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Analysis of PAPR Reduction in OFDM System by using both Signal Scrambling and Distortion Techniques

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***Abstract* - In this paper, we are analyzing the OFDM Systems in different methods to reduce PAPR. An OFDM system is used as multicarrier digital modulation techniques in most of the communications and wireless applications. The high peak to average power (PAPR) ratio is one of the main draw back in OFDM Systems and So Many different methods with new techniques have been proposed in earlier days. Here we are proposing a new method by combining the modified PTS and Discrete Cosine Transformation (DCT) in a single system. The design approach is so flexible and no loss in data rate**.

Keywords—PTS, OFDM, DCT, FFT.PAPR.

I. INTRODUCTION

An OFDM system is used as multicarrier digital modulation techniques in most of the ADSL, Powerline technology, Digital radio, television Broadcasting and finally in wireless standard like LAN, MAN applications.

Orthogonal frequency division multiplexing is one of the data transmission techniques widely used in wireless communication. As OFDM has many advantages such as robustness against frequency selective fading, reduce the complexity of the equalizers. OFDM has a wide application such as digital audio broadcasting, digital video broadcasting, IEEE 802.11, IEEE 802.16 for wireless communication [1].

OFDM is a multi-carrier technique, in which a single high data rate stream is transmitted across a large number of lower data rate subcarriers. One of the main reasons to use OFDM is its' ability to effectively deal with frequency selective channels or a narrow-band interference. Classical multi-carrier techniques divide the available bandwidth into a set of non-overlapping, equally spaced subcarriers, onto which the modulated data is then multiplexed. The spacing between subcarriers would be chosen so as to eliminate the inter-channel interference; guard bands between subcarriers could be used as an example. These methods, however, do not use the available bandwidth very efficiently. A more efficient technique would create an overlap between the used subcarriers without increasing the inter-channel interference.

One of the major drawback of OFDM is it has large peak to average power ratio (PAPR). Because of high PAPR, D/A and A/D converters requires large dynamic range, so the peak values could be clipped off, which causes signal distortion. Because of the increased complexity of A/D and D/A converters the performance of the power amplifier degrades.

The main aim of OFDM is to divide the high data rate bit stream information in to several parallel low rate data substreams and they are used these substreams to perform modulation by number of orthogonal frequency subcarriers by different transformation techniques like DFT, FFT,DCT and others.

This paper is summarized as follows. Section 2 gives a detailed review of the different techniques used in PAPR reduction in OFDM. Section 3 presents the overview of PAPR in OFDM systems. The existing methods and proposing methods are discussed in section 4. Section 5 gives conclusion of the work.

II. RELATED WORK

By solving the combinational optimization problems in OFDM systems to reduce the PAPR, they are chosen Hopfield Neural Networks (HNN) [2] .To solve combinational optimization problems they are used stochastic HNN (S-HNN) in Phase generator. They find a general framework to reduce PAPR using phase sequences in HNN. They proposed all kinds of improved neural networks in HNN and to overcome confined extreme problems by adding a random disturbance in to neural network states and by changing the output states. In simulation they proved that reduction in PAPR is possible using HNN.

In paper [3], one of the methods called Hadamard transform using Blind Selective Mapping (BSLM) is used to reduce the PAPR in OFDM Systems. This method is better compared to Ideal Selective Mapping (SLM). The cumulative distribution function (CDF) of the PAPR is common method to reduce PAPR. In most of the Survey they find Complimentary CDF (C-CDF) is best way to reduce it. In this OFDM Signals are very sensitive to get the data symbols using phase shifts. By using Random Phase Sequence and

Hadamard matrix in BSLM they are increasing in bit data rate. Because no need to transmit the data information for Receiver from Transmitter.

The problem of PAPR Reduction in OFDM systems is considered by using Cubic constellation which is same as the Hadamard constellation; to reduce further they go with selective mapping technique and is applied to constellation. They are achieved much reduction in PAPR without any loss of energy and without any side information being transmitted in receiver [4,5].

Selective mapping is not only single solution to reduce PAPR, In paper [6,7] they are chosen new method by combining the Selective mapping with binary cyclic codes to reduce PAPR in better manner. They are modified SLM by decomposing binary information cyclic codes into direct sum of two cyclic information subcodes. In this, corrected subcode is for error correction and other subcode acts as a scrambling subcode to reduce the PAPR in OFDM system. They concluded with their simulation results achieves reduction in PAPR by using subcodes.

