JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

PAPR Reduction of Beamforming based Massive System using Hybrid Technique for Mm-wave Communication

Komal Kumari[1], Prof. Suresh. S. Gawande[2]
M. Tech. Scholar, Department of Electronics and Communication, Bhabha Engineering Research Institute, Bhopal[1]
Guide, Department of Electronics and Communication, Bhabha Engineering Research Institute, Bhopal[2]

Abstract: **Nowadays, the communication system with a high data rate, high spectral efficiency and a high quality of service are in demand. These features can be achieved when a transmission system has low inter-symbol interference (ISI), immunity to the multipath delay and frequency selective fading, effective utilization of network resources and available spectrum. The Orthogonal Frequency Division Multiplexing (OFDM) is one of the best modulation techniques to achieve these features as well as an encouraging choice for upcoming high data rate communication systems. Thus, OFDM is widely employed in a wired and wireless communication system. This thesis describes the problem of high Peak-to-Average Power Ratio (PAPR) which is a major disadvantage of OFDM and presents different novel algorithms to reduce it with the improved performance of Bit Error Rate (BER). In this paper hybrid discrete cosine transform (DCT) and companding, 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 technique.**

Index Terms – **DCT, COMPANDING, MIMO-OFDM, PAPR, BER**

I. Introduction

The rapid growth of the wireless communication market is expected to continue in the future, as the demand for all types of wireless services is increasing. New generations of wireless mobile radio systems aim to provide flexible data rates and a wide variety of applications to the mobile users while serving as many users as possible. As more and more devices go wireless, future technologies will face spectral crowding, and coexistence of wireless devices will be a major issue. Therefore, considering the limited bandwidth availability, accommodating the demand for higher capacity and data rates is a challenging task, requiring innovative technologies that can coexist with devices operating at various frequency bands. Recent wireless applications demands for high data rate. However the symbol duration reduces with increase in data rate, system using single carrier modulation suffer from severe inter symbol interference caused by dispersive fading channel there by requires more complex equalization. A very complex receiver structure is needed which makes use of computationally expensive equalization and channel estimation algorithms to correctly estimate the channel, so that the estimations can be used with the received data to recover the originally transmitted data. Orthogonal Frequency Division Multiplexing (OFDM) can drastically simplify the equalization problem by turning the frequency-selective channel into a flat channel. A simple one-tap equalizer is needed to estimate the channel and recover the data [1]. OFDM is a special form of multi carrier transmission technique, it divides the entire frequency selective fading channel into many narrow band flat fading sub channels in which high bit rate data are transmitted in parallel and do not undergo Inter Symbol Interference (ISI) due to the long symbol duration [2]. Therefore OFDM Modulation is considered as key Technology and adopted in Digital Audio Broadcasting (DAB), terrestrial TV in Europe, Wireless local area network (WLAN), Multimedia Mobile Access Communication (MMAC)[3-4], Wimax and LTE.

II. 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].

$$X = \sum_{v=1}^{M} X_v \tag{1}$$

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

$$X' = \sum_{v=1}^{M} b_v X_v \tag{2}$$

Finally, at each transmitting antenna, there are (V-1) sub blocks to be optimized, and the candidate sequence with the lowest PAPR is individually selected for transmitting. Assume that there are W allowed phase weighting factors. To achieve the optimal weighting factors for each transmitting antenna, combinations should be checked in order to obtain the minimum PAPR [12].

In, the idea of alternate optimization is introduced, and it can be also applied to PTS in multiple antennas OFDM systems, denoted as alternate PTS. Different from ordinary PTS, phase weighting factors are needed only for half of the sub blocks in A-PTS. That is to say, starting from the first sub block, every alternate sub block is kept unchanged and phase weighting factors are optimized only for the rest of the sub blocks, which leads to the reduction of computational complexity. In this way, the computational complexity is greatly reduced at the expense of PAPR performance degradation [11]. Employed spatial sub block circular permutation for A-PTS scheme to increase the number of candidate sequences which improves the PAPR performance 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:

$$G = \begin{pmatrix} x_1 & -x_2^* \\ x_2 & x_1^* \end{pmatrix} \tag{3}$$

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.

