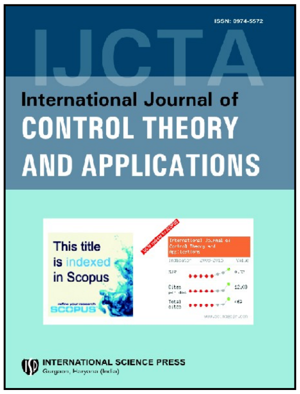

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Reduction of PAPR in MIMO-OFDM System using QCLDPC Codes Combined with PTS

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Abstract: Day by day the demand for higher data rates is increasing in both public sector and private sectors. MIMO-OFDM with STBC is used to achieve high speed, increased system capacity without sacrificing the bandwidth and enhanced diversity gain. But it suffers from higher PAPR and due to this it demands for more expensive power amplifiers. partial transmit sequence(PTS) is one of the main attractive distortion less technique for reducing PAPR .In this paper we analyzed the PAPR,BER performance of MIMO-OFDM with STBC using Quasi Cyclic-Low Density Parity Check(QC-LDPC) codes combined with PTS. Simulation results shown that improved PAPR, BER performances have obtained for QC-LDPC codes combined with PTS as compared to the LDPC codes combined with PTS and only PTS.

Keywords: MIMO,OFDM,PAPR,PTS,LDPC,QC-LDPC.

1. INTRODUCTION

OFDM is very popular in wireless communication due to its robustness against multipath fading ,more resistant to narrowband interference, high speed data transmission, simplification of channel equalization etc. OFDM has been adopted in wireless local area networks (IEEE 802.11a),digital audio broadcasting(DAB), terrestrial television broadcasting (DVB-T),broadband radio access network (BRAN). OFDM[13] system suffers from high peak to average power ratio(PAPR), due to its sub symbols for each subcarrier are added up coherently .In recent years lot of algorithms have been proposed for reducing PAPR of OFDM signals. Partial transmit sequence technique is one of the popular distortion less technique for reducing the PAPR which is based on phase shifting of sub blocks by constant phase factors. Clipping and filtering is a simple technique and it causes out-of –band radiation and in band distortion[3]. Although filtering after clipping can eliminate the out of band radiation ,it may cause considerable increase in peak power. In interleaving method, interleavers are used to reorder the symbols such that PAPR is reduced [5]. In tone reservation method some subcarriers are reserved for reducing PAPR[6]. In tone injection the size of the constellation symbol is increased in order to map the original constellation onto several other points in the expanded constellation. LDPC[8] codes have recently received much attention from the communications industry because of their excellent error correcting capabilities and it also have the highly parallelizable decoding algorithm. LDPC, QCLDPC, turbo codes are used for reducing PAPR. Using these codes the theoretical capacity limits approaches Shannon's limit and performs good in the reduction of PAPR for a MIMO-OFDM system[14].Compared to LDPC codes ,better PAPR reduction is attained in QCLDPC codes with lower encoding complexity [9-10].

The rest of this paper is organized as follows: Section II deals with the brief introduction of MIMO-OFDM with STBC codes and PAPR. In section III block diagram and concepts of PTS are introduced. In section IV the proposed method of QC-LDPC combined with PTS in MIMO-OFDM is introduced. In section V results and conclusions are provided.

2. MIMO-OFDM WITH STBC SYSTEM AND PAPR

MIMO uses more number of antennas at the same time in the transmitter and receiver and one of its key technology is space time block coding that is signals are processed both in time domain and space domain[1]. Alamouti STBC scheme is employed in MIMO-OFDM system in order to achieve the full diversity with N_t transmit antennas and N_r receiver antennas. In Alamouti 2x2 scheme, the successive symbols X_1 and X_2 are encoded with the following space time space time code vector matrix

$$X = \begin{bmatrix} X_1 & -X_2^* \\ X_2 & X_1^* \end{bmatrix} \tag{1}$$

The two symbols X_1 and X_2 are transmitted simultaneously from two transmit antennas in the first instant and two symbols X_2 and X_1 are transmitted in the second instant. In a OFDM system the total bandwidth B is divided into N no.of non overlapping orthogonal subcarriers of bandwidth —f i.e

$$B = N * \Delta f \tag{2}$$

Where $\Delta f = \frac{1}{NT}$, and T represents the spacing between the subcarriers. Then each subcarrier is modulated by a particular constellation.

