with a focus on basic understanding of the methods and their interrelationships rather than detailed proofs or derivations. One of the principle goals is to provide the reader with the background required to understand the principles of commercially available analyses software, and to allow him/her to construct his/her own analysis tools in an environment such as MATLAB®. Multiple color illustrations are integrated in the text Includes an introduction to biomedical signals, noise characteristics, and recording techniques Basics and background for more advanced topics can be found in extensive notes and appendices A Companion Website hosts the MATLAB scripts and several data files: http://www.elsevierdirect.com/companion.jsp?ISBN=9780123708670
Theory and Application SIAM
An efficient, digital technique for the measure ment of the autocorrelation function and power spectrum of Gaussian random signals is described. As is well known, the power spectrum of a signal can be obtained by a Fourier transformation of its autocorrelation function. This report presents an indirect method of computing the autocorrelation function of a signal having Gaussian statistics which greatly reduces the amount of digital processing that is required. A review of the measurement of power spectra through the autocorrelation function method is given. The one-bit technique of computing the autocorrelation function is presented; in partic ular, the mean and variance of the resulting spectral estimate have been investigated. These results are then applied to the problem of the measurement of spectral lines in radio astronomy. A complete radio-astronomy system is described. (Author).
2 Cambridge University Press
Combining clear explanations of elementary principles, advanced topics and applications with step-by-step mathematical derivations, this textbook provides a comprehensive yet accessible introduction to digital signal processing. All the key topics are covered, including discrete-time Fourier transform, z-transform, discrete Fourier transform and FFT, A/D conversion, and FIR and IIR

filtering algorithms, as well as more advanced topics such as multirate systems, the discrete cosine transform and spectral signal processing. Over 600 full-color illustrations, 200 fully worked examples, hundreds of end-of-chapter homework problems and detailed computational examples of DSP algorithms implemented in MATLAB® and C aid understanding, and help put knowledge into practice. A wealth of supplementary material accompanies the book online, including interactive programs for instructors, a full set of solutions and MATLAB® laboratory exercises, making this the ideal text for senior undergraduate and graduate courses on digital signal processing.
Spectral Analysis and Filter Theory in Applied Geophysics Academic Press
Digital Signal Processing, Second Edition enables electrical engineers and technicians in the fields of biomedical, computer, and electronics engineering to master the essential fundamentals of DSP principles and practice. Many instructive worked examples are used to illustrate the material, and the use of mathematics is minimized for easier grasp of concepts. As such, this title is also useful to undergraduates in electrical engineering, and as a reference for science students and practicing engineers. The book goes beyond DSP theory, to show implementation of algorithms in hardware and software. Additional topics covered include adaptive filtering with noise reduction and echo cancellations, speech compression, signal sampling, digital filter realizations, filter design, multimedia applications, over-sampling, etc. More advanced topics are also covered, such as adaptive filters, speech compression such as PCM, u-law, ADPCM, and multi-rate DSP and over-sampling ADC. New to this edition: MATLAB projects dealing with practical applications added throughout the book New chapter (chapter 13) covering sub-band coding and wavelet transforms, methods that have become popular in the DSP field New applications included in many chapters, including applications of DFT to seismic signals, electrocardiography data, and vibration signals All real-time C programs revised for the TMS320C6713 DSK Covers DSP principles with emphasis on communications and control applications Chapter objectives, worked examples, and end-of-chapter exercises aid the reader in grasping key concepts and solving related problems Website with MATLAB programs for simulation and C programs for real-time DSP
Instrumentation and Applications Courier Dover Publications
Quantum-Mechanical Signal Processing and Spectral Analysis describes the novel application of quantum mechanical methods to signal processing across a range of interdisciplinary research fields. Conventionally, signal processing is viewed as an engineering discipline with its own specific scope, methods, concerns and priorities, not usually encompassing quantum mechanics. However, the dynamics of systems that generate time signals can be successfully described by the general principles and methods of quantum physics, especially within the Schroedinger framework. Most time signals that are measured experimentally are mathematically equivalent to quantum-mechanical auto-correlation functions built from the evolution operator and wavefunctions. This fact allows us to apply the rich conceptual strategies and mathematical apparatus of quantum mechanics to

