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BER Improvement in OFDM with ZF and MMSE Equalizers Using ASTC Encoder in Different fading channels - Review

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Abstract

Orthogonal Frequency Division Multiplexing (OFDM) system is modelled with equalizers. Two different equalizers, namely Zero Forcing (ZF) and Minimum Mean Square Error (MMSE), along with QAM modulations are used and analyze with different channels like Rayleigh channel and Rician channel. The modulation with multicarrier is employed; which provides advantages like inter symbol interference (ISI) reduction; high reliability; and better performance in multi-path fading. Equalizers are adopted to remove the ISI generated in the transmitted data under various fading environments. And the results show that, with MMSE and ZFE equalizers; the bit error rate (BER) performance is improved. At last the BER performance of MMSE is superior to ZFE equalizer. Now the main problem of OFDM system is PAPR. This problem is overcome by using ASTC encoder with different equalizer and using different channels and find which equalizer performs better in the system with different channels. Therefore by reducing PAPR, there is further improvement in BER with ZF and MMSE equalizers. To increase spectral efficiency of system, the different QAM modulations technique is used.

Keywords

OFDM, ASTC, ZFE, MMSE, Rayleigh Channel, Rician Channel, PAPR, ISI and ICI

I. Introduction

In this high-speed wireless and mobile communications era, The concept of multi carrier transmission provides high data rates in communication channel. The OFDM is a special kind of multi carrier transmission technique that divides the communication channel into several equally spaced frequency bands. Here the bit streams are divided into many sub streams and send the information over different sub channels. A sub-carrier carrying the user information is transmitted in each band. Each sub carrier is orthogonal with other sub carrier and it is carried out by a modulation scheme. Data's are transmitted simultaneously in super imposed and parallel form. The sub carriers are closely spaced and overlapped to achieve high bandwidth efficiency [2]. The main disadvantage of OFDM is high peak to average power ratio. The peak values of some of the transmitted signals are larger than the typical values

DIFFERENT KINDS OF METHOD TO REDUCE PAPR VALUES

However, one major difficulty is OFDM's large Peak to Average Power Ratio (PAPR). Those are created by the coherent summation of the OFDM subcarriers.

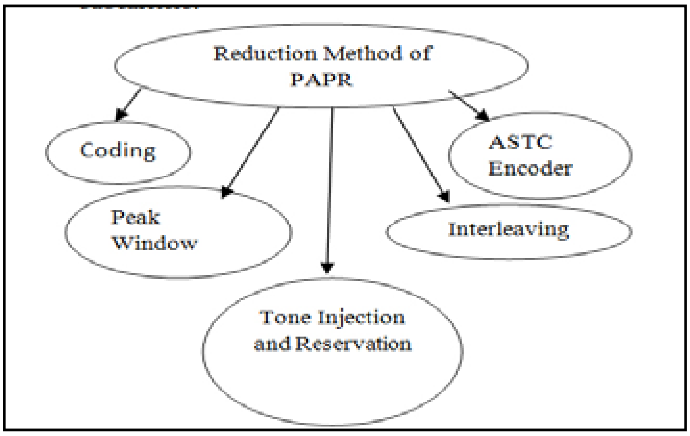

Fig. 1: Method of Reduction PAPR

When N signals are added with the same phase, they produce a peak power that is N times the average power. These large peaks cause saturation in the power amplifiers, leading to intermodulation products among the subcarrier and disturbing out of band energy. Hence, it becomes worth while reducing PAPR. Towards this end there are several proposals such as clipping, coding, peak windowing, Tone Injection, Tone Reservation, Interleaving, Envelope Scaling and ASTC encoder [4]. Respectively, reduction of PAPR comes at a price of performance degradation, mainly in terms of rate and BER [5].

All the above technique which is use to reduce PAPR is not good and efficient except one i.e. ASTC encoder. Because all others techniques have data loss and increases the complexity of system, to overcome this PAPR problem. These methods also increase the power efficiency and increase cost of system. Therefore ASTC encoder use to reduce PAPR values and improve BER with Different SNR values

II. Equalization In Time Domain

Considering non linear channel (or when signaling is not done according to nyquist criterion), there is a great chance that intersymbol interference occur. For linear channels, cyclic prefix is used to convert linear convolution of data into circular convolution. For both the cases, we need to use equalization. For the model used in the paper, two different equalization techniques, namely, ZF equalization and MMSE equalization both in time domain are investigated. A time domain equalizer use shorter length of cyclic prefix which does not affect efficiency of system.

A. Zero Forcing Equalizing Technique

It is a linear equalizer, which inverts the frequency response of the channel. The ZFE transfer function is the inverse of that of channel's response. The name Zero-Forcing, signify bringing down the ISI to zero in a noise free case. This is useful when ISI is significant compared to noise. Let the discrete time transmitted symbols, the channel response, and the set of filter coefficients are represented as s(k), h(k), and c(k) respectively as shown in

Figure 4. According to the definition of ZFE algorithm we have to find filter coefficients which can mitigate the channel effects such that

$$h(k)*c(k) = s(k) \quad (1)$$

In (1), symbol * represents circular convolution. These filter coefficients c(k) are then convolved with received time domain discrete signal y(k) to equalize y(k) as given below.

$$Y_{ZF} = c(k)*y(k) \quad (2)$$

Equation (2) can be further simplified as

$$Y_{ZF} = c(k)* [S(k)*h(k)+n] \quad (3)$$

Where n is AWGN noise in equation (3) can be further reduced to

$$Y_{ZF} = s(k)+c(k)*n \quad (4)$$

Also, we can develop the same model in frequency domain. If the channel response in frequency domain response is H[f], filter coefficients C[f] is constructed by C(f) =1/H(f). Thus combination of channel and equalizer gives a flat frequency response H(f) C(f) = 1.

