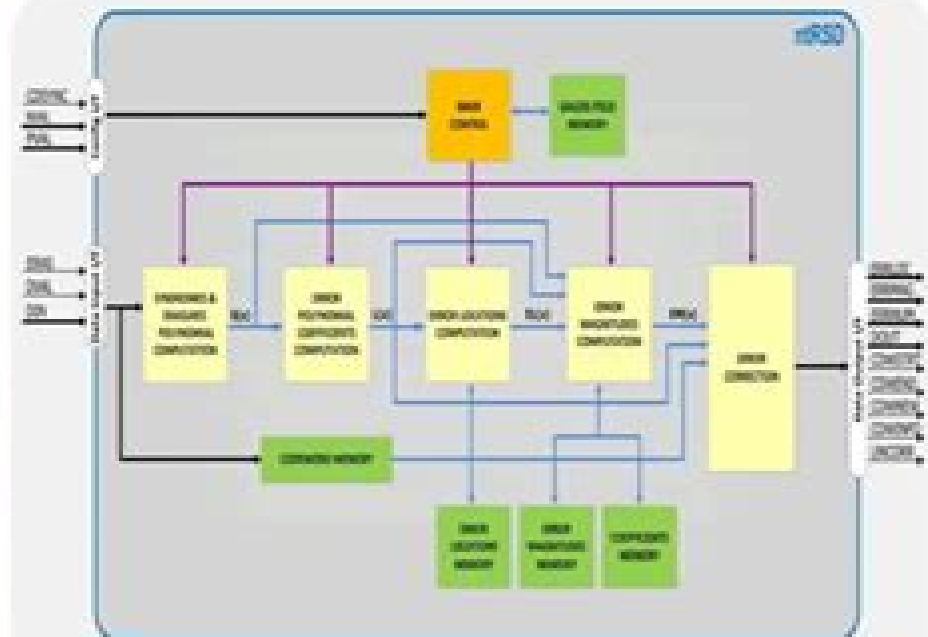
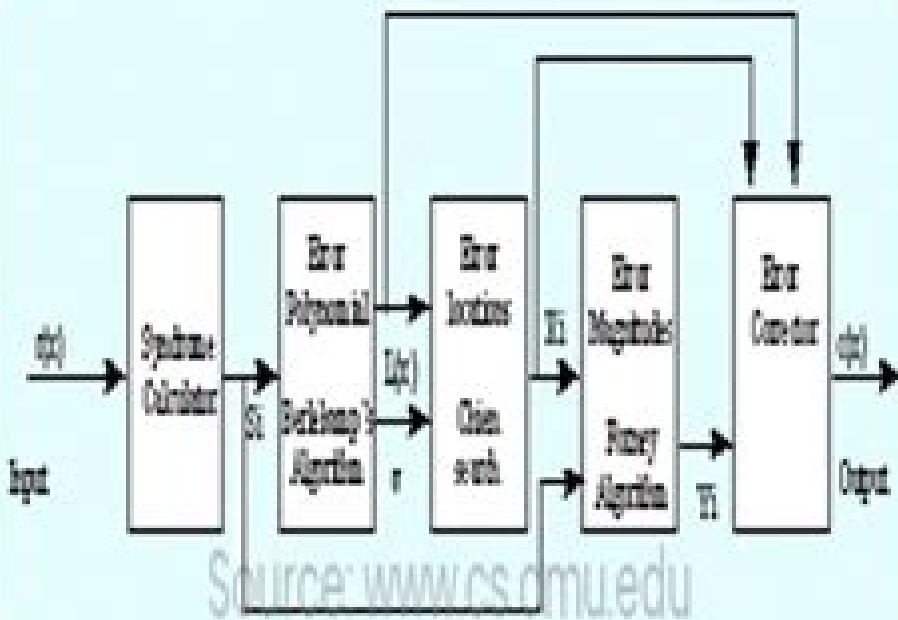


Reed-Solomon Decoder

- The Reed-Solomon (RS) decoder, invented by Reed and Solomon in 1960, is pivotal for error correction in digital communication
- RS codes are non-binary error-correcting codes known for correcting both random and burst errors
- The RS decoder operates in two phases: error detection using syndromes and error correction with algorithms like the Berlekamp-Massey
- These decoders are ubiquitous, being used in data storage, telecommunications, wireless communication, digital broadcasting, and QR codes due to their robust error-handling capacity



