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PAPR AND BER PERFORMANCE OF FILTER DESIGN FOR MIMO-OFDM SYSTEMS WITH MULTIPLE WAVEFORM CONSTRAINTS

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ABSTRACT:

Multiple Inputs Multiple Outputs (MIMO) in combination with Orthogonal Frequency Division Multiplexing (OFDM) is of great interest for researchers and research laboratories all over the world. OFDM is broadly utilized in contemporary correspondence frameworks for its great heartiness in multipath condition, and its high ghostly productivity. The limit of remote framework can be expanded drastically by utilizing MIMO receiving wires. The blend of MIMO and OFDM framework is observed to be extremely helpful. A noteworthy downside of OFDM-MIMO System is its high Peak to Average Power Ratio (PAPR) Reduction. The pinnacle intensity of a flag is a basic structure factor for band constrained correspondence frameworks, and it is important to diminish it however much as could reasonably be expected. Numerous PAPR decrease methods have been utilized to diminish PAPR. Partial transmit arrangement (PTS) is a standout amongst the most notable crest PAPR decrease procedures proposed for MIMO-OFDM frameworks. Anyway the computational multifaceted nature of conventional PTS technique is huge. In this paper a new PTS technique, based on PTS with discrete wavelet transform (DWT) and discrete cosine transform (DCT) technique, for two antennas MIMO-OFDM system, is proposed which can achieve better PAPR performance at much less bit error rate (BER). Simulation results show that the proposed approach can reduce BER and achieve a better PAPR reduction compared to previous PTS technique.

KEYWORDS: *PTS, DWT, DCT, MIMO-OFDM, PAPR, BER*

1. INTRODUCTION

A combination of multiple input multiple output (MIMO) and orthogonal frequency division multiplexing (OFDM) (MIMO-OFDM) is an emerging technology for high speed data multi-carriers transmission in future wireless communication network systems such as digital audio broadcasting (DAB), digital video broadcasting (DVB), medical body area networks (MBANs) applications, the fourth and the fifth generation (4G,5G) of mobile network. In MIMO-OFDM framework, the yield is the superposition of different sub-bearers. At whatever point, the stages and frequencies of these bearers coordinate reasonably, prompt power yields may increment extraordinarily and end up higher than the mean intensity of the powerful intensifier (HPA) bringing about expansive PAPR [1]. Parcel of research work has been improved the situation taking care of the issue of PAPR that worries all sort of multicarrier signals. Along these lines, numerous systems have been proposed, for example, cutting [2], tone reservation [3], nonlinear changes [4], coding [5], choosing mapping (SLM) [6] and incomplete transmit arrangement (PTS). Adjusted methodologies of PTS are proposed in that create better outcomes; in any case, the computational intricacy is as yet staying unsolved completely. In this paper a methodology is proposed to lessen the PAPR in STBC MIMO-OFDM frameworks with less computational unpredictability. So, the mean idea is based on PTS with discrete wavelet transform (DWT) and discrete cosine transform (DCT). The rest of the paper is organized as follows: in section

II, MIMOOFDM system is explained. Section III describes the PTS algorithm. Section IV shows the proposed algorithm, simulation results and the paper are concluded in section V and section VI.

2. MIMO-OFDM SYSTEM

MIMO in combination with OFDM is widely used nowadays due its best performance in terms of capacity of channels, high data rate and good outcome in frequency selective fading channels [7]. Notwithstanding this it likewise enhances dependability of connection. This is accomplished as the OFDM can change recurrence specific MIMO channel to recurrence level MIMO channels [8]. So it is generally utilized in future broadband remote framework/interchanges. Cyclic prefix is the duplicate of last piece of OFDM image which is added to the OFDM image that will be transmitted. It is essentially 0.25% of the OFDM image. We can say that one fourth of the OFDM image is taken as CP (cyclic prefix) and added to each OFDM image. IFFT is utilized at the transmitter and FFT is utilized at the collector which substitutes the modulators and demodulators. Doing as such takes out the utilization of banks of oscillators and lucid demodulators. Additionally the intricate information can't be transmitted for what it's worth; along these lines it is first changed over to simple shape which is practiced by IFFT. It fundamentally changes over the flag from recurrence area to time space. Preceding IFFT activity image mapping is performed which is only the tweak square. Any of the broadly utilized regulation systems can be connected like BPSK, QPSK, QAM, PSK and so on. Further there are higher request balances are additionally accessible which give greater limit at little cost of BER execution debasement [9]. After IFFT square pilot inclusion is done and afterward CP (cyclic prefix) is included.

