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A Modified PAPR Reduction Of OFDM Systems Using Clipping And Filtering For Different Modulation Techniques

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Abstract : *Orthogonal Frequency Division Multiplexing (OFDM) is a technique used for multicarrier modulation and it increases the spectral efficiency and energy efficiency of the communication system. However, OFDM posses one of the drawbacks such as Peak to Average Power Ratio (PAPR), in which is power inefficient and produces non linear distortion at the power amplifier. For this reason, a better method of signal processing is essential to understand the power amplifier nonlinearity problem for OFDM system. In this work, clipping and filtering method is used to reduce the PAPR of OFDM system by considering different digital modulation techniques and a quantitative analysis is proposed and the graphs are drawn to compare the PAPR for different Modulation Techniques.*

Keywords - *CCDF, Clipping and Filtering, IFFT, OFDM, PAPR.*

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I. Introduction

OFDM is a access technique for Multicarrier Multiplexing which is used for Transmitting huge data through RF waves. It is a new technique which is used for the transmission of digital data has been structured to meet the challenges for increasing larger data rates in communication systems which is used in environments such as wired and wireless. An effective modulation technique is to be employed to meet better spectral efficient and higher data rate. In the telecommunication field OFDM is the better modulation technique that is presently adopted in the world. In this method, a signal is divided into different narrowband channels at varities of frequencies and also different Multiple carrier frequencies are encoded using digital data. This technique is modeled into a popular modulation technique for broadband digital communication. It is a frequency Division Multiplexing (FDM) scheme which is used as a multicarrier method. By using different parallel data streams and channels, a large number of perpendicular subcarrier signals are closely spaced.

Multiple input Multiple output (MIMO) systems technology are important for recent RF communication systems and has implemented in different standards like IEEE 802.11 n/ac/ax, 3GPP-LTE-A/pro etc., and because of consumption of power is high incase of wireless systems, this will increase the demand for better excellence of wireless services. Same number of transmitters and receiver antennas is used to maximize the channel capacity by using traditional point to point MIMO. Long Term (LTE) Specification is proposed by the 3rd generation Partnership project to meet the expectation of future generation systems. OFDM for uplink and downlink of IEEE 802.16 standard implemented in the 3rd generation [1]. In the future generation, LTE used uplink for single carrier frequency Division Multiple Access (SCFDMA) and downlink for orthogonal frequency division Multiplexing (OFDM). Therefore in this generation, OFDM is emerging as a promised wireless interface technology and it is a major technique in communication system for multicarrier. When the wired Networks are considered and are implemented in the ADSL, HDSL and VDSL. American National Standards Institute (ANSI) and OFDM technique is also called as Discrete Multi tone (DMT) [1].

When a non linear device is considered and multicarrier signal is passed through it, like high power amplifier with a huge number of subcarriers is hampered by PAPR and the signal may suffer in band distortion and significant spectral spreading. The Conventional solutions to this problem are that the nonlinear amplifier operating point should be moved backwards or to use a linear amplifier, both approaches results in the significant penalty of power efficiency. Moreover, the effect of multipath is mitigated on the subcarriers because of low data rate. OFDM has advantage that it is faster and efficient when it is implemented by Fast Fourier Transform. By limiting the dynamic range of analog to digital and digital to analog converters and the performance of the high power amplifier gets reduced due to high PAPR. The OFDM transmitted signal amplitude suffers from high PAPR due to individual sub channels.

The amplitude clipping is avoided for the high dynamic range digital to analog converter and the power amplifier, when the PAPR is high this high dynamic range reduces efficiency enhances cost and complexity of

the devices. If the dynamic range is too low there will be distortion in the signal which increases the bit error rate (BER) and this distortion will cause a radiation called out of band. To mitigate the problem of PAPR some of the techniques such as coding technique, scrambling and signal distortion [5, 6]. The flow of the paper is proposed as follows, In section 2, Background of the work is discussed. In section 3 the proposed system structure is presented. In section 4, the simulated results of the clipping and filtering method and different modulation techniques are compared graphically, conclusions are made in section 5.

II. Background

In earlier PAPR reduction methods, more parts of the OFDM signal is clipped, this leads to increase in bit error rate and reduction in PAPR and in some of the works signal distortion is slightly reduced with the cost of reducing PAPR. In the recent techniques the baseband signal is passed through a solid state power amplifier which results in insignificant distortion on signal

The PAPR is defined as maximum power of any OFDM transmission to the average power of the same OFDM transmission. PAPR will occur when the subcarriers are out of phase with each other in a multicarrier system. The PAPR for any signal Y(t) is given by (2.1)

$$y(t) = \frac{1}{\sqrt{K}} \sum_{N=0}^{K-1} X_n e^{j2\pi f_n t} \quad 0 \le t \le KT \quad (2.1)$$

Where, K is the total number of subcarriers and X_n, N=(0,1,2,……,k-1) block of K input bits, f_n=N□ f , where □ *f=1/ (KT), T*=original symbol period.

