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A SURVEY ON REED SOLOMON CODE IN DATA TRANSMISSION APPLICATION

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Abstract

A survey paper fundamentally fixate on the reed solomon code in data transmission to detect and redress the multiple errors bits and additionally for decoding technique. The reed solomon computer code is also used to product computer storage elements, deep sea communication, orbiter broadcasting, Bar code. These codes are predicated on non-binary symbols and ergo can rectify multiple bit errors. The main interrogation is that those codes should minimize the delay and surface area penalty. This survey gives the overview of reed solomon code utilization in data transmission and withal avails the incipient researchers to conceive the appliance of reed solomon code.

Keywords: Error Correction Code(ECC),RS Encoder, Bose-Chaudhuri-Hocquenghem Code (BCH Code), RS Code.

1. Introduction

In factual communication system, data or information gets corrupted by noise during transmission. Today there is an incrementing demand for development of reliable communication and wireless systems. Hence it is consequential to detect and rectify errors in the information received over communication channels. Ergo error control coding is consequential in communication system design for sundry applications. The felicitous Error Correction Code (ECC) can be culled depending on the code that is capable of detecting and rectifying maximum number of errors, error type and the performance of encoding and decoding units in terms of speed.

Reed-Solomon (RS) code has a overall use for forward error rectifying in digital transmission and storage systems. It is a one of the special case of BCH codes, and has become a popular cull to provide data integrity due to its good error rectification efficiency for burst transmission errors [1].

The Reed-Solomon encoder takes a digital data from the block and adds additional "redundant" bits. Errors occur during transmission or storage for several reasons (for example noise during transmission or interference, scratches on a CD, etc). The Reed-Solomon decoder processes each and every block and attempts to rectify errors and recover the original data. The number and type of errors that can be rectified depends on the characteristics of the Reed-Solomon code. This predicated on the parity check matrix. and the reduction parity check matrix provide the low delay which indirectly reduces the puissance of the system to detect and rectify errors for multiple bits. A parity bit is marginally that is integrated to a group of source bits to ascertain that the number of set bits (i.e., bits with value 1) in the outcome is even or odd. It is a very simple scheme that can be habituated to detect single or any other eccentric number of errors in the output. An even number of flipped bits make the parity bit appear veridical albeit the data is erroneous. Extensions and variations on the parity bit appliance are horizontal redundancy checks, vertical redundancy checks, and "double," "dual," or "diagonal" parity. A large number of multiple bit ECCs have been proposed to save memories[5]. These include Bose-Chaudhuri-Hocquenghem (BCH), Euclidean Geometry , Difference Set , Orthogonal Latin Squares and Reed-Solomon codes . Reed- Solomon (RS) codes have a unique feature when additionally compared with the other codes: they are not binary. They use symbols from a Galois Field as each symbol is expressed by multiple bits[7].

Consequently a SEC RS code can rectify multiple bit errors as long as they affect a single symbol. This is very alluring for recollection modules as when the number of bits in the contrivances matches those of the symbols in the RS code, failures in one contrivance can be rectified and while transmitting the multi bits it is utilized to decode the error congruously. RS codes are commonly used to bulwark main recollections in computer systems for space applications. In general, the data that composes an RS codeword are considered as polynomial co-efficient with values belonging to the Galois Field. The polynomial represented to a codeword is a multiple of a specific polynomial, called engenderer polynomial g(x). which the clear conception is discussed in textbook error control codes.

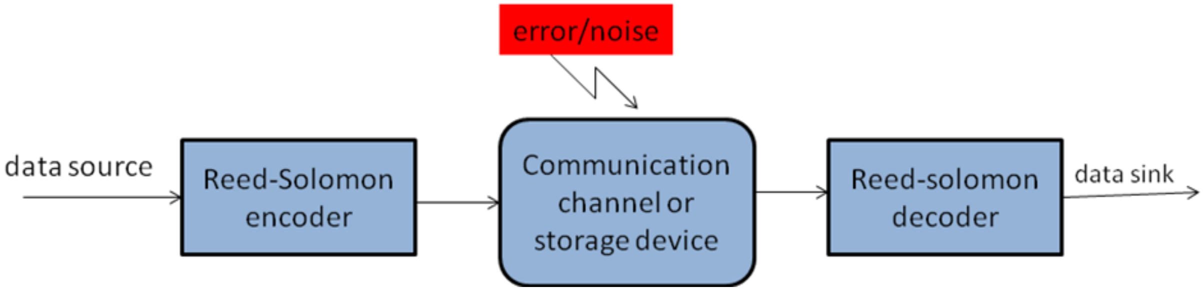

Fig.1.A typical reed solomon system.

