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THE PAPR REDUCTION IN ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING USING NEW SLM

Ashish Bisen, Karuna Markam
Department of Electronics, MITS, Gwalior,

***Abstract*— OFDM (Orthogonal Frequency Division Multiplexing) is a new raised modulation technique. Due to its more advantages in multipath fading channel e.g. vigorous against ISI, ICI and other advantages like best quality of service for various users, efficient usage of bandwidth it is recommended to be the modulation technique for 4G networks But along with all its advantages there are some disadvantages of Ofdm system is its high PAPR (Peak to Average Power Ratio) at the transmitter end and BER (Bit Error Rate) at the receiving end. Since OFDM is use only in the downlink networks of 4G. The present paper presents different PAPR reduction techniques and concludes an overall comparison of these Techniques. The present research paper proposed new selected mapping technique (SLM) by using the complex signal separated into real and imaginary parts, then select minimum PAPR signal of real and imaginary part and then minimum signals are combine. The proposed method is most efficient technique for PAPR reduction and enhance the performance in terms of BER, efficiency, less bandwidth requirement and complexity.**

***Index Terms*— Complementary Cumulative Distribution Function (CCDF), Orthogonal Frequency Division Multiplexing (OFDM), Peak-to-Average Power Ratio (PAPR), Selected Mapping (SLM).**

I. INTRODUCTION

The demand of high data rate services has been increasing very rapidly and there is no slowdown in sight. The data transmission includes both wired and wireless medium. Often, these services require very reliable data transmission over very harsh environment. Most of the transmission systems experience much degradation such as large attenuation, noise, multipath, interference, time variance, nonlinearities and must meet the finite constraints like power limitation and cost factor. One physical layer technique that has gained a lot of popularities due to its robustness in dealing with impairments is multi-carrier modulation technique. In multi-carrier modulation, the most commonly used technique is Orthogonal Frequency Division Multiplexing (OFDM); it has recently become very popular in wireless communication. Unfortunately the major drawback of OFDM transmission is its large envelope fluctuation which is quantified as Peak to Average Power Ratio (PAPR). Since power amplifier is used at the transmitter, so as to operate in a perfectly linear region the operating power must lies below the available power. All of the techniques has some sort of advantages and disadvantages [1]. Clipping and filtering is one of the basic technique in which some part of transmitted signal undergoes into distortion. Also the coding scheme reduces the data rate which is undesirable. If we consider Tone reservation (TR) technique it also allows the data rate loss with more probable of increasing power. Again the techniques like Tone Injection (TI) and the active constellation extension (ACE) having a criteria of increasing power will be undesirable in case of power constraint environment. If we go for the Partial Transmit Sequence (PTS) and Selected Mapping (SLM) technique, the PTS technique has more complexity than that of SLM technique[2].The Selected Mapping is one of the promising technique due to its simplicity for implementation which introduces no distortion in the transmitted signal. It has been described first in i.e. to be

known as the classical SLM technique [2]. The technique has one of the disadvantages of sending the extra Side Information (SI) index along with the transmitted OFDM signal. The concentration of the present paper especially upon the Selected Mapping Technique. Another one important point of the paper is how to reduce the computational complexity. One technique also being proposed which has an advantage of reducing the PAPR simultaneously reducing the computational complexity is the Classical SLM.

An OFDM the entire bandwidth is divided into sub channels or subcarriers, the subcarriers are transmitted parallel to achieve high data rates, and to increase symbol duration and reduce ISI [3], [4]. An OFDM signal is the sum of all independent subcarriers, modulated onto the sub channels of equal bandwidth.

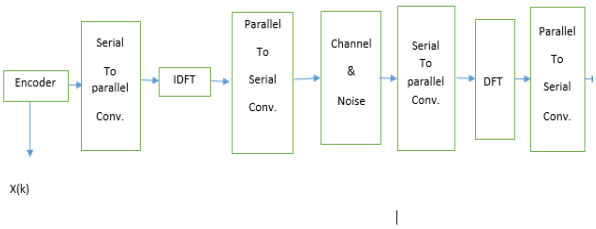

Fig.1.OFDM Block Diagram [3]

II. PROBLEM

PAPR is the main problem of OFDM; it also increases the BER of OFDM signal. A lot of work is done in the literature but still no one bring the PAPR and BER curve to an acceptable level. This paper discusses some of PAPR reduction techniques described in the literature, there advantages and disadvantages and results. Discuss a proposal for future work.

