VOLUME-1 ISSUE-2
ISSN : 2799-18

ANALYSIS OF VARIOUS MEETHODS OF OFDM SYSTEM FOR REDUCTION OF PAPR

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ABSTRACT
High peak-to-average power ratio (PAPR) is a major drawback of orthogonal frequency division multiplexing (OFDM) systems. Among the various PAPR reduction techniques, companding transform appears attractive for its simplicity and effectiveness. This paper proposes a new companding algorithm. Compared with the others, the proposed algorithm offers an improved bit error rate and minimized out-of-band interference while reducing PAPR effectively. The increasing demand on high bit rate and reliable wireless and wire line system has junction rectifier to several new rising modulation techniques. one among the techniques are going to be Orthogonal Frequency Division Multiplexing (OFDM), that offers reliable high bit rate wireless system with cheap complexness. the first reasons OFDM is most popular in most high information measure potency transmission systems ar as a result of it effectively resist Inter Symbol Interference (ISI) and is powerful towards multipath weakening. This paper describes the problem of the height to Average Power magnitude relation (PAPR) in OFDM that could be a major downside, and presents new and variations to existing algorithms to cut back it.

1. INTRODUCTION

Broadband wireless is a technology that provides connection over the air at high speeds. Orthogonal frequency division multiplexing (OFDM) system has generally been adopted in recent mobile communication systems because of its high spectral efficiency and robustness against intersymbol interference (ISI). However, due to the nature of inverse fast Fourier transform (IFFT) in which the constructive and destructive behaviour could create high peak signal in constructive behaviour while the average can become zero at destructive behaviour, OFDM signals generally become prone to high peak-to-average powe r ratio (PAPR) problem. In this chapter, we focus on some of the techniques to overcome the PAPR problem (Krongold and Jones, 2003; Bauml, et al. 1996).

The other issue in wireless broadband is how to maximize the power efficiency of the power amplifier. This can be resolved by applying digital predistortion to the power amplifier (PA) (Varahram, et al. 2009). High PAPR signal when transmitted through a nonlinear PA creates spectral broadening and increase the dynamic range requirement of the digital to analog converter (DAC). This results in an increase in the cost of the system and a reduction in efficiency. To address this problem, many techniques for reducing PAPR have been proposed. Some of the most important techniques are clipping (Kwon, et al. 2009), windowing (Van Nee and De Wild, 1998), envelope scaling (Foomooljareon and Fernando, 2002), random phase updating (Nikookar and Lidsheim, 2002), peak reduction carrier (Tan and Wassell, 2003), companding (Hao and Liaw, 2008), coding (Wilkison and Jones, 1995), selected mapping (SLM) (Bauml, et al. 1996), partial transmit sequence (PTS) (Muller and Huber, 1997), DSI-PTS (Varahram et al. 2010), interleaving (Jayalath and Tellambura, 2000), active constellation extension (ACE) (Krongold, et al. 2003), tone injection and tone reservation (Tellado, 2000), dummy signal insertion (DSI) (Ryu, et al. 2004), addition of Guassian signals (Al-Azoo et al. 2008) and etc (Qian, 2005).

Clipping is the simplest technique for PAPR reduction, where the signal at the transmitter is clipped to a desired level without modifying the phase information. In windowing a peak of the signal is multiplied with a part of the frame. This frame can be in Gaussian shape, cosine, Kaiser or Hanning window, respectively. In companding method the OFDM signal is companded before digital to analog conversion. The OFDM signal after IFFT is first companded and quantized and then transmitted through the channel after digital to analog conversion. The receiver first converts the signal into digital format and then expands it. The companding method has application in speech processing where high peaks occur infrequently. In PTS, by partitioning the input signal and applying several

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ISSN : 2799-18

IFFT, the optimum phase sequence with lowest PAPR will be selected before being transmitted. This technique results in high complexity. In SLM, a copy of input signal is used to choose the minimum PAPR among the multiple signals.

We can conclude that there is always a trade-off in choosing a particular PAPR technique. The trade-off comes in the form of complexity, power amplifier output distortion, cost, side information, PAPR reduction, Bit Error Rate (BER) performance, spectrum efficiency and data rate loss.

