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Performance Analysis of Wireless OFDM System Using Raptor Codes with different Modulation

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Abstract: - From last few decades, wireless communications industry is gaining momentum in both fixed and mobile applications. The continued increase in demand for all types of wireless services (voice, data, and multimedia) is fuelling the need for higher capacity and data rates not only in fixed but also in mobile applications. There are many techniques that fulfil these requirements. One of the most important techniques is Orthogonal Frequency Division Multiplexing (OFDM). In this paper, we analysis the performance of wireless OFDM system using Rapter codes. The time-varying features of wireless communication channels adversely affect the performance of the system. Raptor code is new emerging rate less code which has shown amazing performance over variety of channels. There is a constraint on the interleaving depth of OFDM-based system due to delay and maximum packet size. This non-ideal interleaving affects the maximum achievable diversity from the channel. We investigated the effect of correlation between fading blocks, which relates to the limited interleaving possible between carriers in an OFDM system, based on Raptor code. The simulation result based on different modulation technique using Raptor codes for BER calculation.

Index Terms: **Rapter codes, Orthogonal Frequency Division Multiplexing (OFDM), Bit error rate, QPSK, Stanford University Interim (SUI).**

I. INTRODUCTION

Reliable delivery of large files to many users over unreliable and bandwidth-constraint networks is a challenging task. The necessity to supply mobile and heterogeneous users with large chunks of data is more desired than ever in many different application scenarios. In modern wireless communication systems, forward error correcting codes are employed for efficient transmission of data in noisy environments. Achieving a very less bit error rate (BER) has been the major task in the field of error control coding.

Fountain codes [2] are a concept of forward error correcting codes, recently developed by Digital Fountain Inc. specifically for such broadcast networks. The first realization of Fountain codes was Luby Transform (LT) codes [3]. The encoding and decoding times of these were later improved, and this new version was named Raptor codes [4]. The recently developed Raptor codes, which are a class of Fountain codes and the extension of LT codes, tend to give better performance than the low density parity check (LDPC) codes [1] on burst error channels [5][6].

Raptor Codes is an extension of LT-Codes [3] with linear time encoding and decoding. Raptor codes produces, for a given integer k, and any real $\delta > 0$, a potentially infinite stream of symbols such that any subset of symbols of size $k(1+\delta)$ is sufficient to recover the original k symbols with high reliability.

Raptor code [7] has the properties of linear time, linear time decoding, and very close to ideal code performance under any channel loss conditions. We start with LT codes, the basic Fountain codes and move on to Raptor codes. In Raptor codes, we first deal with a non-systematic code and then finally develop a Systematic Raptor code [7].

The performance of wireless OFDM system is analysis using Rapter codes. The time-varying features of wireless communication channels adversely affect the performance of the system. Raptor code is new emerging rate less code which has shown amazing performance over variety of channels. There is a constraint on the interleaving depth of OFDM-based system due to delay and maximum packet size. This non-ideal interleaving affects the maximum achievable diversity from the channel.

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The rest of the paper is organized as follows: In Section II, basic of Orthogonal Frequency Division Multiplexing (OFDM) with system design requirements is explained. In section III, Fountain Codes, Raptor Codes and Luby Transform code are explained. In Section IV, simulation results will be explained with the help of graphical representation different modulation scheme. Section V, conclusions will be put forward.

II. OFDM

Orthogonal frequency division multiplexing (OFDM) [11] is a multi-carrier modulation technique with bandwidth efficient signalling schemes for use in high data rate communication systems. Orthogonal frequency division multiplexing (OFDM) is a very promising technique for high-speed data transmission in wireless communication systems due to its robustness against the frequency selective fading channel [9][10].

