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Reed Solomon Code Performance with M-Ary FSK Modulation forError Detection & Correction

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Abstract: *The main purpose of this paper is to evaluate the efficient performance of RS code over todays noisy communiationchannel i.e. AWGN.For the transmission of the signal massage we here used M-ary frequency modulation technique. These signal message are encoded & decoded using Error detection & correction RS code.Matlab is used for the evaluation of the performance of RS code over noisy communication channel .The objective of these method is to ensure that the signal massage is received correctly by the receiver in minimum number of retransmission.*
Keywords:*Bit-Error-Rate, M-ary Frequency Shift Keying (M-FSK), MATLAB/SIMULINK, Reed-Solomon codes.*

I. Introduction

In today's world, communication becomes vital role in our day to day life. Communication can takes place between two or more subscriber where effective delivery of signal massage becomes important.Communication can take place with the two categories one is Analog & second one is Digital.Digital communiation is an advancement over Analog communication in number of factors where digital communication signal can be stored & retrieve,retransmission of signals in case of error etc.

The main problem of communication is to efficient & effective delivery of signal to destination side where receiver can easily get the signal as it is which is transmitted from transmitter side.In the current & future communication system data transmission with high bit rate with minimum error rate is important for many services such as online high quality videos, high quality audios & integrated service digital network (ISDN) [1].

In recent years many researchers had been work on the analyzing the performance of various forward error correction teachnics.They used various communication channels like Rayleigh Fading Channel,AWGN channels to analyze the peroformance of various error correcting codes [3].Reed Soloman code performance is analyzed over AWGN channel using MATLAB & gives some concluded results [1].

The main objective of this paper is to evaluate the performance of Rees Soloman over noisy communication channel. The BER performance curve improves as the code size increases with similar error correcting capability as well as redundancy of the code increases [1-2].

II. System model

The basic communication block diagram contains source, encoder, decoder, modulator, demodulator channel & destination.Transmitter can perform several vital roles in the transmission of signal like compressing of signal, provide security to the signal & to make reliable for the transmission over channel. Source produces binary information consisting of 0s & 1s. Compressing of binary data is called as source encoding where mapping sequence of symbols in the original data to shorter ones so the resulting sequence becomes shorter.

In order to provide security to the original data, aredundant bit is added. This is called channel encoding. The modulator simply maps binary 0 & 1 into waveforms. The modulator simply converts digital signals into an appropriate waveform for the transmission over the channel. Due to the channel propogation characteristics like noise, attenuation, phase & harmonic distortion, inter modulation distortion & interference the quality of the original signal gets degraded due to fading effect [1-4].

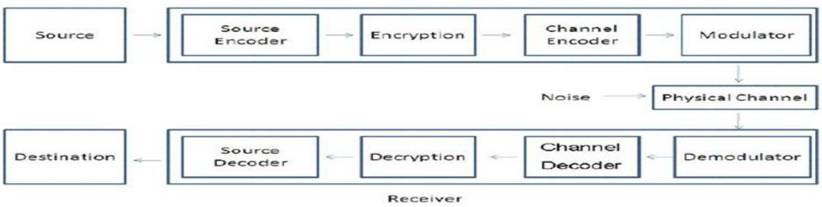


Figure 1: Digital communication system.

If the signal moves over a distance in the order of wavelength due to use of AWGN channel leads to rapid fluctuation of the phase & amplitude of the signal. Where signals are travelled through the channel along with certain noise. The mathematical equation of the received signal is

$$R(t)=S(t)+N(t) \quad (1)$$

AWGN channels add white Gaussian noise to signal that is the transmitted through the AWGN channel. Due to this noise, transmitted signals get disturbed [1-9]. In an M-ary FSK modulation scheme, symbols are modulated as one of the sinusoidal waves described by

$$Si(t)=\sqrt{2Es/Ts}\cos(2\pi fit);\ 0 \leq t \leq T,\ \{i = 1, 2, 3\ldots..M\} \quad (2)$$