The Cumulative Distribution Function (CDF) is the most regularly used parameter to measure the operativeness of PAPR technique. Since there are chances that threshold value will be exceeded by some of the data blocks.

The CCDF can be expressed by equation (2.2)

$$CCDF = P(PAPR > Z) = 1 - (1 - e^{-z^2})^{2N} \quad (2.2)$$

The CCDF is generally used to estimate the bounds of the PAPR and as well as performance evaluation parameter for most of the PAPR reduction schemes [2].

III. Proposed Systems

The system structure is shown in figure 1. The digital input is fed to the modulator, in the modulator mapping is done by different modulation techniques such as BPSK, QPSK, QAM and CPM.

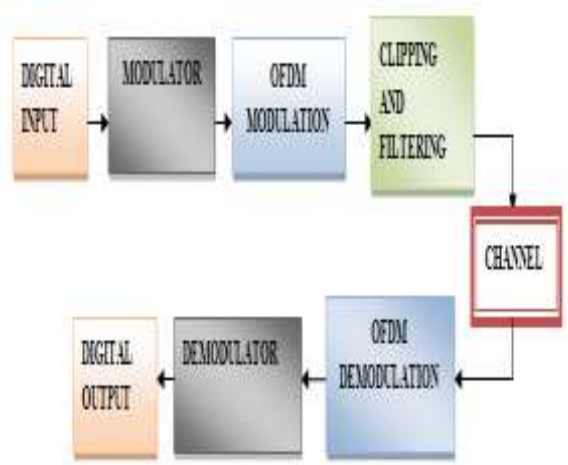

Fig 1: Proposed OFDM Structure

Here the digital input data is fed to the modulator and the modulation techniques such as BPSK, QPSK, QAM and CPM is used to modulate the input signal. The modulator output is passed to the OFDM modulation block, which converts modulated serial data to parallel data then IFFT is applied to the parallel data, after the IFFT the frequency domain signal is processed to time domain signal and they are orthogonal to the signal. After IFFT the parallel data is converted to serial data and Clipping and filtering method restricts signal envelope by adjusting predetermined clipping level by using a clipper. If the clipper passes the signal without distortion, then the signal does not exceeds the clipping level and if it exceeds this clipping level then it causes in band distortion and out of band. The BER rate is reduced by filtering and it is caused by in band distortion

and the other effect caused by out of band distortion is spreading of spectrum and this can be eliminated by filtering the signal. However in band distortion can be reduced taking longer IFFT [7, 8, 9].
The Algorithm of the proposed system is shown below
i. Define the Parameters.
ii. Create the Modulation Object.
iii. Generate the Data and perform Modulation.
iv. Convert serial to parallel and apply IFFT.
v. Apply clipping and filtering with FFT length as 128 and number of iterations is 100.
vi. Again convert parallel to serial data and perform FFT

IV. Simulation Results

Figure 2,3,4,5 shows the graphical representation of CCDF of PAPR for different modulation techniques such as QPSK, BPSK, QAM and CPM with FFT length of 128 and 100 numbers of iterations.