Reed Solomon Code

Madhu Sudan



Reed Solomon Code:

Reed-Solomon Codes and Their Applications Stephen B. Wicker, Vijay K. Bhargava, 1999-10-12 Electrical Engineering Communications Information Theory The Berlekamp article alone will make this book worth having David Forney Vice President Motorola Codex Reed Solomon Codes and Their Applications Edited by Stephen B Wicker Georgia Institute of Technology and Vijay K Bhargava University of Victoria On the Voyager spacecraft they were responsible for sending clear pictures of the planets back to earth They have also played a key role in the digital audio revolution They are Reed Solomon error codes the extremely powerful codes that provide critical error control for many different types of digital communications systems This outstanding collection of thirteen original articles written by leading researchers in the field provides a uniquely comprehensive overview of the history and practical applications some never before published of these important codes Key features include Thirteen original articles from leading researchers in the field with a historical overview by Reed and Solomon An explanation of how Reed Solomon codes were used in the Voyager spacecraft and how they are currently used in the compact disc player Specific applications for digital audio data transfer over mobile radio satellite communications spread spectrum systems and more New techniques for improving the performance of your own communications systems This book will be of interest to design and research engineers in the telecommunications field particularly those in the aerospace satellite and mobile radio industries It is also well suited for use as an advanced level textbook on the subject of error control coding Books of Related Interest from IEEE Press Claude Elwood Shannon Collected Papers Edited by N J A Sloane and A D Wyner AT T Bell Labs The first published collection of papers by Claude E Shannon including his seminal article The Mathematical Theory of Communication 1993 Hardcover 968 pp IEEE Order Number PC0331 9 ISBN 0 7803 0434 9 Multiple Access Communications Foundations for Emerging Technologies Edited by Norman Abramson University of Hawaii at Manoa The first book to explain the connection between spread spectrum and ALOHA channels providing a collection of key developments in the theory and practice of multiple user communications channels 1993 Hardcover 528pp IEEE Order Number PC0287 3 ISBN 0 87942 292 0 **Tutorial on Reed-Solomon Error Correction Coding** William A. Geisel, 1990 **Decoding of Reed Solomon Codes Beyond the Error-correction-bound** International Business Machines Corporation. Research Division, Madhu Sudan, 1996 Reed-solomon Codes and the Deep Hole Problem Matt Ket, 2015 In many types of modern communication a message is transmitted over a noisy medium When this is done there is a chance that the message will be corrupted An error correcting code adds redundant information to the message which allows the receiver to detect and correct errors accrued during the transmission We will study the famous Reed Solomon code found in QR codes compact discs deep space probes ldots and investigate the limits of its error correcting capacity It can be shown that understanding this is related to understanding the deep hole problem which is a question of determining when a received message has in a sense incurred the worst possible corruption We partially resolve

this in its traditional context when the code is based on the finite field F_q or F_q as well as new contexts when it is based on a subgroup of F_q or the image of a Dickson polynomial This is a new and important problem that could give insight on the true error correcting potential of the Reed Solomon code

A Decoding Procedure for the Reed-Solomon Codes Raymond S. Lin, 1978 A decoding procedure is described for the n, k, t error correcting Reed Solomon RS code and an implementation of the 31 15 RS code for the I4 TENEX central system This code can be used for error correction in large archival memory systems The principal features of the decoder are a Galois field arithmetic unit implemented by microprogramming a microprocessor and syndrome calculation by using the $g(x)$ encoding shift register Complete decoding of the 31 15 code is expected to take less than 500 microsecs The syndrome calculation is performed by hardware using the encoding shift register and a modified Chien search The error location polynomial is computed by using Lin's table which is an interpretation of Berlekamp's iterative algorithm The error location numbers are calculated by using the Chien search Finally the error values are computed by using Forney's method

