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BER IMPROVEMENT IN OFDM SYSTEM USING ADAPTIVE MODULATION AND EQUALIZER

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ABSTRACT-In this paper, an Orthogonal Frequency Division Multiplexing (OFDM) system is modelled with ASTC encoder, equalizers using adaptive modulation. In OFDM system inter carrier interference (ICI) is usually not occur due to the principal of orthogonality, but the inter symbol interference (ISI) problem is removed by adopting linear equalizer i.e. minimum mean square error (MMSE) due to which complexity of receiver is also reduced. In OFDM system PAPR is their due to which complexity of system increase. For reducing PAPR use of ASTC code is very effective, but the PAPR is not eliminated completely. The efficiency of the OFDM spectrum is increased by using adaptive modulation which can use the modulation according to the noise in the channel.

Keywords-OFDM, MMSE, ZFE, PAPR, ISI, and ICI

I. INTRODUCTION

Now days the demand of high data rate increasing day by day, especially in communication system, e.g. video conferencing, sending audio-video messages, video calling, maximally all the surfing and woks that is done on desktop is now done on mobile requires high speed data rate and due to cloud computing need of very high speed data rate is increasing in future. Because of this all your computer task can be done on mobile to reach this motive there is requirement of very high speed data rate. OFDM is a one of the technique by which increasing need of high data rate communication can be fulfilled. OFDM is multicarrier modulation technique in which single high rate data stream is divided into multiple low rate data streams, and each of them is modulated with subcarrier which is orthogonal to others sub carriers. Therefore OFDM provides an efficient transmission over limited bandwidth. The OFDM systems exhibits delay spread tolerance and efficient spectral usage by allowing subcarrier overlapping in the frequency domain. The conversion of parallel low rate frequency domain signals to time domain at the transmitter and time domain signals to frequency domain at the receiver is performed, using inverse fast fourier transform (IFFT) and fast fourier transform (FFT) operations. The IFFT and FFT operations are computationally efficient. The various subcarriers in OFDM are synchronized in time and frequency, representing a single block of spectrum. This is to ensure that the orthogonal nature of the structure is maintained.[1]

II. OFDM MODEL

The basic and main building blocks of model shown are shown in figure 1 basically includes transmitter channel and receiver