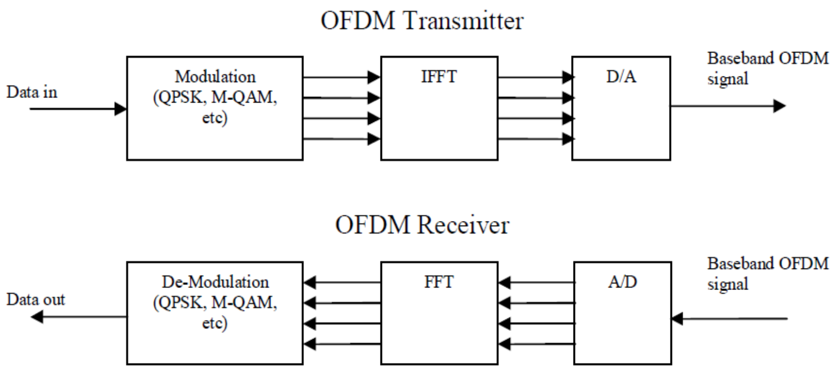

Fig. 1 OFDM Transmitter and Receiver

Basic Principal of OFDM system [8] is to divide high data rate transmission into lower data rate and that are transmitted simultaneously over number of subcarriers. Each of these signal are individually modulated and transmitted over the channel. And at the Receiver and signal will be demodulated and recombine to recover the Original Signal.

A. OFDM System Design Requirements

OFDM system depends on the following four requirements

Available bandwidth: The bandwidth limit will play a significant role in the selection of number of subcarriers. Large amount of bandwidth will allow obtaining a large number of subcarriers with reasonable CP length.

Required bit rate: The system should be able to provide the data rate required for the specific purpose.

Tolerable delay spread: An user environment specific maximum tolerable delay spread should be known beforehand in determining the CP length.

Doppler values: The effect of Doppler shift due to user movement should be taken into account.

III. FOUNTAIN CODES

Digital Fountain Codes has promising performance for erasure channel which is suitable model for packet switching networks. The first practical realization of the Fountain codes was introduced by M Luby in [3] and was further improved in [4]. Raptor code [4] is a class of Digital Fountain Codes, can be used independently of channel loss rate of erasure channel and near optimal performance for every erasure channel. Digital Fountain Codes are considered as "rate less", which means, unlike the traditional block codes such as LDPC codes and RS codes, Digital Fountain Codes do not have a fixed code rate and the rate is determined by the number of transmitted codeword symbols required before the decoder is able to decode. The rate is then not known a priori as it is in traditional fixed-rate block codes. It can generate as many codeword symbols as needed to recover all

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the message bits regardless of the channel performances. Existing rate less codes has the ability to adapt itself according to the channel conditions without knowing the channel knowledge at the transmitter.

A. Luby Transform Code

The Luby Transform code introduced by M.Luby [3] is the first practical realization of the Digital Fountain concept. The length of codeword symbol is arbitrary i.e. encoding symbols can be generated on y, as few or as many as needed depending upon the quality of the channel. The decoder can retrieve original data from any set of the transmitted codeword symbols that are only slightly longer than original data [3]. Regardless of the statistics of the erasure events on the channel, we can send as many encoded symbols unless decoder become able to recover original data from the encoded symbols, so LT code is optimal for any erasure channel. Encoding and decoding time is function of original data. It can recover k symbols from $k + O(\sqrt{k} * ln(\frac{k}{\delta}))$ encoding symbols with probability $1 - \delta$on average $k + O(\sqrt{k} * ln(\frac{k}{\delta}))$symbol operations [3]. Because of the high complexity of the LT codes, Raptor code was proposed as an extension of LT code to achieve linear increase in complexity by using some appropriate pre-coding methods, but Raptor code also requires extra memory to store the pre-code output. The family of Digital Fountain Code has received many designer's attention and have been used in many applications on Transport layer.

B. Raptor Codes

The results of the previous section imply that LT-Codes cannot be encoded with constant cost if the number of collected output symbols is close to the number of input symbols. One of the many advantages of the new construction is that it allows for encoding and decoding with constant cost, as we will see below. The reason behind the lower bound of *log(k)* for the cost of LT-Codes is the information theoretic lower bound of Proposition 1.

