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# *PAPR Reduction in OFDM Systems Using Optimization Techniques by SLM, PTSP*

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**ABSTRACT**

*Communication is one of the most important features of life.With its risingdemands, thegrowth in the field of communication is also increasing. Initially, the signal in the analogdomain was sent but now, signal in the digital domain are being send more. Single-carrier waves are being switched by multicarrier for improved transmission. Multicarrier system like CDMA and OFDM are currently being commonly implemented. In the OFDM system, orthogonally placed sub-carriers are being used to carry the information from the transmitter side to the receiver side. There are many problems in OFDM systems, the problem of ISI and noise can be removed using guard band , But the large Peak to average power ratio of these signal have some undesired effect on the system. In this paper, basic focus is on learning the basics of an OFDM system and has carry out various methods to reduce the PAPR in the system so that this system can be used more efficiently.*

**Keywords:** *OFDM, PAPR, SLM, PTS,*

## 1. INTRODUCTION

OFDM stands for orthogonal frequency division multiplexing. It is a multicarrier modulation technique that has newly found wide implementation in a wide variety of high data rate communication system, including digital subscriber lines (DSL), wireless LAN's, digital video broadcasting, now wimax and many other emerging wireless broadband system. OFDM"s popularity for high data rate application stems mainly from its efficient and flexible supervision of intersymbol interfence (ISI) in highly dispersive channels. The main principle of an OFDM system is to use the serial-to-parallel transform to assign the high data rate stream on some of the relative low data rate parallel and orthogonal subchannels [1]. Due to the low transmission data rate of the sub-channels, the period to transmit one data symbol is inflamed and it decrease the effect of the multi-path and fading effects of wireless channels on the OFDM system performance. To reduce the inter-channel interfence (ICI) cyclic prefix in an OFDM symbol is used as the guard interval, Although the OFDM system has the advantage of the resistance against fading effects and high spectrum efficiency, etc.,

In the practical, this system required a large number of carriers to transmit the data. When these carriers superpose on each other, it will creates a very large peak to average power ratio (PAPR) [1]. Currently, the PAPR reduction algorithms can be categorized into following three sections of algorithms as (1) thepre-distortion algorithms [2,3], (2) coding algorithms [4,5] (3) statistical algorithms [6,7]. In the pre-distortion algorithms, a lot of disturbance and out- of-band interferences inescapably created by reducing the PAPR. In the coding algorithms, the data transmission rate is necessarily small by reducing the PAPR. The statistical algorithms, such as the PTS algorithm [6], and the SLM algorithm [8], have fairly good performance in favours to the out-of-band interferences and information transfer rate.

When the large PAPR signal is inputted to the power amplifier of an OFDM system, it needs the amplifier to have a very large linear amplification interval; otherwise, it will creates nonlinear distortions of the OFDM signal, it leads to non-orthogonality between sub-channels, and also out-of-band spectrum interferences. Practically, this kind of power amplifier either cannot be designed. Due to this reason, the research on the reduction

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of the PAPR in OFDM systems both has theoretical value and practical importance [1]

## II. ISSUES IN OFDM

### A. Inter-SymbolInterference

Inter-symbol interference is a kind of distortion in the signal in which one symbol interferes with the subsequent symbols. It is a kind of unwanted phenomenon as the previous symbols have similar effect as noise, due to this the communication less reliable. ISI is basically caused by multipath propagation. If ISI is present in the system introduces error in the decision device at the receiver end. Therefore, in the design of the transmitting and receiving filters, the main objective is to minimize the effects of ISI with smallest error rate possible

### B. Inter-Carrier Interference

Loss in orthogonality of the sub-carriers is due to the presence of doppler shifts, frequency and phase offset in an OFDM system.Due to this interference is observed between sub-carriers.This phenomena is know as Inter-carrier interference.