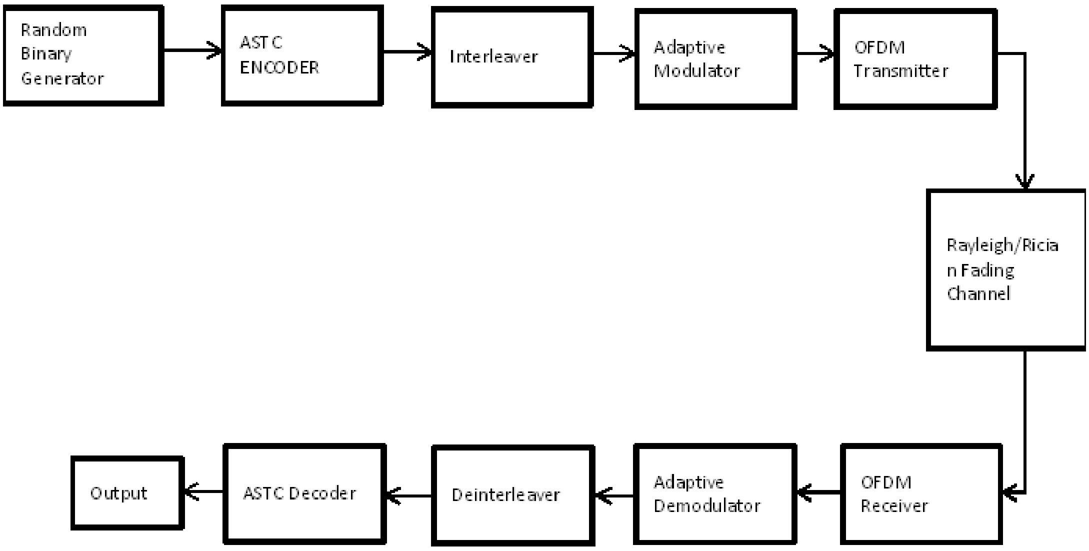

Fig. 1: Block Diagram of OFDM system

A. ASTC Encoder

Powerful coding technique for OFDM is ASTC which come with PAPR reduction scheme. Thus ASTC to their very Algebraic- construction based on Quaternion algebra; have a full rate; full diversity; non-vanishing constant minimum determinant for increasing spectral efficiency; uniform average transmitted energy per antenna and good shaping; readily lend themselves to high data rate situations. ASTC could exceed the alamouti codes performances, thanks to its algebraic construction which guarantees three major advantages:

i. A nonzero lower bound on the coding gain; which is independent of the spectral efficiency (non-vanishing determinant).
ii. The shaping constraints, with an objective to make sure that the codes are energy efficient.
iii. Uniform average transmitted energy per antenna is also required.

To spread their power regarding the bit rate and the BER performance into the selective channel case with time variation; introduce the good perfect algebraic code known as Golden codes. The code was proposed in 2004; STBC comes using division algebra; which is full rate; full diversity; and has a nonzero lower bound on its coding gain; which does not depend on the constellation size. The code word is written as:

$$X_{n_i} = \frac{1}{\sqrt{5}}\begin{pmatrix} \alpha(\vartheta_{n_i}(1)+\theta\vartheta_{n_i}(2)) & \alpha(\vartheta_{n_i}(3)+\theta\vartheta_{n_i}(4)) \\ \bar{\alpha}(\vartheta_{n_i}(3)+\bar{\theta}\vartheta_{n_i}(4)) & \bar{\alpha}(\vartheta_{n_i}(1)+\bar{\theta}\vartheta_{n_i}(2)) \end{pmatrix}$$

Where $\theta = \frac{1+\sqrt{5}}{2}$, $\bar{\theta} = \frac{1-\sqrt{5}}{2}$ & $\alpha = 1+i-i\theta$, $\bar{\alpha} = 1+i-i\bar{\theta}$

B. Interleaving

Interleaving is a simply breaking a single transmission unit up into smaller pieces and spreading them out in time by sequencing them with other transmission units e.g. if the transmission units is a byte then it is interleave with several other bytes. If the transmission unit is block or packet then it must be interleaved with several other blocks or packets

Interleaving is often associated with a forward error correction (FEC) of some sort, and it makes the FEC algorithm better able to deal with burst error, by spreading the effects of those over multiple transmission units. Two types of interleaving is discussed

Block interleaving: it is simplest type of interleaving. It is most often associated with serial code concatenation and a block inner code. Each successive inner code of symbols is written into a corresponding row in the interleaver memory.

Matrix interleaving: In this the input is taken through row of the matrix and output is taken through column.

C. Adaptive Modulation

It is a technique in which transmitter itself choose modulation scheme according to the distance and level of noise in channel. A subscriber station close to the base station can use 64QAM or higher modulation, while the weaker signal from a more remote subscriber might only permit the use of 16QAM or QPSK for better spectral efficiency and reliability communication and employed as high data rate transmission which is not feasible in single-carrier transmission due to large complexity of the equalizer in the receiver end.

D. OFDM Transceiver

It includes different processes as follows

S/P and P/S converter: It convert the serial data into parallel data and parallel data into serial data or low to high and high to low rate data.

Zero Padding and IFFT/FFT: Zero padding increases sampling rate for better resolution of signal in frequency domain. While zero padding provides spectral interpolation in the time domain, the IFFT converts frequency domain data into time domain maintaining the orthogonality of subcarriers. Before IFFT, numbers of zero are inserted in the input to make its length equal to length equal to IFFT bin size (for this paper it is 64). This addition of zero is called zero padding and is used only when the subcarriers are less than bin size. Generally in OFDM system, we selected the number of data symbols equal to 52 giving 12 zero symbols. Zero padding removal does the reverse does the reverse at receiver.

