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A Review Paper on PAPR Reduction in OFDM using SLM and Adaptive Clipping

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Abstract: Orthogonal Frequency division Multiplexing (OFDM) is an effectual technique of data transmission for high speed communication schemes. However, the main drawback of OFDM system is the high Peak to Average Power Ratio (PAPR) of the communicated signals. OFDM contain of large number of independent subcarriers, as a result of which the amplitude of such a signal can have high peak values. Coding, phase rotation and clipping are between many PAPR reduction schemes that have been proposed to overcome this problem. Here in this paper we survey on two different PAPR reduction methods adaptive clipping and selective mapping (SLM) are used to reduce PAPR. Important reduction in PAPR has been achieved using these techniques.

Keywords: *OFDM, PAPR, SLM, PTS, Adaptive clipping techniques etc.*

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I. INTRODUCTION

OFDM is a spectrally effective multiple carrier modulation format which changes high data rate channel into many lower data rate channels which are spectrally orthogonal to each other. Some of the uses of OFDM contain digital subscriber lines, high-definition television distribution, and long-term evolution based cellular network long haul optical communication [11, 12]. OFDM is measured as an appropriate method for high speed optical communication due its inborn promising advantages of decrease in inters symbol interference and high spectral efficiency. Although, the major issue with OFDM is high PAPR value which emerges because of large number of subcarriers which increases the nonlinear effects and also puts a constraint on range of nonlinear network devices such as analog-to digital converters, amplifiers and modulators. Therefore there is a necessity to reduce the PAPR of OFDM sign in optical OFDM schemes [13].

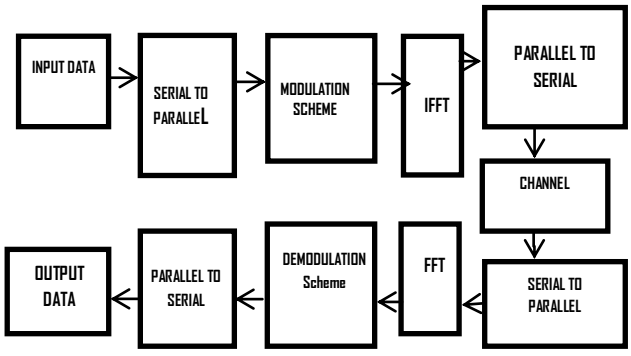

Figure 1: Block diagram of an OFDM system [13]

a. PEAK TO AVERAGE POWER RATIO (PAPR)

Due to occurrence of huge no. of individually moderated sub-carriers in an OFDM organization the peak value of the system can be very high as associated to the average of the whole scheme. This relation of the peak to average power value is labeled as Peak-to-Average Power Ratio. Articulate calculation of N signals of same phase produces a peak which is N times the average signal.

The most important drawbacks of a high PAPR are as follows:-

1. Improved difficulty in the equivalent to digital and digital to correspondent converter.
2. Reduction is effectiveness of RF amplifiers.

b. PAPR OF A MULTICARRIER SIGNAL

Let the data block of length *N* is signified through a vector $X=[X_0, X1 ,.... X_{N-1}]$. Duration of any symbol X_k in the set X is T and signifies one of the sub carriers set $\{f_n, n=0,1,2..,N-1\}$. As the N subcarriers chosen to communicate the signal are orthogonal to each other, so we can have $f_n=n\,\Delta f$ where $n\,\Delta f= 1/NT$ and NT is the duration of the OFDM data block X.