Where Es is the signal energy per modulated symbol. The signals are orthogonal & for non coherent receptions the frequency are spaced by 1/Ts Hz, being the transmission rate. To maintain a strategic distance from sudden changing starting with one recurrence then onto the next, the data bearing signal whose frequency is changes continuously. The demodulation may be accomplishes using 2M correlators , 2 per signal waveform. Thus, every code image out of the encoder can be mapped to one of M frequencies in the M-FSK signal set. Also, if T is the time required to transmit each code symbol or one of the M frequencies, the transmission rate is given by Rb=$\frac{k}{t}$ bits/sec and the information rate is given by Ri=RcRb bits/sec, where the code rate Rc =$\frac{k}{n}$[1-2].

III. Reed-Solomon Codes

Forword error correction method used to control error during the transmission of signal massage from source to destination where transmitter adds some redundant bits to the original massage signal &this redundant bits are known as error correcting code. This redundant bits helps destination side to identify errors.FEC are applied where retransmission is relatively costly or impossible.There are many types of block codes are available but most popular is the Reed Soloman code.

Reed-Solomon codes are an important subset of non-binary cyclic error correcting code and are the most widely used codes in practice. These codes are used in wide range of applications in digital communications and data storage. Reed Solomon describes a systematic way of building codes that helps to detect and correct multiple random symbol errors. By adding t check symbols to the data, an RS code can detect any combination of up to t erroneous symbols, or correct up to [t/2] symbols. Furthermore, RS codes are suitable as multiple-burst bit-error correcting codes, since a sequence of b + 1 consecutive bit errors can affect at most two symbols of size b. The choice of t is up to the designer of the code, and may be selected within wide limits. Reed Soloman code are used for detecting errors in a groups in wireless & mobile communiation links, satellite link, digital TV & so many more [5].

Reed Soloman code are used in coded communication system as well as data storage system for getting data as it is which is transmitted from the transmitter side. Reed-Solomon codes were introduced by Larry S. Reed and Gustave Solomon in 1960

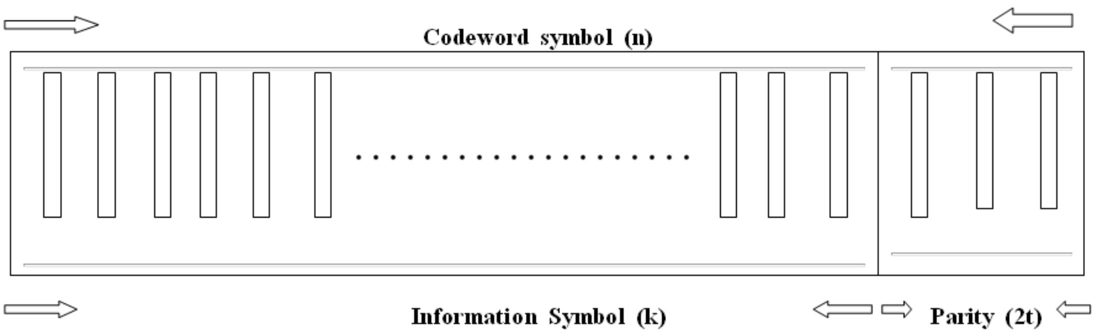


Figure 2: Structure of Reed-Solomon code.

