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PERFORMANCE COMPARISON OF REED-SOLOMON CODE USING M-ARY PSK AND FSK MODULATION IN AWGN CHANNEL

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ABSTRACT

The main aim of this paper is to analyze the Bit error rate (BER) performance of Reed Solomon code (RSC) using M-ary PSK and FSK modulation techniques in the presence of noisy channel i.e. (Additive White Gaussian Noise. In this paper, 32-PSK (Phase Shift Keying), FSK (Frequency Shift Keying) modulation is used for simulation of coded communication system. For simulation, we use MATLAB/SIMULINK as a tool to calculate BER rate using Monte Carlo method. The forward error correction technique is used to detect and correct errors received from AWGN Noise channel. For encoding the received signal by removing burst errors or noise and improves the performance by using Reed Solomon codes. The results are plotted by using BERTOOL. In order to compare performance, we have taken different code rates while block length fixed. From the simulation results, it has been observed that BER performance of RSC is better if FSK modulation is used as compare to PSK modulation.

KEYWORDS: Bit-Error-Rate, Frequency Shift Keying, Phase Shift Keying, The MATLAB/SIMULINK, Reed-Solomon codes.

INTRODUCTION

The Claude E. Shannon gave a formal description in 1948 to a make communication more reliable. Error-correcting coding has become one essential ingredient for the latest information transmission systems. A sender transmits a message through a channel to a receiver. The channel could be wireless network or the channel could be a data cable. Noise may appear on these types of channels, so in order to receive the message with as few errors as possible, ideally the sender should use. High power signal amplification and the channel should be as short as possible. However, in normal situations these are not viable solutions. The most sophisticated codes use block code to improve the performance of data transmission. The message is then transmitted over a channel where errors may be introduced. The received codeword needs to be decoded into the received message. The main advantage of BCH codes is the ease with which they can be decoded using syndrome and many good decoding algorithms exist. A well-known decoding algorithm is the Berlekamp-Massey algorithm. This allows very simple electronic hardware to perform the task, making the need for a computer unnecessary. This implies that a decoding device may be small and consume little power. BCH codes allow control over block length and acceptable error thresholds, which makes them very flexible. This indicates that code can be designed to meet custom requirements. Another reason they are important is that there exist good decoding algorithms that correct multiple errors.

In this communication system model the information is transmitted using Gray Code model with Frequency Shift Keying (FSK) & Phase modulation technique (PSK) in the attendance of Additive White Gaussian Noise channel. Phase Shift Keying modulation is a power proficient modulation method considered for low power applications. [1]

Theory of Reed-Solomon

Reed Solomon Decoder is useful in correcting burst noise; it replaces the whole word if it is not a valid code word. Reed-Solomon codec's (encoders/decoders) can detect and correct errors within blocks of data. Reed-Solomon codec's operate on blocks of data, these codes are generally designated as (n, K) block codes, K is the number of information symbols input per block, and n is the number of symbols per block that the encoder outputs. RS codes are a special case of the larger class of BCH codes but it was not until almost a decade later, by regarding them as cyclic BCH codes, that an efficient decoding algorithm gave us the potential to their widespread application. [3] [10]

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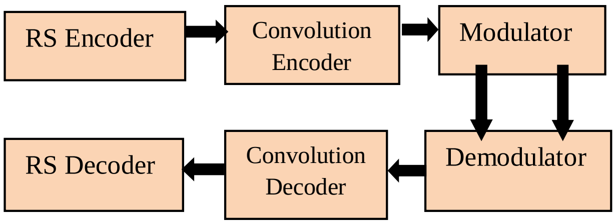

Figure 1: Block Diagram of Communication System

Reed-Solomon (RS) codes have many communication and memory applications and are very powerful in dealing with burst errors, especially when two RS codes are 'interleaved' to control errors. Using interleaving, the burst error channel is effectively transformed into an independent error channel for which many FEC coding techniques are applicable. An interleave scrambles the encoded data stream in a deterministic manner by separating the successive bits transmitted over the channel as widely as possible. In the deinterleaver, the inverse operation is preformed and the received data is unscrambled so that the decoding operation may proceed properly. After deinterleaving, error bursts that occur on the channel are spread out in the data sequence to be decoded, thereby spanning many code words. The combination of interleaving and FEC thus provides an effective means of combating the effect of error bursts.

RS code is demonstrated below:-
RS (n , k) codes on m-bit symbols exist for all n and k for which:-

$$0<k<n<2m+2 \qquad (i)$$

Here k is the number of message bits to be encoded, n is the size of code word in an encoded block and m is the number of bits per symbol. Thus RS (n,k) can be written as follows:-

$$(n, k) = (2(m-1),2(m-1)-1-2t) \qquad (ii)$$

Number of parity bits added to the message bits is calculated by (n-k) = 2t where t is the number of errors corrected by RS code. The distance of the RS code is given by:-

$$dmin= n-k+1 \qquad (iii)$$

RS Encoder

Encoding is a process of converting a input message into a corresponding codeword, where each codeword ∈ GF (2 m)). A RS codeword is generated by a polynomial g(x) of degree n-k with coefficient from GF (2m).