In paper [8] they are used partial transmit sequence (PTS) method to reduce the PAPR in OFDM systems. For PTS sub blocking they are considered DIT or DIF methods in the multiple stages of an N-Point Radix FFT signals. They are used DIF is better than DIT in terms multiplicative complexity and also same on PAPR Reduction on communication systems. The higher stage of radix FFT System achieves better reduction in PAPR per each stage with less complexity than low radix FFT Systems. To reduce further reduction in PAPR they are used Decomposition-PTS (D-PTS) which also signifies reduces the additive and multiplicative complexity.

One of the new signal distortion techniques to reduce PAPR in OFDM Systems is clipping method. It is clubbed with time domain statistical method is discussed in [9] this method is worked with random number of subcarriers without any problems with different types of modulation techniques. In clipping method, they used to process the signals with the effect of changes in the mean and variance values in square rooting method. Using this method they are concluding 6 db reduction in PAPR compare to normal OFDM methods.

The new Signal scrambling techniques is to reduce PAPR by combining Selective Mapping (SLM) with Discrete Cosine Transform (DCT) on OFDM Systems .They are using two methods to reduce the PAPR. In method one, the data is first transferred to DCT before Inverse FFT (IFFT), here the coefficients of IFFT input is reduced then followed by SLM unit, then PAPR reduction in OFDM is appeared. To improve more reduction in PAPR they are using second Method, use of DCT Matrix after the SLM unit [10,11].

In paper [12] to reduce PAPR, they are using four companding transforms in OFDM systems. These four companding transforms are generated transforming to four trigonal distributions from signal statistics. They are concluded by computer simulations results by improvement in bit error rate (BER) performance, spectrum and reduction in PAPR.

The paper [13] discussed about one of the Signal scrambling techniques i.e. Suboptimal Tone Reservation Algorithm based on cross entropy method in OFDM to improve the PAPR performance. In Tone Reservation method, peak reduction carriers (PRCs) are reserved by using unused sub carriers in small number to reduce the PAPR. The main aim of Tone Reservation (TR) Algorithm in transmitter side of OFDM is to find the optimal values of PRCs to reduce the PAPR.

The reduction in PAPR for OFDM systems with QPSK Subcarriers is proposed by using Modified PTS Combined with Interleaving Technique in [14,15]. The drawback of conventional PTS is corrected and modified by combined with Interleaver techniques, this method is very effective and it avoids the extra IFFT in transmitter side and also by dividing the subcarriers into different sub blocks in ordinary PTS to reduce the PAPR and computational complexity.

In paper [16], they are proposed an improved version of SLM, PTS and iterative flipping schemes to reduce the PAPR in fourth generation wireless communication i.e. OFDM. The designs are almost same with few changes in blocks. But the computation complexity is not achieved which is very high.

In [17] they are introducing new precoding technique based on based on Vandermonde-like matrix (VLM) and Selective Mapping (SLM) to reduce the PAPR in OFDM systems. The VLM transform is used to reduce the autocorrelation of input sequences before IFFT algorithm applied to OFDM systems. Here SLM is used to scramble the OFDM signal to generate the alternative input data sequences in transmitter side. At the end they are achieving the high PAPR reduction along without increasing the complexity of the OFDM systems.

III. PAPR OVERVIEW

To reduce PAPR in OFDM systems, two different types of signal techniques used. In that first one is Signal scrambling techniques and second one signal distortion techniques.

Signal scrambling techniques contains different methods includes block coding, sub block coding, Selective level mapping (SLM) , Interleaving method, Linear block coding, Tone injection , Tone reservation and Partial transmit sequence(PTS).

Signal distortion techniques contains different methods includes signal clipping and filtering, Envelope scaling and Peak windowing techniques.

The PAPR of OFDM Signals x (t) is the ratio of peak output power and its average power and it represented as

$$\mathrm{PAPR}[x(t)] = \frac{P_{PEAK}}{P_{AVERAGE}} = 10\log_{10}\frac{\max[|X(n)|^2]}{E[|x_n|^2]} \quad \text{------ (1)}$$

Where
P_{PEAK} = maximum instantaneous output power
$P_{AVERAGE}$ = Average peak power
E [.] = expected value of the data signal.
Xn = transmitted side OFDM Signals.