Figure 2shows the basic structure of RS code where codeword symbol consists of two elements out of which one is the basic information (k) which is to be transmitted over the channel & second one is the redundancy (2t) which is to be added to the original signal for the error detection as well as correction purpose. RS code is a block based code and can be represented as RS (n, k, t). The variable (n) is the length of the codeword symbols, (k) is the number of information symbols, (t) is the error-correction capability and each symbol contains m-bits [14]. The correlation of the symbol size (m), and the codeword symbols (n) is specified as n=2^{m}-1 for m bits in one symbol. The error-correction capability (t) or the maximum number of correctable random errors can be calculated by t= $\frac{n-k}{2}$ [2].For example consider the RS (15,9) [1-2,6]

Block length:	n = 15 symbols
Message length:	k = 9 symbols
Code rate:	r = k/n = 60%
Parity-check symbol length:	n-k = 6 symbols
Minimum code distance:	dmin. = n-k+l = 7 symbols
Error correction capability:	t = (n-k)/2 = 3 symbols
Block correction capability:	(n-k)/2n = 20%
Average message correction capability:	(n-k)/2n = 20%
Galois field order:	q = n+l = 16 symbols

IV. Reed Solomon Encoding & Decoding

Reed Solomon encoding can be done using most of the three methods

- Encoding by polynomial division
- Encoding in the frequency domain
- Encoding using Cauchy cell matrix method

The encoder adds t parity symbols to the k information field to form a codeword of n symbols. The encoder consistsof 2t tap shift register where each register is m bit wide. The multiplier coefficients are the coefficients of the RS generator polynomial. The general idea in the construction of a polynomial, whatever symbols produced by the coefficient generator polynomial will exactly divide the data/parity polynomial.The encoder represents the set of shift registers, joined by means of integrators and multipliers, operating according to the rules of Galois arithmetic. The shift register represents the sequence of memory cells, called bits, each of which contains one element of a Galois field GF(q). The symbol, contained in a specific position, is transmitted to the output line as it leaves this position. Simultaneously, the symbol from the input line is loaded into position. Replacement of symbols takes place discretely, at strictly defined time intervals, known as clocks. In hardware implementation of the shift register, its elements can be connected both series and in parallel manner. In series connection, the sending of a single m-bit symbol requires m clocks, while parallel connection requires only one clock [5].The generator polynomial of the RS encoder is represented by

$$g(x) = g_0 + g_0\,x + g_0x^2 + \ldots + g_{2t-1}\,x^{2t-1} + x^{2t} \quad (3)$$

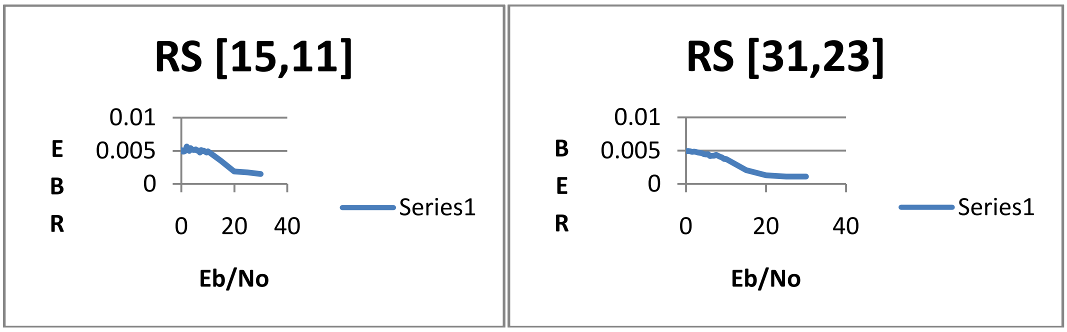
Reed Solomon codes are dependent on specific area of mathematics known as Galois fields or finite fields. Finite field has the property that arithmetic operations (+, -, x, / etc.) on field elements always have a result inside the field.

The RS decoder corrects the error by calculating the syndromes for each of the codeword.Depending upon the syndrome decoder is able to determine the number of errors in the received blocks. If there are errors present, the decoder tries to find the locations of the errors using the Berlekamp-massey algorithm by creating an error locator polynomial. The roots of this polynomial are found using the Chien search algorithm [5].

V. Simulation Results

The proposed RS code performance discussed in earlier paragraph is implemented in matlab simulator software. The performance of the proposed RS code performance for error detection & correction has been evaluated. In this scenario we measure performance of bit error rate with various RS code values using M-Ary modulation over AWGN channel. From the following graph it is clear that as we increase the RS code the performance of bit error rate goes on increases.