Increase in the demand of wireless systems with high data rates, spectral efficiency and reliability, has led to the designing of enhanced feature system for mobile, fixed and next generation communication. Orthogonal frequency division multiplexing (OFDM) has all the capabilities for high data rate transmission. OFDM basically operates on the principle of splitting high rate data stream into several low rate streams being transmitted simultaneously over a number of subcarriers. All these subcarriers are overlapped with guard band eliminating intersymbol interference (ISI) and increasing efficiency.With all these advantages OFDM systems have several challenges, like, multipath guard interval ISI, high peak to average power ratio (PAPR) etc. but the severe one is PAPR.This high peak to average ratio of power provides high peak signals as input to high power amplifiers (HPA) at transmitters.

ORTHOGONAL frequency division multiplexing (OFDM) has been attracting substantial attention due to its excellent performance under severe channel condition [1]. The rapidly growing application of OFDM includes WiMAX, DVB/DAB and 4G wireless systems. However, OFDM is not without drawbacks. One critical problem is its high peak-to-average power ratio (PAPR) [1]. High PAPR increases the complexity of analog-to-digital (A/D) and digital-to-analog (D/A) converters, and lowers the efficiency of power amplifiers. Over the past decade various PAPR reduction techniques have been proposed, such as block coding, selective mapping (SLM) and tone reservation, just to name a few [2]. Among all these techniques the simplest solution is to clip the transmitted signal when its amplitude exceeds a desired threshold. Clipping is a highly nonlinear process, however. It produces significant out-of-band interference (OBI).

2. PAPR OF OFDM SYSTEM

As OFDM signal consists of multiple modulated carriers and able to generate a high peak to average power ratio (PAPR), when these parallel carriers are added up. If N carrier signals which are added together constitute same phase then they generate a peak power which is N times the average power. The increased value of PAPR factor results for clipping noise, non–linear distortion of Power amplifier, BER performance debasement and enhances complexity factor in analog to digital (A/D) or digital to analog (D/A) converter. Let us suppose that, N length data block is represented by the vector as shown X=[X0, X1, X2… XN-1] T where T indicate the duration of any member from set X (Xk), and delineate any single subcarriers {fn ,n=0,1,…..,N-1}. The characteristic feature of multiple subcarriers which are selected to transmit signal is that, they are orthogonal to one another, therefore we have fn = n Δf, where n Δf =1/NT .In this NT indicates the duration of data blocks in OFDM process.

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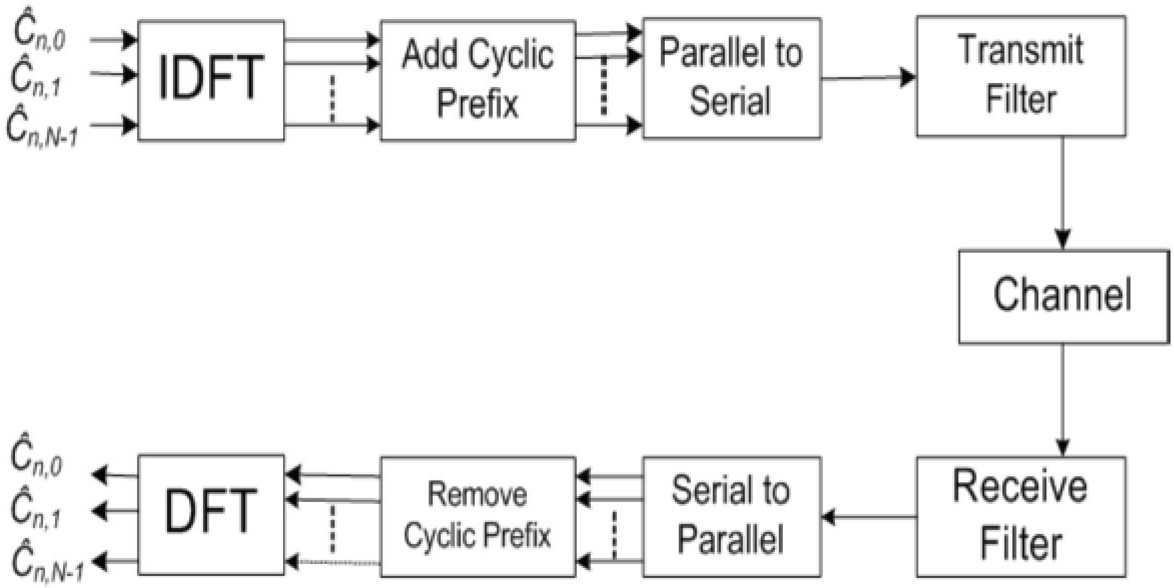

