Scientific Journal of Impact Factor (SJIF): 4.14

e-ISSN : 2348-4470
p-ISSN : 2348-6406

International Journal of Advance Engineering and Research Development

A Review: BER Performance Analysis of Linear Block codes used in FEC over AWGN channel

Amandeep Kaur[1], Gagandeep Kaur[2], Navdeep Singh[3]

[1]*ECE, Yadavindra College of Engineering, Talwandi sabo-151302, Punjab, India*
[2] *ECE, Yadavindra College of Engineering, Talwandi sabo-151302, Punjab, India*
[3]*Electronics and Communication Engineering*

Abstract — *Nowadays, in modern data transmission communication system forward error correction (FEC) codes are widely used for error detection and correction mechanisms. Linear Block codes such as Bose-Chaudhuri-Hocquenghem (BCH), Hamming, Cyclic Redundancy Check (CRC), Reed-Solomon (RS) codes are used as FEC and calculate bit error rate of the system (BER). In this paper, we reviews and analysis the BER performance of these Linear Block codes at same block length of (255, 247) over Additive White Gaussian Noise (AWGN) channel using Binary Phase-shift keying (BPSK) modulation. In addition, while comparing BER performance, we selected lower SNR values from 0 to 9 and analyzed that BCH code gives slightly better results than RS, Hamming and CRC-16 codes. While selecting high SNR values from 0 to 18, the RS code gives better BER performance than BCH, Hamming and CRC-16 codes. The whole simulation process for coding and decoding of Linear Block codes in this paper work is performed using MATLAB software.*

Keywords- *forward error correction codes; linear block codes; block length; BPSK; AWGN channel; SNR*

I. INTRODUCTION

In the modern era, the communication system is playing an important role in the development of mankind and our communication system will be useful to us only, if the sent information reaches to the receiver without any error. In the communication system, it is possible to get the error-free message theoretically, but practically this is not possible. Because our medium (i.e. wire or wireless) is also affects our sent information. Therefore, our communications engineering is working on various communication technologies that will be suitable for reducing errors (i.e. BER) in the data transmission. Least number of errors is mandatory in the data reception for reliable communication. Hence the Forward error correction codes (also be called Channel Coding) is the appropriate technique that's used for the reduction of BER. In this FEC technique errors are detects and corrects. In 1950, Richard Hamming introduced the first FEC code [1], in which the redundant bits are adding in data stream. These redundant bits are allows the receiver to reduction of the BER without re-transmission of the message and it also increases the efficiency of the transmission. Therefore, the FEC code is widely used in data transmission communication systems, because in some communication system retransmission of the signal is impossible or where the cost of retransmit signal is much more.

In FEC the basic principle is that, the original digital information sent to the encoder and the encoder inserts the extra bits (also called redundant bits). This way we receive an long sequence code bits called codeword. Then, we get original information after decoding the codeword sequence by decoder. Mainly, there are two types of FEC: Linear Block codes and Convolutional codes. Here we only discussed about Linear Block codes. Linear Block codes generally works on arbitrary length of bit stream with block length (n, k). Where n is the codeword length and k is the message length. The information data must be divided into blocks of equal length (i.e. k-bits). The redundant bits (i.e. n-k) are added for detection and correction the errors. There are many types of Linear Block codes: CRC, Hamming, BCH and Reed-Solomon codes etc.

CRC code stands for Cyclic Redundancy Check. In this type of code, has shorter message length. It is particularly good for detecting burst errors (i.e. continuously bundle of errors), but they have some error correction capability. CRC have been different standardized generator polynomials [2]. They have simple error detection capability.

Hamming code is a type linear block code with (n, k) block code. It has message length $k = 2^m - m - 1$, codeword length $n = 2^m - 1$ and parity-check bits $m = n - k$.

The BCH codes stands for their inventors named Bose, Chaudhuri, and Hocquenghem. This code firstly introduced in 1959 by Hocquenghem and then it secondly introduced in 1960 by Bose and Chaudhuri [3]. BCH codes are powerful class of random error correcting codes. Binary BCH code have codeword length $n = 2^m-1$, where m is an integer whose value must be lies between $3 \leqslant m \leqslant 16$ and with parity-check bits $n-k \leqslant mt$, where t is the error correction capability.