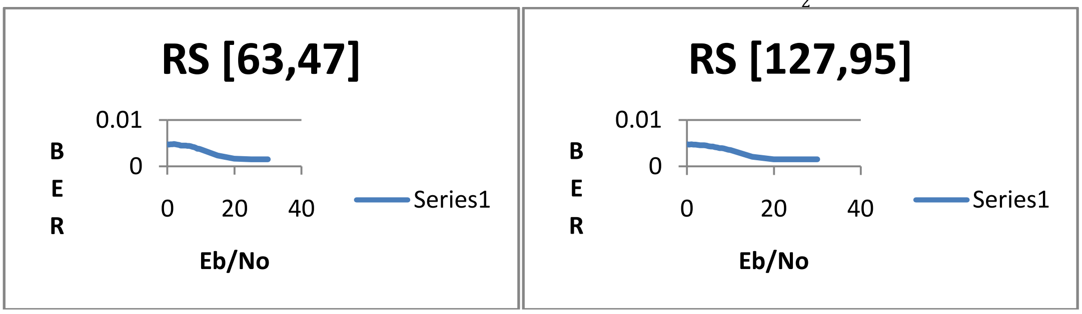
- From Figure 3 (a) and (b) it is observed that at a almost constant code rate bit error rate improves.
- The performance of the RS code has been evaluated in Figure 3 (a) and (b).These two graph result indicate us as we increase the values of RS code, bit error rate of the channel goes on decreases. These two resultshave been obtained by varying the values of Eb/N0 for almostconstant values of code rate R_c=k/n.



(a) (b)

Figure 3: Performance evaluation as a function of RS code (E_b/N_0 v/s BER) (a) RS [15, 11] (b) RS [31, 23].

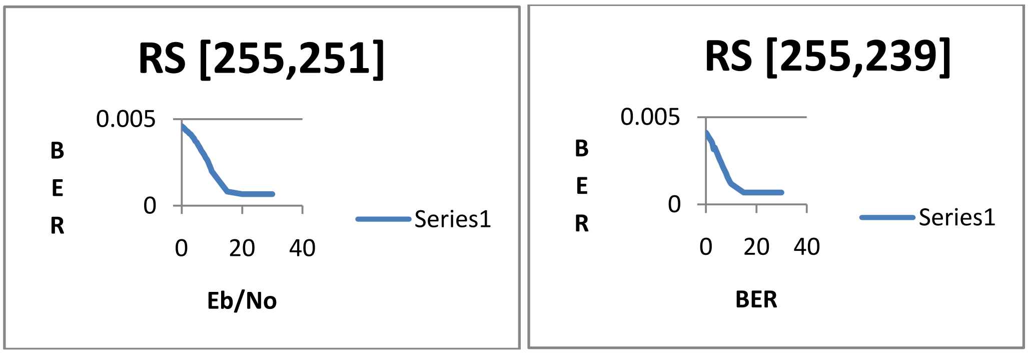
- As we increases the RS values, the bit error rate performance goes on increasing it is shown in Figure 4(a) and (b). It is observed from the following graphs that error correcting RS code becomes more effective as code size of RS increases because noise effect reduces for large code word.
- As we observed from the following Figure 4 (a)&(b) it is indicated that bit error rate performance also improves by increasing the values of error correcting capability i.e. t= $\frac{n-k}{2}$.



(b) (b)

Figure 4: Performance evaluation as a function of RS code (E_b/N_0 v/s BER) (a) RS [63, 47] (b) RS [127, 95].

