Implementation And Analysis Of PAPR Reduction In DHT & DFT-Precoded Wireless OFDM SYSTEM

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Abstract

In this Correspondence, analyze High Peak to Average Power Ratio (PAPR) ,In orthogonal Frequency Division Multiplexing PAPR is one of the major drawback. Analogue to Digital (A/D) and Digital to Analogue (D/A) convertors increases the complexity in High PAPR and also reduces the efficiency of RF High Power Amplifier (HPA). In this paper we present a analysis of precoded OFDM systems of Discrete Hartley Transform (DHT) using M-QAM (where M=16,32, 64,256). We compare the simulation results with DFT precoded OFDM system, Walsh Hadamard Transform (WHT) precoded OFDM system, Selected Mapping (SLM) based OFDM system and OFDM conventional. Simulation results show that the PAPR of WHT precoded OFDM system is greater than DHT precoded OFDM system, SLM-OFDM system and OFDM conventional. Lastly we concluded DFT precoded OFDM system has Zero PAPR.

Keywords- High Power Amplifier, DFT Precoder, DHT Precoder, WHT Precoder.

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is a digital multi carrier modulation scheme, which uses a large number of closely spaced orthogonal sub-carriers. A single stream of data is split into parallel streams each of which is coded and modulated on to a subcarrier, a term commonly used in OFDM systems. Orthogonal Frequency Division Multiplexing (OFDM) is a digital multi carrier modulation scheme, which uses a large number of closely spaced orthogonal sub-carriers. A single stream of data is split into parallel streams each of which is coded and modulated on to a subcarrier, a term commonly used in OFDM Each sub-carrier is modulated with a conventional modulation scheme at a low symbol rate, maintaining data rates similar to conventional single carrier modulation schemes in the same bandwidth. Thus the high bit rates seen before on a single carrier is reduced to lower bit rates on the subcarrier.

So The next generation wireless and wired line digital communication systems Because it has High speed data rates, high spectral efficiency, In frequency selective fading high quality service and robustness against narrowband interference. Frequency selectivity moderates in Multipath channel and inter symbol interference by inserting Guard interval by using Cyclic Prefix(CP) with simple equalizer due to this implementation Hardware implementation cheap and makes design of the receiver simple to design.

The various communication standards like Digital Audio Broadcasting (DAB), Wireless Metropolitan Area Networks (WMAN),Digital Video Broadcasting (DVB), Digital Subscriber Lines (xDSL), Wireless Local Area Networks (WLAN), , Wireless Personal Area Networks (WPAN) and even in the beyond 3G Wide Area Networks (WAN) etc are adapted in OFDM Systems. Additionally, In Wireless Asynchronous Transfer mode (WATM) OFDM is the strong Candidate among others ,In transmitted OFDM signal Peak to average Ratio(PAPR) is one of the major drawback[2]. Therefore, distortion of the OFDM signal is zero, the HPA must not only operate in its linear region but also with sufficient back-off. Thus, the RF High Power Amplifier (HPA) with a large dynamic range are required for OFDM system. The cost of These amplifiers are very expensive and are major cost component of the OFDM System.

Cost of the OFDM system reduces when if we reduce the PAPR not only in the scene of cost also complexity of the Analogue to Digital (A/D) converters, but also increasing the transmit power Signal to noise ratio improving same range, or for the same SNR improving range ,Many reduction techniques regarding PAPR proposed in the literature. PAPR reduction methods have been studied for many years and significant number of methods has been developed. These methods are clipping and coding. Clipping naturally happens in the transmitter if power back-off is not enough. Clipping leads to a clipping noise and out-of-band radiation. methods include Golay complementary sequences [**Error! Reference source not found.**], block coding scheme [**Error! Reference source not found.**], complementary block codes (CBC) [**Error! Reference source not found.**], modified complementary block codes (MCBC) [**Error! Reference source not found.**] etc. Among them The techniques like coding Schemes[4,5],phase optimization[6],nonlinear companding transform[7] ,Tone Reservation(TR) and Tone Injection (TI)[8,9],clipping and filtering are popularly used these techniques.