Let $X = [X_0, X_1, \dots . X_{N-1}]^T$ represents input vector in the frequency domain and X_n denotes the complex data of the nth subcarrier. After applying the IFFT to the input data vector, the obtained time domain OFDM signal is $x = [x_0, x_1, \dots ., x_{n-1}]^T$ where

$$x(t) = \frac{1}{\sqrt{N}} \Sigma_{n=0}^{N-1} X_n e^{j2\pi\Delta ft}, \qquad 0 \le t \le NT \tag{3}$$

In OFDM[7], the instantaneous amplitudes of different subcarriers are having high peaks which are aligned at the same time leads to high PAPR and it is defined as

$$PAPR = \frac{\max_{n=0,1,N-1} |x(t)|^2}{E[|x(t)|^2]} \tag{4}$$

where $E[|x(t)|^2]$ represents the expected value of the $[|x(t)|^2]$ signal.

3. PARTIAL TRANSMIT SEQUENCE

Figure 1 shows the block diagram of OFDM with PTS.

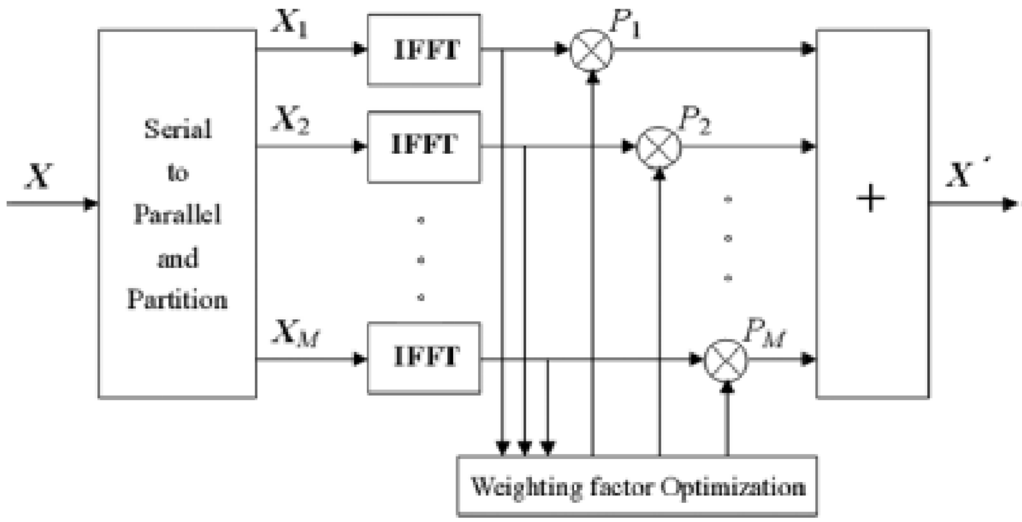

Figure 1: Block diagram of partial transmit sequence for OFDM system

Initially the input data vector is X is partitioned into V no of disjoint subblocks[2].So the input data vector X is denoted as

$$X = \Sigma_{v=0}^{V-1} X^{(v)} \tag{5}$$

Each sub block is oversampled by $(L-1)N$ times to measure the PAPR value and each of these oversampled subblocks after applying IFFT with size LN are transformed into

$$x^{(v)} = \left[x_0^{(v)}, x_1^{(v)}, \dots \dots, x_{LN-1}^{(v)}\right], \ 0 \le v \le V-1 \tag{6}$$

Next each subblock is multiplied by one of the phase factors

$$b_v = e^{j\phi}, \text{where } \emptyset \in \{0, 2\pi\}$$

And finally all subblocks are added. The OFDM signal after applying PTS operation is

$$x(n) = \Sigma_{v=0}^{V=1} b_v\, x^{(v)} \tag{7}$$

Where $b = [b_1, b_2, \dots \ \dots b_{v-1}]$ and it indicates all possible phase factors

$b_0 = 1$ and it is used for the first subblock. For the remaining subblocks

$$\begin{aligned} b_v &= \{\pm 1\} \quad && if\ w = 2 \\ b_v &= \{\pm 1, \pm j\} \quad && if\ w = 4 \end{aligned} \tag{8}$$

Where w' indicates the no.of phase factors.

4. PROPOSED WORK

Figure 2 shows the block diagram of QCLDPC with PTS of STBC-MIMO-OFDM system for reduction of PAPR.