III. CRITERIA FOR PAPR REDUCTION

A criterion is defined for the techniques used for the PAPR, and BER reduction. There are six different techniques and some hybrid techniques (in which two techniques from these six techniques are combined) are used for PAPR and BER reduction. But SLM technique gives acceptable results. For an acceptable technique, that technique must reduce the PAPR and BER largely plus the following performance factors must be considered for OFDM based system:

IV. CAPABILITY OF PAPR REDUCTION

The high capability of PAPR reduction is primary factor to be considered in selecting the PAPR reduction technique with as few harmful side effects such as in-band distortion and out-of band radiation.

A. Low Average Power

Although it also can reduce PAPR through average power of the original signals increase, it requires a larger linear operation region in high power amplifier and thus resulting in the degradation of BER performance.

B. Low Implementation Complexity

Generally, complexity techniques exhibit better ability of PAPR reduction. However, in practice, both time and hardware requirements for the PAPR reduction should be minimal.

C. Less Bandwidth Required

The bandwidth expansion directly results in the data code rate loss due to side information Moreover, when the side information are received in error unless some ways of protection such as channel coding employed. Therefore, when channel coding is used, the loss in data rate is increased further due to side information. Therefore, the loss in bandwidth due to side information should be avoided or at least be kept minimal.

D. Less BER Performance Degradation

The aim of PAPR reduction is to obtain better system performance including BER than that of the original OFDM system. Therefore, all the methods, which have an increase in BER at the receiver, should be paid more attention in practice.

E. Less Additional Power Required

The design OFDM wireless system should always take into consideration the efficiency of power,

F. Good Spectral Efficiency

If a technique destroy the ICI, or, immunity to multipath fading or some other advantage related to spectrum should not be considered a good PAPR reduction technique.

V. LITERATURE REVIEW

In the literature, a large number of PAPR reduction techniques have been proposed. These techniques may be divided in 6 major categories which are:

a) Selective Mapping Techniques
b) Clipping Techniques[**5**]
c) Scrambling Techniques
d) Adaptive Pre Distortion Techniques[6,7]
e) Coding Techniques[8]
f) Pre Coding Based Techniques[9,10]

The illustrations of these techniques are shown in Figure 3. All these techniques are relatively different and impose different constraints e.g. bandwidth expansion, complex optimizations, OOB (out-of-band) radiation, IB (in-band) distortion, side-information, high transmitted power, spectral efficiency reduction, computational complexity, BER (bit-error-rate) degradation and data-rate loss etc.

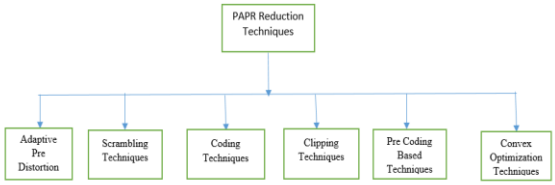

Fig.2. PAPR Reduction Techniques [4]

A. SLM (Selective Mapping)

Selective mapping technique is an effective and distortion less technique used for the PAPR reduction in OFDM. The name of technique indicates that one sequence is to be selected out of a number of sequences. According to the concept of discrete time OFDM transmission we make a data block considering N number of symbols from the constellation plot. Where N is the number of subcarriers to be used. Then using that data block U number of independent candidate vectors are to be generated with the multiplication of independent phase vectors. Let us consider X is the data block with X (k) as the mapped sub symbol (i.e. the symbol from the constellation). Where k = {0, 1, 2 ...N− 1}. Let the u^{th} phase vector is denoted as $B^{(u)}$, where u = {1, 2 ...U}. The u^{th} candidate vector that is generated by the multiplication of data block with the phase vector is denoted as $X^{(u)}$. So we can write the equation to get the k^{th} element of u^{th} candidate vector as

$$X^{(u)}(k) = X(k)B^{(u)}(k) \quad (1)$$

Then by doing IFFT operation to each candidate vector we obtain U number of alternative OFDM signals, so the nth symbol of u^{th} alternative OFDM signal written mathematically as

$$x^{(u)}(n) = \frac{1}{\sqrt{N}}\sum_{k=0}^{N-1} X^{(u)}(k)e^{j(\frac{2\pi nk}{N})} \quad (2)$$

So out of the U number of alternative OFDM signals the signal having minimum PAPR is to be selected for transmission. Let that selected OFDM signal is denoted as x (˜u) (k). The selected mapping (SLM),[2] technique is known as the classical SLM. The block diagram for this technique is shown in figure 3