A soft clipping techniques which preserves the phase only the amplitude proposed by Wang and Tellambura[10].To discover some properties to simplify the PAPR gain is only estimated and limited to specific class of modulation techniques and put a lot of effort to characterize the performance of PAPR. The authors Han and Lee Proposed a PAPR reduction techniques based on which they divide the frequency bins into sub blocks and they multiply each sub block with a constant phase shift simply called as Partial Transmit technique. PAPR Reduces when choosing the appropriate phase shift values. To find out the optimal phase value is the most critical part of this technique, combination and in this regard they also proposed a simplified search method and evaluated the performance of the proposed work.

PSLM technique for PAPR developed authors in[12],In this technique Zadoff–Chu based precoder is applied after the multiplication of phase rotation factor abd before the IFFT in OFDM system. The proposed technique PSLM is signal independent and it does not require any complex optimization technique. Single Carrier Frequency Division Multiple Access(SCFDMA) is proposed Zero PAPR Zadoff-Chu precoder based technique is efficient, signal independent, distortion less, it does not require any optimization algorithm and PAPR is completely eliminated.

Discrete Fourier transform (DFT) is a specific kind of discrete transform, used in Fourier analysis. It transforms one function into another, which is called the frequency domain representation, or simply the DFT, of the original function. FFT algorithms are so commonly employed to compute DFTs that the term "FFT" is often used to mean "DFT" in colloquial settings.

A Discrete Hartley transform (DHT) is a Fourier-related transform of discrete, periodic data similar to the discrete Fourier transform (DFT), with analogous applications in signal processing and related fields. Its main distinction from the DFT is that it transforms real inputs to real outputs, with no intrinsic involvement of complex numbers. Formally, the discrete Hartley transform is a linear, invertible function H : $R^n \rightarrow R^n$ (where R denotes the set of real numbers). The N real numbers $x_0, ..., x_{N-1}$ are transformed into the N real numbers $H_0, ..., H_{N-1}$.

Walsh-Hadamard transform is an efficient algorithm to reduce the computational complexity ,it requires additions or subtractions. An RF power amplifier is a type of electronic amplifier used to convert a low-power radio-frequency signal into a larger signal of significant power, typically for driving the antenna of a transmitter. It is usually optimized to have high efficiency, high output Power compression. The basic applications of the RF power amplifier include driving to another high power source, driving a transmitting antenna, microwave heating, and exciting resonant cavity structures. Among these applications, driving transmitter antennas is most well known.

This paper analyses PAPR of the DHT-Precoding based OFDM system for PAPR reduction organized as follow sections: Section II describes the OFDM system basics and PAPR reduction, In Section III presents our proposed technique ,Section IV presents simulation results and Section V concludes the paper.

II. OFDM SYSTEM & PAPR REDUCTION

The OFDM system transmitted low rates data streams simultaneously over a number of orthogonal subcarriers, and these low data rates getting from splitting the high speed data stream into a number of parallel low data rate streams.

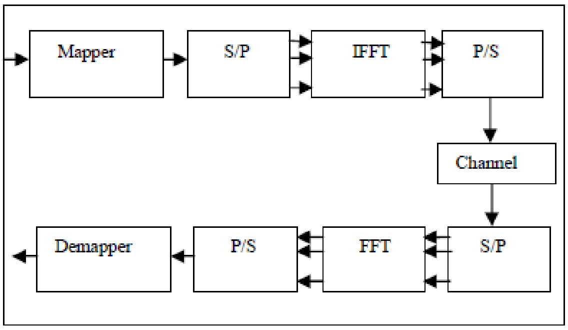

Figure 1: Block diagram of an OFDM system

Fig.1 shows the block diagram of an OFDM system. Baseband modulated symbols are passed through serial to parallel converter which generates complex vector of size N. We can write the complex vector size as X=X0.The symbols passed through IFFT block. the complex baseband OFDM signal with N subcarriers can be written as

$$x_n = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k \, . \, e^{j2\pi \frac{n}{N} k} , \; n=0,\ 1,\ 2...\ N\text{-}1| \qquad (1)$$