signal processing. Among the leading quantum-mechanical signal processing methods, this book emphasizes the role of Pade approximant and the Lanczos algorithm, highlighting the major benefits of their combination. These two methods are carefully incorporated within a unified framework of scattering and spectroscopy, developing an algorithmic power that can be exported to other disciplines. The novelty of the author's approach to key signal processing problems, the harmonic inversion and the moment problem, is in establishing the Pade approximant and Lanczos algorithm as entirely algerbraic spectral estimators. This is of paramount theoretical and practical importance, as now spectral analysis can be carried out from closed analytical expressions. This overrides the notorious mathematical ill-conditioning problems with round-off errors that plague inverse reconstructions in those fields that rely upon signal processing. Quantum-Mechanical Signal Processing and Spectral Analysis will be an invaluable resource for researchers involved in signal processing across a wide range of disciplines.

Bayesian Spectrum Analysis and Parameter Estimation Courier Dover Publications

Tensors, or hypermatrices, are multi-arrays with more than two indices. In the last decade or so, many concepts and results in matrix theory?some of which are nontrivial?have been extended to tensors and have a wide range of applications (for example, spectral hypergraph theory, higher order Markov chains, polynomial optimization, magnetic resonance imaging, automatic control, and quantum entanglement problems). The authors provide a comprehensive discussion of this new theory of tensors. Tensor Analysis: Spectral Theory and Special Tensors is unique in that it is the first book on these three subject areas: spectral theory of tensors; the theory of special tensors, including nonnegative tensors, positive semidefinite tensors, completely positive tensors, and copositive tensors; and the spectral hypergraph theory via tensors.

Statistical Spectral Analysis Springer

Along with finite differences and finite elements, spectral methods are one of the three main methodologies for solving partial differential equations on computers. This book provides a detailed presentation of basic spectral algorithms, as well as a systematical presentation of basic convergence theory and error analysis for spectral methods. Readers of this book will be exposed to a unified framework for designing and analyzing spectral algorithms for a variety of problems, including in particular high-order differential equations and problems in unbounded domains. The book contains a large number of figures which are designed to illustrate various concepts stressed in the book. A set of basic matlab codes has been made available online to help the readers to develop their own spectral codes for their specific applications.

Theory and Applications CRC Press

This dissertation covers both the theory and practice of estimating the spectrum of signals in noise using digital data. The theory of describing some of the signal processing concepts for digital data are given and various spectral estimation methods are given. The theory of MEM is described in detail using approaches from estimation theory, communication theory, and statistics. The work was intended to give researchers the theory and practice of practical means of

spectral estimation using communications or scientific data. The Maximum Entropy Method by John Parker Burg is explained from what was known in 1974-75. KEY WORDS: Calculus-of-Variations, Data Systems, Noise , Spectrum Analysis, Time Series Analysis, Autocorrelation, Computer Programs, Data Windowing, Ergodic Process, Maximum Entropy Method (MEM, Fourier Transformation, Optimum Order of Estimation, Sampling, Spectral Resolution, Statistical Significance Test, Systems Analysis, Wiener-Khinchine Theorem. From The Smithsonian/NASA Astrophysics Data System -- The practical aspects of spectral analysis are contrasted with the mathematical theory. Treatment is limited to ergodic processes and emphasizes data window and noise effects. The Discrete Fourier Transform (DFT) and Maximum Entropy Method (MEM) are covered extensively both in theory and application with FORTRAN programs and many examples being provided. Several of the chapters are tutorial and discuss the important topics of sampling theory and system analysis. Topics on MEM include a complete calculus-of-variations solution, relationship between MEM and the Wiener-Khinchine relations, spectral resolution, and choosing the optimum order of the estimation. DFT leakage effects are modeled. A statistical significance test was developed to determine the realness of a spectral component. Keywords: Data Systems, Noise (Sound), Spectrum Analysis, Time Series Analysis, Autocorrelation, Computer Programs, Ergodic Process, Fourier Transformation, Sampling, Systems Analysis [less]