Figure 1 beneath demonstrates the square chart comprising MIMO and OFDM. Any receiving wire setup for the MIMO can be utilized by the framework necessity. Higher the arrangement more will be the limit and more will be the computational intricacy of the handset plan. It is seen that on account of assessing channel the computational intricacy is expanded. Mapper characterizes the adjustment to be utilized. Image encoder takes the state of the STBC (Space Time Block Code) if spatial assorted variety is to be utilized and it takes the state of the de-multiplexer/multiplexer if spatial multiplexing is to be utilized.

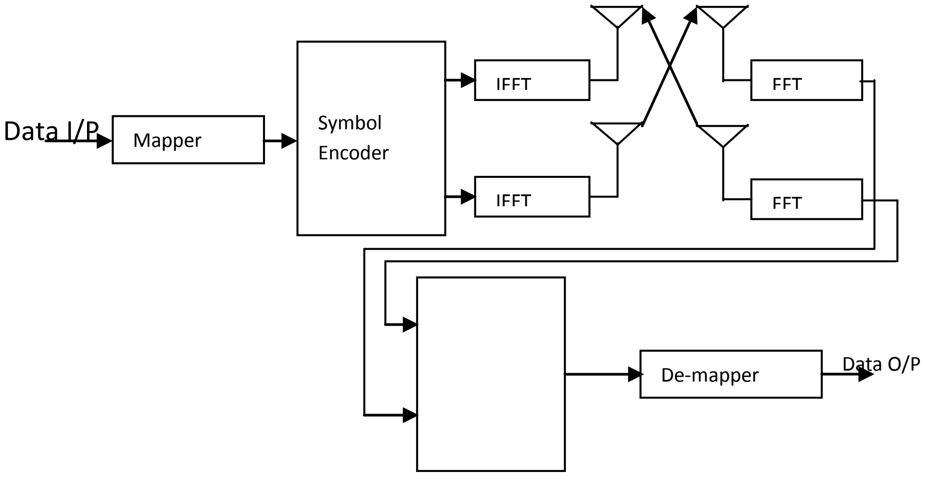


Fig. 1 MIMO-OFDM system model

The received signal at jth antenna can be expressed as

$$R_j[n.k] = \sum H_{ij}[n,k]\, X_i\, [n,k] + W[n,k] \qquad (1)$$

Where H is the channel framework, X is the info flag and W is commotion with zero mean and change. Likewise bi [n,k] speaks to the information square ith transmit radio wire, nth vacancy and kth sub channel file of OFDM. Here I and j meant the transmitting reception apparatuses record and accepting radio wire file individually.

The MIMO-OFDM framework demonstrates [10] with NR gets receiving wires and NT transmits radio wires can be given as:

$$\begin{bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_N \end{bmatrix} = \begin{bmatrix} H_{1,1} & H_{1,2} & \dots & H_{1,NT} \\ H_{2,1} & H_{2,2} & \dots & H_{2,,NT} \\ \vdots & \vdots & \ddots & \vdots \\ H_{NR,1} & H_{NR,2} & \dots & H_{NR,NT} \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \\ \vdots \\ A_{NT} \end{bmatrix} + \begin{bmatrix} M_1 \\ M_2 \\ \vdots \\ M_{NT} \end{bmatrix} \qquad (2)$$

Where, Z speaks to O/P information vector, H signifies Channel network, the remote channel utilized is AWGN channel. After this the flag that is in time area can be again changed over to recurrence space by taking FFT of the got flag. The succession on every one of the OFDM square is then given to channel estimation square where got pilots modified by channel are contrasted and the first sent pilots. Channel estimation square comprises of the calculations that are connected to assess the channel.

