PAPR Reduction in OFDM using PTS Technique

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Abstract— **OFDM system is widely used in the field of trending communication. With the increasing use of the OFDM system many issues related to OFDM comes into existence. PAPR is one of the issues of OFDM. It refers to the increment in the peak-to-average-power ratio of signals that are transmitted to the receiver. It occurs due to the superposition of many sub carriers. The quality of the signals is tainted and the complexity is increased while performing conversion process. Hence it is mandatory to develop such an approach which can help to reduce the PAPR. There are many techniques have been suggested for PAPR reduction, with different levels of success and complexity. Techniques like clipping, filtration, PTS etc were proposed but these techniques achieve PAPR reduction at the bit error rate increase, data rate loss, computational complexity increase, and so on.**
This study provides a review over the techniques meant for reducing the PAPR in OFDM systems. It represents various techniques along with their equations.

Keywords:- PAPR,SLM,PTS,Clipping and Filtering.

I. INTRODUCTION

Since the very genesis of man, communication has been one of the fundamental parts of the human life .Previously different techniques like gesture based communications were executed for this reason. At present there are many ways that through which we communicate, email, internet, social networking, letters, cell phones, signs, newspapers, radio, magazines, the list goes on and on.

With the advancement in the technique of wireless communication channel the need of high rate data transmission comes into existence. To transfer the data on a high rate OFDM is used. OFDM stands for Orthogonal Frequency Division Multiplexing. It is an effective method or technique adopted in wireless channels.

II. PAPR

PAPR stands for Peak-to-Average Power Ratio. PAPR is a exigent issue in OFDM systems. If the PAPR goes high then it leaves direct effects on the performance of the system by degrading it. The PAPR degrades the efficiency of the transmitted signals. Low PAPR increases the efficiency of the power amplifier but high value of PAPR is totally opposite to this.
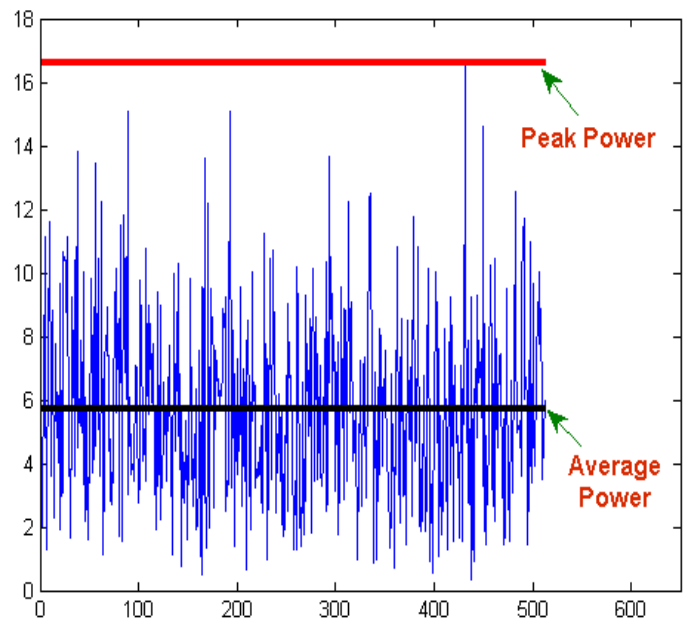

Figure1. Peak value issue in OFDM system

PAPR of a signal is measured or represented in the form of decibels as shown below. It will also express the need of resolving the problem of PAPR.
Equation for PAPR as:

$PAPR_{db} = 10 \log (\max[x (t) x * (t)] / E[x (t) x * (t)])$
(1) Thus, PAPR defined as the ratio of maximum peak power which will be dividing by average power of OFDM signal.
In the above equation, E shows expected value.
Now, PAPR for a single complex tone

$X (t) = e^{2\pi ft}$

(2) Where t shows period and peak value of the signal:

$\text{Max}[x (t) x * (t)] = \max [e^{2\pi ft} \quad e^{-2\pi ft}] = \max [e^{0}] = 1$
As a result, calculate mean square value of the signal:

$E[x (t) x * (t)] = E [e^{2\pi ft} \quad e^{-2\pi ft}] = 1$

(3) Generated output from the above equation is 0db i.e. shows the value of PAPR. Now, consider OFDM time signal which comprises of more than k complex tones (sub Carrier tones).These tones are known as subcarriers. Therefore, the above signal representation will be like:

$X (t) = {}_k e^{j2\pi k t / T}$
Consequently, PAPR reduction can be possible by increasing

the probability of getting low PAPR values. PAPR should be reduced in order to enhance the lifetime of the network. In comparison with single carrier systems PAPR is quite high in multi carrier system. Highest value of PAPR reduces the efficiency of the Power amplifier (Transmitter) [3]. PAPR affects the transmitted signal. PAPR is the problem exists in OFDM system. The input symbol stream in IFFT should have a constant value of power spectrum. But the output of IFFT can result in a variable value and fluctuated wave or spikes. Only few of the sub carriers are allotted with energy to transmit the data. This problem gives rise to other problems in OFDM system. So OFDM signal has a very large PAPR, which is very sensitive to non linear high power comprised amplifier. In OFDM, a block of N symbols{X , k = 0,1,....,N -1} k , is formed with each symbol modulating one of a set of subcarriers, {f , k = 0,1,.....,N -1} k .

1. The N subcarriers are chosen to be orthogonal, that is, f k f k = D , where Df =1 NT and T is the original time period.
2. PAPR of single tone: Consider a sin signal as having the period t. The peak value of the signal is: . The Mean square value of the signal is 5.

Given so, the PAPR of a single sine tone is,

PAPR OF A MULTICARRIER SIGNAL

Let the data block of length *N* be represented by a Duration of vector any system in the set *X* is *T* and represents one of the sub − carriers set. As the *N* sub − carriers selected for transmission of the signal are orthogonal to each other, so we can have *NT* is the duration of the OFDM data block *X*. Reducing the $max|x(t)|$ is the principle goal of PARP reduction techniques. In these cases Discrete Time signals are used. There are many PAPR reducing techniques which can be used to handle amplitude value of x (t).

TECHNIQUES FOR PAPR REDUCTION

There are many techniques used for reducing the PAPR in OFDM. But all of these techniques are not suitable in every case. The use of PAPR reduction techniques based on the needs of the system and various elements.

1. Signal Scrambling Techniques
   a) Block Coding Techniques
   b) Block Coding Scheme with Error Correction
   c) Selected Mapping (SLM)
   d) Partial Transmit Sequence (PTS)
   e) Interleaving Technique
   f) Tone Reservation (TR)
   g) Tone Injection (TI)

2. Signal Distortion Techniques
   a) Peak Windowing
   b) Envelope Scaling
   c) Peak Reduction Carrier
   d) Clipping and Filtering

SELECTED MAPPING TECHNIQUE (SLM)

SLM stands Selected Mapping Technique. In this technique input data is divided into various sub blocks on the basis of given N length. It uses serial to parallel converter for converting the data stream. When the conversion is applied to the signals then the blocks of the OFDM system are arranged in a sequence as follows:

Where u= [0, 1, 2….U], to make OFDM data blocks to be phase rotated. Therefore X (u) expressed as,

After data blocks are phase rotated, the rotated OFDM data blocks represents similar information which are unmodified OFDM data blocks, provided with known phase sequence.

PARTIAL TRANSMITS SEQUENCE (PTS)

According to PTS technique an N symbol input block is taken, and is divided into "V" disjoint sub-blocks. After that the divided sub-bocks are weighted by the phase vector sequence. The selection of phase factor such that the PAPR of the resultant signal is minimum.

Where v = [1, 2, 3…., V], Then, the sub-blocks X are transformed into time-domain partial transmit sequence x, by using IFFT which can be represented as

$$xm = \sum_{v=1}^{V} IFFT(Xm)$$

A. INTERLEAVING TECHNIQUE

It is a PAPR reduction technique which collects the interleavers for reducing the value of PAPR. It is quite different from PTS and SLM as it does not uses the set of phase sequence for PAPR reduction.

B. CLIPPING AND FILTERING

This is easiest and simplest way or technique to reduce the PAPR. It is the combination of two processes i.e. clipping and filtering. Clipping is a technique in which a user defined threshold level or clip level is defined. This threshold level is predefined and then the signals are compared by these pre-defined levels and the signal which crosses the threshold levels clipped or cancelled. The process of clipping causes in-band or out-of-band noise in the signals and clipping is a non-linear process. This process may reduce the spectral efficiency of the signals and also increases the BER. After applying clipping, filtering is applied to the signals which are received after clipping. Filtering is applied to remove the noise from the signals. It is applied to remove the out-of-band distortion and spectrum growth efficiency of the signals. After applying filtering signal may rises above the clip level which is considered as the re-growth f the signals. This is the lacking point of applying filtering after clipping. To overcome the disadvantage of filtering the process clipping and filtering should be applied alternatively.

CONCLUSION

From above literature it is concluded that the OFDM suffers from the problem of highest PAPR. In order to reduce the problem of PAPR large number of techniques has been developed. But these techniques are not work sufficiently to reduce the effect of PAPR on OFDM. Hence still the research is under process to reduce the problem of PAPR.