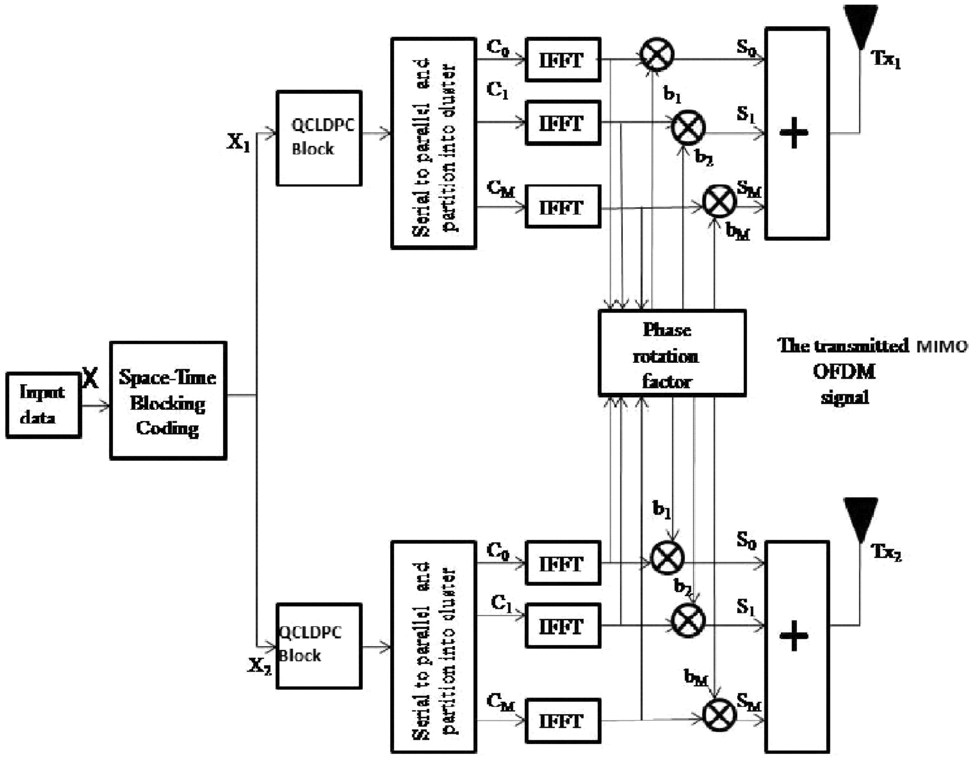

Figure 2: Block diagram of proposed system

In the QCLDPC[11,13] codes, initially construct the H parity check matrix using circulant matrix concept i.e. shift the previous row vector cyclically one position to the right for getting next row vector. Now construct the Generator matrix G which satisfies $GH^T=0$. Next the code vector is generated by multiplying data vector with the generator matrix G. The only difference between the LDPC codes and QCLDPC codes is in the construction of H matrix with circulant shift procedure.

Figure 3 shows the general circulant matrix structure.

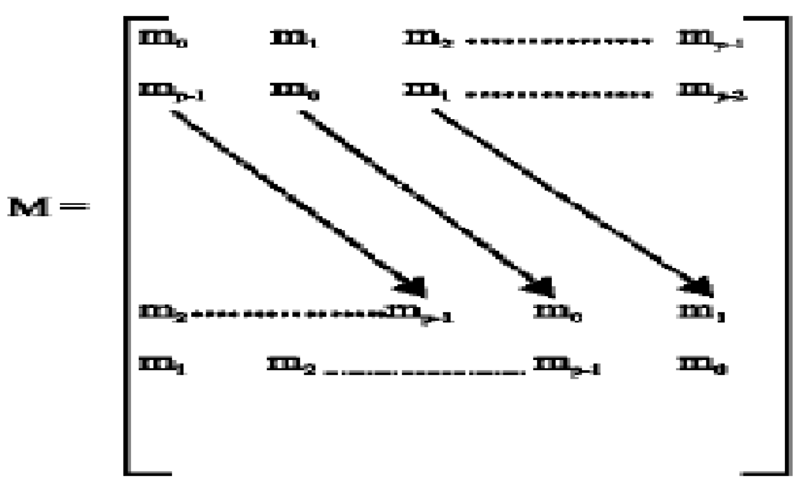

Figure 3: General circulant matrix structure

Algorithm for the proposed work

Step 1: generate the random input bits.

Step 2: Apply the STBC encoding to the input vectors.

