Effect of Bit Error Rate in LDPC Based OFDM System over AWGN, Raician And Raileigh Fading Channels

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Abstract: Modern communication systems are adopting new Morden technologies like OFDM (Ortogonal Frequency Division Multiplexing) and LDPC (Low Density Parity Check) for achieving high performance, low Bit Error Rate (BER) and high capacity. The OFDM communication is inspired effectively from the frequencies of channel over the network. In this type of network some kind of distortion occurs over the channel called Inter Carrier Interference (ICI). The OFDM technique can be implemented using Low Density Parity Check (LDPC) Codes because of their ability to reaching near Shannon limit performance. In this paper we are presenting the effect of Bit Error Rate (BER) with Signal to Noise Ratio (SNR) in OFDM system which is based on LDPC over Additive White Gaussian Noise (AWGN), Rician and Rayliegh Fading Channel using MATLAB. The results are then compared with Conventional based OFDM system.

Keywords: *OFDM, LDPC, BER, AWGN channel model, Rayleigh fading channel model*

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I. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is a digital multicarrier modulation technique. It seems to be an attractive choice for fourth generation (4G) wireless communication systems. The multicarrier technique can be implemented in multiple ways, including vector coding and OFDM [1]. OFDM offers high spectral efficiency, immunity to the multipath delay; low inter symbol interference (ISI), immunity to frequency selective fading and high power efficiency. Due to these advantages OFDM is chosen in high data rate communication systems such as Digital Video Broadcasting (DVB) and based mobile worldwide interoperability for microwave access (mobile Wi-MAX). However OFDM system suffers from serious problem of high PAPR. In OFDM system output is superposition of multiple sub-carriers. In this case, some instantaneous power output may increase to a large extent and may become far higher than the mean power of the system. To transmit signals with such high PAPR, it requires power amplifiers with very high power scope. These kinds of amplifiers are very expensive and have low efficiency. If the peak power is too high, it could be out of the scope of the linear power amplifiers. This gives rise to nonlinear distortion which changes the superposition of the signal spectrum resulting in performance degradation. If no measure is taken to reduce the high PAPR, MIMO-OFDM system could face serious restriction in practical applications. PAPR can be described by its complementary cumulative distribution function (CCDF). In this probabilistic approach certain schemes have been proposed by researchers. These include clipping, coding and signal scrambling techniques. Under the heading of signal scrambling techniques we have included two schemes included [2] [3].

II. OFDM System Design

The OFDM has many advantages such as high bandwidth efficiency, robustness to the selective fading problem, use of small guard interval, and its ability to combat the ISI problem. So, simple channel equalization is needed instead of complex adaptive channel equalization. Apart from various advantages of OFDM, there are certain disadvantages also. The frequency offset of the sub-carriers and the high PAPR are the major drawbacks of OFDM [5].

III. OFDM SYSTEM USING FFT

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier modulation technique in which the spectrum of the subcarriers overlap on each other. The frequency spacing among them is selected in such a way that orthogonality is achieved among the subcarriers. The block diagram of a basic OFDM system is shown in Figure 1.1

The inverse transform block can be implemented using either IDFT or IFFT, and forward transform using DFT or FFT. The data generator first generates a serial random data bits stream [10]. This serial data stream carrying information is grouped into bits/word according to the modulation scheme used and then each word is converted into parallel bit stream. Each bit stream is used to modulate one of the N orthogonal subcarriers [10]. The data is processed using modulator to map the input data into symbols based on the modulation technique used.

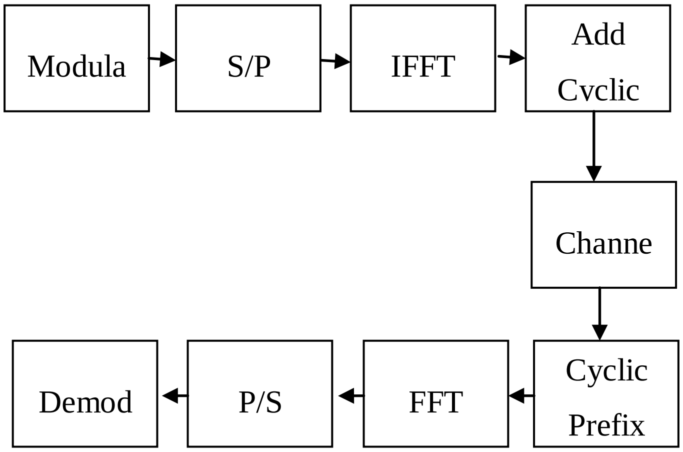

Figure 1.1: OFDM trans-receiver

IV. RAYLEIGH AND AWGN FADING CHANNEL

RAYLEIGH fading is a statistical model for studying the effect of a propagation environment on a radio signal, such that is used by wireless devices RAYLEIGH fading models assume that the magnitude of a signal that has passed through such a transmission medium will vary randomly or fade according to a RAYLEIGH distribution. Rayleigh fading is a reasonable model where many objects in the environment scatter the radio signal before it arrives at the receiver. If there is no dominant component to the scatter, then such process will have zero mean and phase evenly distributed 0 and 2 radians. Calling this random variable R, it will have a probability density function.