### C. PAPR Problem

PAPR stands for peak to average power ratio. It is the key problem in OFDM system. The PAPR is the ratio of maximum power of a sample in a given OFDM transmit symbol to the average power of that OFDM symbol. When in a multicarrier system the different sub-carriers are out of phase with each other, then PAPR occurs. There is large number of independent modulated subcarriers in an OFDM system multicarrier concept, due to that subcarrier in an OFDM; the peak value of the OFDM system can be very high as compared to the average value of the whole system. This ratio of the peak to average power value is termed as peak to average power ratio [9].

PAPR= $\frac{\max |x(t)|^2}{E[|x(t)|^2]}$

## III. LITERATURE REVIEW

### A.Joint ICI Cancellation and PAPR Reduction in OFDM systems without side information [16].

In this paper, researchers have proposed the mathematical analysis of PAPR performance for ICI self-cancellation, new ICI self cancellation and ICI conjugate cancellation schemes. It demands the requirement of PAPR reduction because PAPR performance of these schemes is either very nearer to or poorer than the OFDM signal. Here in this paper, researchers has introduced a multipoint partial transmit scheme (PTS), which progress the PAPR performance the PAPR performance of ICI canellation scheme.

### B. An SDP approach for PAPR reduction in OFDM using partial transmit sequence [17].

The Partial transmit sequence algorithm has been broadly used to lessening the influence of peak to average power ratio in OFDM system. The important phase in PTS is the practice of a finite set of phase factor “bv” to rotate the data or information signal before transmission to decrease the effect of PAPR. In this paper, researchers propose a semi definite programming which discoveries the optimal set of phase rotation factors recycled in the PTS technique.

### C. Reduction of PAPR in OFDM system by intelligentlyapplying both PTS and SLM algorithm [18]

In OFDM system PAPR is the key problem. Selective mapping and partial transmit sequence (PTS) existing scheme are effective but on the other hand it is very hard to gadget due to the high complication. The characteristic algorithm in this research area are the multi-time clipping algorithm SLM algorithm, PTS algorithm and golay complement sequence algorithm. In this paper, researcher found that both SLM and PTS algorithm have good performance in dropping the PAPR than the golay complement sequence algorithm than the clipping algorithm. Thus a new PAPR reduction algorithm is offered, by using both PTS and SLM algorithm, which tries lessening the PAPR problem.

### D. Partial Transmit Sequence for PAPR reduction of OFDM signal with Stochastic Optimization technique [19].

A high PAPR is a major drawback in orthogonal frequency division method. The conventional PTS technique is very effective in PAPR reduction in OFDM, but the complexity is more in pratical. To diminish the complexity still improving the PAPR statistics. So in this paper, researchers have presented a stochastic optimization technique to lessen the PAPR of an OFDM system.

### E. Peak to average power ratio reduction using adaptive digital filter [20].

OFDM is a promosing technique in contrast to the multipath fading channel for wireless communication. In this paper researchers propose a method to condense the PAPR effect of the OFDM signal. Here adaptive digital filters are used to lessen the consequence of PAPR.

### *F. Comparative study of PAPR reduction technique in OFDM [21].*

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 average power of that OFDM symbol. PAPR occures the different sub- carriers are out of phase with each other. This paper represents different PAPR reduction technique and accomplishes the comparison of difficult techniques

## IV. PROBLEM FORMULATION BY DIFFERENT TECHNIQUE

PAPR reduction technique is depending on various factors of the system. There are various factors which are keep in mind before approving a PAPR reduction technique of the system i.e, complexity, increase in power in transmit signal and increase in the bit-error rate at the receiver, loss in data rate.

### *A. Amplitude Clipping and Filtering*

In this process, the amplifier is set on a particular threshold value and if any sub-carrier amplitude is greater than the threshold value, is clipped or that sub-carrier is filtered to show up a lower PAPR value. For reducing PAPR in an OFDM system, this technique is measured as the simplest technique. and if any sub-carrier amplitude is greater than the threshold value, then that sub-carrier is clipped or filtered out to bring out a lower PAPR value[11, 22].

$$I_{(x)}=\begin{cases} x & \text{one } |x|\le A \text{ and for second case } |x|\ge A \\ Ae^{j\phi(x)} & \end{cases}$$

In case the amplitude value after clipping

x = Initial signal value

A = The threshold set by the user for clipping th

Signal

The distortion falls in two band i.e both in band and out of band. Filtering cannot be implementing to reduce the in-band distortion. On the other hand out-of-band radiation can be reduced by filtered after clipping. To solve this problem, a repeated filtering and clipping operation can be taken.