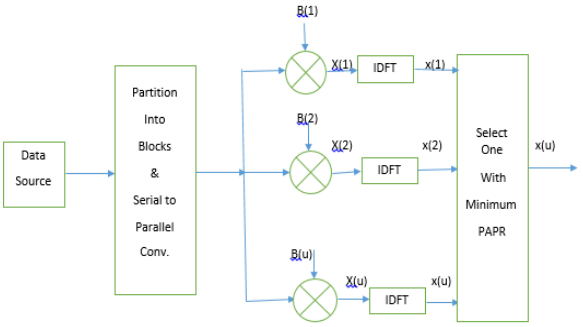

Fig.3.BlockDiagram for SLM Technique [12]

B. Clipping Techniques

One of the simple and effective PAPR reduction techniques is clipping, which cancels the signal components that exceed some unchanging amplitude called clip level. However, clipping yields distortion power, which called clipping noise, and expands the transmitted signal spectrum, which causes interfering . Clipping is nonlinear process and causes in-band noise distortion, which causes degradation in the performance of bit BER and out-of-band noise, which decreases the spectral efficiency. Clipping and filtering technique is effective in removing components of the expanded spectrum. Although filtering decreases the spectrum growth, filtering after clipping reduces the out-of-band radiation, but also causes some peak re-growth, which the peak signal exceeds in the clip level. The technique of iterative clipping and filtering reduces the PAPR without spectrum expansion. However, the iterative signal takes long time and it increases the computational complexity of an OFDM transmitter. But without performing interpolation before clipping causes it out-of-band. To avoid out-of band, signal should be clipped after interpolation. However, causes significant peak re-growth. So, it can use iterative clipping and frequency domain filtering to avoid peak re-growth.

C. Scrambling Techniques

Block Coding Techniques, Selected mapping (SLM), Partial Transmit Sequence (PTS) Interleaving Technique, Tone Reservation (TR),and Tone Injection (TI) etc are Signal Scrambling Techniques.

D. PTS (Partial Transmit Sequence) [11]

In the Partial Transmit Sequence (PTS) technique, an input data block of N symbols is partitioned into disjoint sub blocks. The sub-carriers in each sub-block are weighted by a phase factor for that sub-block. The phase factors are selected such that the PAPR of the combined signal is minimized. But by using this technique, there data rate loss occurs.

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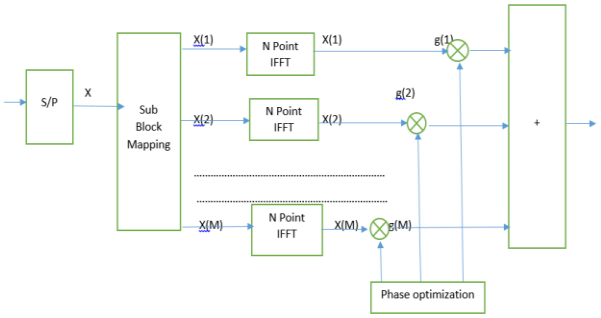

Fig.4. Block Diagram for PTS based OFDM system [11]

E. TR (Tone Reservation)

According to tone reservation technique the transmitter does not send data on a small subset of sub carriers [12] that are optimized for PAPR reduction. Here the objective is to find the time domain signal to be added to the original time domain signal such that the PAPR is reduced. Here the data rate loss be take place also probability of power increase is more.

F. TI (Tone Insertion) [9]

Tone Injection (TI) method has been recommended by Muller, S.H., and Huber, J.B. TI technique is based on general additive method for PAPR reduction. Using an additive method achieves PAPR reduction of multicarrier signal

without any data rate loss. TI uses a setoff equivalent constellation points for an original constellation points to reduce PAPR. The main idea behind method is to increase the constellation size. Then, each point in the original basic constellation is mapped into several equivalent points in the extended constellation, since all information elements is mapped into several equivalent constellation points. This additional amount of freedom is utilized for PAPR reduction. The drawbacks of tone insertion method are; need to side information for decoding signal at the receiver side, and cause extra IFFT operation which is more complex.

G. Adaptive Pre-distortion

The technique reduces the high PAPR problem of OFDM system or in other words compensates the nonlinear effect of HPA (High Power Amplifier) through
automatic adjusting of the input constellation with the help of least hardware; the nonlinear HPA deviation is handled. The convergence time of predistorter and the MSE (Mean Square Error) is decreased through broadcasting techniques with the help of suitable training signal design.

H. Convex Optimization Technique

The techniques the constellation errors and constraints on permissible OOB (Out of Band) noise make a convex optimization problem. Some known algorithms are used to achieve global optimal results with low complexity. With convex optimization technique first of all the PAPR gain is defined then constraints are described for the transmitted OFDM symbol, which is detected by the receiver.