Reed-Solomon Codes Meri Trema Hughes, 1995

Burst Error Correction Extensions for Reed Solomon Codes Pat Owsley, 1988

A Decoding Procedure for the Reed-Solomon Codes National Aeronautics and Space Administration (NASA), 2018-09-10 A decoding procedure is described for the n, k, t error correcting Reed Solomon RS code and an implementation of the 31 15 RS code for the I4 TENEX central system This code can be used for error correction in large archival memory systems The principal features of the decoder are a Galois field arithmetic unit implemented by microprogramming a microprocessor and syndrome calculation by using the $g(x)$ encoding shift register Complete decoding of the 31 15 code is expected to take less than 500 microsecs The syndrome calculation is performed by hardware using the encoding shift register and a modified Chien search The error location polynomial is computed by using Lin's table which is an interpretation of Berlekamp's iterative algorithm The error location numbers are calculated by using the Chien search Finally the error values are computed by using Forney's method

Lim R S Ames Research Center NASA TP 1286 A 7372 RTOP 366 18 50 00 0

Tutorial on Reed-Solomon Error Correction Coding National Aeronautics and Space Administration (NASA), 2018-07-23 This tutorial attempts to provide a frank step by step approach to Reed Solomon RS error correction coding RS encoding and RS decoding both with and without erasing code symbols are emphasized There is no need to present rigorous proofs and extreme mathematical detail Rather the simple concepts of groups and fields specifically Galois fields are presented with a minimum of complexity Before RS codes are presented other block codes are presented as a technical introduction into coding A primitive 15 9 RS coding example is then completely developed from start to finish demonstrating the encoding and decoding calculations and a derivation of the famous error locator polynomial The objective is to present practical information about Reed Solomon coding in a manner such that it can be easily understood

Geisel William A Johnson Space Center CODING DECODING ERROR ANALYSIS FIELD THEORY ALGEBRA MAXIMUM LIKELIHOOD ESTIMATES POLYNOMIALS ERRORS PROVING SYMBOLS

A Course in

Error-correcting Codes Jørn Justesen, Tom Høholdt, 2004 This book is written as a text for a course aimed at advanced undergraduates Chapters cover the codes and decoding methods that are currently of most interest in research development and application They give a relatively brief presentation of the essential results emphasizing the interrelations between different methods and proofs of all important results A sequence of problems at the end of each chapter serves to review the results and give the student an appreciation of the concepts

List Decoding of Error-Correcting Codes Venkatesan Guruswami, 2004-11-29 How can one exchange information effectively when the medium of communication 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 efficiently This thesis presents some spectacular new results in the area of decoding algorithms for error correcting codes Specifically it shows how the notion of list decoding can be applied to recover from far more errors for a wide variety of error correcting codes than achievable before A brief bit of background error correcting codes are combinatorial structures that show how to represent or encode information so that it is resilient to a moderate number of errors Specifically 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 codeword are flipped the resulting string does not look like any other codeword The maximum number of errors that 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 called the decoding problem compute the message from a corrupted codeword when the number of errors is less than $d/2$

High Speed Decoding of Reed - Solomon Codes Shirish Prabhakar Deodhar, 1981 *Trellis Decoding of Reed Solomon Codes* Sooyoung Shin (Kim), 1994

The Original View of Reed-Solomon Coding and the Welch-Berlekamp Decoding Algorithm Sarah Edge Mann, 2013 Reed Solomon codes are a class of maximum distance separable error correcting codes with known fast error correction algorithms They have been widely used to assure data integrity for stored data on compact discs DVDs and in RAID storage systems for digital communications channels such as DSL internet connections and for deep space communications on the Voyager mission The recent explosion of storage needs for Big Data has generated renewed interest in large storage systems with extended error correction capacity Reed Solomon codes have been suggested as one potential solution This dissertation reviews the theory of Reed Solomon codes from the perspective taken in Reed and Solomon's original paper on them It then derives the Welch Berlekamp algorithm for solving certain polynomial equations and connects this algorithm to the problem of error correction The discussion is mathematically rigorous and provides a complete and consistent discussion of the error correction process Numerous algorithms for encoding decoding erasure recovery error detection and error correction are provided and their computational cost is

analyzed and discussed thus allowing this dissertation to serve as a manual for engineers interested in implementing Reed Solomon coding