If a finite field of q elements is chosen , whose GF(2m),as a result the message f to be transmitted, consists of k elements of GF(2m) which are given by:-

$$f = (f0, f1, \ldots fk-1) \qquad (iv)$$

Where f € GF (2m)

Thus message polynomial is calculated by multiplying coefficients of the message with appropriate power of x which is given as follows:-

$$F(x) = f0 +f1x+\_\_\_\_\_\_+fk-1xk-1 \qquad (v)$$

The remaining polynomial is known as parity check polynomial:-

$$B(x) = b0+b1x+\_\_\_\_\_\_+b2t-1x2t-1 \qquad (vi)$$

Then the codeword is form by adding the two polynomials as follows:-

$$V(x) = F(x) + B(x) \qquad (vii)$$

RS Decoder

The channel of transmission, especially in critical applications like space, submarine, nuclear introduces a huge amount of noise into the information message. When the message is being transmitted, then the data can be corrupted due to noisy channel etc. Let r(x) is the received message at the receivers and is given by following expression:-

$$R(x) = C(x) + E(x) \qquad (viii)$$

E(x) is the error and C(x) refers to the original codeword transmitted. Error E(x) is given by expression given as follows:-

$$E(x) =en-1xn-1+\_\_\_\_\_\_\_\_\_+e1x+e0 \qquad (ix)$$

Using RS Code t= {n-k}/2 errors can be corrected.

Phase-shift keying (PSK)

It is a one of the digital modulation technique that sends data by changing, or modulating, the phase of a carrier wave.

Any digital modulation technique uses a finite number of distinct signals to represent digital data. PSK uses a finite number of phases; each assigned a unique pattern of binary digits i.e. 0 or 1. Usually, each phase encodes an equal number of bits. Each pattern of bits forms the symbol that is represented by the particular phase. The demodulator, which is designed

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specifically for the symbol-set used by the modulator, determines the phase of the received signal and maps it back to the symbol it represents, thus recovering the original data. This requires the receiver to be able to compare the phase of the received signal to a carrier signal such a system is termed coherent (and referred to as CPSK).

Frequency Shift Keying (FSK)

It is a Frequency modulation technique in which digital information is transmitted through discrete frequency changes of carrier wave.

The simplest FSK is BFSK (Binary Frequency Shift Keying).It uses a pair of discrete frequencies to transmit binary (0's & 1's) information.

Where 1 is called mark frequency and 0 is called space frequency.

Theory of BER

BER is a system-level performance. It is an indication of how good a digital communication system has been designed to perform. It also provides the quality of service the users of a communication system should need. For example, the accepted BER for toll-quality telephone grade speech signal over land-line telephone system is 10-05, while for second generation cellular telephone systems, the BER is usually less than 10-3only. It is a costlier proposition to expect a BER similar to that enjoyed in landline telephone system because the wireless links in a typical mobile telephone system suffers from signal fading. The acceptable BER values are dependent on the type of information. For example, a BER of 10-05is acceptable for speech signal but is too bad and unacceptable for data service. The BER should be less than 10-07. [2]

MODEL AND SIMULATION

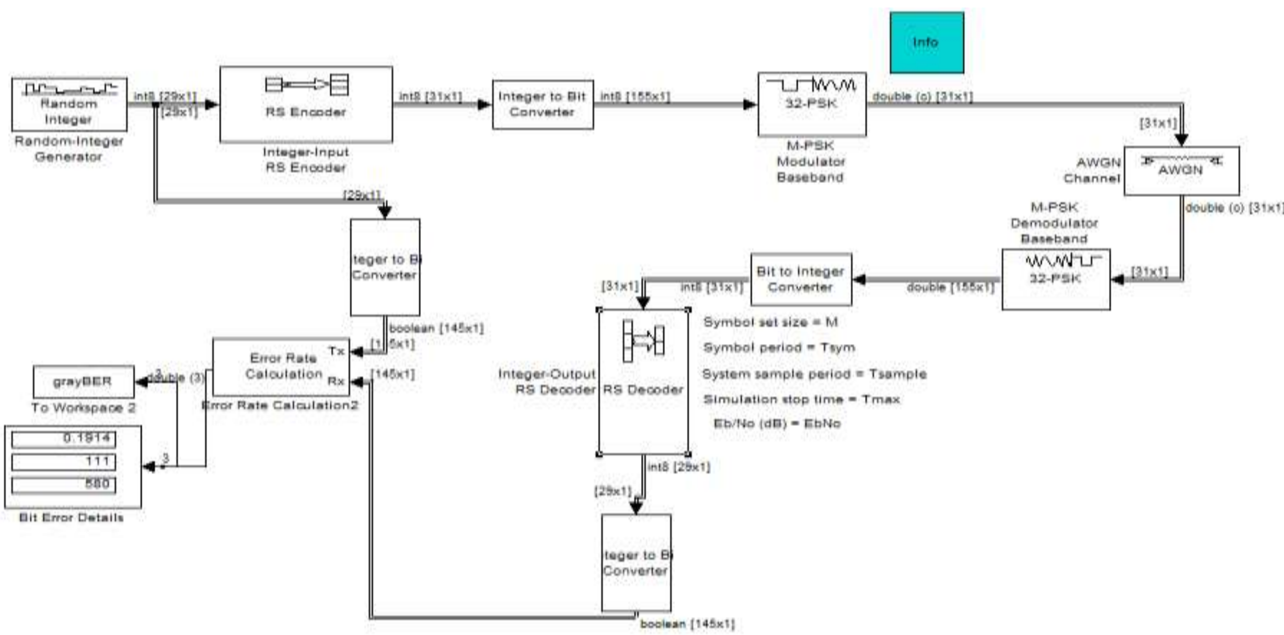

Figure 2: Communication System Model with RS Encoder/RS Decoder over AWGN Channel

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RESULTS

Performance Evaluation as the Function of Redundancy.