B. Minimum Mean Square Equalizer

The zero-forcing equalizer, although removes ISI, may not give the best error performance for the communication system because it does not take into account noises in the system. A different equalizer that takes noises into account is the minimum mean square error (MMSE) equalizer. It is based on the mean square error (MSE) criterion. Without knowing the values of the information symbols I_k beforehand, we model each symbol I_k as a random variable. Assume that the information sequence $\{I_k\}$ is WSS. We choose a linear equalizer $H_E(Z)$ to minimize the MSE between the original information symbols I_k and the output of the equalizer $\hat{}I_k$:

$$MSE = E[e_k^2] = E[(I_k - \hat{}I_k)^2] \quad (5)$$

The linear MMSE equalizer can also be found iteratively. First, notice that the MSE is a quadratic function of h_E. The gradient of the MSE with respect to h_E gives the direction to change h_E for the largest increase of the MSE. To decrease the MSE, we can update h_E in the direction opposite to the gradient. This is the steepest descent algorithm. This is a stochastic steepest descent algorithm called the least mean square (LMS) algorithm.

III. Channel Description

In generally there are various fading channels, which includes Rician and Rayleigh and in this paper OFDM is simulated in two type of fading channels i.e. Rayleigh and Rician.

Rayleigh channel: In a Rayleigh fading channel model, it is assumed that that there is no direct path [4, 5, 11] between transmitter and receiver out of all multiple reflective paths. The output of such channel can be expressed as

$$R(n) = \sum h(n,\tau)S(n-m) + Z(n) \quad (6)$$

Where Z(n) is AWGN noise with zero mean and unit variance, h(n) is channel impulse response which is equal to

$$h(n) = \sum \alpha(n)e^{-j\theta(n)} \quad (7)$$

Where Į(n) and ș(n) are attenuation and phase shift for nth path. So, we summarize them for all the channel taps. The Rayleigh channel can be simulated as flat or frequency selective channel depending upon its coherence bandwidth. If coherence bandwidth is larger compared to signal bandwidth, the channel is called flat, otherwise, it is called frequency-selective. In this paper, OFDM is simulated under Rayleigh frequency-selective channel. The channel is implemented by choosing number of channel taps which should be more than cyclic prefix length. The channel h is known at the receiver.

Rician channel: The Rician fading is similar to that for Rayleigh fading, except that in Rician fading [12], a strong dominant component exists. This dominant component can for instance be the line-of-sight wave. Specifically, in Rician model we have exhibits following properties a) 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. b) The dominant wave can also be subject to shadow attenuation. The system model for Rician channel is same as Rayleigh channel but with difference in scaling factor.

IV. Review Of Literature

[1]. Bhasker Gupta et. Al (2011): This paper deals with the idea of channels, Equalizers with the use of OFDM techniques to investigative the BER improvement manner. At last they find out MMSE equalizer has better BER improvement than ZFE equalizer with different channels i.e. Rayleigh, Rician.

[2]. Dr. S.P. Vimal et. Al (2013): This paper reviewed the main technique to reduce the complexity of PTS and SLM techniques. They showed better result to reduce the complexity of PTS and SLM algorithms as compare to previous result.

[3]. Sonia Singla et. al (2013). This paper reviewed the latest research work done on PAPR with ACO technique. Then it presented the ACO techniques is good to reduce the value of PAPR as compare to the previous result and it also has better performance to reduce the complexity of system

[4]. Ahmad Bannour et. al (2011). Propose a way to increases the capacity MIMO-OFDM system in correlated Rayleigh frequency selective channels. They find that The ASTC code is an optimal space time code with a full-rate and a full-diversity that has a maximal coding gain and good performance in flat fading channels. For a high bit-rate transmission over a multi-path channel, the ASTC codes are not used yet. In this paper, we have considered the MIMO-OFDM system equipped with two well known ASTCs: GC and TC codes. These codes maintain their properties under a multi-path channel and achieve good capacity.

[5]. Atul Gautam et.al (2012). Propose a way to increase the Ergodic capacity of MIMO-OFDM system. This Ergodic capacity is limited due to PAPR. Therefore ASTC encoder and adaptive modulation use to increase the spectral efficiency of system. PAPR is reducing by using ASTC encoder. And find out that ASTC perform better than other previous techniques which reduce the PAPR values.

V. Conclusions

This paper analysed that OFDM has main problem which known as PAPR. Due to this problem the system performance is reduce and power dissipation is not good which reduce the lifetime of electronics components. Therefore it is necessary to reduce PAPR by using ASTC encoder and increase spectral efficiency use 32

QAM modulations.

VI. Aknowlegement

Thanks to my teachers and parents to help me. Special thanks to my loving brother (Late Bunty) who support, guide and help me when need.

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