3. PTS SCHEMES

In the SISO-PTS scheme, the original data sequence in the frequency domain is partitioned into M disjoint, equal length sub blocks Xv (v = 1, 2... M) as follows [11].

$$X = \sum_{v=1}^{M} X_v \qquad (3)$$

By multiplying some weighting coefficients to all the subcarriers in every sub-block, we can get the new frequency sequence.

$$X' = \sum_{v=1}^{M} b_v X_v \qquad (4)$$

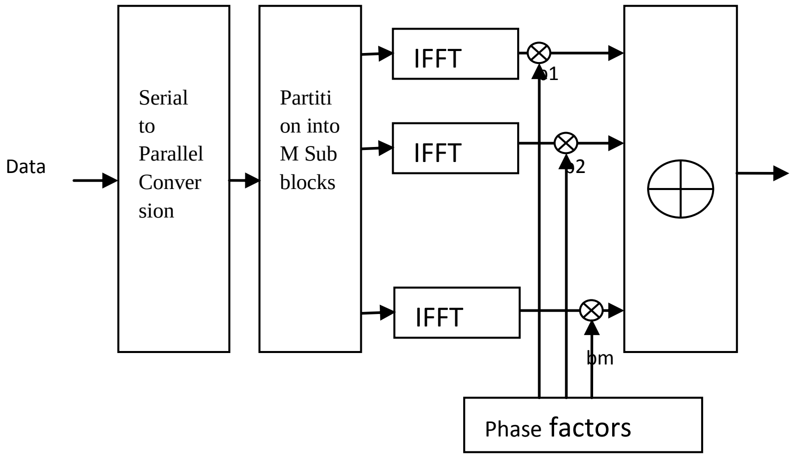


Fig. 2 Block Diagram of PTS Scheme

At long last, at each transmitting radio wire, there are (V-1) sub squares to be streamlined, and the hopeful arrangement with the most reduced PAPR is independently chosen for transmitting.

Accept that there is W permitted stage weighting factors. To accomplish the ideal weighting factors for each transmitting radio wire, mixes ought to be checked so as to acquire the base PAPR [12]. In, substitute streamlining is presented, and it very well may be additionally connected to PTS in numerous reception apparatuses OFDM frameworks, signified as interchange PTS. Not the same as normal PTS, stage weighting factors are required just for half of the sub obstructs in A-PTS. In other words, beginning from the primary sub obstruct, each other sub square is kept unaltered and stage weighting factors are enhanced just for whatever is left of the sub squares, which prompts the decrease of computational unpredictability. Along these lines, the computational multifaceted nature is incredibly diminished to the detriment of PAPR execution corruption [11]. Utilized spatial sub square round change for A-PTS plan to build the quantity of competitor arrangements which enhances the PAPR execution further. Next, the conversion of the optimum weighting coefficient is discussed. In order to maintain the conjugate and symmetric relations between the two antennas after scrambling sequence methods, we should convert the optimum weighting coefficient a(opt) at antenna 1 into that of antenna 2 denoted as b(opt) by the inverse conjugate and symmetric transformation. For example, when the optimum weighting coefficient a (opt) is [1, 1, j, -j], the optimum weighting coefficient for antennas 2 is b (opt) = [1, 1, -j, j]. The PTS scheme can be also applied to the MIMO-OFDM system with more transmits antennas.

