Channel Coding Theory Algorithms And Applications Academic Press Library In Le And Wireless Communications

This book, edited and authored by world leading experts, gives a review of the principles, methods and techniques of important and emerging research topics and technologies in wireless communications and transmission techniques. The reader will: Quickly grasp a new area of research Understand the underlying principles of a topic and its application Ascertain how a topic relates to other areas and learn of the research issues yet to be resolved Reviews important and emerging topics of research in wireless technology in a quick tutorial format Presents core principles in wireless transmission theory Provides reference content on core principles, technologies, algorithms, and applications Includes comprehensive references to journal articles and other literature on which to build further, more specific and detailed knowledge

This text is an elementary introduction to information and coding theory. The first part focuses on information theory, covering uniquely decodable and instantaneous codes, Huffman coding, entropy, information channels, and Shannon’s Fundamental Theorem. In the second part, linear algebra is used to construct examples of such codes, such as the Hamming, Hadamard, Golay and Reed-Muller codes. Contains proofs, worked examples, and exercises.

Coding theory is still a young subject. One can safely say that it was born in 1948. It is not surprising that it has not yet become a fixed topic in the curriculum of most universities. On the other hand, it is obvious that discrete mathematics is rapidly growing in importance. The growing need for mathe maticians and computer scientists in industry will lead to an increase in courses offered in the area of discrete mathematics. One of the most suitable and fascinating is, indeed, coding theory. So, it is not surprising that one more book on this subject now appears. However, a little more justification of the book are necessary. A few years ago it was and a little more history remarked at a meeting on coding theory that there was no book available an introductory course on coding theory (mainly which could be used for for mathematicians but also for students in engineering or computer science). The best known textbooks were either too old, too big, too technical, too much for specialists, etc. The final remark was that my Springer Lecture Notes (# 201) were slightly obsolete and out of print. Without realizing what I was getting into I announced that the statement was not true and proved this by showing several participants the book Inleiding in de Coderingstheorie, a little book based on the syllabus of a course given at the Mathematical Centre in Amsterdam in 1975 (M. C. Syllabus 31).

Information theory lies at the heart of modern technology, underpinning all communications, networking, and data storage systems. This book sets out, for the first time, a complete overview of both classical and quantum information theory. Throughout, the reader is introduced to key results without becoming lost in mathematical details. Opening chapters present the basic concepts and various applications of Shannon's entropy, moving on to the core features of quantum information and quantum computing. Topics such as coding, compression, error-correction, cryptography and channel capacity are covered from classical and quantum viewpoints. Employing an informal yet scientifically accurate approach, Desurvire provides the reader with the knowledge to understand quantum gates and circuits. Highly illustrated, with numerous practical examples and end-of-chapter exercises, this text is ideal for graduate students and researchers in electrical engineering and computer science, and practitioners in the telecommunications industry. Further resources and instructor-only solutions are available at www.cambridge.org/9780521881715.

Coding for Channels with Feedback presents both algorithms for feedback coding and performance analyses of these algorithms, including analyses of perhaps the most important performance criterion: computational complexity. The algorithms are developed within a single framework, termed the compressed-error-cancellation framework, where data are sent via a sequence of messages: the first message contains the original data; each subsequent message contains a source-coded description of the channel distortions introduced on the message preceding it. Coding for Channels with Feedback provides an easily understood and flexible framework for deriving low-complexity, practical solutions to a wide variety of feedback communication problems. It is shown that the compressed-error-cancellation framework leads to coding schemes with the lowest possible asymptotic order of growth of computations and can be applied to discrete memoryless channels, finite state channels, channels with memory, unknown channels, and multiple-access channels, all with complete noiseless feedback, as well as to channels with partial and noisy feedback. This framework leads to coding strategies that have linear complexity and are capacity achieving, and illustrates the intimate connection between source coding theory and channel coding theory. Coding for Channels with Feedback is an excellent reference for researchers and communication engineers in the field of information theory, and can be used for advanced courses on the topic.