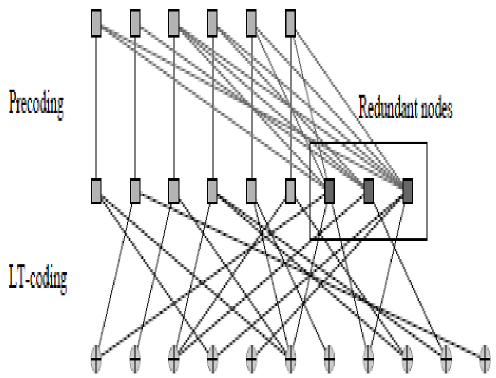

Fig. 2 Raptor Codes: the input symbols are appended by redundant symbols

The decoding graph needs to have of the order of *klog(k)* edges in order to make sure that all the input nodes are covered with high probability. The idea of Raptor Coding is to relax this condition and require that only a constant fraction of the input symbols be recoverable. Then the same information theoretic argument as before shows only a linear lower bound for the number of edges in the decoding graph.

IV. SIMULATION RESULTS

In this section, Analysis of OFDM system using Raptor Code with BPSK and QPSK Modulation technique is explained. Bit error rate (BER) and Spectral Efficiency are the parameter that is used for the analysis of OFDM system using Raptor Codes. After channel equalizer, the data symbols are parallel to series converted, and then symbol demapping is done to get the data bits. Channel decoding is performed with Raptor decoder and we can calculate bit error rate (BER).

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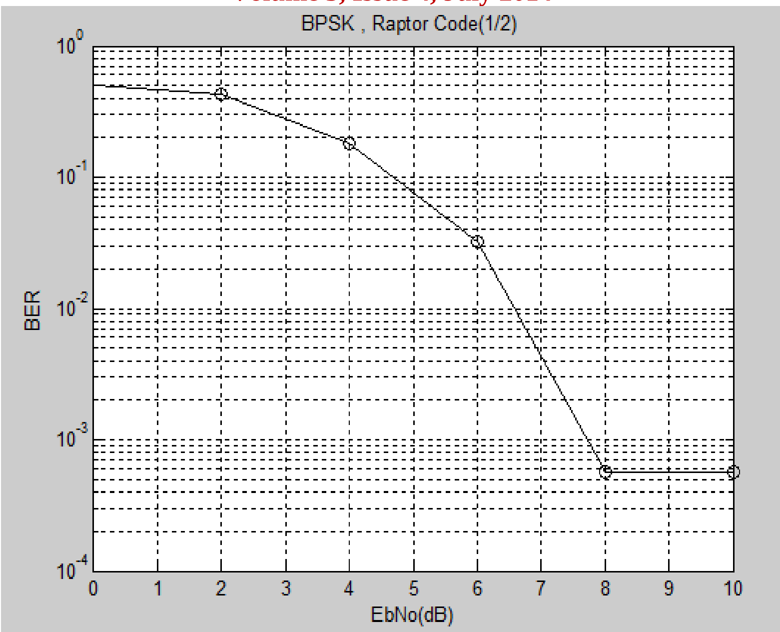

Fig. 3 BER vs EbNo for BPSK using Raptor codes with (r=1/2)