These Transmitted side OFDM Signals are generated by performing the IFFT operation on modulated input data symbols X_K and Xn is represented as

$$x_n = \frac{1}{\sqrt{N}} \sum_{K=0}^{N-1} X_k W_N^{nk} \quad \text{------ (2)}$$

IV. PAPR REDUCTION TECHINQUES

The PAPR reduction techniques are explained below:

- *PTS Technique:*

PTS technique is one of the techniques which are used for PAPR reduction. The Fig.1 shows the block diagram of the PTS technique. The given input data is first converted to serial to parallel transmission, and then the data is divided into M sub blocks. The OFDM signal is produced for each individual sub block by taking IFFT of each sub block. The OFDM signal is then combined with the weighting phase factor. The phase factor is selected such that PAPR is minimized. Then all these blocks are summed and transmitted through a channel and then reverse process will happen at the receiver.

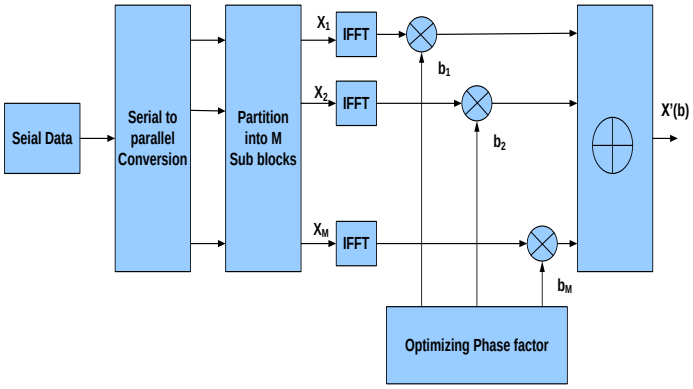

Fig.1: Block diagram of PTS method

- *DCT with PTS Technique*:

Here we are proposing one of the techniques for PAPR reduction. The Fig.2 shows the block diagram of the proposed technique. The given input data is first given to the DCT block which helps to reduce the autocorrelation for the input sequence. Then the data is converted to serial to parallel transmission, and then the data is divided into M sub blocks. The OFDM signal is generated for each sub block by taking IFFT of each sub block. The OFDM signal is then combined with the weighting phase factor. The phase factor is selected such that PAPR is minimized. Then all these blocks are summed and transmitted through a channel and then reverse process will happen at the receiver.

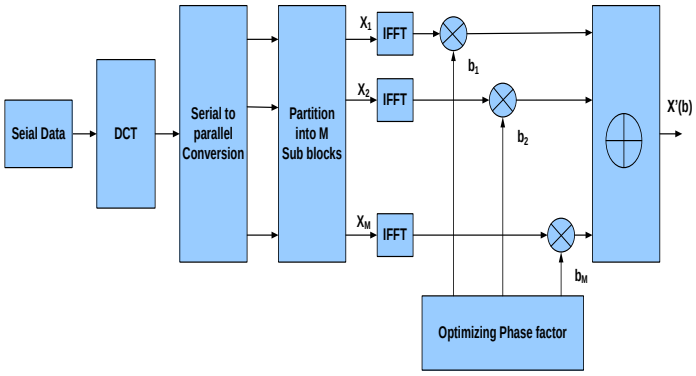

Fig.2: Block diagram of DCT with PTS technique (Proposing method)

- ***DCT:*** The DCT is widely used in image processing and communication systems. The 2-D DCT involves in most of the real time applications like image compression, compression of video frames and streams. In our proposed design, by reducing the number of computations effectively, it reduces the chip area on FPGA and works at high speed. We can easily reconstruct the original data back. Like other transformations the DCT also try to decorrelate or auto-correlate the given sequence data. Our DCT design supports the functionality of de-correlation, energy compaction and separabilty. During the hardware design we are using separabilty like the 2D algorithm is split into two 1-D operations on the rows and columns.

- ***IFFT:*** An IFFT module places the crucial role in our proposed design. Mainly IFFT module is parallel architecture based and contains butterfly module, twiddle factor module, address generator and memory modules for storage purpose. Our IFFT design works at high speed and low latency in efficient manner. Radix -2, eight-point IFFT is designed in out proposed system. The twiddle factor module is simply a ROM coupled with a multiplier. The ROM module stores the pre-computed twiddle factors. Our design uses less number of multiplications.

In the proposed method the modified PTS can be achieved by concentric circle mapping based PTS where the computational complexity can be reduced. Quadrature Amplitude modulation technique is used as a modulation technique in this method.

