PAPR REDUCTION TECHNIQUES WITH HYBRID SLM-TR SCHEMES FOR OFDM SYSTEMS

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ABSTRACT

The Orthogonal Frequency Division Multiplexing is one of the modulation techniques widely used in the broadband wireless technology. One of the main problems of this technology is the high peak-to-average power ratio of transmission signal due to the superposition of many subcarriers. This paper presents a new hybrid peak-to-average power ratio reduction technique, which combines a selective mapping method with the Tone reservation method. The paper presents the performance and advantages of the new technique and compares it with other existing methods.

***Index Terms* –- OFDM, DWT, PAPR, SLM, TR.**

1. INTRODUCTION

OFDM is a multicarrier modulation technique by partitioning the high rate data streams into N parallel low rate date streams which are orthogonally separated leads to increased transmission rate. With OFDM, Quadrature Amplitude Modulation (QAM), which is both analog and digital modulation scheme is employed and uses both amplitude as well as phase for encoding data for higher data rates. The major drawback in the OFDM is by adding all the N subcarrier at the receiver, some of the signals have peak magnitude value leads to high peak to average power ratio (PAPR). High PAPR requires high transmission power.

In paper [1] and [2], DWT wavelet is explained. Wavelet is an efficient tool to reduce the noise which is implemented via filter bank. In this is transmitting signal is decomposed into two stages at each level of decomposition. This high pass and low pass filters are used to obtain the high and the low frequency components to perfectly obtain the noise free component. At the receiver, perfectly reconstruction of signal can be obtained. PAPR reduction techniques are categorized into signal scrambling and signal coding techniques. In paper [3] the PAPR reduction techniques are categorized and are briefly explained. Clipping, Peak windowing, Tone Reservation are the techniques used to reduce the high PAPR but caused the out of

band distortion that is adjacent channel interference and Selective Level Mapping, Partial Transmit Sequence are the PAPR reduction techniques which causes high side lobe suppression and it requires channel side information. Clipping is a PAPR reduction technique, the maximum peak amplitude of the signals is to clip off which is above the threshold value, in order to clip the signal above the threshold value representation of the signal should be in complex domain that is the frequency component is required but hardware implementation is difficult.

In paper [5], Peak windowing is one of the PAPR reduction technique and it is similar to that of clipping but gives better performance than that by adding self-interference and it leads to out of band distortion that is adjacent channel interference is discussed. Tone reservation is also one of the PAPR reduction techniques which are an extension of the clipping noise sharping technique that modifies the noise spectrum. The remainder of the paper is organised as follows.

SLM reduce some PAPR after that PAPR is reduced by Proposed Tone reservation. This paper is organized as follows, section 2 briefly present PAPR of OFDM signals. Section 3 is the overview of SLM and Tone Reservation. Section 4 presents combined scheme of SLM and Proposed Tone Reservation. There are simulation results in section5. Conclusion is given in section 6.

2. PAPR OF OFDM SYSTEM

An OFDM symbol has N independent data symbols of equal bandwidth with frequency separation 1/T. where T is the time duration of the input data point is given as:

$$X = [X_0, X_1 X_2, X_{N-1}] \quad (1)$$

After taking IFFT of these point. The discrete time symbol can be expressed as

$$x_n = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k \, e^{j2\pi nk/N} \;\; ; n = 0,1 \ldots N-1 \quad (2)$$

It can be written in the matrix form

$$X = [X_0, X_1, X_2 \ldots\ldots\ldots\ldots\ldots X_{N-1}]$$

The PAPR is the ratio of maximum peak to average power. It is given by the equation

$$\text{PAPR} = \frac{\max|x_n|^2}{E[|x_n|^2]} \quad (3)$$

Where max $[x_n]^2$ represents the maximum power of a complex base-band signal x_n.$E[|Xn|^2]$ is the average signal power. E[.] denotes expectation operator. In OFDM, PAPR performance can be measured by using CCDF. It gives the probability that PAPR of an OFDM symbol exceeds the given threshold β. It can be denoted as

$$P(PAPR>\beta)=1-(1-e^{(\beta)})^N \quad (4)$$

3. PAPR REDUCTION SLM AND TONE RESERVATION TECHNIQUE

3.1 SLM Technique:

The input QPSK modulated input data sequence X is given as X=[X_0, X_1, X_2, X_{N-1}] is multiplied with the phase vector d=exp (j2πϕ). Where ϕ is the phase sequence can be written as:

Φ=[ϕ_1, ϕ_2, ϕ_3,…….Φ_{N-1}] ϕ∈[0,Ω]

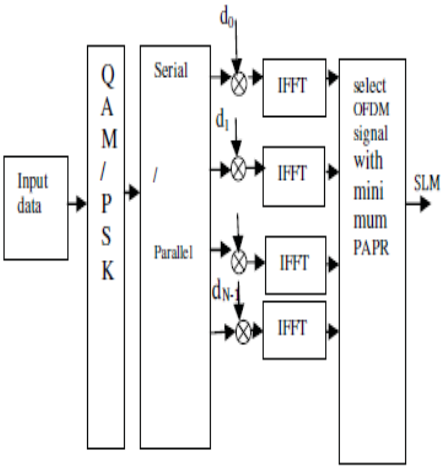

Fig.1.Block diagram of SLM

Taking IFFT of this the given input signal. It can be denoted as

$$x_n = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k * d_{n,k} e^{j2\pi nk/N} \quad (5)$$

Finally lowest PAPR is selected by this equation

$$\dot{x} = \underset{k=0,1,2..N-1}{argmin} \; (\max(|x_n|)) \quad n = 0,1..N-1 \quad (6)$$

3.2 Tone Reservation:

In Tone Reservation technique, some tones are reserved. These tones are known as Peak Reduction tones (PRT).Peak Reduction Tone is used to reduce Peak amplitude of OFDM signal.

$$S_n = X_n + C_n = \begin{cases} X_n & n \in R_t^c \\ C_n & n \in R_t \end{cases} \quad (7)$$

Where Rt is reserved tone and R_t^c is the complement of R_t and C=[C1, C2, C3….CL] where C is the peak cancelling signal it can be changed as

$$C^{i+1} = C^i - p_i$$

Where p is the kernel p_i is the circularly shift. p_i can be written as

$$p_{i=}\alpha_i e^{i2\pi b_i/N} \quad (8$$

α_i. is the scaling factor and b_i is the phase factor.

Taking IFFT of equation 8 we get,

$$s_n = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} (X_k + C_k) e^{j2\pi nk/N}$$

$$s_n = c_n + x_n$$

Here S_n is the IFFT of the signal S_n. PAPR of Tone Reservation signal is given as :

$$PAPR = \frac{max|x_n + c_n|^2}{E[|x_n|^2]} \quad (10)$$

4. COMBINED SCHEME OF SLM AND PROPOSED TONE RESERVATION

In this paper first we use the SLM technique and after that proposed tone reservation technique is applied. Let the IFFT symbol is given after applying SLM technique

$$X=[x_0, x_1, x_2 ,\ldots\ldots] \quad (11)$$

Detect peak by using sorting or other technique, maximum amplitude symbol

$$X_{PEAK}=\max(x_K) \quad (12)$$

$$X_R=[\text{Optimize value of pi}]+X_{PEAK} \quad (13)$$

X_R is the reduced peak. The peak X_{PEAK} is replaced with X_R again and again until the PAPR of transmitted signal reduces a certain level.

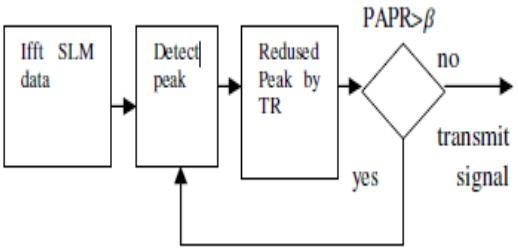

Fig.2.Block diagram of Tone Reservation

Algorithm:

1. Obtain the OFDM symbol after SLM technique.
2. Detect maximum peak.
3. Add or subtract x_{PEAK} with PRT signal and obtain

   Y_r.

4. Replace x_{PEAK} with x_R

   Take PAPR

   If PAPR>β

   Go to step 2

   Else

   Go to step 5

   Transmit the signals.

