A PARALLEL STUDY ON OFDM PAPR REDUCTION TECHNIQUES TO MITIGATE THE EFFECTS OF INTER SYMBOL INTERFERENCE

JUHI DIXIT(A.P)
Department of Electronics and Communication Engineering
AMITY UNIVERSITY M.P, Juhiec21@gmail.com

Abstract
Orthogonal Frequency-Division Multiplexing (OFDM) effectively mitigates intersymbol Interference (ISI) caused by the delay spread of wireless channels. Therefore, it has been Used in many wireless systems and adopted by various standards. Modern wireless communications system demands higher data rate environment and reliable transmission. This is suitable for high data rate transmission. In this paper, we present a comprehensive survey on OFDM for wireless communications and different methods for reducing PAPR. In addition this paper includes comparison between different types of methods

Keywords- *OFDM PAPR reduction techniques, ISI*

1. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is a multicarrier modulation (MCM) technique which seems to be an attractive candidate for fourth generation (4G) wireless communication systems. OFDM offer high spectral efficiency, immune to the multipath delay, low inter-symbol interference (ISI), immunity to frequency selective fading and high power efficiency [2]. In OFDM system output is superposition of multiple sub-carriers. In this case some instantaneous power output might increase greatly and become far higher than the mean power of system. To transmit signals with such high PAPR, it requires power amplifiers with very high power scope .These kinds of amplifiers are very expensive and have low efficiency-cost. If the peak power is too high, it could be out of the scope of the linear power amplifier. This gives rise to non-linear distortion which changes the superposition of the signal spectrum resulting in performance

II. OFDM (Orthogonal Frequency Division Multiplexing)

OFDM is generally used for the Digital Television Broad casting (DTB), Digital Audio Broadcasting (DAB) & Digital Video Broad casting (DVB) like this…OFDM is the technique which divide available spectrum in many carriers and each carrier will modulate by low data rate stream. OFDM uses the spectrum much more efficiently by spacing the Channels more closely together. This can be done by making all the carriers orthogonal to one another, preventing interference between the closely [1]

III. PAPR PROBLEM & REQUIREMENT OF REDUCTION

In previous paragraph basics of OFDM (Orthogonal frequency division multiplexing) has been discussed .actually OFDM system is very efficient & marvelous technique in its manner, but when there is a merits demerits also available. So here we discuss one of the major drawbacks of the OFDM system. Drawback is high PAPR (Peak-to-Average Power ratio). PAPR means randomly sinusoidal leads occurred during transmission of the OFDM signal. So in this chapter we discuss basics of PAPR, why it is created & what the proposed solution are for reduce it So as per the introduction of PAPR we can judge that to reduce the PAPR is most important point in the OFDM system. Because of when we are talking about the high speed data communication in real life like video calling, high speed internet access, and also main point is that high speed data access up to 2mbps while moving on the vehicle at 100km/h, digital video broadcasting (DVB), Microwave terrestrial television, Digital audio broadcasting (DAB), 4G system, hyper LAN.So this most type of communication systems required high data rate. But problem occurs like PAPR in OFDM system prevent these types of facilities in the real life. So to reduce it is most important. Now here is the explanation of PAPR in Mathematical equation form. PAPR is defined as the maximum power occurring in the OFDM transmission to the average power of the OFDM transmission. Mathematical representation has been given below.

$$\mathbf{PAPR = P_{peak} / P_{average} = max\ [|x_n|^2] / E[|x_n|^2]}$$

IV. PAPR REDUCTION TECHNIQUES

Several PAPR reduction techniques have been proposed in the literature. These techniques are divided into two groups - signal scrambling techniques and signal distortion techniques which are given below:

A .**Signal Scrambling Technique**

- Selected Mapping (SLM)
- Partial Transmit Sequence (PTS)
- Interleaving Technique
- Tone Reservation (TR)
- Tone Injection (TI)