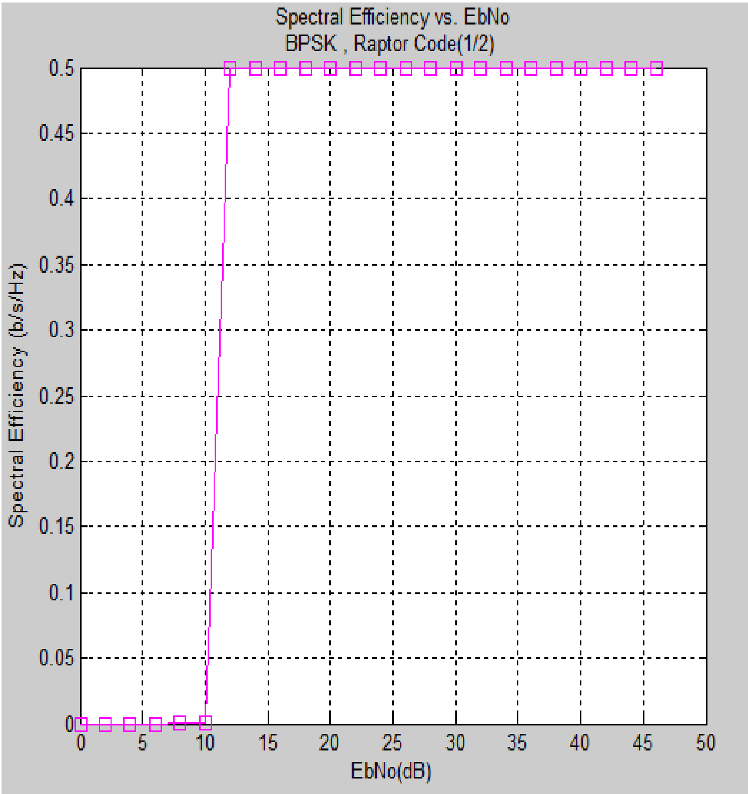

Fig. 4 Spectral Efficiency vs EbNo for BPSK using Raptor codes with (r=1/2)

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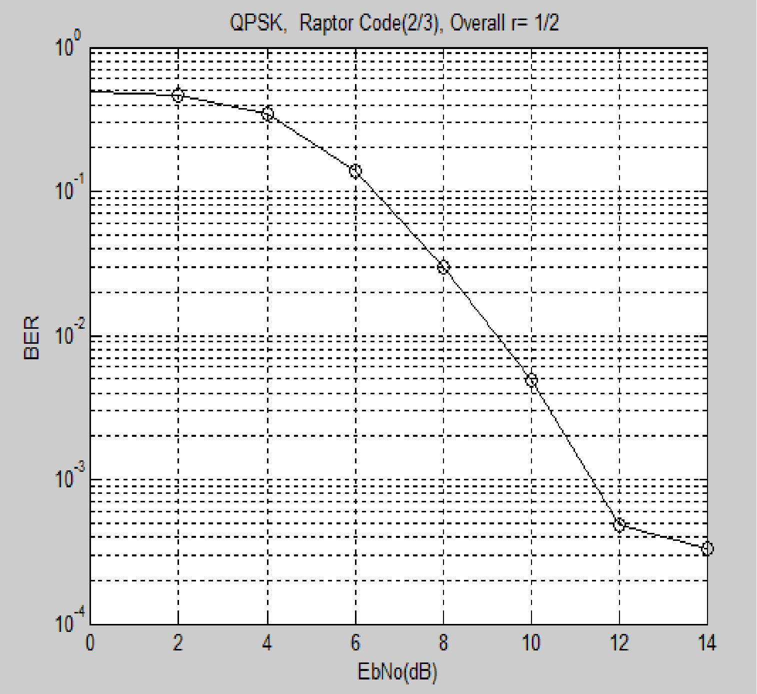

Fig. 5 BER vs EbNo for QPSK using Raptor codes with (r=1/2)

Fig.5 shows the BER vs EbNo for Raptor codes with (r=1/2) using QPSK Modulation Techniques. Fig. 6 shows the Spectral Efficiency vs EbNo for Raptor codes with (r=1/2) using QPSK Modulation Techniques.

