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BER PERFOMANCE OF LDPC & RS CODE IN STBC – OFDM SYSTEM

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Abstract: We Analysis will be carried out for an OFDM wireless communication system using space time block code (STBC) at the transmitter and considering the effect and the wireless channel like delay spread and fading. The analysis will include the effect of imperfect timing recovery at the output of the receiver. In this contribution both Low-Density Parity-Check (LDPC) coding and RS coding space-time block coded OFDM is investigated. We analysis this paper comparing the coding technique (Ldpc & Rs code) using multiple transmit & receiving antenna in digital modulation technique BPSK , QPSK over and additive white Gaussian noise (AWGN) and other fading (Rayleigh and Rician) channel. It is anticipated from the BER simulation that the performance of the communication system degrades with the increase of noise power.

Index Terms: Additive white Gaussian noise (AWGN), Low density parity cheak (LDPC), RS code , Bit error rate (BER) , Orthogonal frequency division multiplexing (OFDM) Multiple antenna ,Space time block coding (STBC)

I. INTRODUCTION

The next generation wireless systems are required to have better voice quality and coverage, be more power and bandwidth efficient, and be deployed in diverse environments. There are two fundamental problems with this approach. The major problem is the required transmitter dynamic range. For the transmitter to overcome a certain level of fading, it must increase its power by that same level, which in most cases is not practical because of radiation power limitations and the size and cost of the amplifiers. The second problem is that the transmitter does not have any knowledge of the channel experienced by the receiver except in systems where the uplink (remote to base) and downlink (base to remote) transmissions are carried over the same frequency. Hence, the channel information has to be fed back from the receiver to the transmitter, which results in throughput degradation and considerable added complexity to both the transmitter and the receiver. In most scattering environments, antenna diversity is a practical, effective and, hence, a widely applied technique for reducing the effect of multipath fading [1]. The problem is that the transmitter does not have any knowledge of the channel experienced by the receiver except in systems where the uplink (remote to base) and downlink. (Base to remote) transmissions are carried over the same frequency. Hence, the channel information has to be fed back from the receiver to the transmitter [2]. The space-time block coding (STBC) technique, one of the representative multiple antenna techniques, is most attractive for these purposes. STBC, an effective transmit diversity technique, was first proposed by Alamouti [2] for flat fading channel. Alamouti suggested a space time code for two transmit antennas, which provides a diversity gain and has a very simple decoder [3]. The transmit diversity has been studied extensively as a method of combating determine effects in wireless fading channel because of its relative simplicity of implementation and feasibility of having multiple antenna at the base station [4]. As a result, diversity techniques have almost exclusively been applied to base stations to improve their reception quality. A base station often serves hundreds to thousands of remote units. For this reason, transmit diversity schemes are very attractive. Recently, multiple antenna techniques have been extensively studied for high rate data transmission and increasing transmission [5]. On the other hand, the OFDM technique has been widely accepted for the transmission of high rate data due to its robustness to inter-symbol interference. In this context, the STBC-OFDM system may be one of most promising system configurations that can be adopted for 4th generation mobile systems. The combination of STBC and OFDM results in an enhanced system performance in wideband wireless channels [6],. Recently, low-density parity-check (LDPC) codes have attracted much attention particularly in the field of coding theory. LDPC were proposed by Gallager in 1962 [7] and rediscovered by Mackay [8]. that LDPC codes are effective to improve the error performance of OFDM in multipath environments. It has also been shown in [9] that LDPC based space-time coded OFDM systems are capable of efficiently exploiting the achievable spatial diversity in wireless channel. The concatenation of convolutional and LDPC channel coding is employed in OFDM system for achieving good error rate performance with reasonable complexity. Further to enhance system performance M.Y. Alias et al. [10]. Reed-Solomon codes are block-based error correcting codes with a wide range of applications in digital communications and storage. It is vulnerable to the random errors but strong to burst errors. Hence, it has good performance in fading channel which have more burst errors [11]. In the decades since their discovery, Reed-Solomon codes have enjoyed countless applications, from compact disc™ players in living rooms all over the planet to spacecraft that are now well beyond the orbit of Pluto. Reed-Solomon codes have been an integral part of the telecommunications revolution in the last half of the twentieth century [12]. It is well suited to wideband systems in frequency selective fading environments, because only a few subcarriers are impacted by a deep fade or narrow band interference, which can be protected by forward error