Cyclic Prefix: it is used to remove ISI effect in the OFDM symbol. This is achieved by adding partial end of symbol information of each cycle to the beginning of the symbol. Higher is the delay spread, higher is the length of cyclic prefix, and we are taken it ¼ of the symbol period. After this the symbols from parallel paths are combined to make a serial data.

E. Equalization

In Non-linear channel great chance ISI occurrence but in linear channels, cyclic prefix is used to convert linear convolution of data into circular convolution. In both cases we required equalization. There are two linear equalizers is used are as follows:

Zero forcing equalizer: It invert the frequency response of the channel. But it has one drawback it amplifies the noise along with the signal.

Minimum mean square error equalizer: It minimizes the mean square error between desired signal and equalized signal.

$$E(e(k))^2 = E\,(s(k)-Y_{ZF})^2$$

This equation is further solved as

$$E(e(k))^2 = E(s(k)-c(k)\otimes y(k))^2$$

Where e(k) is the error at sample time k, s(k) is desired signal, c(k) is set of filter coefficients and Y_{ZF} is equalized output

F. Fading Channels

Fading is deviation in the amplitude, phase, frequency of the signal due to the effect of channel. The fading channel is a communication channel that experiences fading. We are discussion two type of fading channel:

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Rayleigh fading channel: It is the name given to the form of fading that is often experienced in an environment where there are a large number of reflections present. The Rayleigh fading model is normally viewed as a suitable approach to take when analyzing and prediction radio wave propagation performance for areas such as cellular communications in a well built up urban environment where there are many reflections from buildings, etc. HF ionospheric radio wave propagation where reflections (or more exactly refractions) occur at many points within the ionosphere is also another area where Rayleigh fading model applies well. It is also appropriate to use the Rayleigh fading model for tropospheric radio propagation because, again there are many reflection points and the signal may follow a variety of different paths.

Rician Fading Channel: The Rician fading is similar to Rayleigh fading, except that in Rician fading a strong dominant component exists. This dominant component is the line-of-sight wave. Specifically, in Rician model we have exhibits following properties. The dominant wave can be a phasor sum of two or more dominant signals, e.g. the line of sight plus a ground reflection. This combined signal is then mostly treated as a deterministic (fully predictable) process. The dominant wave can also be subjected to shadow attenuation.

III. Results

Simulation Parameters are described below which are chosen in simulation of OFDM system. The results are plotted for bit error rate (BER) with respect to signal to noise ratio (Eb/No.).

Table: 1 Simulation Parameters

S. NO.	**Parameter**	**Value**
1	Carrier Modulation scheme	Adaptive Modulation
2	IFFT size	64
3	OFDM symbol duration	4µsec
4	Cyclic prefix length	16
5	Channel model	Rayleigh, Rician
6	Data Rate	Variable
7	Noise model	AWGN
8	No. of sub carriers	52