Here j= $\sqrt{(-1)}$ and the PAPR of the OFDM of signal (1) can be written as

$$PAPR = \frac{max|x_n|^2}{E[|x_n|^2]} \qquad (2)$$

Where E[.] denotes complementary and the exceptions Cumulative Distribution Function(CCDF) for an OFDM signal can be written as

$$P\,(PAPR > PAPR_0) = 1 - (1 - e^{-PAPR_0})^N \quad (3)$$

Where PAPR0 is the clipping level.this euation can be read as the Probability that the PAPR of a symbol block exceed some clip level PAPR0

III. ANALYSIS OF THE PROPOSED CONCEPT

A. The Precoding Based OFDM system

In Fig.2.shows the block diagram of Precoding Based OFDM System. To reducing PAPR , In Precoding matrix we implementing P of dimension N x N before the IFFT.

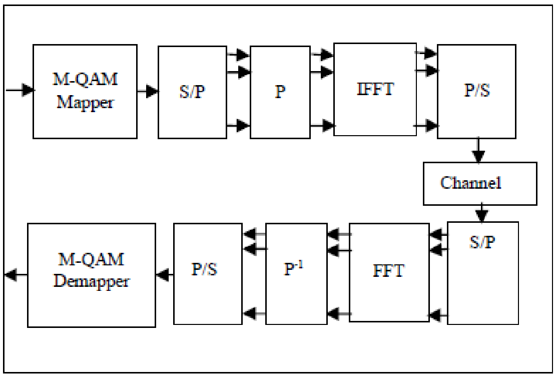

Fig .2. Block diagram of Pre IFFT based OFDM system

The Precoding matrix P can be written as

$$P = \begin{bmatrix} p_{00} & p_{01} & \dots & p_{0(N-1)} \\ p_{10} & p_{11} & \dots & p_{1(N-1)} \\ \vdots & \vdots & \ddots & \vdots \\ p_{(N-1)0} & p_{(N-1)1} & \dots & p_{(N-1)(N-1)} \end{bmatrix} \quad (4)$$

where P is a Precoding Matrix of size _ × _ is shown in equation (4). The complex baseband OFDM signal with _ subcarriers can be written as

$$x(t) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} P.X_k \,.\, e^{j2\pi k\Delta f t}, \quad 0 \le t \le NT \quad (5)$$

The modulated OFDM vector can be express signal with subcarriers N as.

$$x_N = IFFT\{P.X_N\}$$

(6)

The PAPR of OFDM signal in (5) can be written as

$$PAPR = \frac{max|x(t)|^2}{E[|x(t)|^2]} \quad (7)$$

B. The Discrete Fourier Transform (DFT) Precoding

The sequence of DFT of length N can be defined as

$$X(k) = \sum_{n=0}^{N-1} x(n) e^{-j2\pi nk}, \quad k=0, 1 \dots N\text{-}1$$

(8)

and IDFT can be written as

$$x(n) = \frac{1}{N} \sum_{n=0}^{N-1} X(k) e^{j2\pi nk}, \quad k=0, 1 \dots N\text{-}1$$

(9)

Where $p_{mn} = e^{\frac{-j2\pi mn}{N}}$, m and n integers ranging from0 to N-1 and P is precoding matrix of size N x N.

C. The Discrete Hartley Transform (DHT) Precoding

The DHT is a linear transform. In DHT *N* real numbers *X0,X1,… X(N-1)*are transformed in to N real numbers *H0, H1,… H(N-1)*According to [15] the _-point DHT can be defined as

$$H_k = \sum_{n=0}^{N-1} x_n \left[cos\left(\frac{2\pi nk}{N}\right) + sin\left(\frac{2\pi nk}{N}\right) \right]$$

$$= \sum_{n=0}^{N-1} x(n).\ cas\left(\frac{2\pi nk}{N}\right)$$

(10)

Where cos(i)=cos i+sin i and k=0,01,.....N-1

$$p_{m,n} = cas\left(\frac{2\pi mn}{N}\right) \quad (11)$$

Where P is a precoding matrix of size N x N shown in equation (4),m and n integers from 0 to N-1.