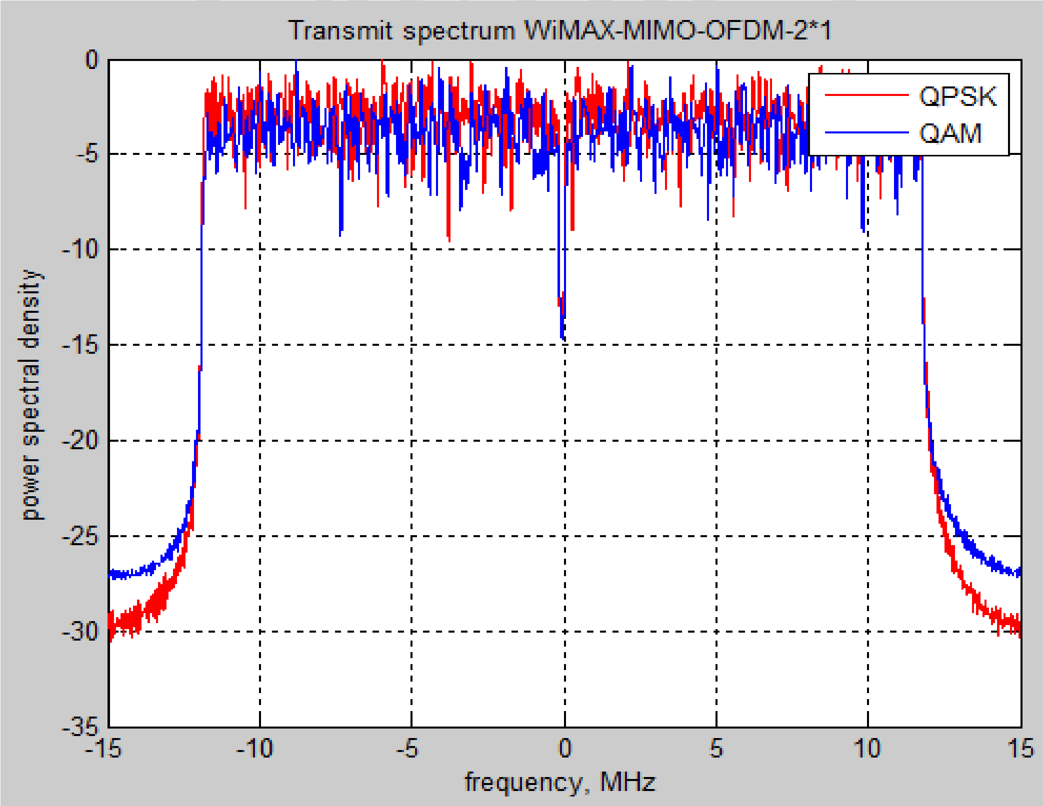

Figure 1: Power Spectral Density of MIMO-OFDM 4×4 System

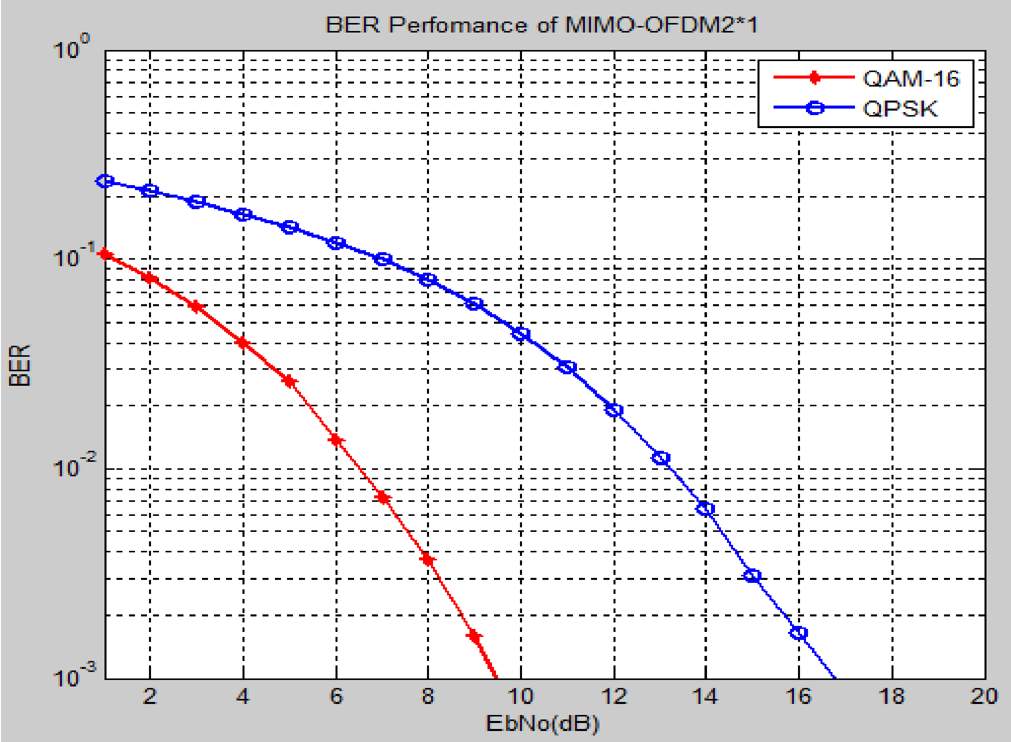

Figure 2: BER Performance of MIMO-OFDM 2×1 System

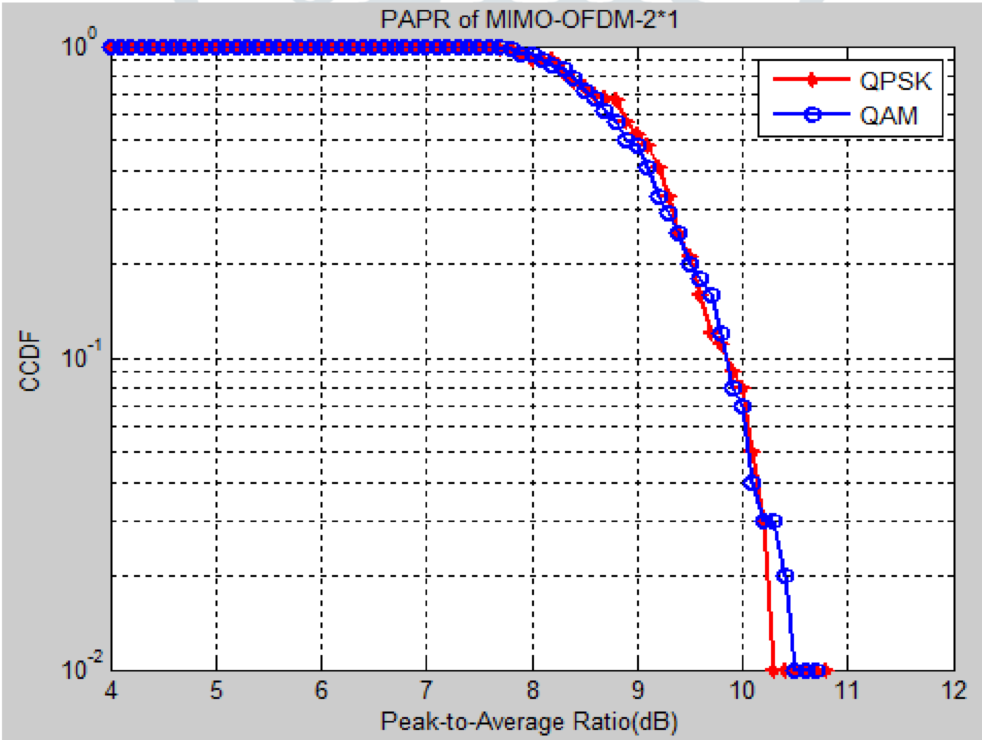

Figure 3: PAPR Performance of MIMO-OFDM 2×2 System

III. 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.

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 6 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.