$P_R(r)=2\pi/\Omega e^{-r^2/\Omega}, r\geq 0$

Where $\Omega = E(R^2)$

ADDITIVE WHITE GAUSSIAN noise (AWGN) channel is a universal channel model for analyzing modulation schemes. In this model, the channel does nothing but add a white Gaussian noise to the signal passing through it. This implies that the channel's amplitude frequency response is flat(thus with unlimited or infinite bandwidth) and phase frequency response is linear for all frequencies so that modulated signal pass through it without any amplitude loss and phase distortion of frequency components . AWGN channel is a theoretical channel used for analysis purpose only.[6]

The received signal in the interval of $0\leq t\leq T$ may be expressed as-

R(t)=S(t)+n(t)

Where n(t) denotes the sample function of additive white Gaussian noise channel(AWGN) process with power spectral density.

V. SIMULATION RESULTS AND ANALYSIS

LDPC based OFDM system is implemented using MATLAB and graphical result are found showing the bit error rate (BER) of the system.

(a) SIMULATION –

To find the Bit Error Rate (BER) of the OFDM system and plot this against the SIGNAL TO NOISE Ratio (SNR) Using AWGN channel

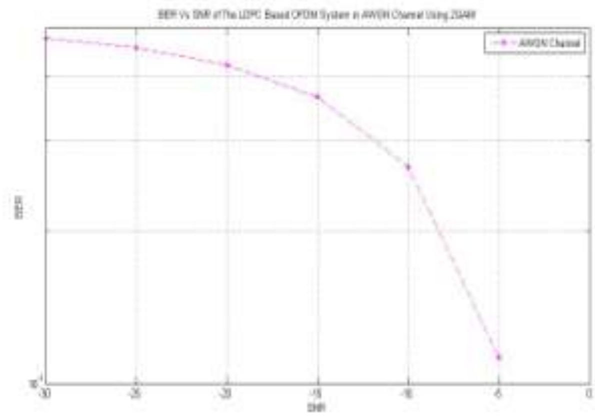

Figure 2 BER: QAM over AWGN channel

As shown in the figure-2 when signal to noise ratio is increasing the value of Bit Error rate (BER) is decreasing. In case of SNR = 8dB for QAM modulation, an error of 0.1 is recorded, and in case of SNR=16dB, an error rate of 0 .001 is noticed, hence the error is linearly decreasing.

(b) SIMULATION –

To find the Bit Error Rate (BER) of the OFDM system and plot this against the SIGNAL TO NOISE Ratio (SNR) Using RICIAN channel

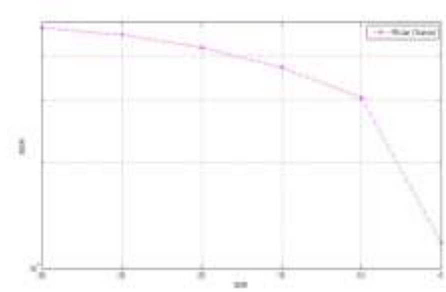

Figure 3 BER: QAM over RICIAN channel

(c) SIMULATION –

To find the Bit Error Rate (BER) of the OFDM system and plot this against the SIGNAL TO NOISE Ratio (SNR) Using RAYLIEGH channel

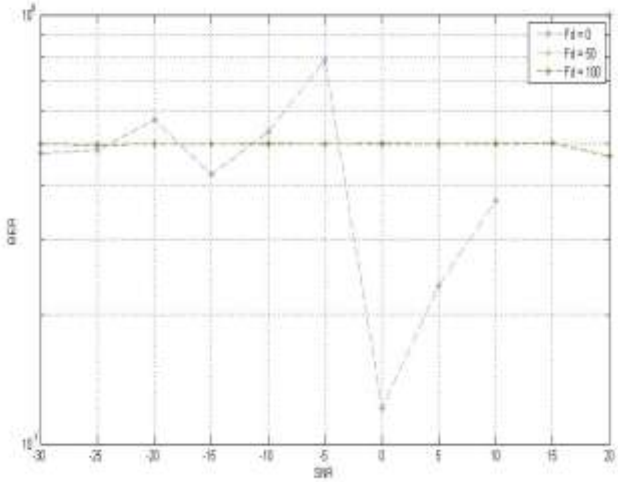

Figure 4 BER: QAM over RAYLEIGH channel

VI. CONCLUSION

The BER performance of the LDPC based OFDM system can be found over AWGN, RAICIAN and RAYLEIGH fading channel using the QAM modulation schemes. From the plots of the BER, it is concluded that when the Signal to Noise Ratio (SNR) is very low it does not have any impact on the BER. However if Signal to Noise Ratio is increased the BER is reduced accordingly. From the performance of both the channels it is found that QAM modulation is better than other modulation because it is more bandwidth efficient.

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