Digital Spectral Analysis MATLAB® Software User Guide Springer Science & Business Media

This state-of-the-art survey serves as a complete overview of the subject. Besides the principles and theoretical foundations, emphasis is laid on practical applicability -- describing not only classical methods, but also modern developments and their applications. Students, researchers and practitioners, especially in the fields of data registration, treatment and evaluation, will find this a wealth of information.

The Intuitive Guide to Fourier Analysis & Spectral Estimation with MATLAB Cambridge University Press

A unified discussion of the formulation and analysis of special methods of mixed initial boundary-value problems. The focus is on the development of a new mathematical theory that explains why and how well spectral methods work. Included are interesting extensions of the classical numerical analysis.

Principles and Applications Steve F. Russell

In pioneering work in the 1950s, S. Karlin and J. McGregor showed that probabilistic aspects of certain Markov processes can be studied by analyzing orthogonal eigenfunctions of associated operators. In the decades since, many authors have extended and deepened this surprising connection between orthogonal polynomials and stochastic processes. This book gives a comprehensive analysis of the spectral representation of the most important one-dimensional Markov processes, namely discrete-time birth-death chains, birth-death processes and diffusion processes. It brings together the main results from the extensive literature on the topic with detailed examples and applications. Also featuring an introduction to the basic theory of orthogonal polynomials and a selection of exercises at the end of each chapter,

it is suitable for graduate students with a solid background in stochastic processes as well as researchers in orthogonal polynomials and special functions who want to learn about applications of their work to probability.

Parametric, Non-Parametric and Advanced Methods Springer Science & Business Media

Spectral analysis requires subjective decisions which influence the final estimate and mean that different analysts can obtain different results from the same stationary stochastic observations. Statistical signal processing can overcome this difficulty, producing a unique solution for any set of observations but that is only acceptable if it is close to the best attainable accuracy for most types of stationary data. This book describes a method which fulfils the above near-optimal-solution criterion, taking advantage of greater computing power and robust algorithms to produce enough candidate models to be sure of providing a suitable candidate for given data.

Concepts and Case Studies Cambridge University Press

Outlines the basic principles, advanced instrumentation, applications and future potential of a range of spectral techniques in food analysis. The book introduces new applications of GC-MS, LC-MS, MALDI TOF-MS, GC-FTIR, SFC-FTIR, ATR, and Raman spectroscopy. The book covers the identification and quantitation of food constituents, additives and contaminants.

Engineering Applications of Correlation and Spectral Analysis Cambridge University Press

This up-to-date introduction to univariate spectral analysis at the graduate level reflects a new scientific awareness of its complexity, as well as its widespread usage on digital computers with considerable computational power.

Spectral Analysis for Physical Applications John Wiley & Sons

Digital signal processing plays a central role in the development of modern communication and information processing systems. The theory and application of signal processing is concerned with the identification, modelling and utilisation of patterns and structures in a signal process. The observation signals are often distorted, incomplete and noisy and therefore noise reduction, the removal of channel distortion, and replacement of lost samples are important parts of a signal processing system. The fourth edition of Advanced Digital Signal Processing and Noise Reduction updates and extends the chapters in the previous edition and includes two new chapters on MIMO systems, Correlation and Eigen analysis and independent component analysis. The wide range of topics covered in this book include Wiener filters, echo cancellation, channel equalisation, spectral estimation, detection and removal of impulsive and transient noise, interpolation of missing data segments, speech enhancement and noise/interference in mobile communication environments. This book provides a coherent and structured presentation of the theory and applications of statistical signal processing and noise reduction methods. Two new chapters on MIMO systems, correlation and Eigen analysis and independent component analysis Comprehensive coverage of advanced digital signal processing and noise reduction methods for communication and information processing systems Examples and applications in signal and

information extraction from noisy data Comprehensive but accessible coverage of signal processing theory including probability models, Bayesian inference, hidden Markov models, adaptive filters and Linear prediction models Advanced Digital Signal Processing and Noise Reduction is an invaluable text for postgraduates, senior undergraduates and researchers in the fields of digital signal processing, telecommunications and statistical data analysis. It will also be of interest to professional engineers in telecommunications and audio and signal processing industries and network planners and implementers in mobile and wireless communication communities.

