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Hybrid Approach For Reduction of PAPR From OFDM

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Abstract — Communication system is considered to be efficient if it uses defined frequency range for transmitting huge amount of data. OFDM is a technique of digital communication that is employed for encoding digital data on multiple carrier frequencies. The technique of OFDM is considered over other techniques because it exploits the frequency spectrum effectively. Other advantages of OFDM technique are its robustness and efficiency against multipath fading channel. Because of the presence of numbers of sub carriers and the guard band in OFDM systems, the ISI effect and noise on the channel are lessened. The only drawback of this multicarrier transmission system is the PAPR effect that causes power inefficiency. This paper presents an efficient technique for PAPR reduction even in the presence of large number of sub carriers.

Keywords- *OFDM system, Digital Communication, ISI,FFT, PAPR effect*

I. INTRODUCTION

Communication mediums have evolved with the passage of time. Wireless communication has introduced an upsurge in the communication technology and has changed the lifestyle of people. The most extreme need of wireless communication system today is high speed and reliability. To achieve high speed, high data rate is required but it reduces the symbol rate. Multipath effect of wireless channel and the complexity of receiver are reasons behind limited data rates of the conventional single carrier modulation techniques. The most advantageous technique for achieving high rate of data transmission is OFDM. OFDM stands for Orthogonal Frequency Division Multiplexing which is a multi carrier transmission scheme in which data transmission is done through closely spaced orthogonal sub carriers. Parallel bits of data are transmitted through these sub-carriers. Some modulation technique like QPSK is used for sub-carrier modulation to maintain total data rates. The principle on which OFDM system works is splitting high-rate data streams to lower rate data streams so that transmission can be done on number of sub-carriers. OFDM is a modulation and multiplexing technology, and is the basis of many telecommunication fields. The advantages of the OFDM system are:

1. **Effectively defy multipath fading channel**
2. **Improves bandwidth efficiency**
3. **Improves system capacity**
4. **Immune to impulse interferences**
5. **Improves spectral efficiency**
6. **Flexible and easy equalization**
7. **Reduces ISI and noise**

The only drawback of this multicarrier transmission system is the PAPR effect that causes power inefficiency. PAPR is the effect of coherent addition of multiple sub-carrier amplitudes & phases from the OFDM system. The efficiency of the OFDM system is reduced due to PAPR effect because it limits the range of linear operation of RF power amplifier in transmitter. To avoid distortions caused in the signal, peaks should be shown in the linear region only and for that there is a need of large linear region for the operation of RF power amplifiers. For this, numbers of PAPR reduction techniques have been developed. In this paper we will discuss various PAPR reduction techniques.

PAPR of any signal can be measured using the formula depicted below:

$$PAPR(x) = \max |x(t)|^2 / E[|x(t)|^2]$$

Where E [.] depicts Expectation operator

II. PAPR REDUCTION :

Various techniques have been developed till for reducing the PAPR effect on OFDM systems so that power efficiency of the system could be improved.

PAPR reductions have been classified as below:

1. **Signal scrambling techniques.**
2. **Signal Distortion techniques.**

1. **Signal scrambling techniques:** In these techniques, some extra components or signal bits are added to the original data and the manipulation of data is done before transmission of data. There are five types of signal scrambling techniques:

   1.1. Partial Transmit Sequence (PTS): PTS technique is considered as one of most well planned technique to reduce PAPR effect. In this technique signal transmission is done after dividing the input block into numbers of sub blocks. The PAPR effect in this technique is reduced on the basis of method used for dividing sub blocks. Partitioning of sub blocks can be adjacent, interleaved or pseudorandom depending on the technique employed for partitioning. After partitioning of the blocks, phase rotation is added to the signal and then the signal with the lowest PAPR is selected. The drawback of this PTS technique is high complexity and side information.

   $$b=[b_1,b_2,..b_v]=\text{argmin}_{(b1,b2,.....bv)}(\max_{1\le n\le N}|\sum_{v=1}^{v} b_v X_v|^2) \quad \ldots \quad (3)$$

   1.2. Selective Mapping (SLM): The BER of the system is not affected by applying the SLM technique; it is employed for reducing the PAPR of the system. The OFDM modulated data is first phase rotated; IFFT is then applied on the Input data bits. After these operations, the signal that is selected for transmission is the one with the lowest PAPR. The advantages of the SLM technique are less distortion and no hike in the power of the signal.