Based on advance PTS, an approach to solve the contradiction between the PAPR performance and computational complexity in STBC MIMO-OFDM system is proposed. Let us consider a STBC MIMO-OFDM system that employs Alamouti scheme. The coding matrix is:

$$G = \begin{pmatrix} x_1 & -x_2^* \\ x_2 & x_1^* \end{pmatrix} \tag{5}$$

Simulation experiments are conducted to evaluate the transmit spectrum, bit error rate (BER), peak average to peak ratio (PAPR) reduction performance of the MIMO-OFDM scheme using PTS technique. In addition, it is assumed that the data are QPSK, 16-QAM modulated and are transmitted using 256 FFT.

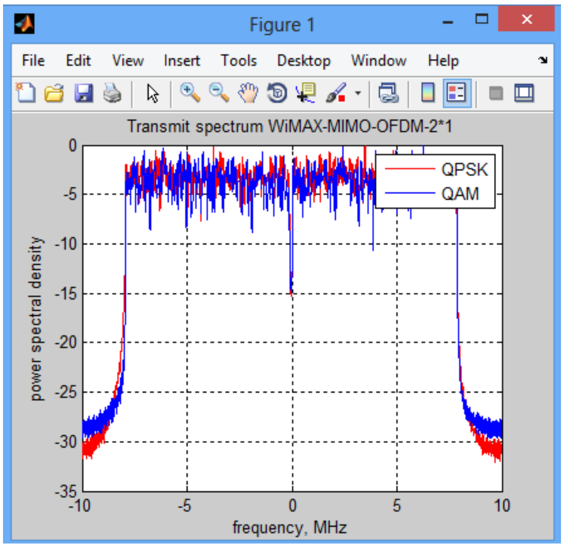


Fig. 3 Power Spectral Density of MIMO -OFDM 2×1 System

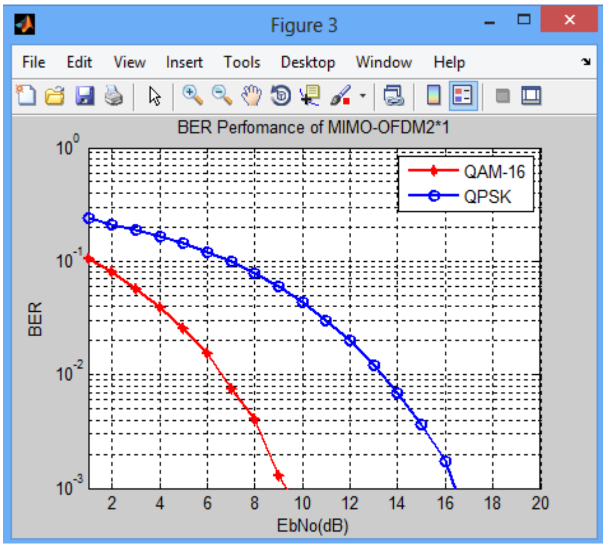
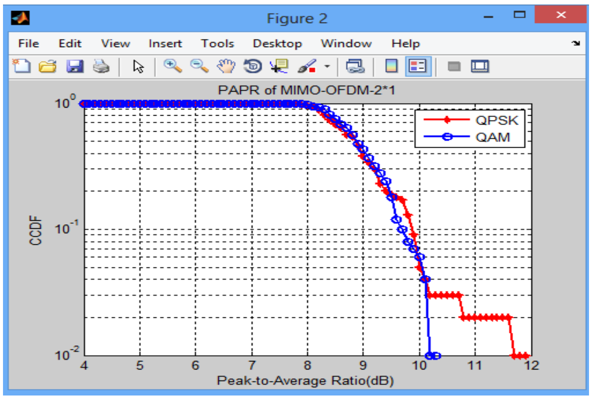