In 1960 Reed-Solomon code discovered by I. Reed and G. Solomon. It is also an powerful capability for burst error correction. RS code can be correct errors up to $t = (n - k)/2$. The block length of the RS code must be $n = 2^m-1$, and parity check bits $n – k = 2t$, where m is the number of bits per symbol. The k is the message length.

The rest of the paper has been prepared in such a way that, the past workdone is describes in section II. The proposed work for this paper is discusses in section III. The simulation results and its discussion are detailed in section IV. The last section V concludes the paper.

II. PAST WORK

Obtaining reliable communication in the Modern era is the most difficult task, but the past work is also very important for this work and we should be considered them. So the details of the previous work are as follows:

Authors evaluated the performance and application of forward error-correcting codes. In which the authors concluded that there is no need to retransmission the data in FEC, so that it enhances the efficiency of data transmission. Authors also concluded that, in the application of internet, FEC is just for restored the corrupted bit and in the application of wireless communication, it used for detecting and correcting the errors [4].

The authors evaluated the performance of FEC in underwater optical wireless communication system. Their simulations show that the RS code performs better than BCH code. It has also been shown that the RS(127, 85) code performs better than the RS(255, 207) code [5].

In this work, authors compared the performance of RS and BCH codes using QAM and BPSK modulation over Rayleigh fading channel. Their simulations show that the BCH code system gives better BER performance on both QAM and BPSK modulation scheme than RS code [6].

In this work, authors compared the BER performance of Hamming and LDPC codes using OFDM technique in underwater communication application. The authors concluded that, the LDPC code gives better BER performance as compared to Hamming code and without coded OFDM [7].

In this work, authors analysis the BER performance of Linear Block codes over three different channels that are used in wireless communication system [8]. They concluded that the BER performance of RS code after E_b/N_0 4dB is better as compared to BCH code over AWGN channel. They also investigated that the AWGN channel gives better performance than other Rayleigh and Ricean channel.

In this paper, we review the BER performance of the Linear Block codes used in the FEC using AWGN Channel.

III. SIMULATION SETUP

In this section III, the simulation structured model in MATLAB software is described. The simulation model for Linear Block codes with block length (255, 247) of each encoder is shown in Fig. 1 using AWGN channel. The block length (255, 247) for Linear Block codes encoder (i.e. BCH, Hamming and Reed-Solomon encoder) is used with BPSK modulation. The random binary 197600 bits are used as message input to the Linear Block code encoder. For AWGN channel we selected the two particular value of E_b/N_0 from 0 to 9 and 0 to 18. In CRC code, the CRC-16 code scheme generator polynomial [16, 15, 2, 0] is used. In this whole simulation operation, the BER performance of BCH, Hamming, RS and CRC-16 Linear Block codes are calculated by compared of final output data sequence of the given decoder along with original input data sequence using Ex-OR operation in the simulation.

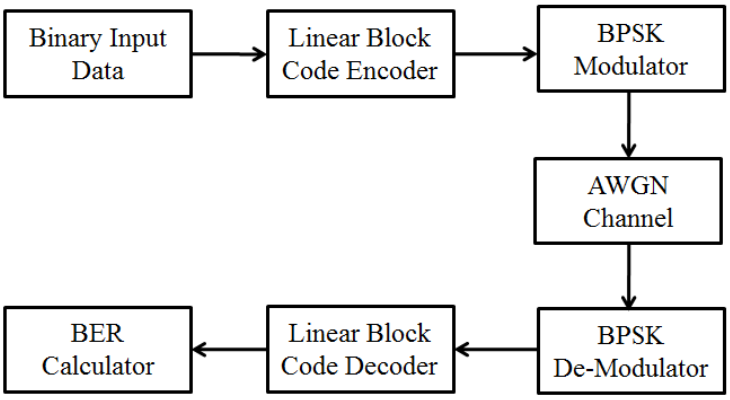

Fig. 1. Simulation model for Linear Block codes with block length (255, 247) over AWGN channel at certain value of E_b/N_0.