Automatic Autocorrelation and Spectral Analysis Holden Day

Digital Spectral AnalysisSecond EditionCourier Dover Publications

A Nonprobabilistic Theory Digital Spectral AnalysisSecond Edition Spectral analysis is widely used to interpret time series collected in diverse areas. This book covers the statistical theory behind spectral analysis and provides data analysts with the tools needed to transition theory into practice. Actual time series from oceanography, metrology, atmospheric science and other areas are used in running examples throughout, to allow clear comparison of how the various methods address questions of interest. All major nonparametric and parametric spectral analysis techniques are discussed, with emphasis on the multitaper method, both in its original formulation involving Slepian tapers and in a popular alternative using sinusoidal tapers. The authors take a unified approach to quantifying the bandwidth of different nonparametric spectral estimates. An extensive set of exercises allows readers to test their understanding of theory and practical analysis. The time series used as examples and R language code for recreating the analyses of the series are available from the book's website.

Digital Signal Processing and Spectral Analysis for Scientists Springer Science & Business Media

Introduction and background; Probability functions and amplitude measures; Correlation and spectral density functions; Single input/single output relationships; System identification and response; Propagation path identification; Single input/multiple output problems; Multiple input/output relationships; Energy source identification; Procedures for solving multiple input/output problems; Statistical errors in measurements.

Handbook of Digital Signal Processing Butterworth-Heinemann

This book provides comprehensive, graduate-level treatment of analog and digital signal analysis suitable for course use and self-guided learning. This expert text guides the reader from the basics of signal theory through a range of application tools for use in acoustic analysis, geophysics, and data compression. Each concept is introduced and explained step by step, and the necessary mathematical formulae are integrated in an accessible and intuitive way. The first part of the book explores how analog systems and signals form the basics of signal analysis. This section covers Fourier series and integral transforms of analog signals, Laplace and Hilbert transforms, the main analog filter classes, and signal modulations. Part II covers digital signals, demonstrating their key advantages. It presents z and Fourier transforms, digital filtering, inverse filters, deconvolution, and parametric modeling for

deterministic signals. Wavelet decomposition and reconstruction of non-stationary signals are also discussed. The third part of the book is devoted to random signals, including spectral estimation, parametric modeling, and Tikhonov regularization. It covers statistics of one and two random variables and the principles and methods of spectral analysis. Estimation of signal properties is discussed in the context of ergodicity conditions and parameter estimations, including the use of Wiener and Kalman filters. Two appendices cover the basics of integration in the complex plane and linear algebra. A third appendix presents a basic Matlab toolkit for computer signal analysis. This expert text provides both a solid theoretical understanding and tools for real-world applications.

Recent Advances in Digital Spectral Analysis Springer

"This thesis describes applications of digital spectral analysis and Monte Carlo simulations to the measurement of signal characteristics. Specifically, it treats two applications of Digital Signal Processing: 1) analysis of a Doppler experiment, and 2) measurement of sonar echo parameters in the presence of noise. The first experiment is meant as a teaching tool and consists of analyzing an audio signal received from a rotating buzzer. Measurements of the rotation frequency and the speed of sound are made from the signal's static and dynamic spectra. Monte Carlo simulations are performed in the second application to find Butterworth filter order and bandwidth required for sufficiently accurate and precise measurements sonar echo parameters. These optimum filter settings are given as a function of the signal-to-noise ratio. Better measurements of these echo parameters are needed in fisheries acoustics to characterize, track and count fish"--Leaf 3.