The compound data block for the OFDM signal to be transmitted is given by:

$$x(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X(n) e^{j2\pi nt/N} 0 \le t \le T, \quad (1)$$

Where T is the duration of the OFDM symbol. The input information symbols are assumed to be statistically independent and identically distributed. The amplitude, or modulus, of OFDM signal is given by

$$x_t = \sqrt{\mathrm{Re}^2\{x_t\} + \mathrm{Im}^2\{x_t\}} \quad (2)$$

The power of OFDM signal can be calculated as

$$|x_t|^2 = \frac{1}{\sqrt{N}} \sum_{m=0}^{N-1} \sum_{k=0}^{N-1} X_m X_k \frac{\exp(j2\pi(m-k)t}{N} \quad (3)$$

According to the central limit theorem, when N is large, both the real and imaginary parts of $x(t)$ become Gaussian distributed, each with zero mean and a variance of $E[|x(t)|2]/2$, and the amplitude of the OFDM symbol follows a Rayleigh distribution. Consequently it is possible that the maximum amplitude of OFDM signal may well exceed its average amplitude. Practical hardware (e.g. A/D and D/A converters, power amplifiers) has finite dynamic range; therefore the peak amplitude of OFDM signal must be limited. PAPR is mathematically defined as [4]:

$$PAPR = 10\log_{10} \frac{\max[|x(t)|^2]}{1/T \int_0^T |x(t)|^2 \, dt} (dB) \quad (4)$$

The peak power occurs when modulated symbols are added with the same phase. It is easy to see from above that PAPR reduction may be achieved by decreasing the numerator $\max[|x(t)|^2]$, increasing the denominator $1/T \int_0^T |x(t)|^2 \, dt$, or both. The effectiveness of a PAPR reduction technique is measured by the complementary cumulative distribution function (CCDF), which is the probability that PAPR exceeds some threshold, i.e.:

CCDF = Probability (PAPR > $p0$), (5)

Where $p0$ is the threshold.

II. PAPR REDUCTION TECHNIQUES

In instruction to decrease the high PAPR value in optical OFDM schemes, numerous methods have been proposed in present work. Some of the significant methods are signal clipping, companding, SLM, PTS, nonlinear descending standard changes etc.

A. Signal Clipping

Amplitude feature is a simple technique to reduce the PAPR of OFDM signal. A predefined value of the amplitude is used to boundary the peak value of the involvement signal. Signal having values higher than this threshold value are clipped to the threshold value as follows.

$F(x) = \{A$ when $x > A,$
A when $0 \le x < A\}$

The core problematic in this circumstance is that the amplitude clipping presents undesired clipping noise.

B. Companding based signal distortion

The companding method is a pre-distortion procedure in which the amplitude of the small signal is enlarged while the large signal remains closely the same. Using this technique signal amplitude is re-distributed after transformation which results in condensed PAPR. Also, the gain of PAPR decrease and noise improvement are increased as μ is increased. Hence there is increase in noise due to companding for a constant value of signal-to-noise ratio. It is significant to select values of companding parameters to avoid significant noise.

C. Selected mapping (SLM) for PAPR reduction

In selected mapping method, M independent data blocks **S**m=[Sm,0,Sm,1,…,Sm,N−1]T, m=1,2,…,M signify the same information are achieved via multiplying the original sequence with M uncorrelated sequence **P**m.These are then progressed into IFFT process concurrently. And then the PAPR is designed for every vector discretely. The classification with the smallest PAPR is selected for final transmission. The receiver is compulsory to have evidence around designated phase vector sequence and confirm that the vector sequence is received correctly. This can degrade the spectral efficiency of the system.

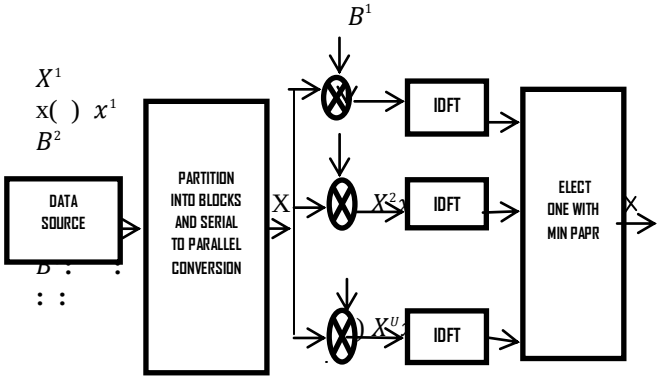

Figure 2: The Block Diagram of Selected Mapping Technique [12]

D. Partial transmit sequence (PTS)

In this technique, the original OFDM sequence is separated into numerous sub-sequences and every sub-sequence is increased through changed weights till an optimal worth is selected.