III. SIMULATION RESULTS

The simulation outputs of different Linear Block codes are obtained using BPSK modulation over AWGN channel. The BER performance of different Linear Block codes are calculated for AWGN channel at value of E_b/N_0 from 0 to 9 is shown in Fig. 2 and for AWGN channel at value of E_b/N_0 from 0 to 18 is shown in Fig. 3. When we select the value of E_b/N_0 from 0 to 9, the BCH(255, 247) Linear Block code gives better BER value as compared to RS(255, 247), Hamming(255, 247) and CRC-16 codes (in Fig. 2) and its resulted values are shown in Table I. When we select the value of E_b/N_0 from 0 to 18, the RS(255, 247) Linear Block code gives better BER value as compared to BCH(255, 247), Hamming(255, 247) and CRC-16 codes (in Fig. 3) and its resulted values are shown in Table II.

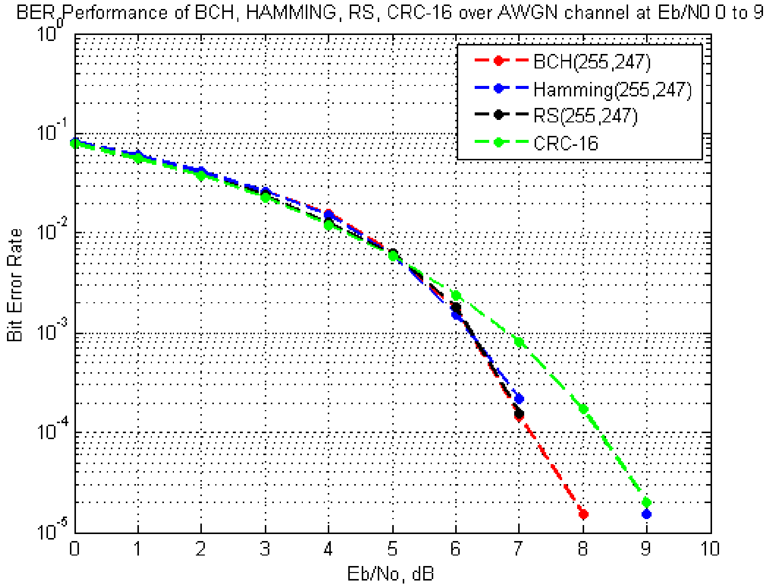

Fig. 2. BER performance of different Linear Block codes over AWGN at value of E_b/N_0 0 to 9.

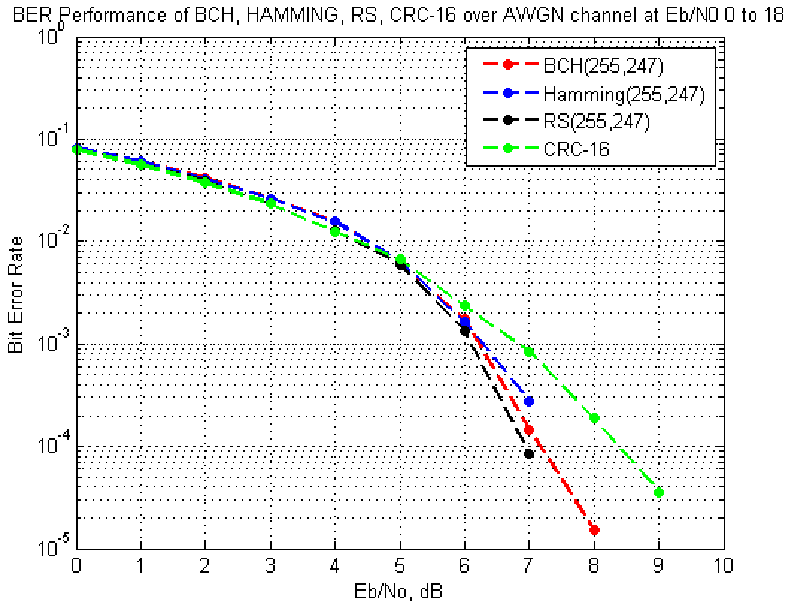

Fig. 3. BER performance of different Linear Block codes over AWGN at value of E_b/N_0 0 to 18.