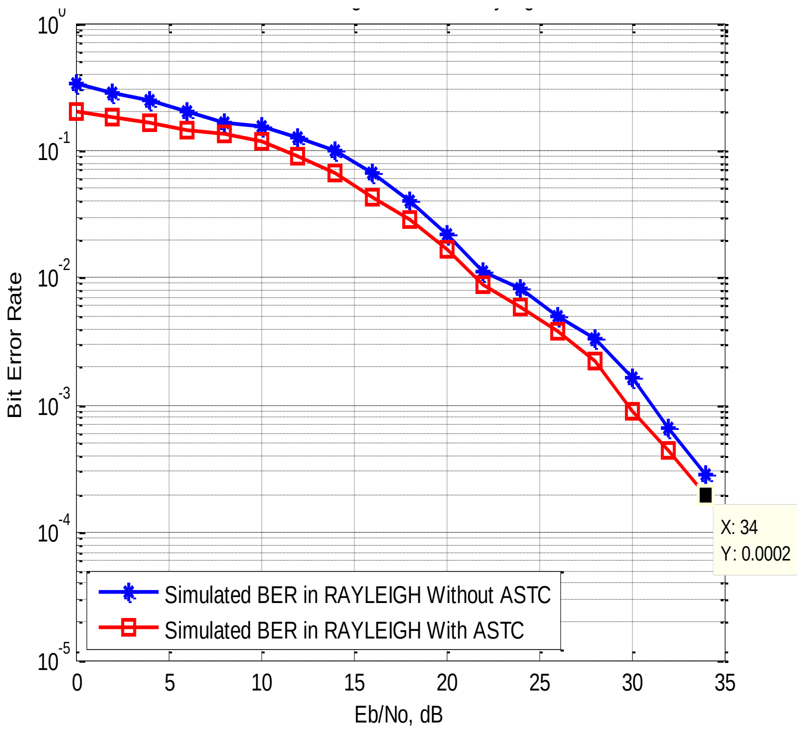

Fig:2 BER Comparison for Rayleigh with or without ASTC Encoder.

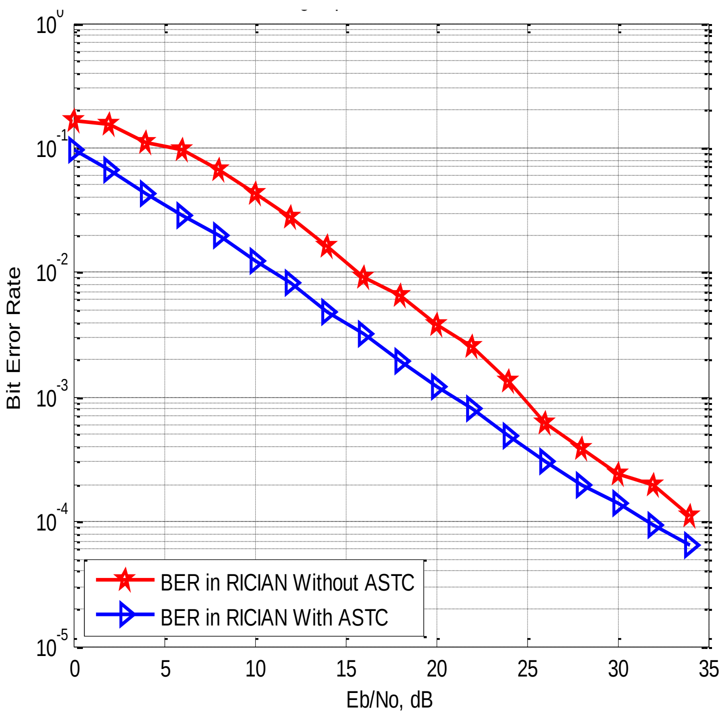

Fig:3 BER Comparison for Rician with or without ASTC Encoder.

In the above figures 2 and 3 the comparative graph between BER and Eb/No with Rayleigh and Rician fading channel with and without using ASTC encoder. Form graphs it is cleared that BER are improve with using ASTC encoder and adaptive modulation.

IV. CONCLUSION

In this study it is cleared that to increase the spectral efficiency, reducing BER and improving ISI and ICI, the PAPR problem has to be overcome in OFDM system. From the previous chapter results, it has been cleared that the parameters i.e. BER and SNR provide better results for OFDM system by using MMSE equalizer with ASTC encoder and adaptive modulation. MMSE reducing the ISI and ICI generated in the transmitted signal due to multipath propagation and providing improved BER. ASTC encoder reduces the PAPR generated in the transmitted signal. Hence, due to this the BER of the OFDM system is improved. It is also conclude that use of adaptive modulations in OFDM system increases the spectral efficiency of the system. In a period of low fade, or high gain, will improve our instantaneous SNR, allowing higher rate modulation schemes to be employed with low probability of error. Periods of high fade will lower the effective SNR and force us to use low rate modulation in order to make transmission more robust. The experimental results explained that the proposed method is effective. However, some other works will be explored to obtain better performance.

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