REFERENCES

[1] Kavita Mhatrea," Efficient Selective Mapping PAPR Reduction Technique ", International Conference on Advanced Computing Technologies and Applications , Pp 620 – 627, 2015

[2] Suverna Sengar, , "Performance improvement in OFDM system by PAPR reduction" Signal & Image Processing : An International Journal (SIPIJ) Vol.3, No.2, April 2012,Pp 157-169

[3] Md. Ibrahim Abdullah, "Comparative Study of PAPR Reduction Techniques in OFDM" Journal of Systems and Software, VOL. 1, NO. 8, ,Pp 263-269, 2011

[4] Zhongpeng Wang, "Reduction PAPR of OFDM Signals by Combining SLM with DCT Transform" Int. J. Communications, Network and System Sciences, Vol 3, Pp 888-892, 2010

[5] Reshma Elizabeth. Regi, Haris P.A, "Performance of PAPR Reduction in OFDM System with Complex Hadamard Sequence using SLM and Clipping , International Journal of Engineering and Advanced Technology (IJEAT), Volume-3, Issue-4, Pp 381-384,2014

[6] V.B.MALODE, B.P.PATIL, "Performance of Linear Block Coded OFDM system", International Journal of Applied Information Systems, IJAIS Journal, Vol 3, issues-4,2012

[7] K. Srinivas Rao,"Peak to average power reduction in MIMO-OFDM systems using Sub-Optimal Algorithm", IJDPS, vol 3(3), Pp 261-273, 2012

[8] Maan Singh, Vijay Kumar, Jan, "Signal Scrambling Techniques for PAPR Reduction in OFDM Systems" IJECS Vol. 2, No. 1, Pp. 311-317, 2013

[9] Seung Hee Han, SEPTEMBER, "Modified Selected Mapping Technique for PAPR Reduction of Coded OFDM Signal" , IEEE Transactions On Broadcasting Vol. 50, No. 3, Pp.335-341, 2004

[10] Peyali Choudhury, Achala Deshmukh, "Comparison and analysis of PAPR reduction techniques in OFDM", IOSR- JECE Vol. 4, No. 5, Pp. 01-06, 2013

[11] Leman Dewangan, Mangal Singh, Neelam Dewangan, November, "A Survey of PAPR Reduction Techniques in LTE-OFDM System", IJRTE Vol. 1, No. 5, Pp. 10-13, 2013

[12] R. Divya Kanti and R.V. Ch. Sekhar Rao, "Systematic Comparison of Different PAPR Reduction Methods in OFDM Systems" , IJECE Vol. 7, No. 1, Pp. 21-30.

[13] Mr.Jobin Raj, Mr.M.Malleswaran, "DCT Based Modified SLM Technique for PAPR Reduction in OFDM Transmission", IJSER Vol. 3, No. 6, Pp. 1-6, 2012

[14] Pawan Sharma, Seema Verma, "Performance Analysis of Peak-to-Average Power Ratio Reduction Techniques for Wireless Communication Using OFDM Signals", IJCSI Vol. 7, No. 6, Pp.261-268, 2010

[15] Reshma Elizabeth Regi, Haris P.A, "Performance of PAPR Reduction in OFDM System with Complex Hadamard Sequence using SLM and Clipping", IJEAT Vol. 3, No. 4, Pp.381-384, 2014

[16] Kuang Xu, "Beam forming MISO-OFDM PAPR Reduction", ijareeie, vol 5(8), Pp 6926-6931, 2016

[17] Gurtej Singh Toor, Harjinder Singh, Amandeep singh Bhandari,''REVIEW PAPER ON PAPR REDUCTION TECHNIQUES IN OFDM SYSTEM'', IJTRE Vol. 1, No. 8, Pp.640-642, 2014

[18] Panduranga mukunthan,"Modified PTS with interleaving for PAPR reduction of OFDM signals with QPSK sub blocks", ijfcc, vol 3(1), Pp 22-26, 2014

[19] Karuna A Mahajan, "Comparison of Signal Scrambling PAPR Reduction Techniques with Signal Distortion Techniques in OFDM Signal", ijca, 2012

[20] Md. Mahmudul Hasan,"An overview of PAPR Reduction Technique in oFDM System", ijca, vol 60(15), Pp 33-38, 2012

[21] M.V.R Vittal,"Performance enhancement of OOFDM signals using PAPR reduction Techniues and the comparison of their performance", ijca, vol 41(19), Pp 36-40, 2012