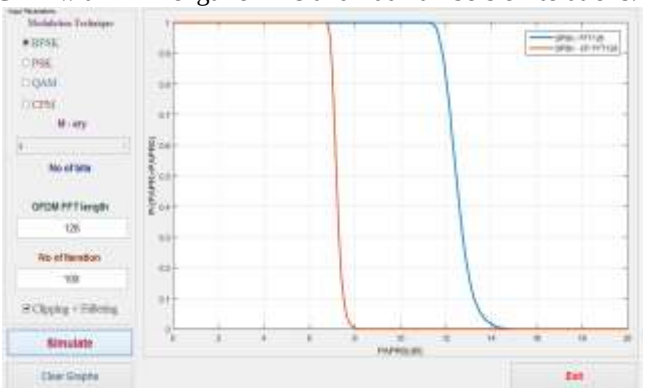

Fig 2: Graph for the reduction of PAPR in BPSK modulation scheme

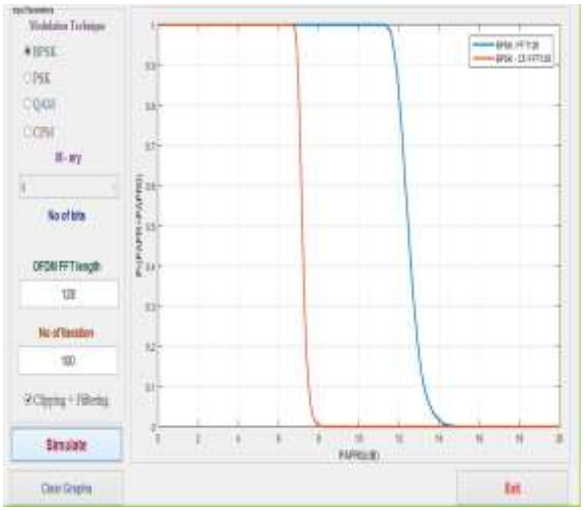

Fig 3: Graph for reduction of PAPR in QAM modulation scheme

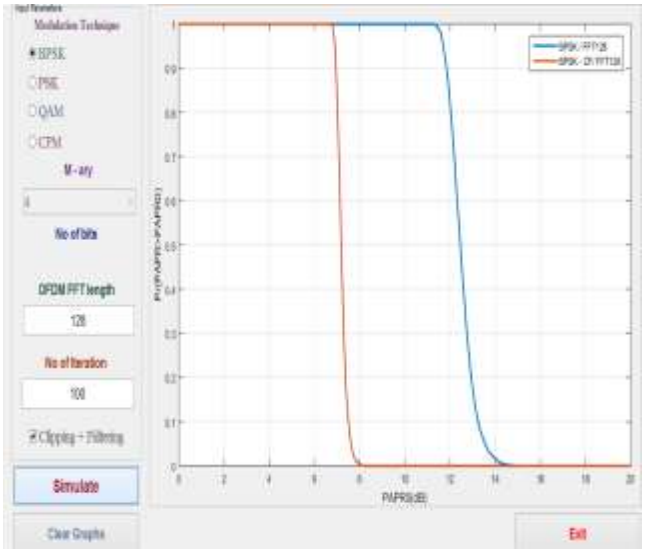

Fig 4: Graph for reduction of PAPR in CPM modulation scheme

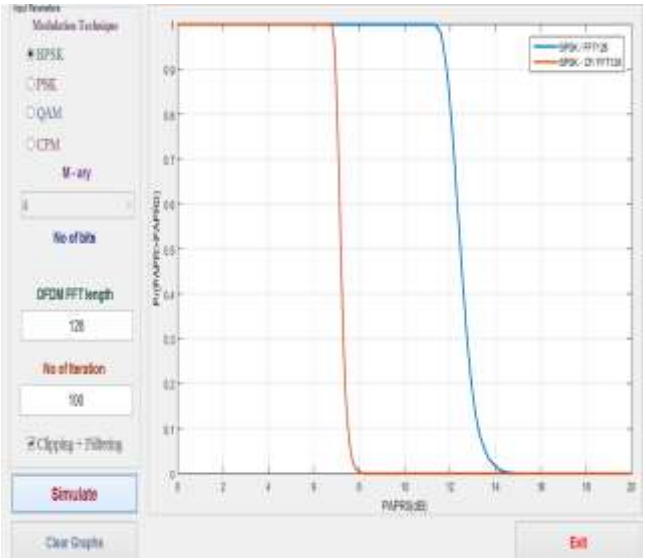

Fig 5: Graph for reduction of PAPR in CPM modulation scheme

Figure 6 shows the graphical representation of CCDF of PAPR for different modulation techniques. In these results QPSK is the better modulation technique to get less PAPR when compared to other modulation techniques such as BPSK, QAM and CPM. The results are tabulated in Table 1 which shows the PAPR of different modulation techniques using Clipping and filtering method.

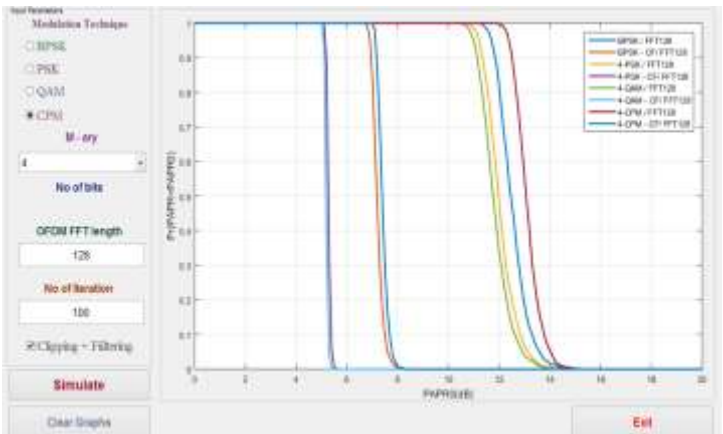

Fig 6: CCDF of PAPR with clipping and filtering for different modulation techniques

Table 1 Quantitative analysis of PAPR for different modulation techniques

MODLATION TECHNIQUES	WITHOUT CLIPPING AND FILTERING PAPR(dB)	WITH CLIPPING AND FILTERING PAPR(dB)
BPSK	14	8
PSK(QPSK)	13.9	5.6
QAM	13.8	5.8
CPM	14.2	8.1

V. Conclusion

In this study, PAPR is reduced by using one of the simplest method i.e., clipping and filtering. The excessive peaks in OFDM signal are clipped. This study has extended the earlier PAPR reduction by using different modulation technique with less number of iterations and also shown the quantitative analysis of different modulation techniques which shows the PAPR without and with clipping and filtering. The future work is to found on techniques by considering large number of subcarriers for higher modulated signal

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