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Peak to Average Power Ratio (PAPR) Reduction Techniques for enhancing the performance of OFDM System

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ABSTRACT:In the Present world, communication is the basic thing we all need. As the demands in communication are increasing, the growth in this field is also increasing at a rapid rate. For improved transmission of the data, multi-carrier waves replaces the single carrier waves. For the transmission of multicarrier waves, Code Division Multiple access (CDMA) and Orthogonal frequency division multiplexing (OFDM) techniques are used commonly. OFDM is an effective technique for the transmission of the data at high speed. In OFDM systems, carriers which are placed orthogonally are used to transmit the data from transmitter to receiver. In OFDM Systems, various problems occur like Inter symbol Interference, Inter-carrier Interference, Noise problem, Peak to average power ratio (PAPR) problem. In this paper, our main focus is on the PAPR problem as it is the major drawback of the OFDM systems. In OFDM, large number of independent sub carriers are contained which results in high peak values of the amplitudes of such signals. In this paper various techniques are discussed for the reduction of PAPR in the system so that our system work more efficient.

KEYWORDS:OFDM, PAPR, SLM, PTS.

I. INTRODUCTION

OFDM stands for orthogonal frequency division multiplexing. This technique is a multicarrier modulation technique for fourth generation wireless communication systems. This technique is implemented widely for high rate data transmissions in Digital subscriber lines (DSL), WiMAX, Wireless Local area Networks (WLAN's), Digital video Broadcasting and many other wireless broadband systems. OFDM uses the principle of serial to parallel transform so that the high data rate stream is assigned on some relative low data rate parallel and orthogonal sub-channels [6]. As the transmission data rate is low, the period to transmit one data symbol is inflated and the effect of fading and multi-path is reduced on OFDM system performance. With OFDM, the major problem is with PAPR. In OFDM, the non-linear effects are increased due to the large number of sub carriers which results in the high PAPR value. So there is a necessity for the reduction of the PAPR in OFDM [10].

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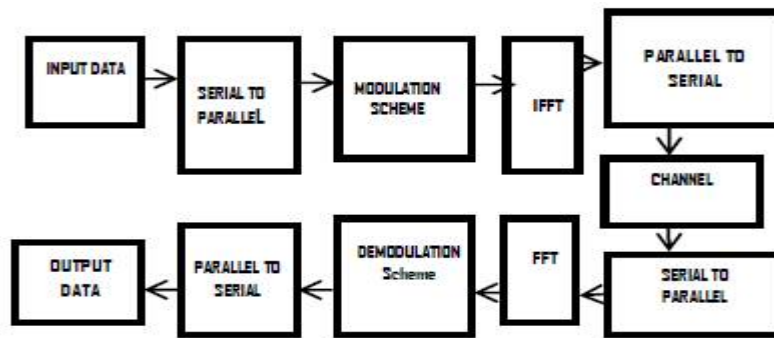


Figure 1: Block diagram of OFDM System[10]

II. LITERATURE REVIEW

1. Ahmad Rushdi, Chen Meng and Jamal Tuqan : For influence of peak to average power ratio in OFDM System, the partial transmit sequence has been used. In this paper, semi definite programming which finds the optimum set of phase revolution factors is proposed.
2. Peak to average power ratio reduction using adaptive digital filter. In this paper, there is a proposal of using the adaptive digital filters to condense the effect of PAPR.
3. D. Narendra and P. Reddy: OFDM was used when large information is to be broadcasted. As OFDM is complex, so to reduce complexity and to reduce PAPR, PTS scheme is proposed and with this the loss of data is very less.
4. Reduction of PAPR by applying both PTS and SLM algorithm: In OFDM, the main problem is of high PAPR value. Although selective mapping and partial transmit sequence are both effective but they are complex too. Thus a new PAPR reduction technique is offered by using both the PTS and SLM algorithm.
5. Sun et.al proposed a DCT (Discrete cosine Transform) for MSE-OFDM which can effectively decrease PAPR without degrading the error performance.

III. ISSUES IN OFDM

1. Inter carrier Interference:

Due to the frequency and phase off-sets, Doppler shifts, there is loss of orthogonality of the sub carriers in an OFDM System. Sub carriers face this type of interference and this phenomena is known as Inter-carrier interference.

2. Inter-symbol Interference:

When one symbol interferes with subsequent symbols, there is distortion in the signal. This type of interference is known as inter-symbol interference. Multipath propagation is the main reason for inter-symbol Interference. The main objective for the reduction of Inter-symbol Interference is that at the receiver end, there should be smallest error rate possible.

3. PAPR Problem:

PAPR stands for Peak to average power ratio. PAPR is the major problem in OFDM system. It is the ratio of maximum power of a sample in a OFDM transit symbol to the average power of that OFDM Symbol. PAPR occurs when different sub-carriers are out of phase with each other in a multi-carrier system. The peak value of the system can be very high as compared to average value of the whole because of the occurrence of large number of individually moderated sub-carriers in an OFDM System. Also with high value of PAPR, the effectiveness of the RF amplifiers is reduced. In this paper, our main emphasis is on the reduction of the PAPR with various techniques so to increase the effectiveness of the OFDM system.

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

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IV. PAPR REDUCTION TECHNIQUES

To reduce the PAPR, there are various dependent factors like complexity, increase of power in transmitted signal and also increase in bit error rate at the receiver end. In order to decrease the PAPR value, there are some methods like Signal Clipping, companding, SLM, PTS.

