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Comparative Study of a PAPR Reduction Techniques in MIMO OFDM System

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ABSTRACT: Multiple input Multiple output orthogonal frequency division multiplexing (MIMO-OFDM) Technology is one of the most useful technology for forth generation (4G) mobile radio communication. it effectively combats multipath fading , improves the bandwidth efficiency and increases the system capacity so as to provide reliable transmission .however , the main drawback in the MIMO-OFDM system is PAPR and offset sensitivity which results in restriction for practical applications[1][3]. there are many methods for PAPR reduction such as coding , phase rotation , clipping . In this paper we mainly investigate PAPR reduction methods i.e. PTS,SLM, Clipping and filtering

KEYWORDS: Multiple input multiple output (MIMO),orthogonal frequency division multiplexing (OFDM), peak-to average power ratio (PAPR), selected mapping (SLM), partial transmit sequence (PTS).

I.INTRODUCTION

Third generation (3G) mobile communication technologies implemented almost around the world ,but they are not able to meet the requirements of the day v.i.z., high data rates throughput .voice communication in 3G relies on circuit switching technology .To improve the spectrum efficiency and achieve higher data rates better techniques must be used. next mobile generation system uses more sophisticated modulation scheme and transmission structure. Orthogonal frequency is multicarrier transmission technology, which can effectively combat multipath fading and inter symbol interference (ISI)and can achieve high speed data transmission. OFDM posses some serious problem of high PAPR which limits the applications[4][5]. It provide good result against frequency selective fading, it also provides high spectral efficiency and low computational complexity. Space time coding has been proved effective combative against fading and increasing the data rates. If we combine both techniques MIMO OFDM and space time coding results into spectrally efficient wideband system space time coding is gaining a widespread attention. space time code along with MIMO OFDM can achieve spatial diversity .The main advantages of using MIMO OFDM techniques which can decrease the receiver complexity and efficiently decrease the multipath fading .It also provides high spectral efficiency and robustness against narrowband interference , uniform average spectral density , capability of handling very strong echoes, less non-linear distortion and efficient implementation.MIMO system is the use of multiple antennas at both transmitter as well as receiver so as to improve the performance. Simple way to reduce PAPR in MIMO OFDM is to apply PAPR reduction methods to SISO OFDM i.e. on each antenna separately[2]. STBC used to provide transmit diversity and secure means of data propagation. However, MIMO OFDM also suffers through problem of high PAPR and carrier frequency offset sensitivity. Due to high PAPR, there is some kind of distortion in the signal. Hence , it is necessary to reduce the PAPR; other option is that the HPA in transmitter region need to have more linear region much greater than average power , but , it will be more expensive and inefficient. if, HPA has linear region slightly greater than average power , it will cause spectral widening , increase in BER and adjacent channel interference.There are number of techniques proposed to control the PAPR of OFDM system such as Clipping and filtering , Partial Transmit Sequence (PTS), Selective Mapping (SLM),interleaving and pulse shaping .

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II. PAPR IN MIMO OFDM SYSTEM

In a Multicarrier system, IFFT can be used as modulator and FFT can be used as modulator and FFT can be used as demodulator . High Peak to average power is recognized as one of the major problem involving OFDM Modulation. High PAPR results from the nature of the modulation itself where multiple subcarriers to be added together to form the signal to be transmitted. when, we add N sinusoids peak of the signal may increase and average might be quite low due to destructive interference .High PAPR is cause due to inter symbol interference between the sub carries and it is undesirable for the system. To overcome this problem a Partial Transmit Sequence method which is based on optimally combining the signal sub blocks and phase rotation factor is considered. as the number of sub blocks and the rotation factor, PAPR reduction improves .PAPR reduction technique vary according to needs of the system and it depends on many factor . There are many PAPR reduction techniques such as PTS , SLM ,Clipping and Filtering . it is still indeed needed to give a comprehensive review including some motivations of PAPR reductions, such as power saving . An effective PAPR reduction technique should be should be given the best tradeoff between the capacity of PAPR reduction and transmission power, data rate loss, implementation complexity and Bit-Error-Ratio (BER) performance. The main disadvantage of high PAPR areas follows

1 there is increased complexity in analog to digital and digital
to analog conversion.

2 efficiency of RF amplifier is reduced.

Consider, the MIMO OFDM system containing Mt number of antennas and each antenna using N subcarriers. Xmk is continuos time baseband signal. It can be expressed as

$$\mathrm{Xm,k} = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} Xn * e^{\mathrm{j2nfnk}}$$

where, Xn is the transmitted OFDM signal at the n subcarriers of the mth transmit antennas. The PAPR is given by

$$\mathrm{PAPR} = \frac{\max_{0 \le t \le \mathrm{MT}} |\mathrm{x(t)}|^2}{\frac{1}{\mathrm{MT}} \int_0^{\mathrm{MT}} |\mathrm{x(t)}|^2}$$

This is PAPR for continuous time signal , but it cannot be precisely computed at the Nyquist sampling rate . To reduce PAPR effectively, signal peaks may be skipped. To increase the resolution of discrete time OFDM signal ,oversampling factor must be greater than 4.