Fig. 4 BER Performance of MIMO-OFDM 2×1 System



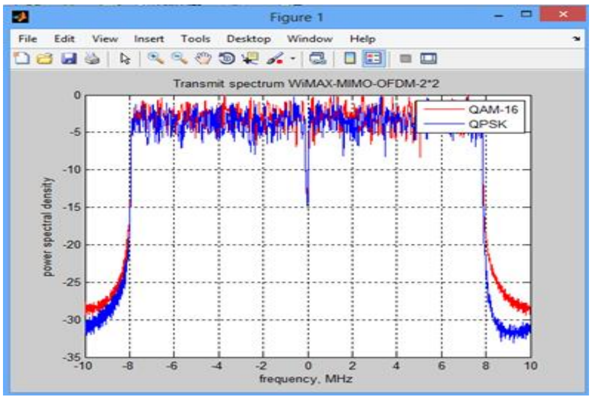
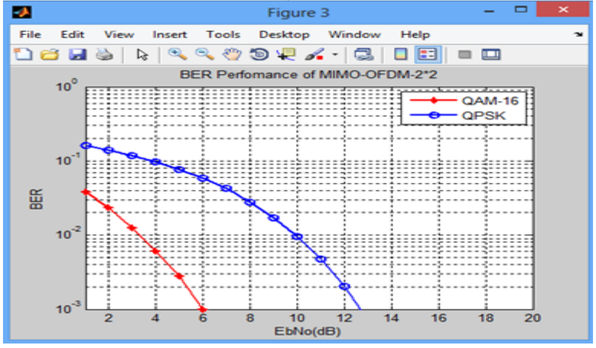


Fig. 5 PAPR Performance of MIMO-OFDM 2×1 System

Fig. 6 Power Spectral Density of MIMO-OFDM 2×2 System



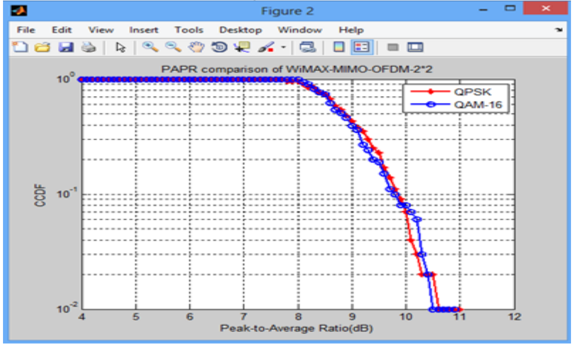


Fig. 7 BER Performance of MIMO-OFDM 2×2 System

Fig. 8: PAPR Performance of MIMO-OFDM 2×2 System

4. PROPOSED METHODOLOGY

We have proposed a wavelet based MIMO-OFDM system for the reduction of PAPR, which effectively reduces the PAPR on rational selection of phase values.

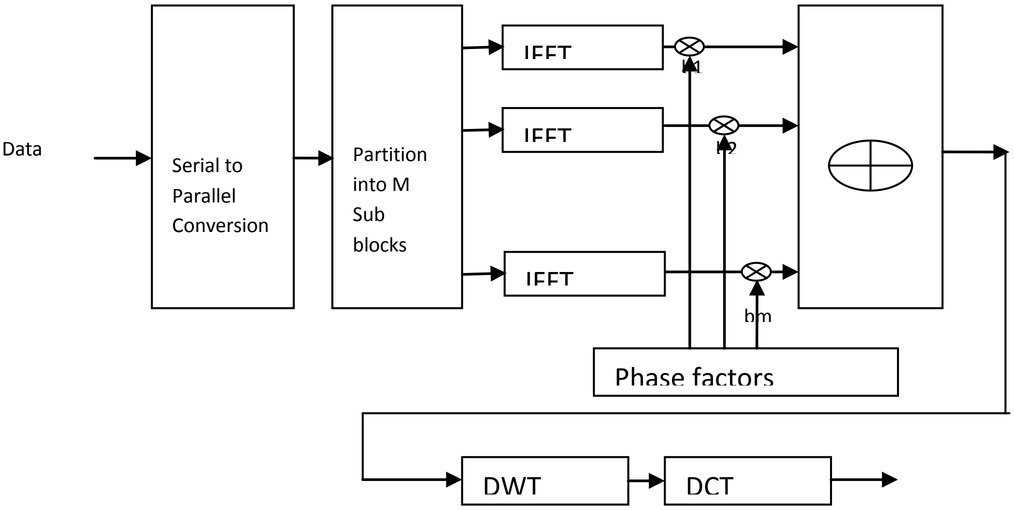


Fig.9 Flow Char of Proposed Methodology

First the original input signal is modulated with BPSK, QPSK, QAM-16 and PTS technique had been applied, where the phase values are generated using optimized algorithm.