2. Reed solomon codes

Reed Solomon codes are a secondary set of BCH codes and are linear block codes. This is generally used for data transmission and data storage. Redundant information is integrated to data so that it can be recuperated reliably despite errors in transmission or storage and retrieval. All linear codes offer the advantages that they are facile to encode, and the less Hamming distance reduces to a smaller concept, the weight. However, the weight of an arbitrary linear code is still not facile to determine. Reed-Solomon codes are based on a specialist area of mathematics known as Galois fields or finite fields.

3. Reed solomon parity addition with data

A Reed-Solomon code is designated as RS(n,k) with s-bit symbols. This agency that the encoder yield k data symbol s of s bits each and adds parity symbol to make an n symbol codeword. There are *n-k* parity symbols of s bits each. A Reed-Solomon decoder can correct up to*t* symbols that contain errors in a codeword, where *2t* = *n-k* [2].

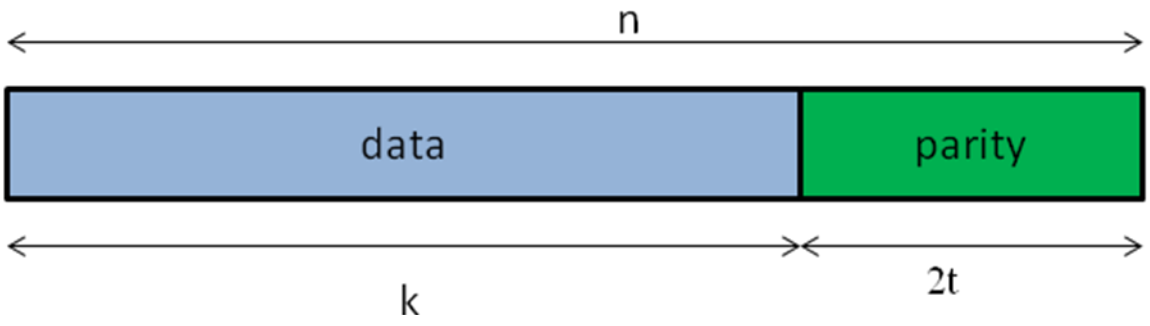

Fig.2. Reed-Solomon codeword.

Example: 2.1.

A commonly used reed-solomon code is RS(255,223) with 8-bit symbols. Each codeword hold 255 code word bytes, of this data are 223 bytes and parity are 32 bytes. For this code: n = 225, k = 223, s = 82t = 32, t = 16. The decoder can rectify any 16 symbol erros in the code word. I.e. Error in up to 16 bytes all over in the codeword can be automatically corrected. symbol size is termed as s, the maximum codeword length (n) for a reed-solomon code is n = $2^s - 1$. For example, the code with maximum length is 8 - bit symbols (s = 8) for 255 bytes [2].

Reed-solomon codes may be minimized by (conceptually) fashioning a number of data symbols zero at the encoder , not addressing them, and then re - inserting them at the decoder.

4. RS encoder

RS codes are encoded by directly adding the parity symbols at the end of k-symbols message block [3]. This message block totally called as codeword and is shown in figure 1 [4]. At the encoder side, the information is shifted into the left most bits by multiplying by X2t, leaving a codeword of the form,

$$C(X) = X2t\ m(x) + p(x) \qquad \text{----------}(1)$$

The codeword polynomial is C(x), the message polynomial is m(X) and the redundant polynomial is p(x) [8]. The parity symbol is the remainder which is realized by dividing message block with the originated polynomial and it is represented as,

$$p(X) = (X2t\ m(X)) \bmod g(X) \qquad \text{--------}(2)$$

So, originated polynomial is responsible for originating RS codeword, which has a exclusive property that all valid code words are precisely divisible by the originator polynomial. The originator polynomial is shown as,

$$G(X) = (X+\alpha)(X+\alpha2)(X+\alpha3)\ldots(X+\alpha2t) = g0 + g1X + g2X2 + \ldots + g2t\text{-}1X2t\text{-}1 + X2t \qquad \text{----}3$$

where α is a primitive element in GF(2m), and g0,g1,g2, ... g2t-1 are the coefficients from GF(2m).