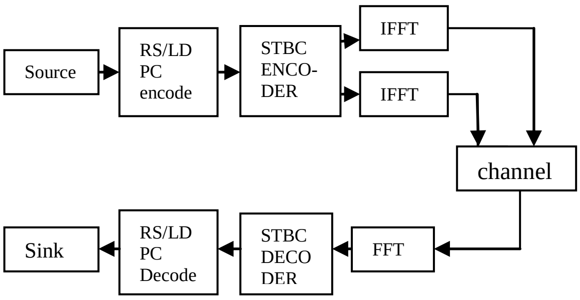

Figure 1 System overview of one-receiver **G**2 space-time block coded OFDM.

Correction. In addition, OFDM is bandwidth efficient, since a nearly square power spectrum can be created with narrow subcarriers with each subcarrier supporting a constellation with many bits per symbol. Because these subcarriers are orthogonal, they do not interfere with one another [13]. The BER performance of a concatenated LDPC encoded OFDM system is studied by M.D. Haque et al. [14] and concluded that the proposed system is very much effective in proper identification and retrieval of transmitted color image in noisy and fading environment [14]. M. M. Hossain et all. [15] .Also studied the impact of LDPC on the performance of an OFDM system under various digital modulations over an AWGN and other fading channels and they shown that the proposed system with deployment of QAM modulation is highly effective to combat inherent interferences and to retrieve the transmitted black and white image properly under noisy and fading situation.

II. SYSTEM MODEL

1. RS CODE model--

The architecture of our STBC-OFDM system show in fig 1.1 for text message transmission that utilizes a concatenated LDPC & RS code scheme with multiple input multiple output antennas. At the transmitter, a text messages ‘Computer is a very usefull machine.” is taken as input. . The stbc block (2x400 double) Cyclic prefix data (5x16 double) , mod data (48 x 5 double). These coded bits are interleaved to minimize burst error and subsequently applied to the convolutional code and modulated digitally by binary phase shift keying (BPSK)/ quadrature phase shift keying (QPSK)/ at the modulator. The outputs of the modulator are complex BPSK/QPSK/ modulation symbols, which are passed to the Alamouti STBC encoder where the symbol values are multiplexed to the multiple inputs & multiple output antenna. At the data is encode & convert to serial to parallel convert & use in ifft in data pass by insert cyclic prefix . At the receiver, the received time domain signals after discarding the cyclic prefix are passed through an fast Fourier transform (FFT) operation to obtain the k-th subcarrier values for symbol period (2i) and (2i +1) .The signals are then fed to the Alamouti STBC decoder which A block of k information bits is taken and then encoded into a block of n bits known as codeword (n>k) which is used for actual transmission. As there are k bits in the block 2k codeword’s are possible. RS codes find their use in digital communication and storage. This code finds its application in space communication, storage media, wireless communication, digital television etc. RS code is demonstrated below:-

RS (n , k) codes on m-bit symbols exist for all n and k for which:-.

$$0<k<n<2m+2 \quad (1)$$

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:-

$$(n, k) = (2^{(m-1)},2^{(m-1)}-1-2t) \quad (2)$$

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:-

$$Dmin=n-k+1 \quad (3)$$

Thus the minimum distance of RS code is similar to hamming distance. Reed-Solomon code is based on galoi’s field, According to galoi’s a finite field has the property that arithmetic operations (+,-,*, / etc.) on the field elements always have a result within the field itself.