Figure 1. Block diagram of OFDM system

3. HYBRID TECHNIQUES

Hybrid techniques refer to those schemes in which the joint use of more than one PAPR reduction techniques has been proposed. As pointed out by [3], not a single technique can be designated as the best, and choices are usually made based on trade-off between BER, PAPR and overall system complexity. This covers more recent work as summarized below;

A. Joint PTS and Quantized Clipping Scheme

As obvious from the title, this scheme is a combination of two techniques namely, the conventional Partial Transmit Sequence (PTS) technique and a modified clipping technique. The joint scheme achieves a better trade-off between PAPR and BER performance as compared to other PAPR reduction techniques, as reported by [6]. In this scheme, firstly, the conventional PTS technique is applied to the OFDM signal followed by the modified clipping or quantized clipping (QC).

B. Joint Clippingand Companding Technique

In this technique, clipping & filtering scheme is combined with companding scheme. First, the signalundergoes clipping followed by filtering process used to remove the distortion caused due to clipping. Then, the clipped signal is passed through a companding block. The companding increases the average power of low signal level and attenuates the higher signal level. This technique reduces the PAPR without degrading the BER performance. It has reported that this technique reduces the PAPR to 4 dB without degrading the BER. [1]

C. Joint Precoding and Clipping Technique*:*

This technique combines the simple clipping scheme with pre-coding or improved Nyquist pulse shaping. The signal is passed through a pre-coding block which acts before the IFFT. This additional block is used to pre-code the pulse shape of the input signal. This removes peaks from the input signal hence reducing PAPR of the signal. The precoded signal (with improved pulse shape) is then passed through the IFFT block. Following IFFT, the signal undergoes clipping to further improve performance of the system.

D. Joint Clipping and ACE Technique*:*

In this technique, as reported by [9], clipping scheme is combined with Active Constellation Extension (ACE) scheme. Clipping is simple to implement but causes in-band and out-of-band distortion. To remove the in-band distortion, ACE technique is used. ACE technique is based on amplitude pre-distortion of high power amplifier. Due to amplitude pre-distortion, the efficiency of the power amplifier is improved. The advantage comes from the ACE as it does not degrade BER performance.

E. Joint SLM and Quantization ClippingScheme:

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ISSN : 2799-18

This technique, proposed by combines Selective Mapping (SLM) scheme with the quantized clipping scheme. First, the SLM reduces the PAPR and then the quantized clipping operates to improve the efficiency of the system. As it stands, in SLM technique, different copies of the signal are generated and multiplied with different phase sequences.

4. PAPR REDUCTION TECHNIQUES

In this section, some of the most important PAPR reduction techniques such as Selected Mapping (SLM), Partial Transmit Sequence (PTS) and Enhanced PTS EPTS) are presented.

4.1 Conventional SLM (C-SLM)

In Conventional SLM (C-SLM) method, OFDM signal is first converted from serial to parallel by means of serial-to-parallel converter. The parallel OFDM signal is then multiplied by several phase sequences that are created offline and stored in a matrix. A copy of the OFDM signal is multiplied with a random vector of phase sequence matrix. For each subblock IFFT is performed and its PAPR is calculated to look for the minimum one. The OFDM signal having minimum PAPR is then selected and be transmitted. The main drawbacks of this technique are the high complexity due to the high number of subblocks and the need to send side information which result in data rate and transmission efficiency degradation, respectively. In Fig. 2, the number of candidate signal or subblocks is given by *U*, hence *log2U* number of bits is required to be sent as side information.

The other drawback of this method is that by increasing *U*, higher number of IFFT blocks are required which increase the complexity significantly. Hence, a method with low complexity and high PAPR performance is required.