Step 3: Serial input data is converted into parallel data.

Step 4 : Construct the H matrix with the fixed code rate.

Step 5: Find the new H matrix by applying circulant matrix procedure and find the corresponding generator matrix which satisfies $GH^T=0$.

Step 6: Generate the code vectors by multiplying data vector with the generator matrix G.

Step 7: Modulate the code vector with BPSK,16-PSK modulation schemes.

Step 8: Partition the code vectors into V no.of sub blocks

Step 9: Convert the subblocks into time domain with IFFT operation.

Step 10: Find the optimum phase vector for each sub block in order to minimize the PAPR by applying PTS technique.

Step 11:Multiply the optimum phase vector with the sub block of code vector.

Step 12: Draw the CCDF plot i.e threshold Vs probability of PAPR.

5. SIMULATION RESULTS

In this section, we have shown the performance of QCLDPC combined with PTS interms of PAPR and BER.

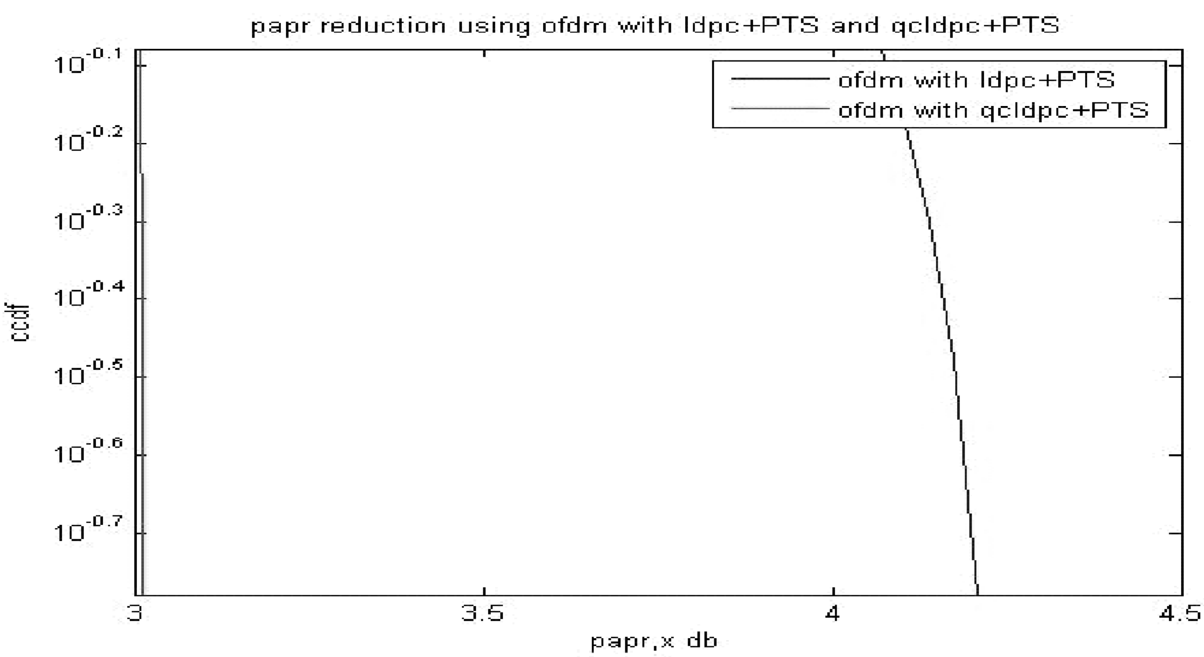

Figure 4: PAPR comparison of QCLDPC with PTS and LDPC with PTS

Figure 4 shows the CCDF curves of MIMO-OFDM system with two PAPR reduction techniques which are QCLDPC codes combined with PTS, LDPC codes combined with PTS. When $Pr(PAPR>PAPR_0) = 10^{-0.7}$ PAPR by LDPC codes with PTS is 4.2 dB and for the QCLDPC codes with PTS is 3.05dB. For PTS adjacent partitioning technique[4] is used for better PAPR reduction. The PAPR performance of QCLDPC codes with PTS is improved compared to the performance of LDPC codes with PTS.