IV. CONCLUSION

On analyzing the BER performance of all four Linear Block codes using BPSK modulation over AWGN channel at certain value of E_b/N_0. The BCH(255, 247) code gives better BER performance over AWGN channel at certain value of E_b/N_0 0 to 9 as compared to RS(255, 247), Hamming(255, 247) and CRC-16 code. But at value of Eb/N0, RS(255, 247) code gives better BER performance over AWGN channel as compared to BCH(255, 247), Hamming(255, 247) and CRC-16 code. We also concluded that as increases the value of E_b/N_0 from 0 to 18, there is no changes in BER of BCH(255, 247) code excepting Hamming(255, 247), RS(255, 247) and CRC-16 code. But in these three excepted codes, the RS(255, 247) code gives slightly better BER value after 4dB as compared to Hamming(255, 247) and CRC-16 Linear Block code. So we can say that the RS(255, 247) code can be used, where the high value E_b/N_0 upto 0 to 18 is required.

Further work will be considered to improving the BER performance of FEC code using concatenated codes techniques.

Table I. Resulted BER values of different Linear Block Codes over AWGN Channel at E_b/N_0 0 to 9

Linear Block code		BCH (255,247)	Hamming (255,247)	RS (255,247)	CRC-16
Signal to noise ratio (E_b/N_0)	0	0.0826	0.0827	0.0785	0.0783
	1	0.0600	0.0594	0.0570	0.0562
	2	0.0411	0.0413	0.0380	0.0381
	3	0.0261	0.0263	0.0239	0.0228
	4	0.0157	0.0154	0.0126	0.0121
	5	0.0062	0.0060	0.0063	0.0059
	6	0.0017	0.0015	0.0018	0.0024
	7	0.0001	0.0002	0.0002	0.0008
	8	0.0000	0	0	0.0002
	9	0	0.0000	0	0.0000

Table II. Resulted BER values of different Linear Block Codes over AWGN Channel at E_b/N_0 0 to 18

Linear Block code		BCH (255,247)	Hamming (255,247)	RS (255,247)	CRC-16
Signal to noise ratio (E_b/N_0)	0	0.0826	0.0816	0.0792	0.0789
	1	0.0600	0.0598	0.0564	0.0555
	2	0.0411	0.0405	0.0383	0.0373
	3	0.0261	0.0261	0.0232	0.0233
	4	0.0157	0.0155	0.0126	0.0126
	5	0.0062	0.0064	0.0059	0.0067
	6	0.0017	0.0016	0.0013	0.0023
	7	0.0001	0.0003	0.0001	0.0008
	8	0.0000	0	0	0.0002
	9	0	0	0	0.0000

REFERENCES

[1] A. Bhattacharya, "Dgital Communication," Tata Mcgraw Hill, 2005.

[2] https://en.wikipedia.org/wiki/Cyclic_redundancy_check#Introduction

[3] Y. Juang, "Practical guide to error control coding," Artech House London, 2010.

[4] D. Yan, "The Evaluation and Applicatin of Forward Error Coding," IEEE Int. Conf. on Comput. Sci., And Network Technol., pp. 718-721, 24-26 Dec. 2011.

[5] Y. Xinsheng, J. Weiwei, S. Meihong, and L. Zhigong, "Evaluation of Forward Error Correction Scheme for Underwater Wireless Optical Communication," IEEE 3rd Int. Conf. on Commun. And Mobile Computing, pp. 527-530, 2011.

[6] F. R. Lone, . Puri, and S. Kumar, "Performance Comparison of Reed Solomon code and BCH code over Rayleigh Fading channel," Inter. J. of Comput. Appli., vol. 71, no. 20, pp. 23-26, Jun. 2013.

[7] B. Pranitha, L. Anjaneyulu, "Performance Evaluation of Underwater Communication System using Block Codes," IEEE 5th Int. Conf. on Eco-Friendly Computing and Commun. Syst., pp. 58-62, Dec. 2016.

[8] P. R. Kamala and R. V. S. Satyanarayana, "Optimal Linear Block code Modeling and Performance Analysis over various channels for use in Wireless Communications," IEEE Int. Conf. on Emerging Trends in Engg., Technol. And Sci.(ICETETS), 24-26 Feb. 2016.