Providing in-depth treatment of error correction Error Correction Coding: Mathematical Methods and Algorithms, 2nd Edition provides a comprehensive introduction to classical and modern methods of error correction. The presentation provides a clear, practical introduction to using a lab-oriented approach. Readers are encouraged to implement the encoding and decoding algorithms with explicit algorithm statements and the mathematics used in error correction, balanced with an algorithmic development on how to actually do the encoding and decoding. Both block and stream (convolutional) codes are discussed, and the mathematics required to understand them are introduced on a “just-in-time” basis as the reader progresses through the book. The second edition increases the impact and reach of the book, updating it to discuss recent important technological advances. New material includes: Extensive coverage of LDPC codes, including a variety of decoding algorithms. A comprehensive introduction to polar codes, including systematic encoding/decoding and list decoding. An introduction to fountain codes. Modern applications to systems such as HDTV, DVBT2, and cell phones Error Correction Coding includes extensive program files (for example, C++ code for all LDPC decoders and polar code decoders), laboratory materials for students to implement algorithms, and an updated solutions manual, all of which are perfect to help the reader understand and retain the content. The book covers classical BCH, Reed Solomon, Golay, Reed Muller, Hamming, and convolutional codes which are still component codes in virtually every modern communication system. There are also fulsome discussions of recently developed polar codes and fountain codes that serve to educate the reader on the newest developments in error correction.

This book provides a comprehensive overview of the subject ofchannel coding. It starts with a description of information theory,focusing on the quantitative measurement of information andintroducing two fundamental theorems on source and channel coding.The basics of channel coding in two chapters, block codes andconvolutional codes, are then discussed, and for these the authorsintroduce weighted input and output decoding algorithms andrecursive systematic convolutional codes, which are used in therest of the book. Trellis coded modulations, which have their primary applicationsin high spectral efficiency transmissions, are then covered, beforethe discussion moves on to an advanced coding technique calledturbocoding. These codes, invented in the 1990s by C. Berrou and A.Glavieux, show exceptional performance. The differences betweenconvolutional turbocodes and block turbocodes are outlined, and foreach family, the authors present the coding and decodingtechniques, together with their performances. The book concludeswith a chapter on the implementation of turbocodes in circuits. As such, anyone involved in the areas of channel coding anderror correcting coding will find this book to be of invaluableassistance.

Books on information theory and coding have proliferated over the last few years, but few succeed in covering the fundamentals without losing students in mathematical abstraction. Even fewer build the essential theoretical framework when presenting algorithms and implementation details of modern coding systems. Without abandoning the theoret

This book provides the first comprehensive and easy-to-read discussion of joint source-channel encoding and decoding for source signals with continuous amplitudes. It is a state-of-the-art presentation of this exciting, thriving field of research, making pioneering contributions to the new concept of source-adaptive modulation. The book starts with the basic theory and the motivation for a joint realization of source and channel coding. Specialized chapters deal with practically relevant scenarios such as iterative source-channel decoding and its optimization for a given encoder, and also improved encoder designs by channel-adaptive quantization or source-adaptive modulation. Although Information Theory is not the main topic of the book OCo in fact, the concept of joint source-channel coding is contradictory to the classical system design motivated by a questionable practical interpretation of the separation theorem OCo this theory still provides the ultimate performance limits for any practical system, whether it uses joint source-channel coding or not. Therefore, the theoretical limits are presented in a self-contained appendix, which is a useful reference also for those not directly interested in the main topic of this book. Sample Chapter(s). Chapter 1: Introduction (98 KB). Contents: Joint Source-Channel Coding: An Overview; Joint Source-Channel Decoding; Channel-Adaptive Scaled Vector Quantization; Index Assignments for Multiple Descriptions Vector Quantizers; Source-Adaptive Modulation; Source-Adaptive Power Allocation; Appendices: Theoretical Performance Limits; Optimal Decoder for a Given Encoder; Symbol Error Probabilities for M-PSK; Derivative of the Expected Distortion for SAM. Readership: Students at advanced undergraduate and graduate level; practitioners and academics in Electrical and Communications Engineering, Information Technology and Computer Science."