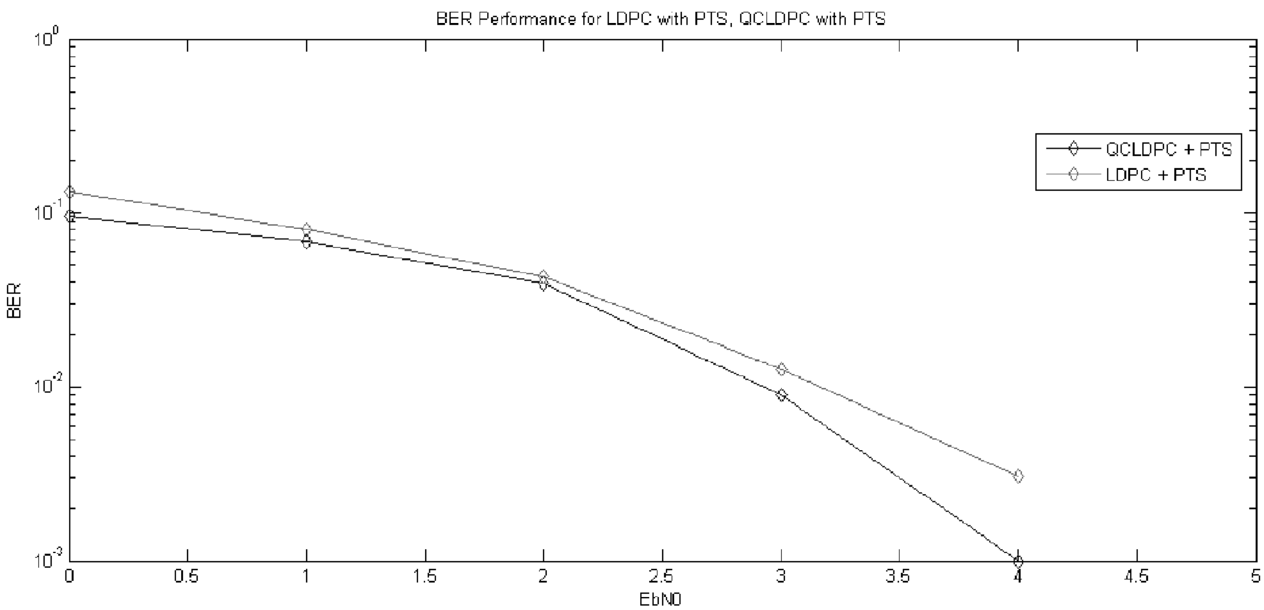

Figure 5: BER comparison of QCLDPC combined with PTS and LDPC combined with PTS

Figure 5 shows the BER curves of MIMO-OFDM system with two PAPR reduction techniques of QCLDPC codes with PTS ,LDPC codes with PTS. The BER performance of QCLDPC with PTS is better than the performance of LDPC with PTS.

Table 1 shows various parameters used in our simulation

Table I
Simulation parameters

Simulation Parameters	*Values*
Number of OFDM blocks	10000
Number of subcarriers	128
Number of subblocks	4
Type of partitioning	Adjacent partitioning
Number of antennas	2
Modulation scheme	BPSK
Phase weighting factor	1,-1,j,-j

Figure 6 shows the CCDF curves of MIMO-OFDM with three PAPR reduction techniques such as PTS, LDPC codes combined with PTS, QCLDPC codes combined with PTS.When $Pr(PAPR>PAPR_0) = 10^{-1}$, PAPR by QCLDPC codes with PTS is 3 dB and for the LDPC codes with PTS is 4.2dB,only PTS is 8.3dB.The PAPR performance of QCLDPC codes with PTS is improved than the other two systems.