1.1 RS Encoder 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:-

$$f = (f0, f1 \ldots fk-1) \quad (4)$$

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Where fi € GF (2m) Thus message polynomial is calculated by multiplying coefficients of the message with appropriate power of x which is given as follows:-

$$F(x) = f_0 + f_{1x} + \_\_\_\_\_\_ + f_{k-1}x^{k-1} \quad (5)$$

The remaining polynomial is known as parity check polynomial:-

$$B(x) = b_0 + b_{1x} + \_\_\_\_\_\_ + b_{2t-1}x^{2t-1} \quad (6)$$

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

$$V(x) = F(x) + B(x) \quad (7)$$

1.2 RS Decoder

When the message is being transmitted a lot of issues can arise such as corruption of the sent message due to a noisy channel etc..Thus the received message at the receivers end is r(x) which is given by following expression:-

$$R(x) = C(x) + E(x) \quad (8)$$

C(x) corresponds to the original codeword transmitted and E(x) is the error, which is further given by expression given as follows:-

$$E(x) = e_{n-1}x^{n-1} + \_\_\_\_\_\_\_\_\_ + e_1x + e^0 \quad (9)$$

Using RS Code t= {n-k}/2 errors can be corrected; if errors are more than t then this code fails.

2. LDPC code model

The same method of our STBC-OFDM system for text message transmission that utilizes a concatenated LDPC code scheme with multiple input multiple output antennas. At the transmitter, a text messages 'Computer is a very usefull machine." is taken as input. . The Text message is converted into binary data of length 696 bits. The binary bits are encoded at the LDPC encoder An irregular LDPC code defined by 696x1392 parity check matrix as (1392, 696) LDPC with a code rate of r = k / n generated in Mat lab. The STBC – block (2x2000 size) & bytes is 64000.mod data is (48x25) & code length is bytes is 8. These coded bits are interleaved to minimize burst error and subsequently applied to the convolutional code and modulated digitally by binary phase shift keying (BPSK)/ quadrature phase shift keying (QPSK)/ at the modulator. The outputs of the modulator are complex BPSK/QPSK/ modulation symbols, which are passed to the Alamouti STBC encoder where the symbol values are multiplexed to the

Multiple input & multiple output antenna. At the data is encode & convert to serial to parallel convert & use in ifft in data pass by insert cyclic prefix . At the receiver, the received time domain signals after discarding the cyclic prefix are passed through an fast Fourier transform (FFT) operation to obtain the k-th subcarrier values for symbol period (2i)and (2i +1) .The signals are then fed to the Alamouti STBC decoder which. The outputs of the STBC decoder are subsequently demapped, convolutionally decoded, deinterleaved and then fed to the RS decoder to retrieve bits using an iterative sum-product algorithm. Finally the RS decoded binary bit stream is converted into text message.

III. RESULT ANALYSIS

we only consider a (2x1 , 2x2) multiple input multiple output antenna.. The STBC-OFDM system is developed by applying Alamouti's representative STBC scheme to the OFDM system for text message transmission. We are use in text message "Computer is a very usefull product" transmitted has been performed to evaluate the BER performance of the LDPC encoded STBC – OFDM system under multiple input multiple output in use different modulation scheme. Figs 2 through 5 show the BER performance of a LDPC encoded & RS code STBC – OFDM system under two types digital modulation (BPSK, QPSK,) and multiple antenna (2x1 , 2x2) on AWGN channel.

A. *BPSK MODULATION (2x1)* – THE BPSK (binary phase shift keying) modulation technique is use of STBC OFDM in different antenna use in improve reception quality in.