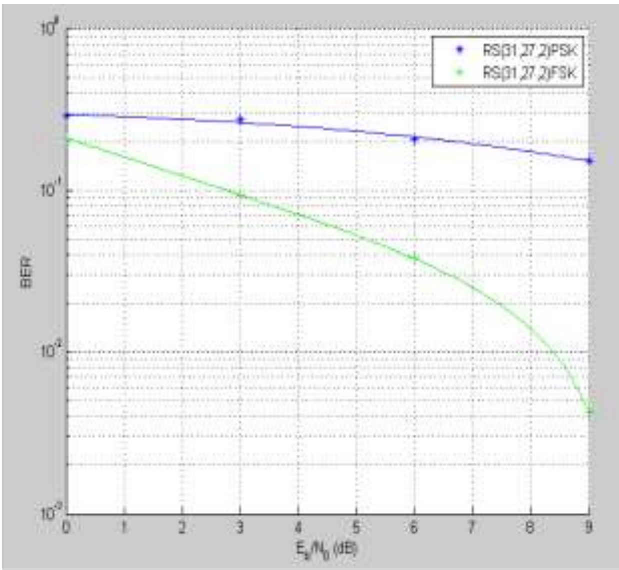

Figure 3: BER Vs Noise Plot (N=31 and K=27).

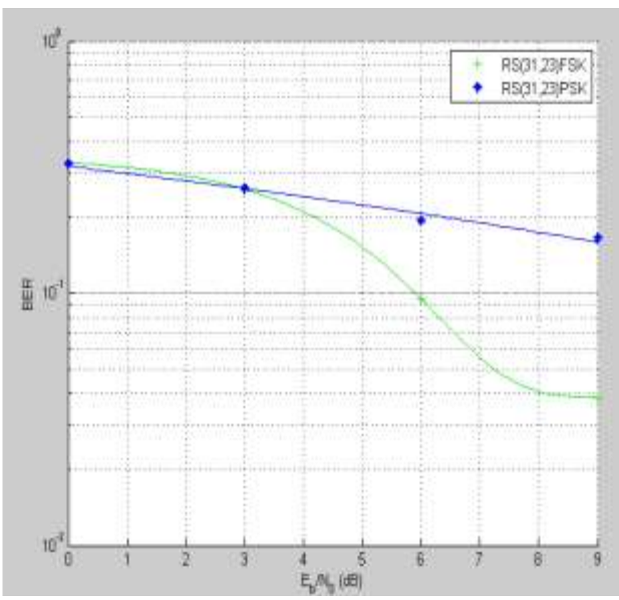

Figure 4: BER Vs Noise Plot (N=31 and K=23).

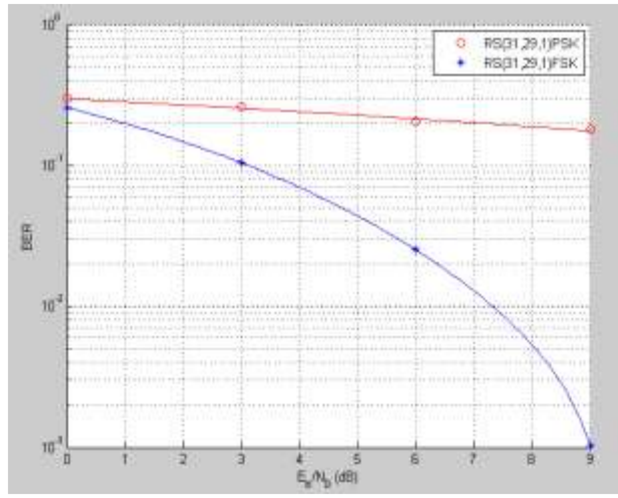

Figure 5: BER Vs Noise Plot (N=31 and K=29).

CONCLUSION

In wireless digital communication systems, reducing bit error rate is very challenging factor. Various coding techniques have been employed for the transfer of data with minimum error. Channel coding for error detection and correction helps the communication system designers to reduce the effects of a noisy transmission channel. In this paper we analyzed the performance of Reed Solomon codes using two different modulation techniques FSK and PSK by varying code rate while keeping block length constant. From the simulation results as shown in figure 3, 4 and 5, it can be observed that BER performance of RSC is better if FSK modulation is used in comparison to PSK modulation. Therefore, properly chosen modulation technique can significantly improve the BER performance for efficient communication system.

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