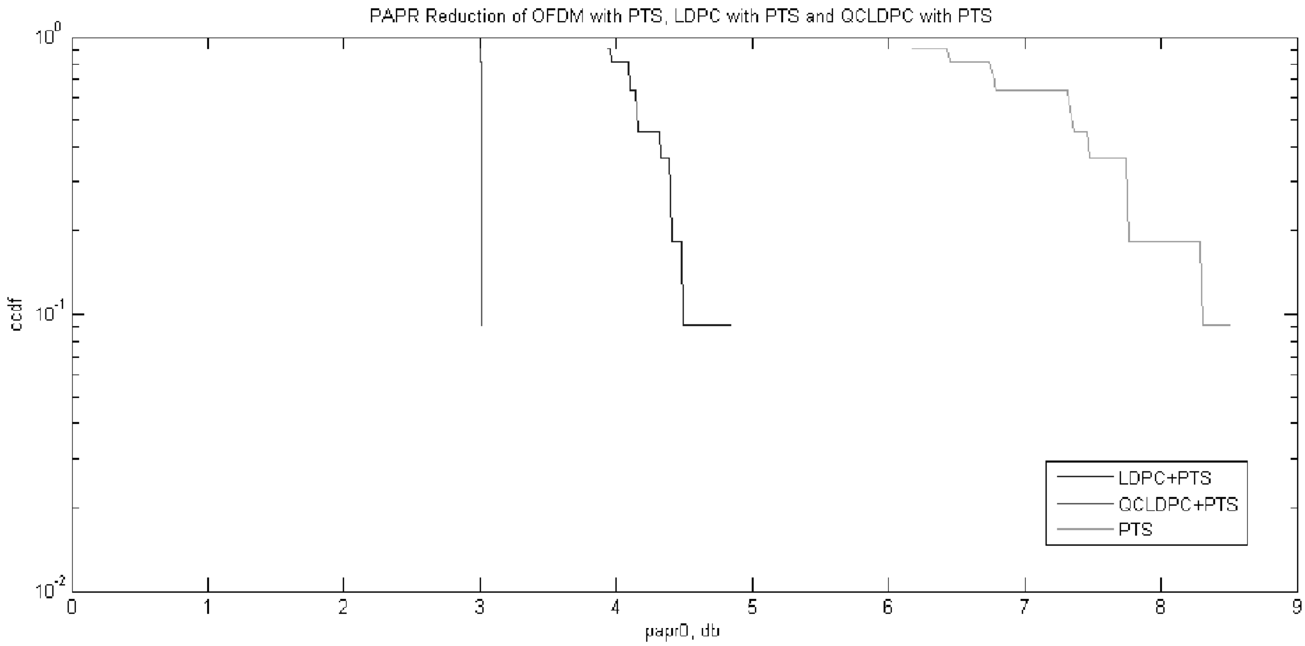

Figure 6: PAPR comparison of QCLDPC with PTS, LDPC combined with PTS, PTS

Figure 7 shows the BER curves of MIMO-OFDM system with three PAPR reduction techniques which are QCLDPC with PTS, LDPC with PTS and PTS. The BER performance of QCLDPC with PTS is better than the performance of LDPC with PTS and PTS