This helps to minimize the PAPR of the input signal. Then discrete wavelet transform is applied and has been followed by DCT which is applied transmitted through AWGN channel. At the receiver, the inversion of transmitter will be done.

Figure 9 shows the enhanced transmitter block diagram of the presented work. In this research work conventional OFDM is followed by the WPT and DCT for PAPR reduction and vice versa is also simulated. Both transmitter and receiver are simulated in order to calculate the BER.

5. SIMULATION RESULT

The CCDF is generally used to evaluate the performance of PAPR reduction on MIMO-OFDM system (IEEE 802.16e) signals for a statistical pair of view. The CCDF is defined as the probability that the PAPR as in equation and PAPR$_0$ as shown in the following:

$$PAPR\{Y\} = \arg \underbrace{\max}_{k=1,2,3,......N_T} (PAPR\{Y_k\}) \qquad (6)$$

Where Y_k, $k = 1.2.3.......N_T$ represents the time-domain transmitted signal of the k-th antenna

$$CCDF(PAPR_0) = \Pr(PAPR\{Y\} > \{PAPR_0\})$$

Figure 10 shows the graphical illustration of the performance of MIMO-OFDM 2×2 System using PTS with DWT-DCT technique discussed in this research work in term of bit error rate (BER). From the above graphical representation it can be inferred that the proposed algorithm gives the best performance for QAM-16 modulation technique.

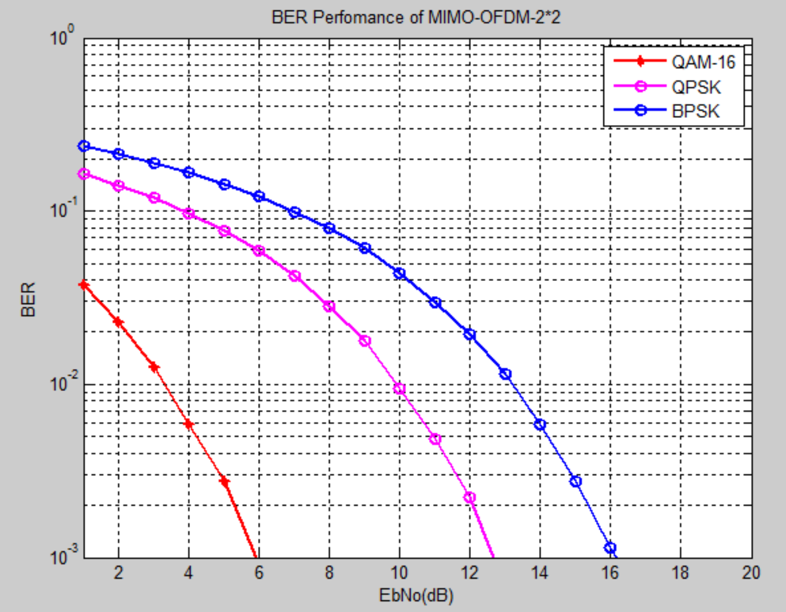


Fig. 10 BER Performance of MIMO-OFDM 2×2 System

Figure 11 shows the graphical illustration of the performance of MIMO-OFDM 2×2 System discussed in this research work in term of peak signal to noise ratio (PAPR). From the above graphical representation it can be inferred that the proposed PTS with DWT and DCT technique based MIMO-OFDM algorithm gives the best performance for QAM-16 modulation technique.