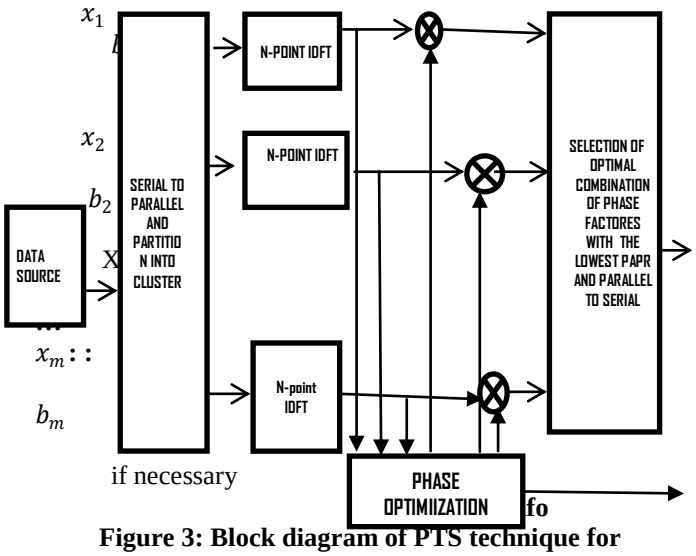

Figure 3: Block diagram of PTS technique for PAPR reduction [3]

E. Selective Mapping (SLM) for OFDM

In this method the sign real transmit at the most condensed PAPR is chosen from an arrangement of various signs which are speaks to the same data SLM system are extremely adaptable as they don't force any confinement on the regulation which connected in the subcarriers or on their number. Piece chart of the SLM approach

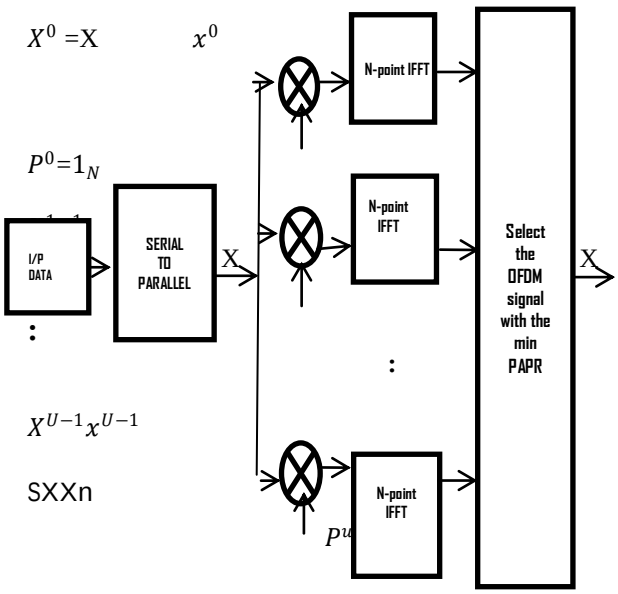

Figure 4: Block Diagram Of OFDM transmitter with SLM Technique [12]

U U U U
X =[X0 +X1 +….XN -1]

Let's describe the data stream after serial to parallel conversion as written above appearance,

Where n=0, 1, 2 , … N-1,

According to this expression OFDM data block provide the same information as the unmodified OFDM data block provide the phase sequence.

SLM method effectively reduces the PAPR with any signal distortion. but it has higher system complexity and computational Burden.

This complexity can less by reducing the number of IFFT block.