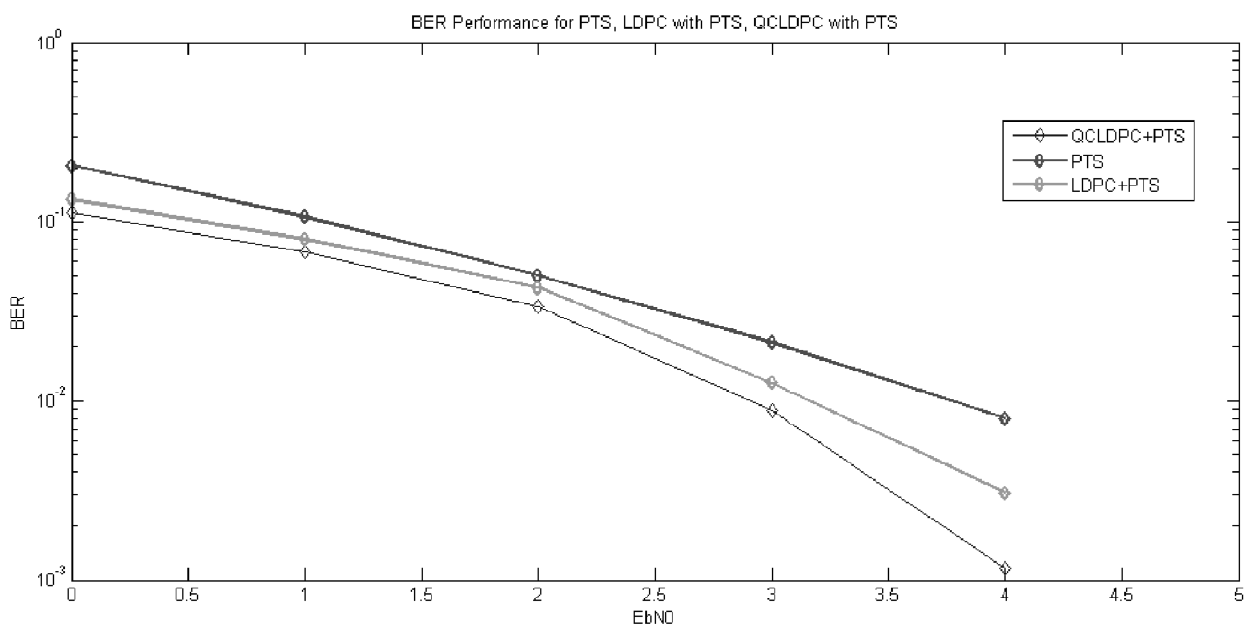

Figure 7: BER comparison of QCLDPC with PTS, LDPC combined with PTS, PTS

6. CONCLUSION

PTS is deemed as an more efficient method to reduce the PAPR in MIMO-OFDM system regardless of the no. of subcarriers. In this paper we have shown that a significant improvement in PAPR reduction is attained by adding Quasi LDPC codes as compared to the PTS combined with LDPC codes and PTS .The simulation results also shows that the proposed method that is QCLDPC codes combined with PTS provides slightly better BER Performance than LDPC codes combined with PTS and at the same time it requires lower memory space for storage of Parity check matrix.

REFERENCES

[1] P. SunilKumarl, M.G.Sumithra, E.Praveen Kumar, "Performance Analysis of PAPR reduction in STBC MIMO-OFDM System" 2013 Fifth International Conference on Advanced Computing (ICoAC).

[2] P. Mukunthan and P. Dananjayan, "PAPR reduction of an OFDM signal using modified PTS combined with interleaving and pulse shaping method", European Journal ofScientific Research, Vol. 74, No. 4, May 2012.

[3] P. Mukunthan and P.Dananjayan, "A Modified PTS Combined with Interleaving and Pulseshaping Method Based on PAPR Reduction for STBC MIMO-OFDM System" Wseas transactions on communications, Issue 3, volume 12, pp. 121-131.

[4] Zeyid T. Ibraheem, Md. MijanurRahman, S. N. Yaakob, Mohammad ShahrazelRazalli, F Salman, Kawakib K. Ahmed "Performance comparison of partitioning pts based papr reduction of ofdm systems under different modulations techniques"Journal of Theoretical and Applied Information Technology 31st August 2014. Vol. 66, No.3,pp no 775-781.

[5] Prabal gupta,B.Arun Kumar,Sandeepkumar jain, "peak to average power ratio reduction in OFDM using higher order partitioned PTS sequence and Bose Chaudari Hocquenghem codes",SPACES-2015,IEEE International conference, 2015,guntur, pp no443-447.

[6] Lingyin Wang, Xinghai Yang and Yutai Wang "PTS with low complexity IFFTs for PAPR Reduction in SISO/MIMO OFDM",ICEIEC 2013,IEEEconference,pp. 181-184.

[7] Duanmu, C., & Chen, H. (2014). "Reduction of the PAPR in OFDM systems by intelligently applying both PTS and SLM algorithms". Wireless personal communications, 74(2), pp no.849-863.

[8] Osamu Muta ,Yoshihiko Akaiwa, "Peak power reduction method based on structure of parity –check matrix for LDPC coded OFDM transmission", 2007, IEEE.

[9] Abid Yahya,Farid Ghani,R.Badlishah,Raj Malook, "An overview of low density parity check codes"journal of applied sciences10(17):pp no.1910-1915, 2010.

[10] Li Li and Daiming Qu, "joint decoding of LDPC code and phase factors for OFDM systems with PTS PAPR reduction"2012, IEEE.

[11] S.P Vimal,K.R Shankar Kumar,PAPR reduction in OFDM system using Quasi cyclic LDPC codes", 2013,.Asian journal os scientific reasearch 6(4): 715-725.

[12] Necmi TASPINAR,Dervis KARABOGA,Mahmut YILDIRIM, "PAPR reduction using artifitial bee colony algorithm in OFDM systems"Turk j Elec Eng & Comp Sci,Vol.19, No. 1, 2011.

[13] Zhang T,Parthi K.K,joint (3,4)-regular LDPC code and Decoder/Encoder Design,"IEEE Transactions on Signal Processing,Vol 52, no 4, pp 1065-1079, 2004.

[14] O. Muta and Y.Akaiwa, Peak power reduction method based on structure of parity –check matrix for LDPC coded OFDM Transmission," in Proc.IEEE Veh.Technol.Conf., Apr, 2007, pp.2841-2845.