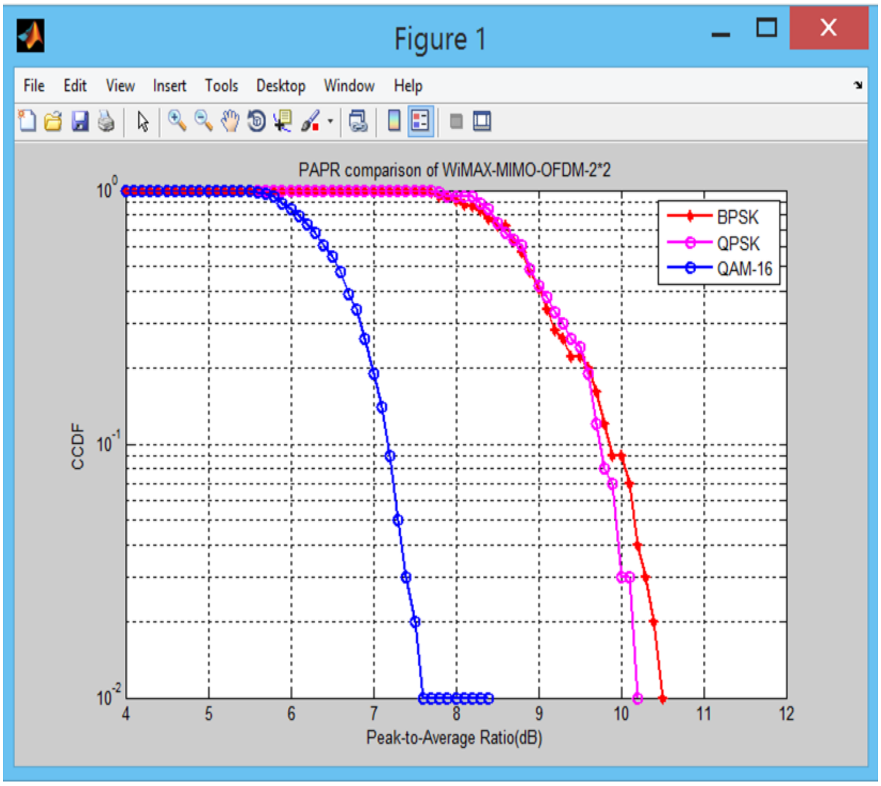


Fig. 11 PAPR Performance of MIMO-OFDM 2×2 System

Table 1. Comparison of PAPR (dB) values for Hybrid, PTS and original PAPR signal for FFT SIZE 256

Original PAPR	**PTS Technique**	**Hybrid PTS with Clipping Technique**	**PTS with DWT-DCT Technique**
10.3 dB	8.7 dB	8.0 dB	7.5 dB

Table 2. Comparison of BER (dB) values for Hybrid, PTS and original signal

BER (dB)			
Energy per bit (EbNo)	**BPSK**	**QPSK**	**QAM-16**
10^{-3}	16.1	12.2	6
10^{-2}	13.2	10	3.5
10^{-1}	7	4	0
10^{-0}	0	0	0

6. CONCLUSION

MIMO-OFDM is a very agreeing method for the new wireless digital communication system. Along with the simplicity of equalization in Orthogonal Frequency Division Multiplexing (OFDM) modulation, it combines the capacity and diversity gain of MIMO systems for better performance. However, like conventional OFDM, MIMO-OFDM has a major challenge called high PAPR. Hence, it requires high dynamic range power amplifier, which makes more cost of system and decreases the efficiency of power. In this paper, a method is proposed for minimization of PAPR in MIMO-OFDM systems using PTS method. The PTS is concatenated with DCT and DWT signal processing algorithm to improve the efficiency and reduction of peak power of the MIMO-OFDM system. Because of autocorrelation of DCT the average power will be reduced. Using DWT, the data is divided into high and low coefficient such that the cyclic prefix can be avoided. By using PTS method, the optimum phase’s factors are selected to reduce the average power. Hence it is achieved that MIMO- OFDM signals with less PAPR.

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