I. Coding Techniques

The coding technique [10] is used to select such code words that minimize or reduce the PAPR .The technique causes no distortion and creates no out-of-band radiation, but technique suffers from bandwidth efficiency as the code rate is reduced .Also suffers from complexity to find the best codes and to store large lookup tables for encoding and decoding, especially for a large number of sub carriers.

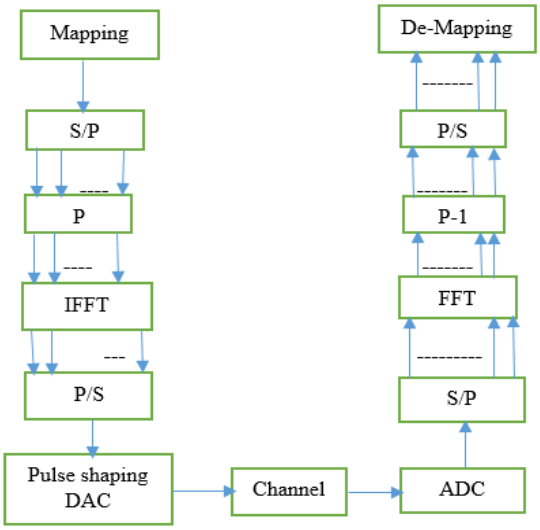

Fig. 4. Pre-coding based OFDM System (6)

TABLE I: Comparison between different PAPR techniques [8]

Techniques	Distortion	Power increase	Data rate loss
Clipping and Filtering	YES	NO	NO
Coding	NO	NO	YES
Partial Transmit Sequence	NO	NO	YES
Tone Reservation	NO	YES	YES
Tone Injection	NO	YES	NO
ACE	NO	YES	NO
Selected Mapping	NO	NO	YES

VI. CONCLUSION

OFDM has been seen as the core technique of the future communication systems because it has many advantages .OFDM transmission has many favourable features, such as robustness against multipath fading and narrow-band interference, high spectral efficiency and simple channel

estimation and equalization, which are why it is an attractive method for wireless communication systems. One of the challenging issues for Orthogonal Frequency Division Multiplexing (OFDM) system is its high Peak-to-Average Power Ratio (PAPR). High peak-to average power ratio (PAPR) of the transmitted signal is a major drawback of orthogonal frequency division multiplexing (OFDM).In present paper; we discuss the OFDM and PAPR of an OFDM signal. SLM [12] technique is a very efficient technique for reducing PAPR. Simulation results show that the proposed SLM method for PAPR reduction.

VII. FUTURE WORK

A survey paper on PAPR reduction in OFDM based system is presented in paper. In future a Pre-coder will be combined with any Scrambling technique and the system performance will be compared with already work done for Next Generation Vehicular Ad-hoc Networks (NGVANET).

VIII. SIMULATION RESULT

The PAPR reduction is very easy through the CCDF. The present performance using the new SLM technique is shown in figure 5. If we consider all the candidate vectors in a matrix form then without following the oversampling concept the dimension of that matrix be U × N and with following the oversampling concept the dimension becomes U × V N. Here the number of subcarriers used to be N = 64 and the oversampling factor V = 4. So this figure5 describes the performance criteria of the SLM technique on the basis of PAPR reduction performance. Another PAPR reduction also being on the basis of different phase vectors [13] to satisfy the equation

$$E\left[e^{j\emptyset}\right] = 0 \quad (3)$$

With considering the case 1 as the ϕ takes on values 0 and π with equal probability. In case2, π is uniformly distributed in (0, π/2]. The expression of theoretical PAPR [12] for the classical SLM is given by

$$\Pr\left(PAPR\{x\} > y\}\right) = (1 - (1 - e^{-\gamma})^N)^U \quad (4)$$

Where U is the number of alternative vectors. This comparison plot is shown in figure. Results of this simulation are shown without using any oversampling factor.

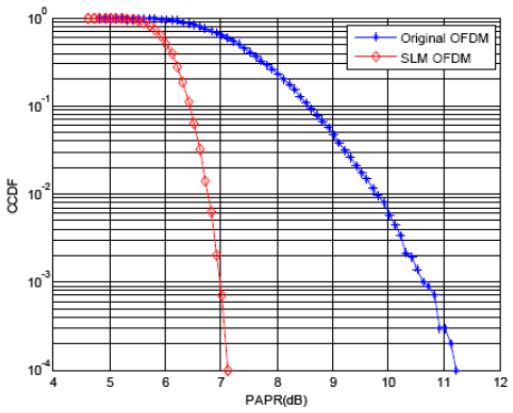

Fig.5. PAPR Reduction for SLM

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