B. **Signal Distortion Techniques**

- Peak Windowing
- Envelope Scaling
- Peak Reduction Carrier

Signal Scrambling Techniques

The fundamental principle of these techniques is to scramble each OFDM signal with different crumbling sequences and select one which has the smallest PAPR value for transmission. Apparently, this technique does not guarantee reduction of PAPR value below to a certain threshold, but it can reduce the appearance probability of high PAPR to a great extent. This type of approach include: Selective Mapping (SLM) and Partial Transmit Sequences (PTS). SLM method applies scrambling rotation to all sub-carriers independently while PTS method only takes scrambling to part of the sub-carriers

Selected Mapping (SLM):

The SLM scheme has an advantage that the structure for PAPR reduction is simple due to parallel signal processing. However, information on which phase sequence is selected should be transmitted to the receiver as an overhead for the correct demodulation, and a large amount of IFFT calculation sand multiplications with phase sequences is required in proportion to the number and length of the phase sequences. In this paper, we propose two effective SLM-PRSC hybrid schemes to improve the PAPR reduction performance of the SLM. In the proposed schemes, to avoid excessive increase of computational complexity, the identical time domain PRSC sequences generated a priori are repeatedly used. [3]

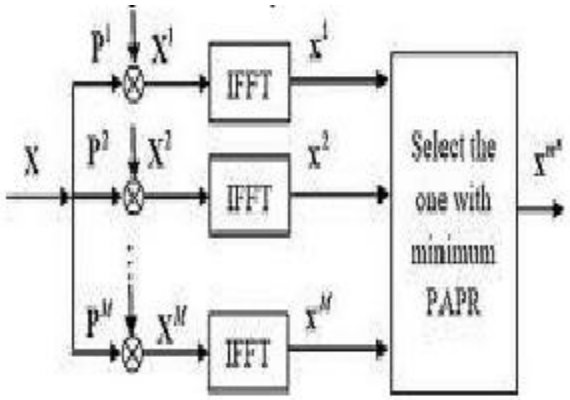

Fig 1: Selected mapping

Fig. 1 shows a block diagram of the conventional SLM scheme for the OFDM signals. In the scheme, an OFDM symbol sequence $X=[X0, X1\ldots\ldots X_{N-1}]$ of length N in the frequency domain is multiplied component-wise by U different phase sequences $r^{\bar{A}}(A=1\ldots U)$ such as cyclic Hadamard code before the IFFT, whose length is also equal N. Here, the phase rotated symbol sequence is denoted $\mathbf{X^{(A)}=X}$ **convolution** $\mathbf{r^{\bar{A}}}$Then the PAPR is calculated for the statistically independent sequences $X(A)= IFFFT\{X^{(A)}\}$ and the Sequence $x^{\bar{A}}$with the lowest PAPR is selected by finding as $\bar{A}$ = argmin [PAPR $X^{(A)}$]

Partial Transmit Sequence (PTS)

Partial transmit sequence is also one of the Probabilistic based. Main idea of this scheme is data block divide into non overlapping sub block with independent rotation factor. This rotation factor generates time domain data with lowest amplitude. This is modified technique of SLM scheme.And gives better performance than SLM. Because of differential modulation no needs to transmit the side information [4]

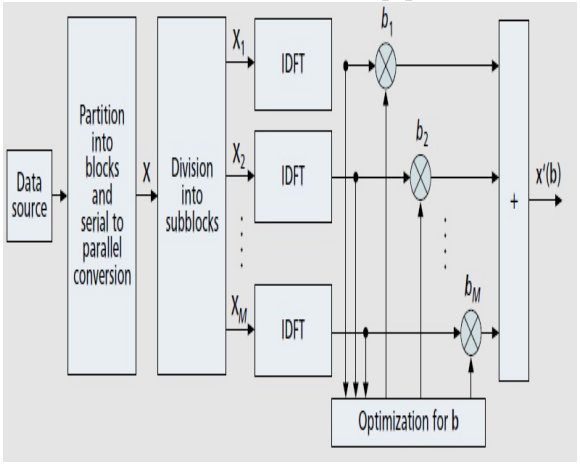

Fig 2: Partial Transmit Sequence

Interleaving:

In this technique highly correlated data frame .in this adaptive technique also reduces the complexity. Adaptive interleaving is to establish an early terminating threshold. So the searching process is terminated when the value of PAPR reaches below the threshold value. So, these low threshold force the AIL to search for all interleaving sequence. This technique is less complex than PTS [1]

Tone Reservation:

This technique contains some set of reservation of tones. By using this technique reserved tones can be used to minimize the PAPR. This method is used for multicarrier transmission and also shows the reserving tones to reduce the PAPR. This technique is depend on amount of complexity .when there is number of tones is small reduction in PAPR may represent non negligible samples of available bandwidth. Advantage of this tone reservation is very positive that no process is needed at receiver end. And also do not need to transmit the side information along with the transmitted signal. In this data block is added to the time domain signal to reduce the peak leads [1]

Tone Injection:

This method is generally used additive method for PAPR reduction. Using this method data rate loss is very less. This method used the set of active constellation point for an original constellation point to reduce the PAPR. In this each unit all original constellation is mapped on the several equivalent constellation point. & this extra point's freedom canbe easily used to reduce the PAPR. This method is popularly used as the tone injection method because of the newly applying points into basic constellation for the new points for larger constellation. Main thing is injecting tone of appropriate phase and frequency in OFDM symbol. Main demerits are that transmission of side information is necessary at the receiver side. [1]

Signal distortion techniques:&filtering-

Peak Windowing

Here peak windowing technique is very similar to the clipping technique bit it will give better performance with adding some self interferenceand increasing in the BER (bit error rate). Due to this out band radiation is also increased. in this method we multiply different windows with large signal peaks like Gaussian shaped window, cosine, Kaiser and Hamming window. OFDM signal is multiplied with several of these windows; the resulting spectrum is a convolution of the original OFDM spectrum with the spectrum of the applied window. Means the windows should be narrow as possible. By using this technique PAPR can be reducing to 4db of each subcarrier.SNR is limited to .3db due to signal distortion [1]

Envelope scaling

This technique is related to scaling means before OFDM signals sent to the IFFT all subcarrier is scaled the input envelope. In this technique 256 subcarrier is used so all subcarrier will remains equal. Main idea is that to scheme is that the input envelope in some sub carrier is scaled to achieve the smallest amount of PAPR at the output of the IFFT. Here receiver does not need any side information at the receiver end for decoding. This scheme is suitable for the PSK modulation .when it is applied with the QAM high degradation is occurred in the BER. [1]

Peak Windowing

Here peak windowing technique is very similar to the clipping technique bit it will give better performance with adding some self interference and increasing in the BER (bit error rate). Due to this out band radiation is also increased. in this method we multiply different windows with large signal peaks like Gaussian shaped window, cosine, Kaiser and Hamming window. OFDM signal is multiplied with several of these windows; the resulting spectrum is a convolution of the original OFDM spectrum with the spectrum of the applied window. Means the windows should be narrow as possible. By using this technique PAPR can be reducing to 4db of each subcarrier.SNR is limited to .3db due to signal distortion [1]

V.RESULTS

SIMULATION RESULTS:

Figure 4 shows the CCDF as a function of PAPR distribution when SLM method is used with 64 numbers of subcarrier. Figure 5 shows the same result for 128 numbers of subcarrier. M takes the value of 1 (without adopting SLM method), 2, 4, 8 and 16. It is seen in Figure 4 and Figure 5 that withincreaseof branch number M, PAPR's CCDF gets smaller.