Audio Coding: Theory and Applications provides succinct coverage of audio coding technologies that are widely used in modern audio coding standards. Delivered from the perspective of an engineer, this book articulates how signal processing is used in the context of audio coding. It presents a detailed treatment of contemporary audio coding technologies and then uses the DRA audio coding standard as a practical example to illustrate how numerous technologies are integrated into a fully-fledged audio coding algorithm. Drawing upon years of practical experience and using numerous examples and illustrations Dr. Yuli You, gives a description of practical audio coding technologies including: • Designing high-performance algorithms that can be readily implemented on fixed-point or integer microprocessors. • How to properly implement an audio decoder on various microprocessors. Transient detection and adaptation of time-frequency resolution of subband filters. • Psychoacoustic models and optimal bit allocation. Audio Coding: Theory and Applications will be a valuable reference book for engineers in the consumer electronics industry, as well as students and researchers in electrical engineering.

This book discusses the latest channel coding techniques, MIMO systems, and 5G channel coding evolution. It provides a comprehensive overview of channel coding, covering modern techniques such as turbo codes, low-density parity-check (LDPC) codes, space–time coding, polar codes, LT codes, and Raptor codes as well as the traditional codes such as cyclic codes, BCH, RS codes, and convolutional codes. It also explores MIMO communications, which is an effective method for high-speed or high-reliability wireless communications. It also examines the evolution of 5G channel coding techniques. Each of the 13 chapters features numerous illustrative examples for easy understanding of the coding techniques, and MATLAB-based programs are integrated in the text to enhance readers’ grasp of the underlying theories. Further, PC-based MATLAB m-files for illustrative examples are included for students and researchers involved in advanced and current concepts of coding theory.

Having trouble deciding which coding scheme to employ, how to design a new scheme, or how to improve an existing system? This summary of the state-of-the-art in iterative coding makes this decision more straightforward. With emphasis on the underlying theory, techniques to analyse and design practical iterative coding systems are presented. Using Gallager's original ensemble of LDPC codes, the basic concepts are extended for several general codes, including the practically important class of turbo codes. The simplicity of the binary erasure channel is exploited to develop analytical techniques and intuition, which are then applied to general channel models. A chapter on factor graphs helps to unify the important topics of information theory, coding and communication theory. Covering the most recent advances, this text is ideal for graduate students in electrical engineering and computer science, and practitioners. Additional resources, including instructor's solutions and figures, available online: www.cambridge.org/9780521852296.

Links information theory and digital communication through the language of lattice codes, featuring many advanced practical setups and techniques.

An important text that offers an in-depth guide to how information theory sets the boundaries for data communication In an accessible and practical style, Information and Communication Theory explores the topic of information theory and includes concrete tools that are appropriate for real-life communication systems. The text investigates the connection between theoretical and practical applications through a wide-variety of topics including an introduction to the basics of probability theory, information, (lossless) source coding, typical sequences as a central concept, channel coding, continuous random variables, Gaussian channels, discrete input continuous channels, and a brief look at rate distortion theory. The author explains the fundamental theory together with typical compression algorithms and how they are used in reality. He moves on to review source coding and how much a source can be compressed, and also explains algorithms such as the LZ family with applications to e.g. zip or png. In addition to exploring the channel coding theorem, the book includes illustrative examples of codes. This comprehensive text: Provides an adaptive version of Huffman coding that estimates source distribution Contains a series of problems that enhance an understanding of information presented in the text Covers a variety of topics including optimal source coding, channel coding, modulation and much more Includes appendices that explore probability distributions and the sampling theorem Written for graduate and undergraduate students studying information theory, as well as professional engineers, master’s students, Information and Communication Theory offers an introduction to how information theory sets the boundaries for data communication.