II. LITRATURE SURVEY

Sun et.al [1] presented a DCT precoded PAPR reduction technique for MSE–OFDM system and it is shown that Discreet Cosine Transform based precoding method can significantly decrease the PAPR deprived of degrading the error performance. In this we proposed another DCT precoder based SLM technique and HADAMARD precoder based VLM and SLM precoding SLM procedure for PAPR lessening with fewer computational composite than other precoders and it does not necessitate any complex optimization technique.

A. Goel · Prerana Gupta · M. Agrawal [2]In this paper, researchers have proposed themathematical analysis of PAPR performance for ICIself-cancellation, new ICI self-cancellation and ICIconjugate cancellation systems. It weights theobligation of PAPR decrease because PAPRconcert of these structures is either very nearer toor poorer than the OFDM signal. Here in this paper,investigators has presented a multipoint partialtransmit scheme (PTS), which development the PAPRenactment the PAPR performance of ICI canellationscheme.

Ahmad Rushdi, Chen Meng, and Jamal Tuqan[3]The Partial transmit sequence algorithm has beenbroadly used to lessening the influence of peak toaverage power ratio in OFDM system. The importantphase in PTS is the practice of a determinate set of stagefactor "bv" to alternate the facts or information signalearlier broadcast to decrease the effect of PAPR. Inthis paper, researchers propose a semi definiteprogramming that findings the optimum set ofphase revolution factors reprocessed in the PTS method.

Chunjiang Duanmu , Hongtao Chen[4]In OFDM system PAPR is the key problem. Selectivemapping and PTS presentsystem are actual then on the other hand it is verysolid to implement due to the high difficulty. Thecharacteristic algorithm in this research part is themulti-time clipping procedure SLM technique, PTSprocess and golay accompaniment sequence algorithm.In this paper, researcher found that both SLM and PTSalgorithm have good concert in plummeting thePAPR than the golay accompaniment arrangement processthan the clipping procedure. Thus a new PAPRreduction algorithm is offered, by using both PTS and SLM algorithm, which tries lessen the PAPR problem.

Jung-Chieh Chen[5]A high PAPR is a major drawback in orthogonalfrequency division method. The conventional PTStechnique is very effective in PAPR drop inOFDM, then the complexity is additional in practical. Toreduce the complexity still civilizing the PAPRdata. So in this paper,

researchers have presented astochastic optimization technique to lessen the PAPRof an OFDM system.

Aping Yao, Yi Zheng[6]OFDM is a promising technique in contrast to themultipath fading channel for wireless communication.In this paper investigators suggest a technique tosummarize the PAPR consequence of the OFDM indication. Nowadaptive digital filters are used to lessen theconsequence of PAPR.

Md. Ibrahim Abdullah, Md. Zulfiker[7]OFDM suffers the PAPR problem and that is a major problem of multicarrier transmission system. The PAPR is the ratio of maximum power of a sample in a given OFDM transmit symbol to the usual power of that OFDM symbol. PAPR arises when the different subcarriers are out of stage with each other.

S. Bhavi et al. [8] had proposed that OFDM was multi carrier modulation scheme. OFDM used orthogonal subcarrier and also used available bandwidth effectiveness. To accomplish high speed broadcast OFDM was usually used. As the number of subcarrier in OFDM increase the Peak to average power ratio increased. To minimize the effect of PAPR number of capable procedures had been projected. Clipping and clarifying method contributes development in PAPR reduction with minor increase in BER.

D.Narendra et al.[9] had proposed that for high information broadcast OFDM was normally used. OFDM providing high bandwidth efficacy as the carrier was orthogonal to each other and multiple carriers share the existing data. The chief problem of OFDM scheme was great peak to typical influence relation of the communicated indication. In order to reduce complexity and to achieve better PAPR reduction by PTS scheme was proposed. PTS was further effectual, applied, and attractive and there was low information damage.