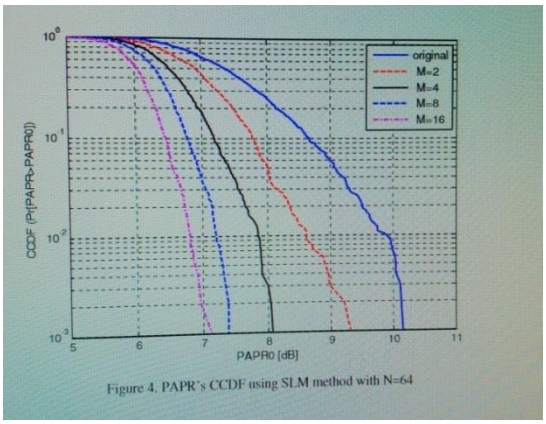

Figure 4. PAPR's CCDF using SLM method with N=64

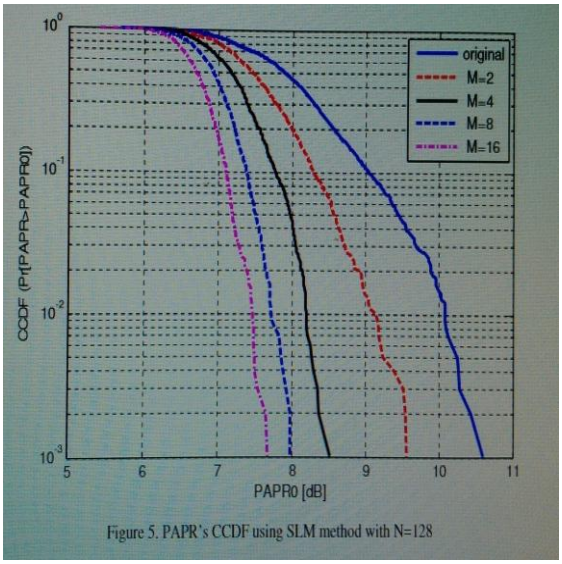

Figure 5. PAPR's CCDF using SLM method with N=128

Now discussed the simulation result for PTS technique, there are varying parameters which impact the PAPR reduction performance these are: 1) The number of sub-blocks V, which influences the complexity strongly; 2) The number of possible phase value W, which impacts the complexity; and 3) The sub-block partition schemes. Here, only one parameter is considered that is sub-block size V.

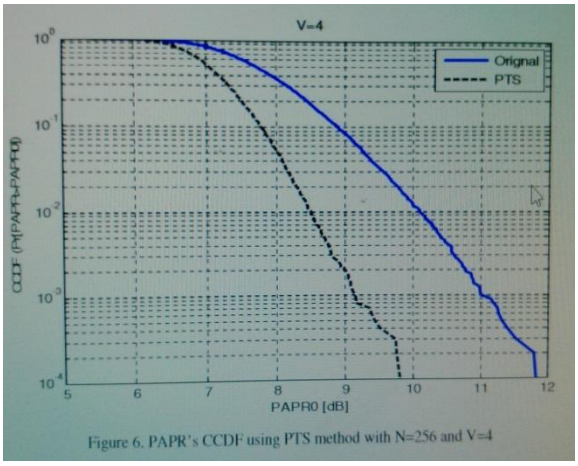

Figure 6. PAPR's CCDF using PTS method with N=256 and V=4

Figure 6 shows that PTS technique improves the performance of OFDM system, moreover, it can be shown that with increasing the value of V the PAPR performance becomes better