1. Signal clipping:

In this technique, we use the amplitude in order to reduce the PAPR value. We define a value of the amplitude which bounds the peak value of the signal. Signal having values higher than this threshold are clipped.

$$F(x) = \begin{cases} A & \text{when } x > A, \\ x & \text{when } 0 \leq x \leq A \end{cases}$$

The main problem in this technique is that the clipping of amplitude presents undesired clipping noise. This problem can be solved by repeated filtering and clipping operation.

2. Selected mapping (SLM) for PAPR Reduction:

In this technique, suppose there are N data blocks which are independent.

$S_n = [S_{n,0}, S_{n,1}, \dots, S_{n,M-1}]$, $n=1,2,\dots,N$ signify the same information and is obtained by multiplying the main sequence with N uncorrelated sequence P_n . Then IFFT taken into process. Then the PAPR value is designed for every vector. For final transmission, symbol having lowest PAPR value is selected. Also it is necessary for receiver to verify that the vector sequence which is received is correct.

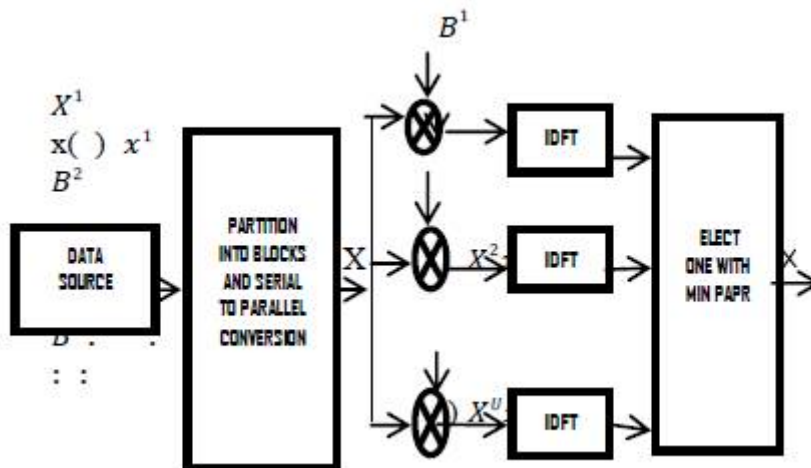


Figure 2:Block diagram of selected mapping Technique [9]

3. Companding based signal distortion:

In this technique, the amplitude of the small signal is enlarged and we do not change any values of the amplitudes of the large signal. This method results in condensed PAPR as the signal is redistributed. Also there is drawback while using this technique that Noise is increased for a constant value of signal to noise ratio due to companding. The Noise can be avoided by selecting the values of companding parameters significantly.

4. Partial Transmit sequence(PTS):

In this method, we divide the main OFDM sequence into a number of sub sequences and there is increase in sub-sequence through changing weights till an optimal value is selected.

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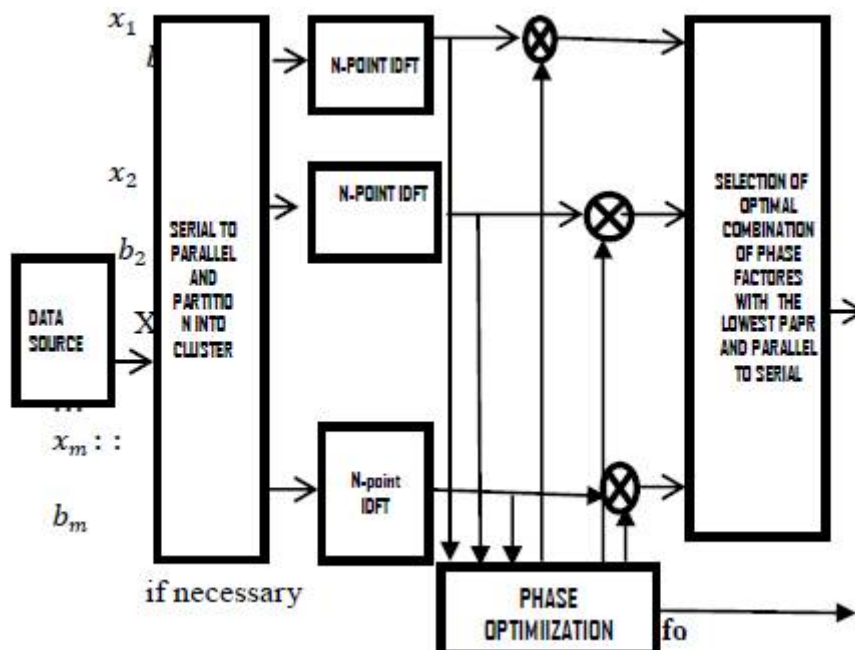


Figure 3:Block diagram of PTS technique [1]

V. CHALLENGES

1. The principle which OFDM is using is very old but its practical realization is new but still have some problems.
2. The major challenges are Inter-symbol Interference which effects the big peak to average ratio due to non-linearity and phase noise problems.
3. High peak to average power ratio (PAPR) is still a big challenge in Orthogonal Frequency Division Multiplexing(OFDM) System.

VI. CONCLUSION

In this paper, four PAPR reduction techniques named signal clipping, Selected mapping for PAPR reduction, companding based signal distortion, Partial Transmit sequence (PTS) were studied. Out of these four, SLM and clipping are the most effective techniques for minimization of the PAPR value and also the Bit error rate is improved.

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