An unparalleled learning tool and guide to error correction coding Error correction coding techniques allow the detection and correction of errors occurring during the transmission of data in digital communication systems. These techniques are nearly universally employed in modern communication systems, and are thus an important component of the modern information economy. Error Correction Coding: Mathematical Methods and Algorithms provides a comprehensive introduction to both the theoretical and practical aspects of error correction coding, with a presentation suitable for a wide variety of audiences, including graduate students in electrical engineering, mathematics, or computer science. The pedagogy is arranged so that the mathematical concepts are presented incrementally, followed immediately by applications to coding. A large number of exercises expand and deepen students' understanding. A unique feature of the book is a set of programming laboratories, supplemented with over 250 programs and functions on an associated Web site, which provides hands-on experience and a better understanding of the material. These laboratories lead students through the implementation and evaluation of Hamming codes, CRC codes, BCH and R-S codes, convolutional codes, turbo codes, and LDPC codes. This text offers both "classical" coding theory-such as Hamming, BCH, Reed-Solomon, Reed-Muller, and convolutional codes-as well as modern codes and decoding methods, including turbo codes, LDPC codes, repeat-accumulate codes, space time codes, factor graphs, soft-decision decoding, Guruswami-Sudan decoding, EXIT charts, and iterative decoding. Theoretical complements on performance and bounds are presented. Coding is also put into its communications and information theoretic context and connections are drawn to public key cryptosystems. Ideal as a classroom resource and a professional reference, this thorough guide will benefit electrical and computer engineers, mathematicians, students, researchers, and scientists.

How can one exchange information e?ectively when the medium of com- nication introduces errors? This question has been investigated extensively starting with the seminal works of Shannon (1948) and Hamming (1950), and has led to the rich theory of “error-correcting codes”. This theory has traditionally gone hand in hand with the algorithmic theory of “decoding” that tackles the problem of recovering from the errors e?ciently. This thesis presents some spectacular new results in the area of decoding algorithms for error-correctingcodes. Speci?cally,itshowshowthenotionof“list-decoding” can be applied to recover from far more errors, for a wide variety of err- correcting codes, than achievable before. A brief bit of background: error-correcting codes are combinatorial str- tures that show how to represent (or “encode”) information so that it is - silient to a moderate number of errors. Speci?cally, an error-correcting code takes a short binary string, called the message, and shows how to transform it into a longer binary string, called the codeword, so that if a small number of bits of the codewordare ?ipped, the resulting string does not look like any other codeword. The maximum number of errorsthat the code is guaranteed to detect, denoted d, is a central parameter in its design. A basic property of such a code is that if the number of errors that occur is known to be smaller than d/2, the message is determined uniquely. This poses a computational problem,calledthedecodingproblem:computethemessagefromacorrupted codeword, when the number of errors is less than d/2.

Channel Coding in the Presence of Side Information reviews the concepts and methods of communication systems equipped with side information both from the theoretical and practical points of view. It is a comprehensive review that gives the reader an insightful introduction to one of the most important topics in modern communications systems.

Modern introduction to theory of coding and decoding with many exercises and examples.