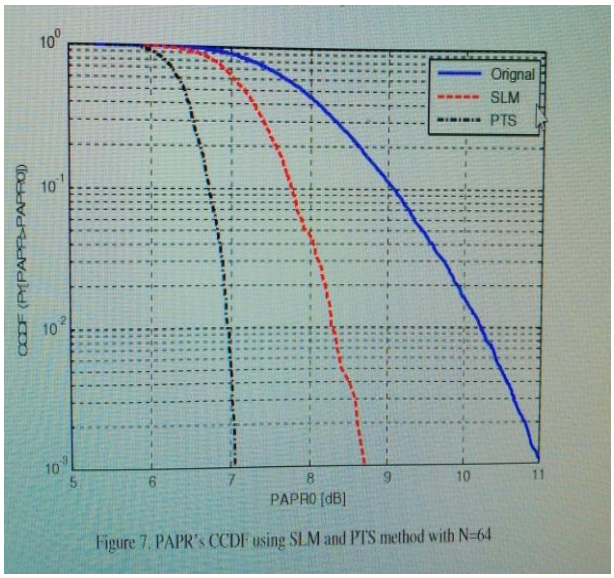

Figure 7. PAPR's CCDF using SLM and PTS method with N=64

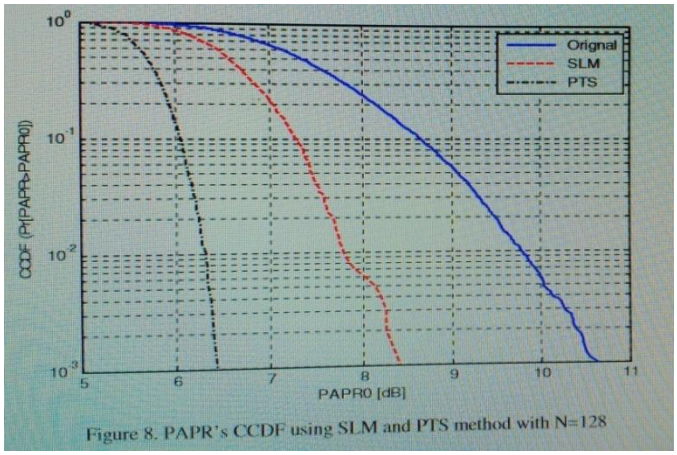

Figure 8. PAPR's CCDF using SLM and PTS method with N=128

In Figure 7 and Figure 8 it is clear that PTS method provides a better PAPR reduction performance compared to SLM method

VI. CONCLUSION

Basically as per the information about all above described techniques to reduce the PAPR in OFDM system all techniques are different in their way, and using each technique PAPR will be reduced at some what level. To reduce the PAPR any technique can be used. Due to the fabrication costs and the throughput requirement, the most practical PAPR techniques are Clipping and PTS. In this application, coding, SLM, and the iterative optimization methods such as TI, TR and

ACE, which need several iterations of IFFT calculations, are of limited utility because of computational requirement SLM and PTS algorithms are two typical non-distortion techniques for reduction of PAPR in OFDM system [2]. SLM method applies scrambling rotation to all sub-carriers independently while PTS methods only take scrambling to part of the sub-carrier

REFERENCE

[1] MalharChauhan, Saurabhpatel, Hardikpatel / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-962Vol. 2, Issue 3, May-Jun 2012, Different Techniques to Reduce the PAPR in OFDM System

[2]SuvernaSengar, ParthaPratim Bhattacharya2 Performance improvement in OFDM System by PAPR reduction Signal& Image Processing: An International Journal (SIPIJ) Vol.3, No.2, April 2012

[3] An Effective SLM-PRSC Hybrid Scheme for OFDMPAPR Reduction Based on Repeated Utilization of Identical PRSC Sequences in Time Domain by Seungwoo Han, Suckchel Yang and Yoan Shin.

[4] Jianping Wang, Ying Guo, Xianwei Zhou PTS-Clipping Method to Reduce the PAPR in ROF-OFDM System IEEE Transactions on Consumer Electronics, Vol. 55, No. 2, MAY 2009

[5] C. Liu, E. Skafidas, T. Walsh and R.J. Evans A Survey on OFDM PAPR Reduction Techniques for 60 GHz Wireless CMOS Radio 2007 Australasian Telecommunication Networks and Applications Conference December 2nd – 5th 2007