IV. MATLAB/SIMULINK RESULTS OF THE PROPOSED CONCEPT

To evaluate the performance of DHT Precoder based OFDM system is shown in simulation results. To show the PAPR analysis of DHT-precoded OFDM system, data is generated randomly then modulated by M-QAM(where M=16,32,64,256).we compared our simulation results with WHT-Precoder OFDM system, DFT Precoding system and Original System. To show the overall performance of the DHT precoder based OFDM system for PAPR reduction in MATLAB we considered M-QAM for N=16,also we considered results in M-QAM are N=32,64,256 ,then compare the results with different precoding systems and show the output simulation results.

Figure.3 shows the CCDF comparisons of DHT-Precoder Based OFDM System with DFT precoder based OFDM system, WHT-Precoder system and Original System for N=16.At clip rate 0.01.DHT precoding based OFDM system does not perform as well as DFT-Precoding based OFDM system, Which is better than DHT-Precoding based OFDM system. Thus PAPR gain to achieve the better results with DHT Precoded system with other precoding systems DFT,WHT .

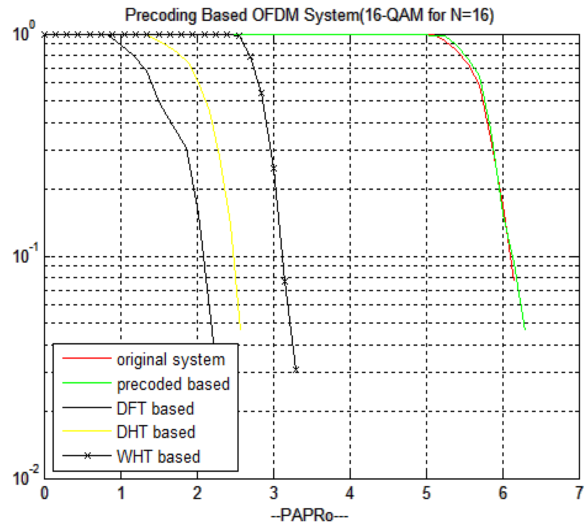

Fig.3. CCDF comparison of DHT-Precoder Based OFDM System with DFT-Precoder Based OFDM system, WHT-Precoder Based OFDM System, and OFDM Original System for 16-QAM

Figure.4 shows the CCDF comparisons of DHT-Precoder Based OFDM System with DFT-Precoder based OFDM system, WHT-Precoder system and Original System for N=16.At clip rate 0.01.DHT precoding based OFDM system does not perform as well as DFT-Precoding based OFDM system, Which is better than DHT-Precoding based OFDM system. Thus PAPR gain to achieve the better results with DHT Precoded system with others

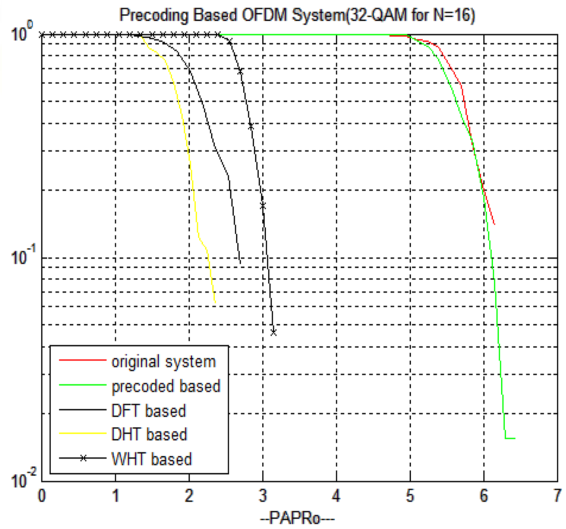

Fig.4. CCDF comparison of DHT-Precoder Based OFDM System with DFT-Precoder Based OFDM system, WHT-Precoder Based OFDM System, and OFDM Original System for 32-QAM

Figure.5 shows the CCDF comparisons of DHT-Precoder Based OFDM System with DFT precoder based OFDM system, WHT-Precoder system and Original System for N=16.At clip rate 0.001.DHT precoding based OFDM system does not perform as well as DFT-Precoding based OFDM system, Which is better than DHT-Precoding based OFDM system. Thus PAPR gain to achieve the better results with DHT Precoded system with others.