   $$P\{PAPR_{low}>Z\}=((1\exp(-Z))^{N})^{M..} \quad \ldots\ldots .(4)$$

   1.3. Block Coding Technique: In this technique, code words with the lowest peak power are selected after encoding. The information is divided into number of sub blocks, and these sub blocks are then encoded using system on programmable chips (SOPC). This technique helps in achieving large PAPR reduction.

   $$s(t)= \sum_{n=1}^{n} d_n(t)e^{j\,(2pifnt\,+\varphi n\,)} \quad ..(5)$$

   1.4. Tone Reservation: It is considered to be the easiest way of lessening the PAPR effect in OFDM systems. In this technique the tones that are unable for reliable transmission or the tones that cannot be employed because of low SNR are referred to as reserved tones. The technique is applied by summing the data block and the time domain signal. The peak of the signal is minimized by the data block as it depends on the block signal to the original multi carrier signal. The time domain signal depends is the signal at the transmitter and stripped off at receiver. This technique reduces BER along with the PAPR of the system and is also less complex than the other techniques.

   $$X[n]= x[n] +c[n]= \text{IFFT}\ (X_k + C_k) \quad ..(6)$$

   1.5. Tone Injection: In this technique, set of certainty points are selected to lessen the PAPR effect for the actual certainty points. A constant 'C' is added to the equivalent signal so that there is reduction in the PAPR effect without increase in BER.

2. **Signal Distortion Techniques:** there are certain kinds of signal distortion techniques applied on OFDM system for PAPR reduction. The description of the techniques is given below:

   $$x(t)=\sum_{k=0}^{n-1} X_k\ e^{j\,2\pi f_k t}\,,\ 0\le t\le NT \quad ..(8)$$

   2.1. Peak Windowing: This technique is employed by multiplying a particular window like Kaiser, cosine or hamming window with the peak of large signals. This will form a spectrum of the convolved original OFDM signals which will reduce the PAPR of the signal. In this technique the size of the window should be restricted to avoid increase in BER. The advantage of this technique is that it reduces signal peaks at compact volume of interference. Superior spectral properties of the OFDM signal are obtained with diminished PAPR.

   2.2. Envelope Scaling: In this technique, the scaling of input envelope of sub-carriers is done so that when the output of IFFT is obtained, there is lower volume of PAPR in the signal. This technique reduces PAPR of the signal by scaling.

   2.3. Peak Reduction Carrier: In this technique, the lower order modulation symbol is symbolized by higher order modulation scheme. The data bearing peak reduction carriers (PRCs) are involved in this technique to lessen the PAPR effect. This technique of PAPR reduction is appropriate for PSK modulation because in this type of modulation the envelopes of all sub carriers are equal.

2.4. Clipping & filtering: this is considered to be the simplest, easy and efficient technique for reducing the PAPR effect on the OFDM signal. In the clipping technique, a clip level or the threshold level is set and the signal above that level is cancelled or clipped off. This technique of clipping is a non-linear process that introduces in-band & out-of-band noise distortion, reduces spectral efficiency and also increases BER of the signal. Filtering is then applied on the clipped signal to reduce the out-of-band distortions and the spectrum growth. The disadvantage of applying filtering after clipping is that it may cause re-growth of the signal due to which the signal may rise above the clip level. This disadvantage is overcome by applying clipping and filtering approach iteratively.

$$C(X) = \begin{cases} x, & |x| \le A \\ \mathbf{A, |x| > A} & \mathbf{]} \end{cases} \quad \text{.....(9)}$$

III. PROPOSED WORK :

The only drawback of the multicarrier transmission system i.e. OFDM system is the PAPR effect that causes power inefficiency. Many technique were proposed earlier to reduce the effect of PAPR, but were not able to reduce it to that extent. These conventional techniques either introduced distortion or increased BER of the signal. Techniques like filtering and clipping were considered efficient enough but these reduced the systems gain.

This paper presents an effective technique for reducing the PAPR effect on the OFDM systems. A hybrid technique of clipping & filtering, PTS technique and companding is employed that helps obtain the satisfactory results for reducing PAPR. This hybrid technique removes the disadvantages that were faced using the conventional techniques like loss of gain of the signal and the increasing complexity of the signal.

$$b=[b1,b2,..bv]=\text{argmin}(b1,b2,.....bv)(\max 1\le n\le N|\sum_{v=1}^{v} b_v X_v|2) \quad \text{.....(10)}$$

$$C(X) = \begin{cases} [\, x, & |x| \le A \\ A, |X| > A &] \end{cases} \quad \text{.....(11)}$$