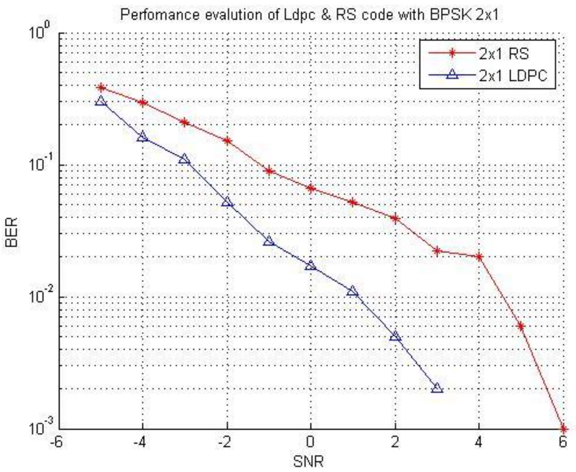

Fig 2 Ldpc & rs code stbc ofdm system with bpsk

A . LDPC CODE – (TWO TRANSMITTER & ONE RECEIVER)

a)..(SNR = -5 , BER = 0.500)

ckitqter is0a våòy usdFUl ggsnS1!

b).(SNR = -3 , BER = 0.0100)

computer is a very usef}d ma%c!ne

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c). (SNR = -1 , BER = 0)

computer is a very usefull machine

B . RS CODE – (Two transmitter & one receiver)

a).(SNR = -3 , BER = 0.1400)

bnlñäeuò¡èò p0bar}$usaf5l p3&^%c!

b). (SNR = -1 , BER = 0.1100)

b☐aedur is !`6esx0Esín}d #$!du5t

c). (SNR = 2 , BER = 0)

Computer is a very usefull machine

B. BPSK MODULATION (2x2) -- The use in 2x2 multiple input & multiple output antenna in bpsk modulation technique in ldpc & rs code error correction technique.

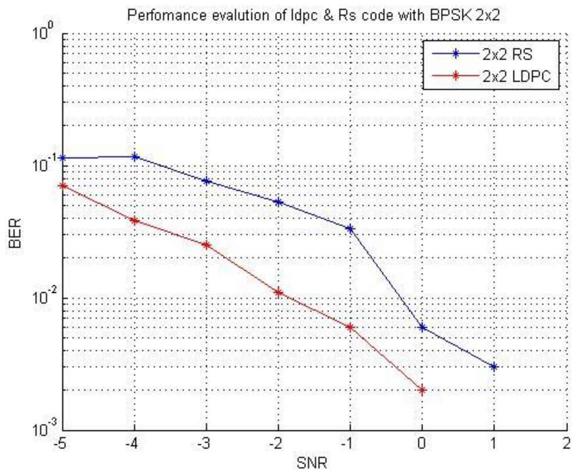


Fig 3. Ldpc & rs code stbc ofdm system with bpsk

A . LDPC CODE – (Two transmitter & two receiver)

a).(SNR = -4 , BER = 0.0433)

computer is a very usef}d mj{]e#

b)..(SNR = -3 , BER = 0.0288)

computer is a ve38 trefull m2%$ne

c). (SNR = -2 , BER = 0)

computer is a very usefull machine

A. RS CODE – (Two transmitter & two receiver)

a).(SNR = -4 , BER = 0.800)

bndhuter2{c a fuby uwaful $A^%$!ne

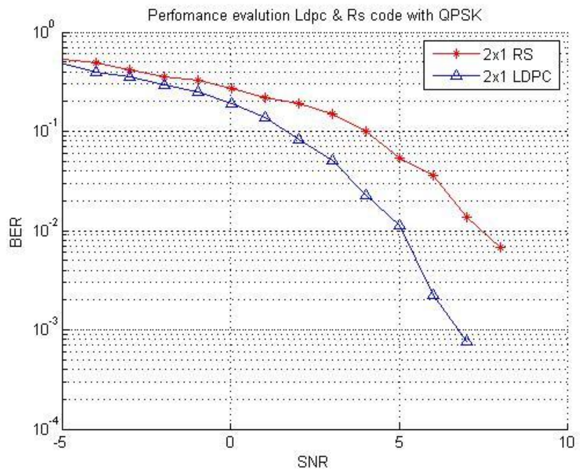
b). (SNR = -2 , BER = 0.0300)

comptudr ir!` very useful mac!N%

c). (SNR =- 1 , BER = 0)

computer is a very usefull machine

A. QPSK MODULATION (2x1) – The use in 2x1 multiple input & multiple output antenna in qpsk modulation technique in ldpc & rs code error correction technique.