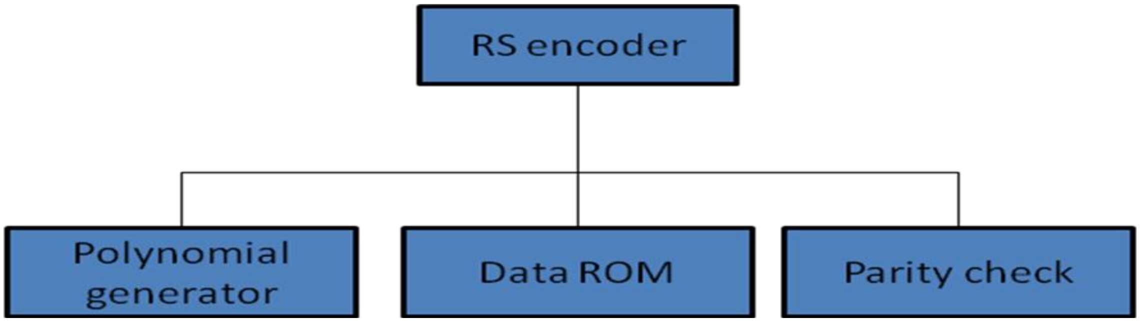

Fig.3.The architecture of RS encoder.

5. RS decoder

At the receiver side, the received codeword is given to RS decoder which we have to decode. The decoder first endeavors to check if this codeword is a valid codeword or not. If it not the codeword which was sent by the encoder it signifies that there are some errors occurred during transmission. This circumstances of the decoder processing is called fault catching . If the errors are detected then the decoder tries to correct these errors using error correction part [3].

The architecture of Reed Solomon decoder is make up of two briny parts: 1. Error detection part which is also called as Syndrome Computation pulley-block. 2. Error correction part, this part consists of three blocks: First is the decoding algorithm which is used to find the coefficient of error-positioning polynomial σ(x) and error-judge polynomial W(x) and it is sometimes called as Key par solver. Second is the Chien search block which is used to find the roots of σ(x)[8] i.e.

The computer error localisation polynomial which presents the inverse of the error locations. And the third block is the Forney algorithm block which helps to find the values of the errors. Hence we can correct the received transmitter from the values and locations of the misplay which we get from the above two block by xoring with the erroneous belief vector. The description of each block is given below:

1. Syndrome Computation block: The syndrome values are calculated in this block. The syndrome is a remainder obtained by dividing the received codeword by the generator polynomial.

2. KES Block: The Key equating problem solver (KES) block provides two polynomial - mistake locator polynomial and error magnitude polynomial which calculates the error location and magnitude.

3. CSEE Block: The error will be located by Chien Search and Error Evaluator block identifies while computing its error magnitude.

4. FIFO register: The received word symbol are stored in FIFO register. Since the mistake vector is engendered in the inversion order of magnitude of the received codeword, the FIFO register is applied to match the order of bytes in misplay vector and received codeword [6].

5. Controller: The controller is utilized to control and synchronize all four modules -SC, KES, CSEE and FIFO Registers.

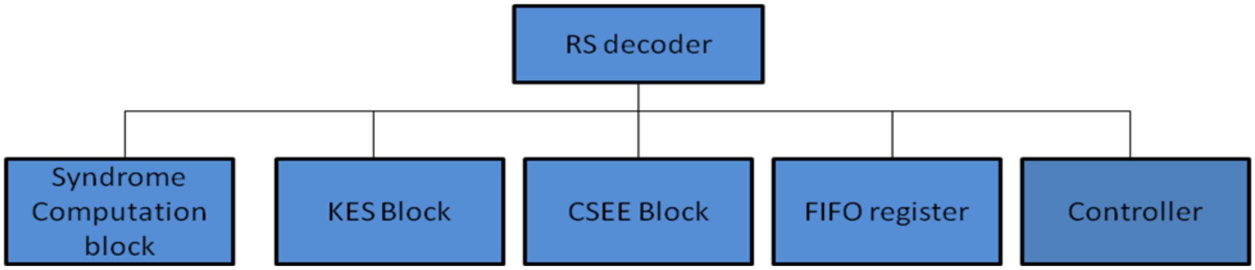

Fig.4.The architecture of RS decoder.

6. Conclusion

Reed Solomon codes contribute a high range of code values that can be opted to optimize the performance. RS codification have wide application and are used in data transmission, Radio set Communication such as mobile phones, microwave links, in Deep Distance and Satellite Communication theory Mesh , mass storage devices such as hard disk drives, Videodisk , barcodes and Broadband Modems. This report gives the overall working mechanism of the beating-reed instrument solomon computer code . This survey will avail the incipient readers to understand the concept of reed-solomon code.

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