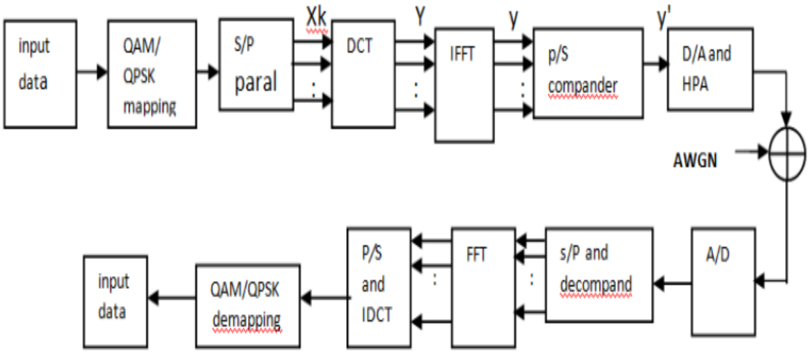

Figure 4: Flow Char of Proposed Methodology

Beamforming:-

Beamforming is a type of radio frequency (RF) management in which a wireless signal is directed toward a specific receiving device. Beamforming is applied to numerous technologies, including wireless communications, acoustics, radar and sonar. The RF management technique directs radio and sound waves for signal transmission or reception. Rather than sending a signal from a broadcast antenna to be spread in all directions -- how a signal would traditionally be sent -- beamforming uses multiple antennas to send out and direct the same signal toward a single receiving device, such as a laptop, smartphone or tablet. The connection results in a faster, more reliable wireless data transfer. The concept originates from 1905, but more recently, the technology has been applied to Wi-Fi and fifth-generation (5G) networks. As an example, the 802.11 standard gives a specification for routers to implement Wi-Fi beamforming.

The radiating elements -- or parts of the antenna designed to support RF currents -- in multiple antennas need to transmit a signal at identical wavelengths and phases.

Other beamforming techniques include the following:

Analog beamforming uses phase-shifters to send the same signal from multiple antennas. The signal is set to different phases, which creates an antenna pattern that points a specific direction. The signal phases of antenna signals are adjusted in an RF domain, which improves coverage.

Digital beamforming has different signals for each antenna in a digital baseband. Digital receivers are placed at the radiating elements of each antenna. Different phases are applied to different frequency bands, enabling digital beamforming to be more flexible. A digital beamforming processor can then steer numerous independent beams in any direction. This method is useful for spatial multiplexing.

Hybrid beamforming is a combination of analog and digital beamforming. The hybrid approach uses analog beamforming along with digital precoding, which is used to support multistream transmission, to form the patterns transmitted from an antenna array. The process defines the number of analog beams while allowing for some frequency variations. 5G base stations can use hybrid beamforming.

Massive MIMO, or multiple input and multiple output, is an antenna technology for wireless networks where multiple antennas are used at both the transmitter and the receiver ends. Massive MIMO uses a common frequency that is then steered in multiple directions. It requires digital signal processors and an area with a lot of signal interference. The different signal arrival times form multiple time-division duplexing channels, providing path redundancy. Massive MIMO is used in wireless, Wi-Fi and 5G technology.

Beam steering changes the phase of input signals on each radiating antenna element. This method essentially tracks the receiving device, steering a signal to it. A common frequency is steered with a signal beam in the correct direction. Meanwhile, different signals can be sent to other devices.

IV. **SIMULATION RESULTS**

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:

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

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

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

Fig. 5 represents the PAPR of 8×8 Massive system using channel estimation and ANN with the help of QAM-16, QAM-32 and QAM-64. QAM -64 provide best PAPR compared to QAM-16.