. Fig.4. Ldpc & rs code stbc ofdm system with qpsk

A. LDPC CODE – (Two transmitter & one receiver)

a)..(SNR = -2 , BER = 0.3333)

;
\^¡RjQ0b\ebé´ñãÑÃjTlQiYYz

b).(SNR = 0 , BER = 0.3939)

QER÷öfÑÙ&¬Xdh^k!ýmf7|i)+()®ì

c). (SNR = 5 , BER = 0)

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B. RS CODE – (Two transmitter & one receiver)

a).(SNR = 1 , BER = 0.4338)

bnlñäeuò¡èò p0bar}$usaf5l p3&^%c!

b). (SNR = 10 , BER = 0.0478)

âïíputer I`! very usefull!l`chine

c). (SNR = 15 , BER = 0)

computer is a very usefull machine

B. RS CODE – (Two transmitter & two receiver)

a).(SNR = -2 , BER = 0.2684)

gsQ@r éøïJGPu$53ån|emMCkbkxe

b). (SNR =1, BER = 0.0625)

compUTUb is a tery uwabull mñóêëne

c). (SNR = 4 , BER = 0)

computer is a very usefull machine

B. QPSK MODULATION (2x2) -- The use in 2x2 multiple input & multiple output antenna in qpsk modulation technique in ldpc & rs code error correction technique.

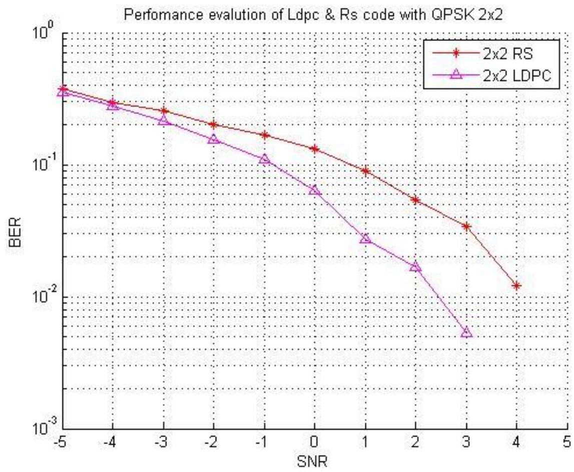

Fig 5. Ldpc & rs code stbc ofdm system with qpsk

A. LDPC CODE – (Two transmitter & two receiver)

a)..(SNR = -4 , BER = 0.2757)
;
\^¡RjQ0b\ebé´ñãÑÃjTlQiYYz

b).(SNR = 1 , BER = 0.0147)

Computer IS A very usefull machine

c). (SNR = 2 , BER = 0.0110)

computer is a very usefull macèéîe

d). (SNR = 1 , BER = 0)

computer is a very usefull machine

IV. CONCLUSION

In this paper, we have analyzed the bit error rate performance of a concatenated low density parity check encoded-based & Read Solomon (Rs) encoded based space-time block coded Orthogonal frequency division multiplexing system under various digital modulations employing multiple input multiple output (2x1, 2x2,) antenna. It has been showed that the proposed system achieves good error rate performance under (2x2) Antenna BPSK modulation techniques in AWGN, Rayleigh and Rician fading channels. On the basis of the results obtained in the present simulation based study, it can be concluded that the deployment of a concatenated channel coding scheme with low-density parity-check and convolutional codes RS & cc code and MIMO transmit diversity technique in Orthogonal frequency division multiplexing based wireless communication system under BPSK modulation is very much effective in proper identification and retrieval of transmitted text message in noisy and fading environments.

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