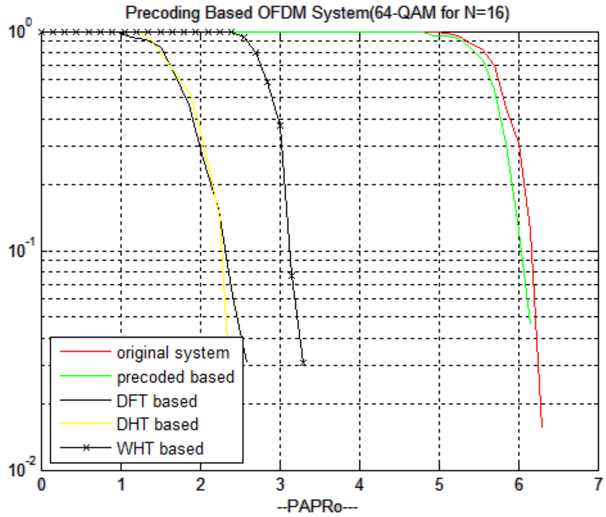

Fig.5. CCDF comparison of DHT-Precoder Based OFDM System with DFT-Precoder Based OFDM system, WHT-Precoder Based OFDM System, and OFDM Original System for 64-QAM

Figure.6 shows the CCDF comparisons of DHT-Precede Based OFDM System with DFT precede based OFDM system, WHT-Precoder system and Original System for N=16.At cliprate 0.01.DHT precoding based OFDM system does not perform as well as DFT-Precoding based OFDM system, Which is better than DHT-Precoding based OFDM system. Thus PAPR gain to achieve the better results with DHT Precoded system with others.

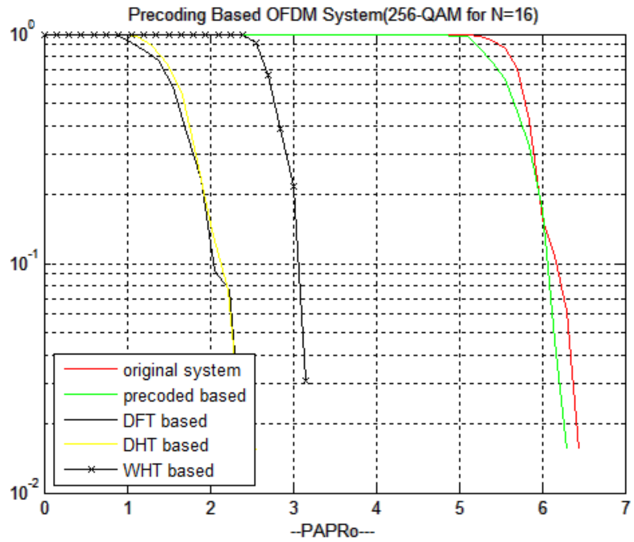

Fig.6. CCDF comparison of DHT-Precoder Based OFDM System with DFT-Precoder Based OFDM system, WHT-Precoder Based OFDM System, and OFDM Original System for 256-QAM

V CONCLUSION

In this Paper ,PAPR of DHT-Precoded OFDM system for M-QAM (Where M=16,32,64,256) analyzed. The simulation results shows that DHT-Precoded OFDM System shows better PAPR gain as compared to OFDM-Original system, WHT-Precoder Based OFDM system respectively. Thus, it is concluded that DHT Precoder Based OFDM System shows better PAPR reduction then WHT-Precoder Based OFDM System, and OFDM-Original system for MQAM. Additionally, the DHT-Precoded OFDM system does not require any power increase, complex optimization and side information to be sent for the receiver.

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