Covering the full range of channel codes from the most conventional through to the most advanced, the second edition of Turbo Coding, Turbo Equalisation and Space-Time Coding is a self-contained reference on channel coding for wireless channels. The book commences with a historical perspective on the topic, which leads to two basic component codes, convolutional and block codes. It then moves on to turbo codes which exploit iterative decoding by using algorithms, such as the Maximum-A-Posteriori (MAP), Log-MAP and Soft Output Viterbi Algorithm (SOVA), comparing their performance. It also compares Trellis Coded Modulation (TCM), Turbo Trellis Coded Modulation (TTCM), Bit-Interleaved Coded Modulation (BICM) and Iterative BICM (BICM-ID) under various channel conditions. The horizon of the content is then extended to incorporate topics which have found their way into diverse standard systems. These include space-time block and trellis codes, as well as other Multiple-Input Multiple-Output (MIMO) schemes and near-instantaneously Adaptive Quadrature Amplitude Modulation (AQAM). The book also elaborates on turbo equalisation by providing a detailed portrayal of recent advances in partial response modulation schemes using diverse channel codes. A radically new aspect for this second edition is the discussion of multi-level coding and sphere-packing schemes, Extrinsic Information Transfer (EXIT) charts, as well as an introduction to the family of Generalized Low Density Parity Check codes. This new edition includes recent advances in near-capacity turbo-transceivers as well as new sections on multi-level coding schemes and of Generalized Low Density Parity Check codes Comparatively studies diverse channel coded and turbo detected systems to give all-inclusive information for researchers, engineers and students Details EXIT-chart based irregular transceiver designs Uses rich performance comparisons as well as diverse near-capacity design examples

This book provides a comprehensive explanation of forward error correction, which is a vital part of communication systems. The book is written in such a way to make the subject easy and understandable for the reader. The book starts with a review of linear algebra to provide a basis for the text. The author then goes on to cover linear block codes, syndrome error correction, cyclic codes, Galois fields, BCH codes, Reed Solomon codes, and convolutional codes. Examples are provided throughout the text. Provides a comprehensive treatment of forward error correction Includes examples through the book, which are solved in steps, making them easier to understand Ideal for researchers, professionals and students.

Distributed source coding is one of the key enablers for efficient cooperative communication. The potential applications range from wireless sensor networks, ad-hoc networks, and surveillance networks, to robust low-complexity video coding, stereo/Multiview video coding, HDTV, hyper-spectral and multispectral imaging, and biometrics. The book is divided into three sections: theory, algorithms, and applications. Part one covers the background of information theory with an emphasis on DSC; part two discusses designs of algorithmic solutions for DSC problems, covering the three most important DSC problems: Slepian-Wolf, Wyner-Ziv, and MT source coding; and part three is dedicated to a variety of potential DSC applications. Key features: Clear explanation of

distributed source coding theory and algorithms including both lossless and lossy designs. Rich applications of distributed source coding, which covers multimedia communication and data security applications. Self-contained content for beginners from basic information theory to practical code implementation. The book provides fundamental knowledge for engineers and computer scientists to access the topic of distributed source coding. It is also suitable for senior undergraduate and first year graduate students in electrical engineering; computer engineering; signal processing; image/video processing; and information theory and communications.

Boolean functions are essential to systems for secure and reliable communication. This comprehensive survey of Boolean functions for cryptography and coding covers the whole domain and all important results, building on the author's influential articles with additional topics and recent results. A useful resource for researchers and graduate students, the book balances detailed discussions of properties and parameters with examples of various types of cryptographic attacks that motivate the consideration of these parameters. It provides all the necessary background on mathematics, cryptography, and coding, and an overview on recent applications, such as side channel attacks on smart cards, cloud computing through fully homomorphic encryption, and local pseudo-random generators. The result is a complete and accessible text on the state of the art in single and multiple output Boolean functions that illustrates the interaction between mathematics, computer science, and telecommunications.

The advent of wireless sensor technology and ad-hoc networks has made DSC a major field of interest. Edited and written by the leading players in the field, this book presents the latest theory, algorithms and applications, making it the definitive reference on DSC for systems designers and implementers, researchers, and graduate students. This book gives a clear understanding of the performance limits of distributed source coders for specific classes of sources and presents the design and application of practical algorithms for realistic scenarios. Material covered includes the use of standard channel codes, such as LDPC and Turbo codes, to DSC, and discussion of the suitability of compressed sensing for distributed compression of sparse signals. Extensive applications are presented and include distributed video coding, microphone arrays and securing biometric data. This book is a great resource covering the breadth and depth of distributed source coding that’s appropriate for everyone from theoreticians to practitioners. – Richard Baraniuk, Rice University *Clear explanation of the principles of distributed source coding (DSC), a technology that has applications in sensor networks, ad-hoc networks, and distributed wireless video systems for surveillance *Edited and written by the leading players in the field, providing a complete and authoritative reference *Contains all the latest theory, practical algorithms for DSC design and the most recently developed applications