Error Coding for Engineers A. Houghton, 2001-09-30 Error Coding for Engineers provides a useful tool for practicing engineers students and researchers focusing on the applied rather than the theoretical It describes the processes involved in coding messages in such a way that if errors occur during transmission or storage they are detected and if necessary corrected Very little knowledge beyond a basic understanding of binary manipulation and Boolean algebra is assumed making the subject accessible to a broad readership including non specialists The approach is tutorial numerous examples illustrations and tables are included along with over 30 pages of hands on exercises and solutions Error coding is essential in many modern engineering applications Engineers involved in communications design DSP based applications IC design protocol design storage solutions and memory product design are among those who will find the book to be a valuable reference Error Coding for Engineers is also suitable as a text for basic and advanced university courses in communications and engineering

Implementation of (255, 223) Reed Solomon Code Encoder /decoder Ahmed Alotaibi, 2012 In this project the algorithm of the Reed Solomon code encoder and decoder is discussed followed by the implementations of 255 223 Reed Solomon codes The encoder takes a 223 byte data block and generates a 255 byte code block to be transmitted on a digital communication channel This code is defined over a Galois Field $GF(2^8)$ and has the capability of correcting up to sixteen short bursts of errors The software part of the design is written in C language and tested using Simulink and the hardware part is implemented using a microcontroller The encoding process is simpler than the decoding process and requires less complex hardware The decoder however is implemented using a parallel structure to speed up the Galois Field computations necessary to find out the locations of the errors and their values The decoder logic circuit comprises multiple units in order to perform a parallel computation for the syndrome calculation The Berlekamp's iterative algorithm is used to determine the coefficients of the error location polynomial At the same time the Chien's searching algorithm is used to calculate the roots of the error location polynomial their error values and perform the correction of the found errors

Algebraic Codes on Lines, Planes, and Curves Richard E. Blahut, 2008-04-03 The past few years have witnessed significant developments in algebraic coding theory This book provides an advanced treatment of the subject from an engineering perspective covering the basic principles and their application in communications and signal processing Emphasis is on codes defined on the line on the plane and on curves with the core ideas presented using commutative algebra and computational algebraic geometry made accessible using the Fourier transform Starting with codes defined on a line a background framework is established upon which the later chapters concerning codes on planes and on curves are developed The decoding algorithms are developed using the standard engineering approach applied to those of Reed Solomon codes enabling them to be evaluated against practical applications Integrating recent developments in the field into the classical treatment of algebraic coding this is an invaluable resource for graduate students and researchers in

telecommunications and applied mathematics

Applied Algebra, Algebraic Algorithms and Error-Correcting Codes

Serdar Boztas, Hsiao-feng Lu, 2007-11-30 This book constitutes the refereed proceedings of the 17th International Symposium on Applied Algebra Algebraic Algorithms and Error Correcting Codes AAECC 17 held in Bangalore India in December 2007

The 33 revised full papers presented together with 8 invited papers were carefully reviewed and selected from 61

submissions Among the subjects addressed are block codes including list decoding algorithms algebra and codes rings fields algebraic geometry codes algebra rings and fields polynomials permutations lattices cryptography cryptanalysis and complexity computational algebra algebraic algorithms and transforms sequences and boolean functions

Decoding of Reed Solomon Codes Beyond the Error-correction Bound Madhu Sudan, 1996 Abstract We present a randomized algorithm which takes as input n distinct points $x_i, y_i, 1 \leq i \leq n$ from $F \times F$ where F is a field and integer parameters t and d and returns a list of all univariate polynomials f over F in the variable x of degree at most d which agree with the given set of points in at least t places i.e. $y_i = f(x_i)$ for at least t values of i provided $t \geq \sqrt{nd}$ The running time is bounded by a polynomial in n This immediately provides a maximum likelihood decoding algorithm for Reed Solomon Codes which works in a setting with a larger number of errors than any previously known algorithm To the best of our knowledge this is the first efficient i.e. polynomial time bounded algorithm which provides error recovery capability beyond the error correction bound of a code for any efficient i.e. constant or even polynomial rate code

Coding Theory

Andre Neubauer, Jurgen Freudenberger, Volker Kuhn, 2007-10-22 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

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