IV. BLOCK DIAGRAM:

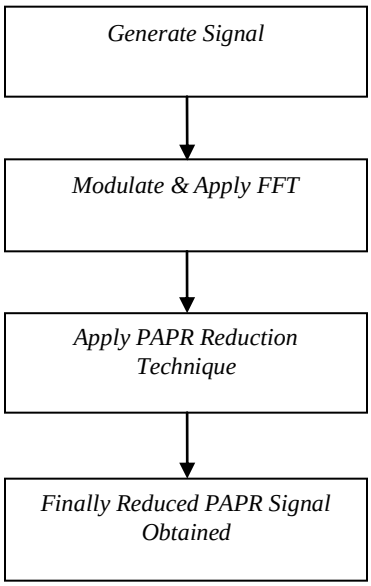


Fig 1. Process of applying PAPR reduction technique on OFDM signal

For reducing PAPR of the OFDM signal:

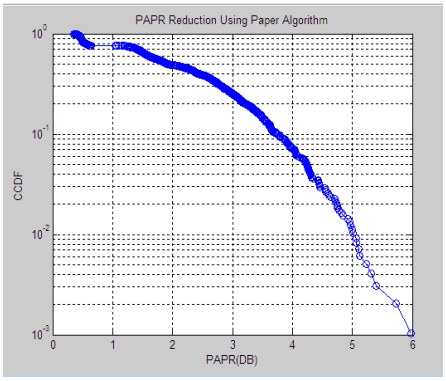
1. OFDM signal will be generated "X"be the signal
2. The generated signal will be modulated and FFT is then applied after modulation.

$$B= FFT(X)$$

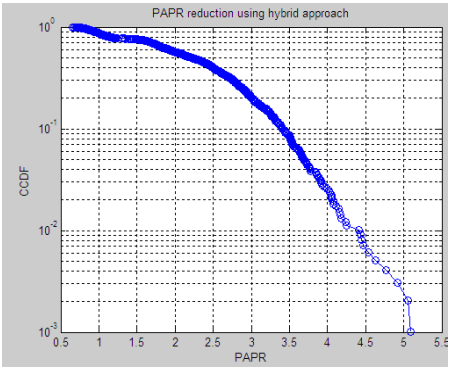
3. The proposed technique for PAPR reduction will be employed and applied on the modulated and FFT applied signal.
4. A final OFDM signal is obtained with satisfactory results of reduced PAPR

V. RESULTS & DISCUSSIONS:

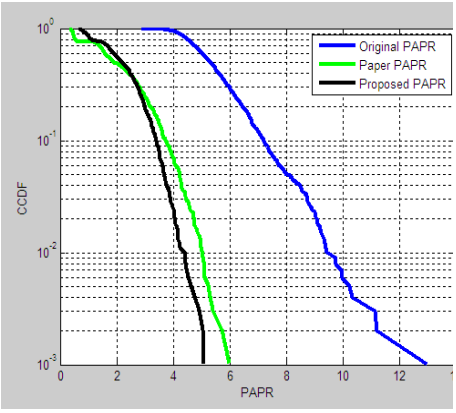
PAPR is the major problem in the OFDM system. Many techniques have been earlier proposed for the reduction of the PAPR. In this proposed work a new technique for the reduction of the PAPR in the OFDM signals. This section shows the graphical representation of the reduced PAPR using the conventional technique described in the paper and the PAPR reduction using the proposed technique.. Calculation of various parameters has done in to made comparison between the traditional technique and the proposed technique of the PAPR reduction. The graphs clearly show the efficiency of the proposed technique in reducing PAPR of the OFDM system



(a)



(b)



(c)

Fig 2. (a) PAPR reduction using paper algorithm, (b) PAPR reduction using hybrid approach, (c) comparison between original PAPR, PAPR reduction using Paper algorithm and PAPR reduction using proposed technique.

VI. CONCLUSION:

The proposed technique has proved to be better than the conventional techniques to a certain extent because it significantly reduced the effect of PAPR on the OFDM systems and the performance of the OFDM systems improved. The proposed technique used the conventional techniques along with a new technique that increased the efficiency of the OFDM systems.

VII. FUTURE SCOPE:

Since the proposed technique yields better results, for getting much more efficient results and reducing the effect of PAPR to a larger extent swarm optimization techniques can be used along with the conventional techniques. The optimization techniques like GA, PSO etc optimize the results and hence will reduce the effect of PAPR to larger extent along with increasing the efficiency of the OFDM systems.

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