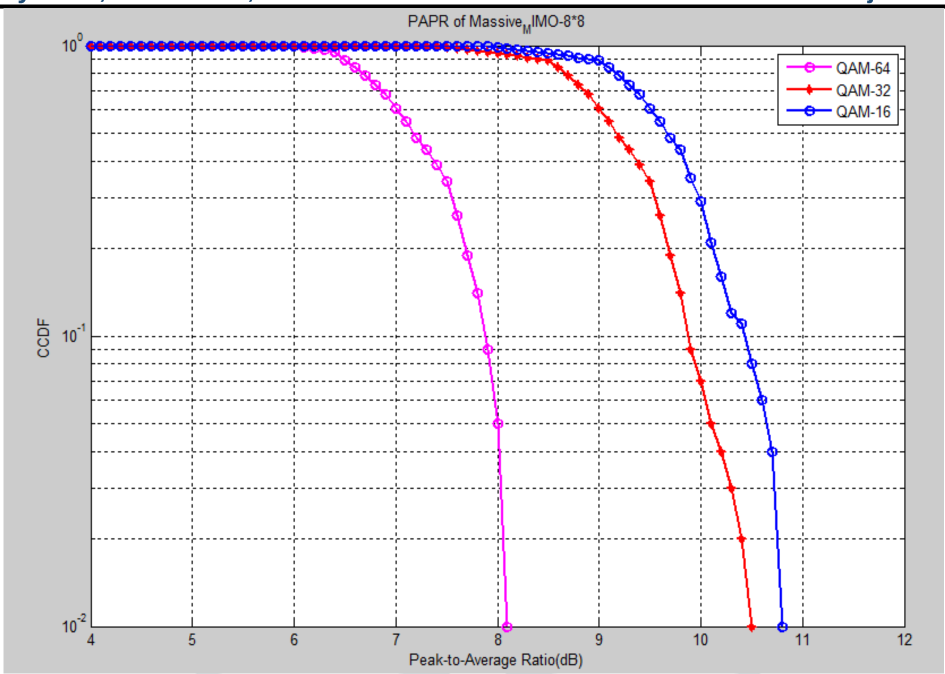

Figure 5: PAPR of Massive 8×8 System using Hybrid Technique

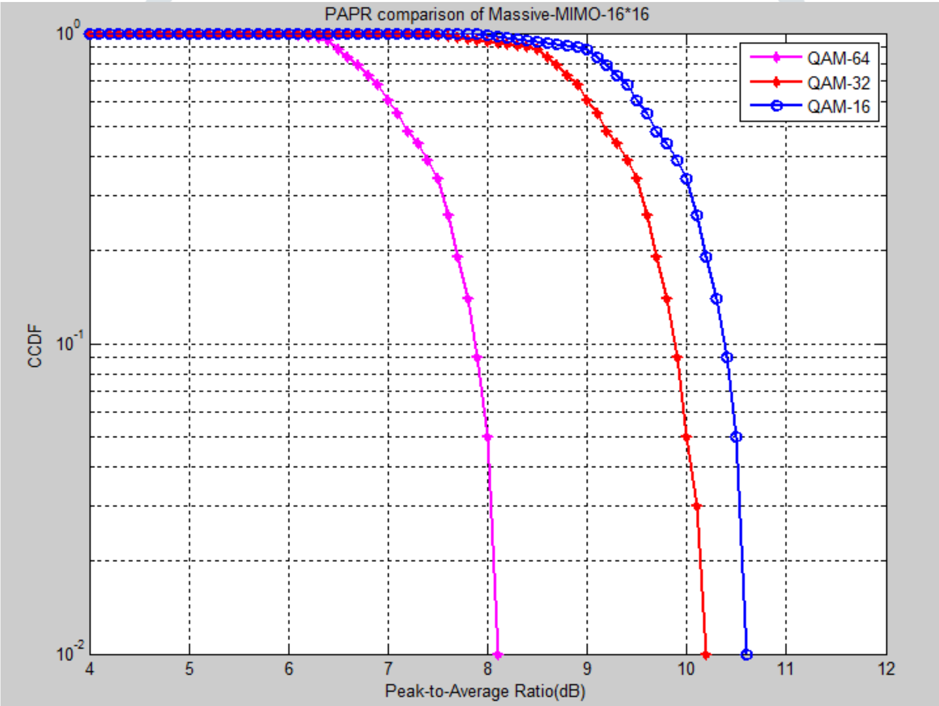

Figure 6: PAPR of Massive 16×16 System using Hybrid Technique

V. 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.

REFERENCES

[1] Ebubekir Memisoglu, Ahmet Enes Duranay and Hüseyin Arslan, “Numerology Scheduling for PAPR Reduction in Mixed Numerologies”, IEEE Wireless Communications Letters, Vol. 10, No. 6, June 2021.