5. SIMULATION RESULT

In order to simulate the OFDM system, we consider QAM modulation of data symbols and there are 64 subcarriers. Combined SLM and tone reservation is applied for reducing PAPR in OFDM system.

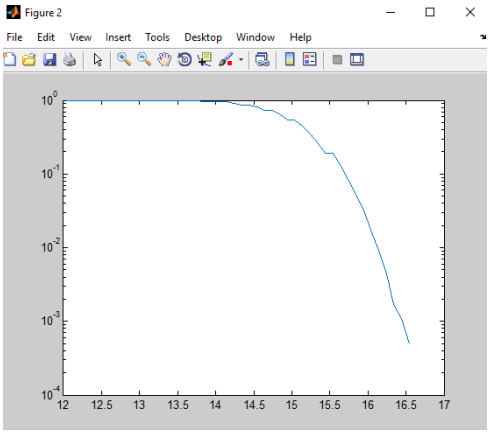

Fig.1.SLM with FFT of PAPR Reduction

Fig.1. Shows the simulation curve of SLM with FFT technique for the number of subcarrier N=64 and the data is transmitted using different number of sub-blocking factor.

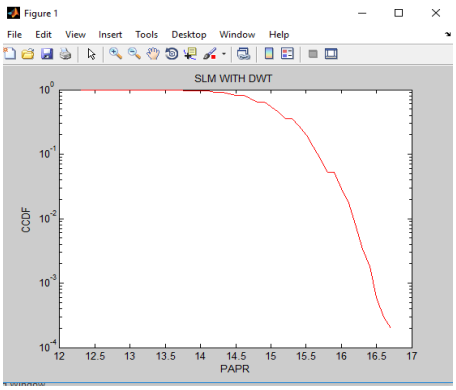

Fig.2.SLM with DWT of PAPR Reduction

Fig.2 shows the simulation curve of SLM with DWT technique for the number of subcarrier N=64 and the data is transmitted

using different number of sub-blocking factor.

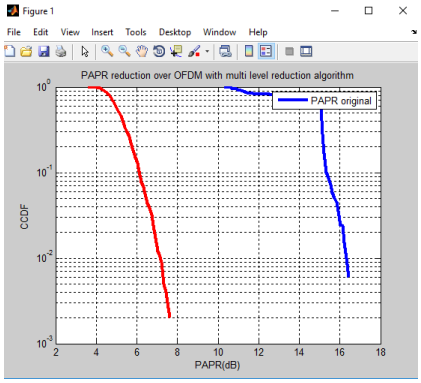

Fig.3.TR with FFT of PAPR Reduction

Fig .3 Shows the simulation curve of TR with FFT technique for the number of subcarrier N=64 and the data is transmitted using different number of sub-blocking factor.

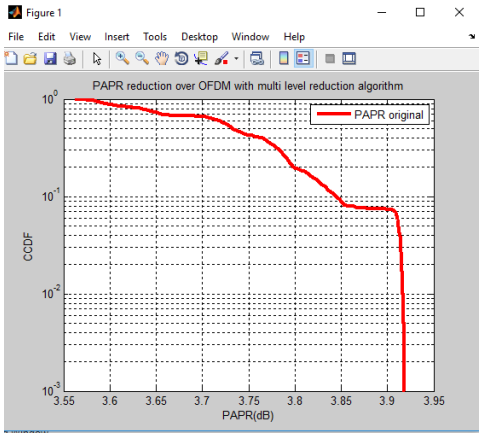

Fig .4. TR with DWT of PAPR Reduction

Fig .4 Shows the simulation curve of TR with DWT technique for the number of subcarrier N=64 and the data is transmitted using different number of sub-blocking factor.

6. CONCLUSIONS

In this paper, a classical Selected mapping and Tone Reservation technique is introduced to reduce the PAPR in multicarrier system applying QAM with N=64 subcarriers. The PAPR of two different algorithms is compared with each other. The different PAPR reduction techniques are shown using 64 subcarriers with QAM technique. Results show that Classical Selected Mapping is better than Tone Reservation.

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