This is the revised edition of Berlekamp's famous book, 'Algebraic Coding Theory', originally published in 1968, wherein he introduced several algorithms which have subsequently dominated engineering practice in this field. One of these is an algorithm for decoding Reed-Solomon and Bose-Chaudhuri-Hocquenghem codes that subsequently became known as the Berlekamp-Massey Algorithm. Another is the Berlekamp algorithm for factoring polynomials over finite fields, whose later extensions and embellishments became widely used in symbolic manipulation systems. Other novel algorithms improved the basic methods for doing various arithmetic operations in finite fields of characteristic two. Other major research contributions in this book included a new class of Lee metric codes, and precise asymptotic results on the number of information symbols in long binary BCH codes.Selected chapters of the book became a standard graduate textbook.Both practicing engineers and scholars will find this book to be of great value.

This book introduces turbo error correcting concept in a simple language, including a general theory and the algorithms for decoding turbo-like code. It presents a unified framework for the design and analysis of turbo codes and LDPC codes and their decoding algorithms. A major focus is on high speed turbo decoding, which targets applications with data rates of several hundred million bits per second (Mbps).

One of the most important key technologies for digital communication systems as well as storage media is coding theory. It provides a means to transmit information across time and space over noisy and unreliable communication channels. Coding Theory: Algorithms, Architectures and Applications provides a concise overview of channel coding theory and practice, as well as the accompanying signal processing architectures. The book is unique in presenting algorithms, architectures, and applications of coding theory in a unified framework. It covers the basics of coding theory before moving on to discuss algebraic linear block and cyclic codes, turbo codes and low density parity check codes and space-time codes. Coding Theory provides algorithms and architectures used for implementing coding and decoding strategies as well as coding schemes used in practice especially in communication systems. Feature of the book include: Unique presentation-like style for summarising main aspects Practical issues for implementation of coding techniques Sound theoretical approach to practical, relevant coding methodologies Covers standard coding schemes such as block and convolutional codes, coding schemes such as Turbo and LDPC codes, and space time codes currently in research, all covered in a common framework with respect to their applications. This book is ideal for postgraduate and undergraduate students of communication and information engineering, as well as computer science students. It will also be of use to engineers working in the industry who want to know more about the theoretical basics of coding theory and their application in currently relevant communication systems

Coding TheoryAlgorithms, Architectures and ApplicationsJohn Wiley & Sons

In this book, leading authorities unify algebraic- and graph-based LDPC code designs and constructions into a single theoretical framework. Table of contents

This book gives a review of the principles, methods and techniques of important and emerging research topics and technologies in Channel Coding, including theory, algorithms, and applications. Edited by leading people in the field who, through their reputation, have been able to commission experts to write on a particular topic. With this reference source you will: Quickly grasp a new area of research Understand the underlying principles of a topic and its applications Ascertain how a topic relates to other areas and learn of the research issues yet to be resolved Quick tutorial reviews of important and emerging topics of research in Channel Coding Presents core principles in Channel Coding theory and shows their applications Reference content on core principles, technologies, algorithms and applications Comprehensive references to journal articles and other literature on which to build further, more specific and detailed knowledge

The communication chain is constituted by a source and a recipient, separated by a transmission channel which may represent a portion of cable, an optical fiber, a radio channel, or a satellite link. Whatever the channel, the processing blocks implemented in the communication chain have the same foundation. This book aims to itemize. In this first volume, after having presented the base of the information theory, we will study the source coding techniques with and without loss. Then we analyze the correcting codes for block errors, convutional and concatenated used in current systems.