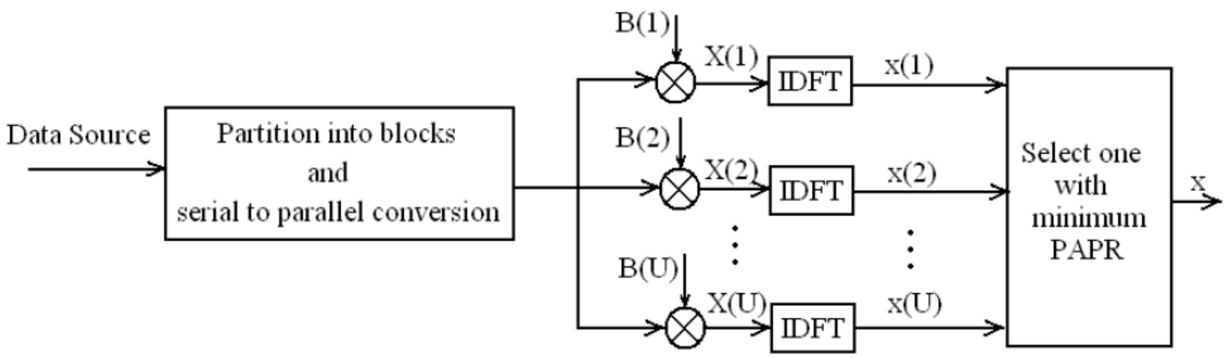

Fig. 2. The block diagram of the C-SLM method**.**

4.2 Numerical analysis

In order to evaluate and compare the performance of the PAPR methods with C-PTS, simulations have been performed. In all the simulations, we employed QPSK modulation with IFFT length of *N*=512, and oversampling factor *F*=4. To obtain the complementary cumulative distribution function (CCDF), 40000 random OFDM symbols are generated**.** Fig. 3 shows the CCDF of three different types of phase sequences interleaved, adjacent and random for D=2. From this figure, PAPR reduction with random phase sequence outperforms the other types and hence this type of phase sequence is applied in the following simulations.

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ISSN : 2799-18

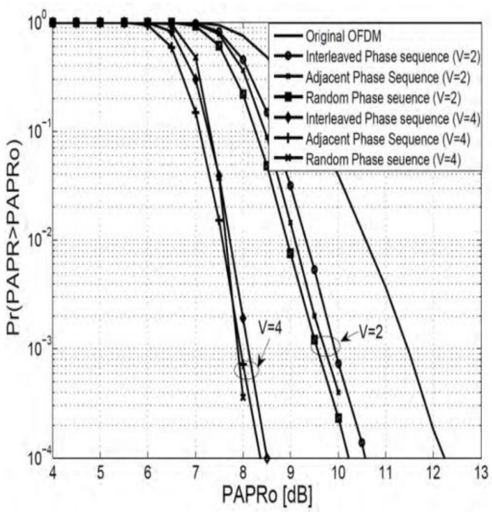

Fig. 3. CCDF of PAPR of the proposed method for different phase sequence when D=2

4.3 Dummy Sequence Insertion (DSI)

The DSI method reduces PAPR by increasing the average power of the signal. Here, after converting the input data stream into parallel through the serial to parallel converter a, dummy sequence is inserted in the input signal. Therefore, the average value is increased and the PAPR is subsequently reduced (Ryu, et al. 2004). IEEE 802.16d standard, specifies that the data frame of OFDM signal is allocated with 256 subcarriers which is composed of 192 data subcarriers, 1 zero DC subcarrier, 8 pilot subcarriers, and 55 guard subcarriers. Therefore, the dummy sequence can be inserted within the slot of 55 guard subcarriers without degradation of user data. However, if added dummies are more than 55, the length of the data and the bandwidth required, will be increased.

CONCLUSION

This paper projected and compared techniques for PAPR reduction in OFDM transmission. we compare our proposed technique with other well-known PAPR reduction techniques in terms of BER, data rate, and computational complexity. Furthermore, the error performance of the OFDM system with and without the proposed technique is the same. Due to the low computational complexity of the proposed PAPR reduction technique, it can be implemented using field programmable gate array (FPGA), which is a good future extension of this paper.

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