V. CONCULSION

We are concluding that OFDM is one of the efficient techniques in wireless, mobile communication systems. In survey, we are reviewed all different types of signal scrambling and distortion techniques to reduce the PAPR in OFDM systems. In most of the techniques there is small amount of reduction in PAPR, but the Computation complexity is always there in all and few techniques are trying to achieve it but not so great. In our proposed system, we are combining the modified PTS with DCT to achieve the computation complexity along with spectral efficiency and reduction in PAPR in OFDM systems.

REFERENCES

[1] Aeizaal Azman Abdul Wahab and Mohd. Fadzil Ain, "Clipping and Time Domain Statistical Method for PAPR Reduction in OFDM System", Pulau Pinang, Malaysia, 2009.

[2] Hanming Wang, "PAPR reduction for OFDM system With class of HNN", NKC, China, 2006.

[3] Alireza Zolghadrasli, M.H. Ghamat, "PAPR reduction in OFDM system by using hadamard Transform in BSLM techniques", Shiraz University, Shiraz-Iran 2007.

[4] Amin Mobasher, Student Member, IEEE, and Amir K. Khandani, Member, IEEE, "Integer-Based Constellation-Shaping Method for PAPR Reduction in OFDM Systems", VOL. 54, NO. 1, JANUARY 2006.

[5] Yahui Hu, "An Improved Algorithm for PAPR Reduction in OFDM System", Beijing, China, 2008.

[6] Houshou Chen, Member, IEEE, and Hsinying Liang, "Combined Selective Mapping and Binary Cyclic Codes for PAPR Reduction in OFDM Systems", VOL. 6, NO. 10, OCTOBER 2007.

[7] Jin Soo Wang, Ji Hye Lee, Jae Cheol Park, Iickho Song, Fellow, IEEE, and Yun Hee Kim, Senior Member, IEEE, "Combining of Cyclically Delayed Signals: A Low-Complexity Scheme for PAPR Reduction in OFDM Systems", VOL. 56, NO. 4, DECEMBER 2010.

[8] Abolfazl Ghassemi, Student Member, IEEE, and T. Aaron Gulliver, Senior Member, IEEE, "A Low-Complexity PTS-Based Radix FFT Method for PAPR Reduction in OFDM Systems", VOL. 56, NO. 3, MARCH 2008.

[9] V.Sudha, Sneha Balan, Dr.D.Sriram Kumar, "Performance Analysis of PAPR Reduction in OFDM System with Distortion and Distortion less Methods", (ICCCI -2014), Jan. 03 – 05, 2014, Coimbatore, INDIA.

[10] Ms. Reny A, Ms. Reshma C, Mr. Rajeev S K, " Papr Reduction In Ofdm Systems: Using DCT" , Kerala, IJERT , Vol. 2 Issue 4, April – 2013.

[11] Zhongpeng Wang, "Reduction PAPR of OFDM Signals by Combining SLM with DCT Transform", Hangzhou, China, Int. J. Communications, Network and System Sciences, 2010, 3, 888-892.

[12] Xinchun Wu, Jinxiang Wang, Bin Zhou, Zhigang Mao and Zhiqiang Gao, "Companding schemes based on transforming signal statistics into trigonal distributions for PAPR reduction in OFDM systems", Harbin, People's Republic of China ,Int. J. Commun. Syst. 2011.

[13] Jung-Chieh Chen, Member, IEEE, Min-Han Chiu, Yi-Syun Yang, and Chih-Peng Li, Member, IEEE, "A Suboptimal Tone Reservation Algorithm Based on Cross-Entropy Method for PAPR Reduction in OFDM Systems", VOL. 57, NO. 3, SEPTEMBER 2011.

[14] P. Mukunthan and P. Dananjayan, "P APR Reduction by Modified PTS Combined with Interleaving Technique for OFDM System with QPSK Subcarriers", IEEE-International Conference On Advances In Engineering, Science And Management (ICAESM -2012) March 2012, Pondicherry - 605 014, India.

[15] P. Mukunthan and P Dananjayan, "P APR Reduction based on a Modified PTS with Interleaving and Pulse Shaping method for STBC MIMO-OFDM System", Coimbatore, India, ICCCNT-2012.

[16] Kamal Singh Manoranjan Rai Bharti Sudhanshu Jamwal, "A modified PAPR reduction scheme based on SLM and PTS Techniques", Hamirpur, India, 2012.

[17] Md. Mahmudul Hasan, "VLM Precoded SLM Technique for PAPR Reduction in OFDM Systems", © Springer Science Business Media New York 2013.

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