This 2006 book introduces the theoretical foundations of error-correcting codes for senior-undergraduate to graduate students.

oW should coded communication be approached? Is it about prob H ability theorems and bounds, or about algorithms and structures? The traditional course in information theory and coding teaches these together in one course in which the Shannon theory, a probabilistic the ory of information, dominates. The theory's predictions and bounds to performance are valuable to the coding engineer, but coding today is

mostly about structures and algorithms and their size, speed and error performance. While coding has a theoretical basis, it has a practical side as well, an engineering side in which costs and benefits matter. It is safe to say that most of the recent advances in information theory and coding are in the engineering of coding. These thoughts motivate the present text book: A coded communication book based on methods and algorithms, with information theory in a necessary but supporting role. There has been muchrecent progress in coding, both inthe theory and the practice, and these pages report many new advances. Chapter 2 cov ers traditional source coding, but also the coding ofreal one-dimensional sources like speech and new techniques like vector quantization. Chapter 4 is a unified treatment of trellis codes, beginning with binary convolu tional codes and passing to the new trellis modulation codes.

This book clearly describes the leading techniques for channel coding. An advanced tutorial greatly improves the reader's understanding of the material. Rigorous analytical and theoretical examples are provided along with sample problems and solutions. The latest research findings on new techniques in channel coding are also included.

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" While multiple-access communication dates back to systems invented in the 1870s to transmit simultaneous data through a single wire, the foundation of the discipline now known as multiuser information theory was laid in 1961, when Claude E. Shannon published his paper on two-way channels. Since then, multiuser information theory has been an extremely active research area, and has seen a large number of fundamental contributions, covering, besides the two-way channel studied in, multiple access, interference, broadcast, and wiretap channels. However, several key canonical problems have defied many efforts. This book brings together leading experts working in the fields of information theory, coding theory, multiple user communications, discrete mathematics, etc., who survey recent and general results on multiple-access channels (rate regions, rate splitting, etc.), and give an overview of the problems of current CDMA solutions (fading channels, multi-user detection, multiple-antenna systems, iterative joint decoding, OFDMA, etc.). This publication consist of three parts. The first part includes chapters devoted to the information-theoretical aspects of multiple-access communication. In the second part, multiple-access techniques are discussed and the third part of this volume covers coding techniques. "

Channel coding lies at the heart of digital communication and data storage, and this detailed introduction describes the core theory as well as decoding algorithms, implementation details, and performance analyses. In this book, Professors Ryan and Lin provide clear information on modern channel codes, including turbo and low-density parity-check (LDPC) codes. They also present detailed coverage of BCH codes, Reed-Solomon codes, convolutional codes, finite geometry codes, and product codes, providing a one-stop resource for both classical and modern coding techniques. Assuming no prior knowledge in the field of channel coding, the opening chapters begin with basic theory to introduce newcomers to the subject. Later chapters then extend to advanced topics such as code ensemble performance analyses and algebraic code design. 250 varied and stimulating end-of-chapter problems are also included to test and enhance learning, making this an essential resource for students and practitioners alike.