III.PAPR REDUCTION TECHNIQUES

The PAPR reduction schemes are basically divided into 2 types

1) Distortion Based Techniques.

2) Non-distortion Techniques.

Distortion based PAPR reduction techniques introduces distortion and Noise in to the signal. Clipping and filtering is one of the example of distortion based technique.

I. Clipping and Filtering :

Clipping and Filtering is effective Technique for reduction of PAPR. In this method, OFDM signal is deliberately clipped at particular threshold value before amplification .However , clipping causes in band distortion and out of band noise due to which bit error rate and spectral efficiency is reduced. Clipping is a non linear process in which it suppress time domain OFDM signal of which the signal power exceeds the certain threshold .

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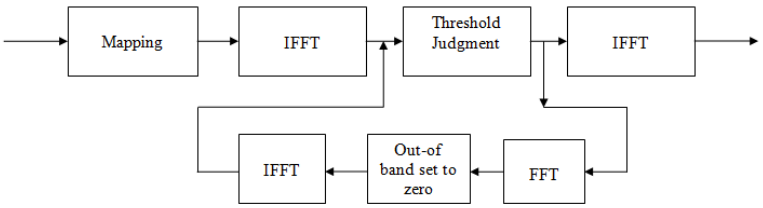

Fig 1 : Clipping and Filtering block diagram

There is increase in a out of band energy as a penalty[5]. To reduce this out of band energy filtering is used after To give better performance Recursive clipping and filtering can be used so as to decreases the both PAPR and out of band energy.

Non-distortion techniques :

in these type of techniques there is no distortion is introduced into OFDM signal . IT includes PTS ,SLM etc.

II. Selective Mapping Method :

In particular SLM technique, entire data stream is divided into different blocks of N symbols each. each block is multiplied with U different phase factors to generate U modified blocks before giving to modified block[7]. each modified block is given to IFFT block which gives OFDM signal as a output.

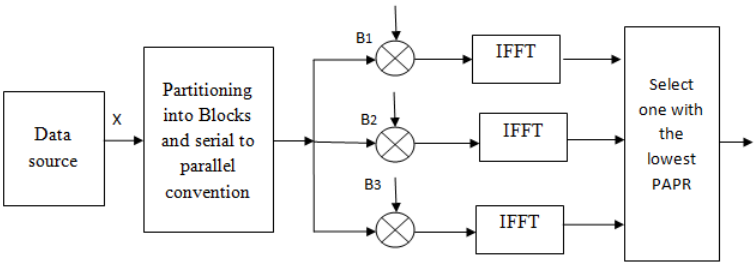

Fig 2: Block diagram of SLM technique

In SLM , one OFDM signal is selected from several signals containing the same information data . SLM is very flexible scheme and it effectively reduce the PAPR . to improve its performance 'U' must be increased. It includes several IFFT stages and complex optimization procedure which increase the complexity and computational burden.

III. PARTIAL TRANSMIT SEQUENCE

PTS is probabilistic based method in which input data block is divided into sub blocks and each subcarrier is multiplied with phase factor .information in frequency domain X is divided into V non-overlapping vectors of same size N . Data block is divided into non-overlapping sub block such that they have independent rotation factor .rotation factor generates time domain data with lowest amplitude[6]. Ordinary PTS scheme is simple and distortion less sometimes it may be burdensome. As we know we divide data block into disjoint sub block , These sub blocks are multiplied with different phase weighing factors; and then added together to produce OFDM symbols or candidate signal with low PAPR.

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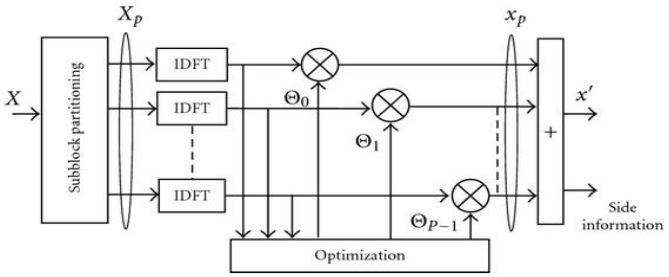

Fig 3: Block diagram of PTS technique

Phase factor is selected such that it will result in to sub block with low PAPR. Each of the sub blocks having minimum PAPR and hence combined signal having a minimum PAPR.