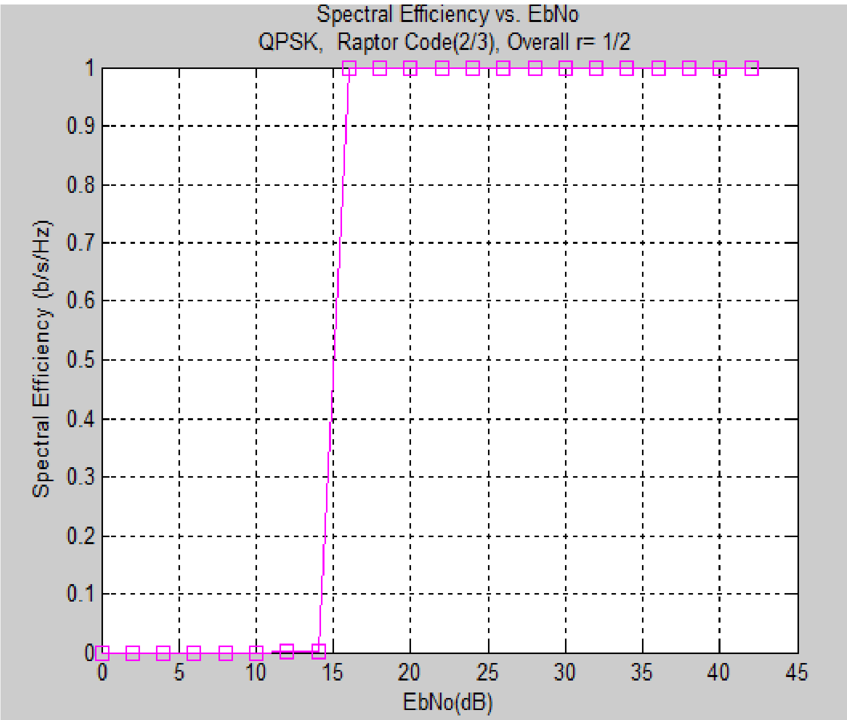

Fig. 6 Spectral Efficiency vs EbNo for QPSK using Raptor codes with (r=1/2)

Fig.3 shows the BER vs EbNo for Raptor codes with (r=1/2) using BPSK Modulation Techniques. The spectral efficiency of a channel is a measure of the number of bits transferred per second for each Hz of bandwidth.

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Spectral efficiency for various modulation levels as a function of short-term average SNR is depicted. Fig.4 shows the Spectral Efficiency vs EbNo for Raptor codes with (r=1/2) using BPSK Modulation Techniques.

V. CONCLUSIONS

In this paper, we analysis the performance of wireless OFDM system using Rapter codes. Raptor code is new emerging rate less code which has shown amazing performance over variety of channels. We investigated the effect of correlation between fading blocks, which relates to the limited interleaving possible between carriers in an OFDM system, based on Raptor code. The simulation result based on different modulation technique using Raptor codes for BER calculation. The modulation techniques used are BPSK, QPSK. The simulation result for Spectral Efficiency calculation was observed using raptor code for error correcting codes.

REFERENCES

[1]. R.G. Gallager, “Low Density Parity Check Codes", Cambridge: MA: MIT Press, 1963.

[2]. D.J.C. Mackay, “Fountain Codes", IEE Proc.-Commun. Vol. 152, No.6, December 2005.

[3]. M.Luby, “LT-Codes", Proceedings of the 43rd Annual IEEE Symposium on the Foundations of Computer Science, pp. 271-280, 2002.

[4]. Amin Shokrollahi, “Raptor Codes", IEEE Transaction on Information Theory, VOL. 52, N0. 6, June 2006.

[5]. M. Rahman, S. Das, F. Fitzek, OFDM based WLAN systems, Technical Report, Aalborg University, Denmark, February 2005.

[6]. R.V. Nee & R. Prasad, “OFDM for Wireless Multimedia Communications”. Artech House Publishers, 2000.

[7]. Michael Luby, Mark Watson,Tiago Gasiba, Thomas Stock hammer and Wen Xu, “Raptor Codes for Reliable Download Delivery in Wireless Broadcast Systems”, Proceedings of IEEE CCNC 2006.

[8]. M. Rahman , S. Das , F. Fitzek, OFDM based WLAN systems, Technical Report, Aalborg University, Denmark, February 2005.

[9]. R.V. Nee & R. Prasad, “OFDM for Wireless Multimedia Communications”. Artech House Publishers, 2000.

[10]. Gault, S. ; Hachem, W. ; Ciblat, P., "Performance Analysis of an OFDMA Transmission System in a Multicell Environment”, IEEE Transactions on Communications, Vol: 55 , Issue: 4 , Page: 740 – 751, 2007 .

[11]. Mohammadnia-Avval, M. ; Snow, C. ; Lampe, L., "Error-Rate Analysis for Bit-Loaded Coded MIMO-OFDM”, IEEE Transactions on Vehicular Technology, Vol: 59 , Issue: 5 , Page: 2340 – 2351, 2010.