Iterative algorithms are now widely used in all areas of signal processing and digital communications. In modern communication systems, iterative algorithms are notably used for decoding low-density parity-check (LDPC) codes, a popular class of error-correction codes known to have exceptional error-rate performance under iterative decoding. In a more recent field known as compressed sensing, iterative algorithms are used as a method of reconstruction to recover a sparse signal from a linear set of measurements. This work primarily deals with the development of low-complexity iterative algorithms for the two aforementioned fields, namely, the design of low-complexity decoding algorithms for LDPC codes, and the development and analysis of a low complexity reconstruction algorithm for compressed sensing. In the first part of this dissertation, we focus on the decoding algorithms for LDPC codes. It is now well known that LDPC codes suffer from an error floor phenomenon in spite of their exceptional performance. This phenomenon originates from the failures of traditional iterative decoders, like belief propagation (BP), on certain low-noise configurations. Recently, a novel class of decoders, called finite alphabet iterative decoders (FAIDs), were proposed with the capability of surpassing BP in the error floor region at a much lower complexity. We show that numerous FAIDs can be designed, and among them only a few will have the ability of surpassing traditional decoders in the error floor region. In this work, we focus on the problem of the selection of good FAIDs for column-weight-three codes over the binary symmetric channel. Traditional methods for decoder selection use asymptotic techniques such as the density evolution method, but the designed decoders do not guarantee good performance for finite-length codes especially in the error floor region. Instead we propose a methodology to identify FAIDs with good error-rate performance in the error floor. This methodology relies on the knowledge of potentially harmful topologies that could be present in a code. The selection method uses the concept of noisy trapping set. Numerical results are provided to show that FAIDs selected based on our methodology outperform BP in the error floor on a wide range of codes. Moreover first results on column-weight-four codes demonstrate the potential of such decoders on codes which are more used in practice, for example in storage systems. In the second part of this dissertation, we address the area of iterative reconstruction algorithms for compressed sensing. This field has attracted a lot of attention since Donoho's seminal work due to the promise of sampling a sparse signal with less samples than the Nyquist theorem would suggest. Iterative algorithms have been proposed for compressed sensing in order to tackle the complexity of the optimal reconstruction methods which notably use linear programming. In this work, we modify and analyze a low complexity reconstruction algorithm that we refer to as the interval-passing algorithm (IPA) which uses sparse matrices as measurement matrices. Similar to what has been done for decoding algorithms in the area of coding theory, we analyze the failures of the IPA and link them to the stopping sets of the binary representation of the sparse measurement matrices used. The performance of the IPA makes it a good trade-off between the complex l1-minimization reconstruction and the very simple verification decoding. The measurement process has also a lower complexity as we use sparse measurement matrices. Comparison with another type of message-passing algorithm, called approximate message-passing, show the IPA can have superior performance with lower complexity. We also demonstrate that the IPA can have practical applications especially in spectroscopy.

The book discusses modern channel coding techniques for wireless communications such as turbo codes, low parity check codes (LDPC), space-time coding, Reed Solomon (RS) codes and convolutional codes. Many illustrative examples are included in each chapter for easy understanding of the coding techniques. The text is integrated with MATLAB-based programs to enhance the understanding of the subject’s underlying theories. It includes current topics of increasing importance such as turbo codes, LDPC codes, LT codes, Raptor codes and space-time coding in detail, in addition to the traditional codes such as cyclic codes, BCH and RS codes and convolutional codes. MIMO communications is a multiple antenna technology, which is an effective method for high-speed or high-reliability wireless communications. PC-based MATLAB m-files for the illustrative examples are included and also provided on the accompanying CD, which will help students and

researchers involved in advanced and current concepts in coding theory. Channel coding, the core of digital communication and data storage, has undergone a major revolution as a result of the rapid growth of mobile and wireless communications. The book is divided into 11 chapters. Assuming no prior knowledge in the field of channel coding, the opening chapters (1 - 2) begin with basic theory and discuss how to improve the performance of wireless communication channels using channel coding. Chapters 3 and 4 introduce Galois fields and present detailed coverage of BCH codes and Reed-Solomon codes. Chapters 5–7 introduce the family of convolutional codes, hard and soft-decision Viterbi algorithms, turbo codes, BCJR algorithm for turbo decoding and studies trellis coded modulation (TCM), turbo trellis coded modulation (TTCM), bit-interleaved coded modulation (BICM) as well as iterative BICM (BICM-ID) and compares them under various channel conditions. Chapters 8 and 9 focus on low-density parity-check (LDPC) codes, LT codes and Raptor codes. Chapters 10 and 11 discuss MIMO systems and space-time (ST) coding.