M. Hasan et al. [10] had proposed that OFDM was an attractive signaling scheme for communication systems and accepted in numerous wireless values. The foremost disadvantage of OFDM was its high Peak-to- Average Power Ratio (PAPR) which limits its applications in communication systems. In fact PAPR could reason power deprivation and spectral dispersion. The presentations of dissimilar PAPR reduction methods in OFDM systems, depends on Complementary Cumulative Distribution Function (CCDF), computational difficulty, bandwidth growth, in-band signal alteration and out-of-band energy. Extensive computer simulations show that up to 8.4 dB reduction in PAPR can be achieved by different techniques.

III. CHALLENGES

1 High Peak to Average Power Ratio (PAPR) is still one of the most important challenges in Orthogonal Frequency Division Multiplexing (OFDM) system.
2 The key challenges are ISI reason behind to multipath-use protector intermission, big peak to average ratio due to non-linearity of amplifier; phase noise problems of oscillator, need frequency offset correction in the receiver.
3 The concept OFDM principle has been introduced a long time ago, but its realization is quite new and still has some challenges such as frame synchronization.
4 The choice of the guard interval length was major design challenge for OFDM based systems.

IV. APPLICATION

1. OFDM (Orthogonal Frequency Division Multiplexing) is being widely used for wireless applications as it provides high data rate and helps to improve spectral Efficiency.
2. The rapid growth in multimedia-based uses has activated a voracious thirst for high data rates and hence amplified request on OFDM-based wireless schemes that can support high data rates and high mobility.
3. The OFDM communication systems find it's applications in Digital television and audio broadcasting, DSL Internet access, wireless networks and 4G mobile communications.
4. It is an effective high speed data transmission scheme without using very expensive equalizers and it has been proposed as the air interface for broadband wireless applications such as wireless local area networks (WLANs).
5. OFDM has been popularly standardized in many applications such as high performance wireless LAN, IEEE 802.11 (Wi-Fi), in Asynchronous Digital Subscriber Line (ADSL) and in power line communication.

V. DISSCUSSION

In beyond numerous works in literature survey accessible by numerous Authors, we examine about various or many present research idea in terms of concept of the peak-to-average power ratio (PAPR), orthogonal frequency-division multiplexing (OFDM) and selected mapping (SLM).Orthogonal Frequency Division Multiplexing is measured to be a capable method beside the multipath fading frequency for wireless communications.One foremostdrawback of OFDM is the high peak-to-average power ratio (PAPR) of the source's outputsignal. Selected-Mapping (SLM) system that does not need the broadcast of side information andcan reduce the peak to average power ratio (PAPR) in turbo coded orthogonal frequency divisionmultiplexing (OFDM) system is proposed. Multiple-input multiple-output orthogonal frequency division multiplexing (MIMO-OFDM) technologyis in order to upsurge the variety gain and scheme volume finished the time variant frequency-selective channels. Orthogonal frequency division multiplexing is multicarrier technique for high information broadcast rate usually castoff in 4Gcommunication these days likewise used in numerical video broadcasting (DVB) and many more application whenever high data transmission rate isrequired. The key difficult of OFDM is high Peak-to-average power ratio because OFDM is extremely delicate to non-linear region of high poweramplifier. Many more technique has been proposed and implemented to decrease Peak to Average power ratio and transport PAPR to anticipated level.Maximum usually used methods are partial transmitted sequence, selective mapping, clipping, tone injection and many more.

VI. CONCLUSION

In this paper we studied various PAPR reduction techniques such as partial transmit sequence(PTS), selected mapping,Companding based signal distortion, envelope scaling, clipping and filtering and peak windowing has been studied. We observe that SLM and adaptive clipping is the most effective techniques to minimise PAPR to great extent and also improve BER performance of the system. PAPR reduction, increase in power in transmit signal, loss in data rate, complexity of computation are several factors which are taken to overcome, before adopting a PAPR reduction technique of the system.

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