IV. PERFORMANCE COMPARISON

Simulation results of different techniques such as PTS, SLMetc have been compared in this section .PTS technique is applied to the sub blocks of the input information ,and modulated by QPSK technique and phase factors are directly transmitted to receiver through sub block. Complementary cumulative distribution function is used for performance evaluation[4]. Performance is evaluated for different no of subcarriers such as 64,128,256 . and oversampling factor is greater than 4 is used to increase the resolution of discrete time OFDM signal .

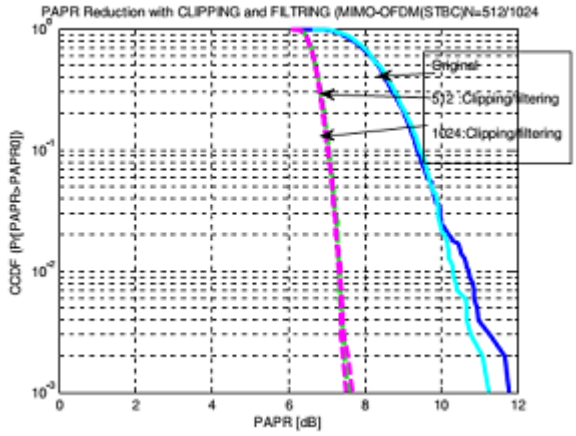

Fig 4: PAPR Reduction in with clipping and filtering [4]

To implement PAPR reduction in STBC MIMO OFDM system, 512 and 1024 symbols of OFDM are generated, 301 and 601 tones are used for data transmission an oversampling factor 6 is applied to all OFDM symbols. figure 4,5,6 shows Simulation of PAPR reduction of symbol length 512 with different methods Clipping Filtering , SLM ,PTS etc.

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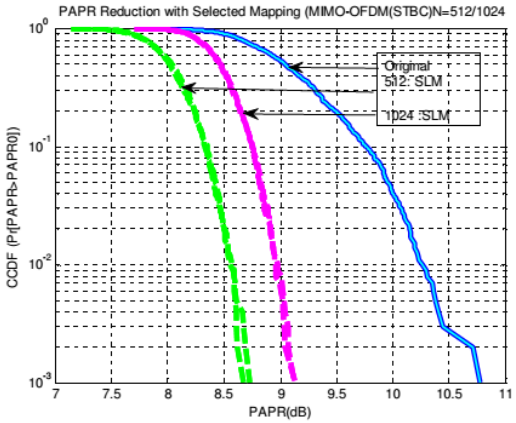

Fig 5:PAPR reduction for SLM Technique

The impact of the subblock V=8 on the performance of PAPR reduction for different number of subcarriers N= 64,128, 256, 512, 1024 with 2 transmit antennasis shown in Fig. 5 at CCDF = 10-2 From this Fig. 6 it is observed that the values of PAPR for 2 transmit antennas for different subcarriers N= 64, 128, 256, 512, and 1024 become 5, 6, 6.8, 7.4 and 7.9 dB when CCDF = 10^{-2}. By comparing the Figures 2 and 3 it is evident that PAPR is decreased from 8.2 dB to 6.8 dB for 2 transmit antennas when N=256 subcarriers with number of subblocks increased from V=4 to 8 at CCDF of 10^{-2}. The PAPR value increases significantly as number of subcarriers used in the MIMO-OFDM transmission increase, but PAPR values decreases as the number of subblocks increases.

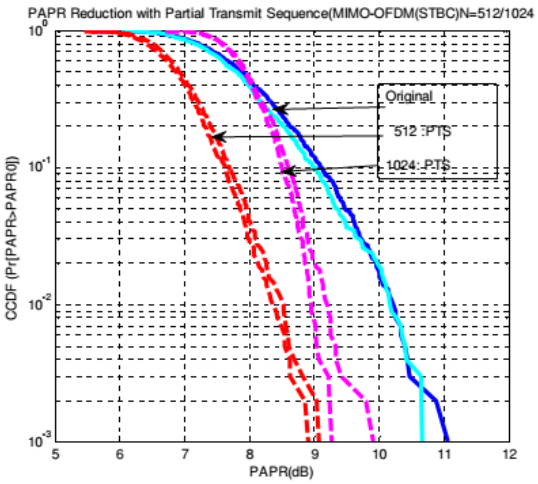

Fig 6 : PAPR reduction for PTS technique[4]

V.CONCLUSION

Comprehensive research and comparison is put forward for currently promising methods for PAPR reduction such as Clipping & Filtering , SLM ,PTS. These Methods have lots of merits such as high coding rate, low redundancy also it only optimizes the statistical charecteristics of PAPR in OFDM system .This paper have presented 3different PAPR reduction techniques SLM ,PTS ,Clipping and Filtering .Simulation results shows clipping and filtering provides better PAPR reduction techniques.

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