### *B. Selective Mapping*

In this process, set of different data blocks are expressing the information same like the original data blocks are selective. The data block which is having the low PAPR value would be selected and makes it appropriate for transmssion. In selective mapping technique is to generate a set of data blocks at the transmitter end and itsignify the original data information, then to select the most appropriate block among them for transmission. Let us consider an OFDM system with N orthogonal sub-carriers. A data block is a vector $X=(x_n)_N$ composed of N complex symbols $x_n$ , each of them representative modulation symbol transmitted over a sub-carrier. X is multiplied element by element with U vector

symbols $x_n$ , each of them representative modulation symbol transmitted over a sub-carrier. X is multiplied element by element with U vector $B_u=(b_{u,n})_N$ , u € {0,1,2…..U-1}, defined so that $|b_{u,n}|=1$ ,where |.| represent the modules operator. Each resulting vector $X_u=(x_{u,d})_N$ , where $x_{u,n}=b_{u,n}. x_n$ , produces after IDFT, a conforming OFDM signal $s_u(t)$ given by

$$S_u(t)=\frac{1}{\sqrt{N}}\sum_{n=0}^{N-1} x_{u,n}e^{j2n\Delta ft} \quad (0\le t\le T)$$

Where T is the OFDM signal duration and $\Delta f=1/t$ is the sub-carrier spacing [13,14].

### *C. Partial Transmit Sequence*

In this process, only selective part of data would be transmitted as a whole , whose varying sub-carrier which covers all the information and this process is called partial transmit sequence [3,4,5,6,7,8]. In the technique, input data block X is divided in M disjoint sub-blocks $X_m=[X_{m,o},X_{m,1},\ldots\ldots\ldots,X_{m,N-1}]^T$, m=1,2,…,M, such that =X and the sub- blocks are united to reduce the PAPR in the time domain. The L times oversampled time domain signal of $X_m$, m=1,2,…..,M, is gained by taking the IDFT of length NL on $X_m$ concatenated with (L-1)N zeroes and these are called the partial transmit sequences. Complex phase factor $b_m=$ , m=1,2,……,M, are introduced to combine the PTSs. The set of phase factors is denoted a vector b $=[b_1,b_2,\ldots\ldots,b_m]^T$. The time domain signal after merging is given by

$$x'(b)=\sum_{m-1}^{M} bm.\ xn$$

Where $x'(b)=[x'_0(b), x'_1(b),\ldots\ldots\ldots,X'_{NL-1}(b)]^T$. The objective is to find the set of phase factors that minimizes the PAPR[10,11,12,13,14,15,23].

## V.CONCLUSION

OFDM has newly found wide assumption in a wide variety of high data communication system. OFDM is a very advance technique for multicarrier

transmission and has become one of the important standard picks for high speed transmission over a communication channel. There are many problems in OFDM one of them is PAPR i.e Peak to average power ratio. PAPR basically occures when in the multicarrier system the different sub-carrier are out of phase from each other. In this paper it is aimed to investigation some of t h e techniques which are used to reduce the high PAPR of the system. Some techniques are amplitude clipping and flittering, selective mapping, partial transmit sequence. Amplitude clipping and filtering results in data loss but SLM and PTS do not affect the data. However, there is no specific PAPR reduction technique.

## VI. FUTURE SCOPE

In this study, different problems of OFDM system have been considered and appropriate solutions have been provided. It is an well-known fact, that research is never ending process, Therefore, following are the works that may be considered as a future scope in this direction:

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