- Random integer source is used to generate data source which is transmitted using M-Arymodulation. From the following Figures5 (a) & (b), and Figure 6 it is observed that by keeping the values of RS codeword symbol (n)constant &decreasing the data symbol (k) we can see that the code rate goes on decreasing that means we can say that redundancy goes on increasing.
- So, by observing this simulation results we assume that by increasing the redundancy, RS code performance become more effective. In another word we can say that the bit error rate performance increases by increasing the redundancy with the help of lowering the code rate.
- It is observed from the following figure that noise percentage going to be reduced as codeword size increases & also it can be notice that received noise supposed to be average over long period of time.



(c) (b)

Figure 5: Performance evaluation as a function of RS code (E_b/N_0 v/s BER) (a) RS [255, 251 (b) RS [255, 239].

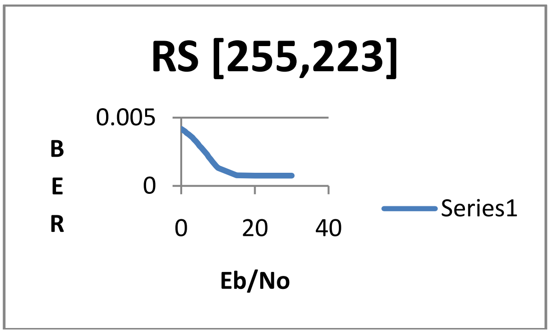


Figure 6: Performance evaluation as a function of RS code (E_b/N_0 v/s BER)

VI. Conclusions AND Future Work

Reed Solomon code performance with M-ary modulation for error detection & correction has been presented. The performance of RS code was investigated in different points of views like increasing the values of RS codeword, by keeping code rate constant, by evaluating the error correction capability, and by increasing the values of redundancy.

So, it is observed that by properly choosing error correction coding schemes, bit error rate performance goes on increasing.From the results presented in this paper it may be concluded that:

- By increasing the values of RS code word, bit error rate performance improves
- By increasing the values of redundancy, bit error rate performance improves.

The future work of this investigation includes the improvement in bit error rate performance with the help of the different digital modulation techniques and further investigation of effect using additional noises.

References

[1] SaurabhMahajan; Gurpadam Singh, Reed-Solomon Code Performance for M-ary Modulation over AWGN Channel, International Journal of Engineering Science and Technology (IJEST), Volume 3 no. 5, May 2011.

[2] SaurabhMahajan, Gurpadam Singh.,Simulation Performance of Reed-Solomon Codes as a Function of Redundancy in AWGN Channel, National Conference, "RACTEE-2011" Feb. 25-26, 2011, SLIET, Longowal, Punjab, India.

[3] Faisal Rasheed Lone, ArjunPuri, Sudesh Kumar," Performance Comparison of Reed Solomon Code and BCH Code over Rayleigh Fading Channel", Volume 71 No.20, June 2013.

[4] MohitAgarwal," Implementation of Reed Soloman Error Crrecting Codes" National Institute of Technology Rourkela.

[5] PriyankaShrivastava, UdayPratapSingh ," Error Detection and Correction Using Reed Solomon Codes".

[6] William A. Geisel," Tutorial on Reed-Solomon Error Correction Coding" NASA Technical Memorandum 102162.

[7] Lionel Biard, Dominique Noguet," Reed-Solomon Codes for Low Power Communications" Journal of Communication, Volume 3, no. 2, April 2008.

[8] A. SudhirBabu, Dr. K.V SambasivaRao." Evaluation of BER for AWGN, Rayleigh and Rician Fading Channels under Various Modulation Schemes" International Journal of Computer Applications (0975 – 8887) Volume 26– No.9, July 2011

[9] Nitha V Panicker, Sukesh Kumar A," BER Performance Evaluation of Different Digital Modulation Schemes for Biomedical SignalTransceivers under AWGN and Fading Channel Conditions", International Journal of Engineering and Advanced Technology (IJEAT), Volume. 3,issue 5, June 2014.

[10] Rashmi, Satnam Singh, RaminderPreet Pal Singh," BER Analysis of Reed-Solomon Codes using M-Ary FSK Modulation in the Presence of AWGN Channel", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-3 Issue-3, July 2014.