[2] Zhitong Xing, Kaiming Liu, Aditya S. Rajasekaran, Halim Yanikomeroglu and Yuanan Liu, “A Hybrid Companding and Clipping Scheme for PAPR Reduction in OFDM Systems”, IEEE Access 2021.

[3] H. Chen, J. Hua, J. Wen, K. Zhou, J. Li, D. Wang, and X. You, ‘‘Uplink interference analysis of F-OFDM systems under non-ideal synchronization,’’ IEEE Trans. Veh. Technol., vol. 69, no. 12, pp. 15500–15517, Dec. 2020.

[4] S. Rajasekaran, M. Vameghestahbanati, M. Farsi, H. Yanikomeroglu, and H. Saeedi, ‘‘Resource allocation-based PAPR analysis in uplink SCMA-OFDM systems,’’ IEEE Access, vol. 7, pp. 162803–162817, 2019.

[5] Z. Zhou, L. Wang, and C. Hu, ‘‘Low-complexity PTS scheme for improving PAPR performance of OFDM systems,’’ IEEE Access, vol. 7, pp. 131986–131994, 2019.

[6] W. Hu, ‘‘SLM-based ACO-OFDM VLC system with low-complexity minimum amplitude difference decoder,’’ Electron. Lett, vol. 54, no. 3, pp. 141–146, 2018.

[7] Y. Hori and H. Ochiai, ‘‘A new uplink multiple access based on OFDM with low PAPR, low latency, and high reliability,’’ IEEE Trans. Commun., vol. 66, no. 5, pp. 1996–2008, May 2018.

[8] Ashna Kakkar, Sai Nitesh Garsha,Ojasvi Jain and Kritika, "Improvisation in BER and PAPR by using hybrid reduction techniques in MIMO-OFDM employing channel estimation techniques", 7th International Advance Computing Conference, IEEE 2017.

[9] Ho-Lung Hung, Yung-Fa Huang, Ching-Chuan and Rung-Ching Chen, "Performance of PTS-Based Firefly Algorithm Scheme for PAPR Reduction in SFBC MIMO-OFDM Communication Systems", International Symposium on Computer, Consumer and Control, IEEE 2016.

[10] P. Kothai and R. Prabhu M.E., "PAPR Reduction in MIMO OFDM Using Adaptive SLM Scheme", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol. 03, No. 05, pp. 729-735, May 2015.

[11] Muhammet Nuri Seyman, Necmi Taspmar, "Channel estimation based on neural network in space time block coded MIMO-OFDM system", Digital Signal Processing, Vol. 23, No.1, pp. 275-280, Jan. 2013.

[12] P. Mukunthan and, P Dananjayan," PAPR Reduction based on a Modified PTS with Interleaving and Pulse Shaping method for STBC MIMO-OFDM System", IEEE ICCCNT'12 , 26th _28th July 2012, Coimbatore, India.

[13] L. Yang, K. K. Soo, S. li, and Y. M. SU, "PAPR Reduction Using Low Complexity PTS to Construct of OFDM Signals Without Side Information", IEEE Transactions on Broadcasting, Vol. 57, No. 2, pp. 4532-4539, June 2011.

[14] Anushree Neogi and Abhijit Mitra "MAP Estimation of CFO and STO for a Convolutionally Coded OFDM System" National Conference on Communications (NCC), pp. 01-05, IEEE 2011.

[15] Chin-Liang Wang and Shun-Sheng Wang and Hsiao-Ling Chang, "A Low-Complexity SLM Based PAPR Reduction Scheme for SFBC MIMO-OFDM Systems", 978-1-61284-254-7/11 IEEE 2011.

[16] Li, M., Wang, X. and Guo, L.W. "The Research on the Performance of Iterative KALMAN Channel Estimation in MIMO-OFDM System", Journal of Hebei University of Science and Technology, Vol. 31, No.6, pp. 550-552, Dec. 2010.