iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 Issue: X Month of publication: October 2018

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue X, Oct 2018- Available at www.ijraset.com

A Hybrid PAPR Reduction Scheme for MIMO OFDM System

Nitin M. Chore[1], Dr. Nitiket N. Mhala[2]
[1]BDEC, Sevagram, [2]Principal, Government Polytechnique, Thane

Abstract: Combination of the multiple input multiple outputs (MIMO) and orthogonal frequency division multiplexing (OFDM) is considered a promising solution to augment the channel capacity and multiplicity of wireless communication system without any enhancement in bandwidth. In this paper, Hybrid PTS-Clipping scheme is projected to reduce peak-to-average power ratio in MIMO–OFDM system under Rayleigh fading environment on an additive white Gaussian Noise channel. The results show that the proposed method not only reduces the PAPR but also maintains satisfactory bit error rate.
Keywords: MIMO, OFDM, PAPR, PTS, BER

I. INTRODUCTION

MIMO OFDM is extensively used as a promising technique for next-generation broadband wireless applications due to its robustness against multipath fading and the potential of providing high throughput [1]. As encountered for multicarrier systems, a major challenge of MIMO-OFDM transmission systems is the problem of high peak-to-average power ratio (PAPR), which leads to server distortion at the output of power amplifier. To overcome this problem, a variety of PAPR reduction methods for OFDM systems have been presented in the literature, including companding [2], clipping [3], selected mapping (SLM) [4], and partial transmit sequences (PTS) [5] etc. Among these schemes, PTS is attractive due to effective reduction of PAPR without distorting OFDM signals. However, PTS requires transmitting side information for signal recovery at the receiver. Clipping is the simplest method of PAPR reduction but it distorts the signal that causes the in band distortion and out band distortion.

In order to reduce PAPR, several PTS-based schemes have been extended to the context of MIMO-OFDM systems. In this paper hybrid method of PTS and Clipping is used for better PAPR reduction and maintain bit error rate.

II. PAPR IN MIMO OFDM SYSTEM

An OFDM data block with N subcarriers, Xk=(X0,X1,...XN-1), is formed with each symbol modulating the corresponding subcarrier from a set of subcarriers. In an MIMO-OFDM system, the N subcarriers are chosen to be orthogonal, over the period $0 \le t \le T$ where, T is the original data symbol period, and f0=1/T is the frequency spacing between adjacent subcarriers.

The complex baseband OFDM signal for N subcarriers can be written as

$$x(t)=\frac{1}{\sqrt{N}}\sum_{k=0}^{N-1} X_k\, e^{j2\pi k f_0 t}\ ,\ 0 \le t \le T \quad (1)$$

Replacing t=nTb, where Tb =T/N, gives the discrete time version denoted by

$$x(t)=\frac{1}{\sqrt{N}}\sum_{k=0}^{N-1} Xk\, e^{j2\pi kn/LN}\ ,\ n=0,1,......NL-1 \quad (2)$$

where, L is the oversampling factor. The symbol-spaced sampling occasionally misses some of the signal peaks and results in optimistic results for the PAPR. The sampling can be implemented by an inverse fast Fourier transform (IFFT).

The PAPR of the transmitted OFDM signal, x(t), is defined as the ratio between the maximum instantaneous power and the average power, defined by

$$PAPR=\frac{\max_{0\le t\le T} |x(t)|^2}{E[|x(t)|^2]} \quad (3)$$

where E [•] is the expectation operator.

The PAPR of the continuous-time OFDM signal cannot be correctly computed in the Nyquist sampling rate, which relates to N samples per OFDM symbol. In this case, signal peaks may be skipped and PAPR estimates are not correct. So, oversampling is necessary. To evaluate the PAPR reduction performance precisely from the statistical point of view, the complementary cumulative distribution function (CCDF) of the PAPR of OFDM signals is used. CCDF describes the probability of exceeding a given threshold PAPR0 and is represented [24] as

$$CCDF(PAPR(x(n)))=Pr(PAPR(x(n))>PAPR0) \quad (4)$$

Due to the independence of the N samples, the CCDF of the PAPR of single input single output (SISO) OFDM as a data block with Nyquist rate sampling is given by

$$P= Pr(PAPR(x(n))>PAPR0)=1- (1- e^{-PAPR\circ})^{N} \quad (5)$$

According to the central limit theorem, the time domain signal samples are mutually independent and uncorrelated and it is not precise for a small number of subcarriers. The independent assumption in (5) is not true for the oversampling case [6]-[8]. An empirical expression for the CCDF of PAPR can be obtained by approximating the distribution for N subcarriers and oversampling by the distribution for LN, (L > 1) uncorrelated subcarriers without oversampling. Therefore, the CCDF of PAPR computed of the L-time oversampled OFDM signal can be rewritten as

$$P= Pr(PAPR(x(n))>PAPR0)=1- (1- e^{-PAPR\circ})^{LN} \quad (6)$$

For a MIMO-OFDM system, analysis of the PAPR performance is the similar as the SISO case on each single antenna. For the entire system, the PAPR is defined as the maximum of PAPRs among all transmit antennas [9], i.e.,

$$PAPR_{MIMO-OFDM} = \max_{1\leq i\leq Mt} PAPRi \quad (7)$$

where, PAPRi denotes the PAPR at the ith transmit antenna. Specifically, since in MIMO-OFDM, Mt LN time domain samples are compared to LN in SISO-OFDM, the CCDF of the PAPR in MIMO-OFDM can be written as

$$Pr(PAPR_{MIMO-OFDM}>PAPR0)=1- (1- e^{-PAPR\circ})^{Mt\,LN} \quad (8)$$

Comparing (8) with (6), it is evident that MIMO-OFDM results in even worse PAPR performance than SISO-OFDM.

III. PREVIOUS METHOD

A. PTS Technique

PTS technique is extensively used to diminish the PAPR reduction in MIMO-OFDM signals. In this method firstly splits the frequency vector into a tiny number of blocks [10]. This frequency separation is done before applying the phase transformations in MIMO-OFDM signals [11], [12]. Figure 2 represents the functional diagram of the PTS technique. In PTS technique, block partition is used to separate the input frequencies into a number of blocks. Each block is processed with the help of IFFT. Finally, the appropriate phase vector is chosen from the group of phase vectors. The optimization of b block represents the responsibilities of choosing the optimal phase vectors [13], [14]. The input frequency vector length N can be separated into V disjoint sub-blocks as follows:

$$X = [X1X2.....Xv] \quad (1)$$

where, Xi = represents the sub-blocks (i = 1,2,…,V). Scrambling technique is used in PTS method to a set of sub-carrier. These sub-carriers form into a sub-block and multiplied by a phase factor as follows

b v = e j v for v = 1, 2,…, V (2)

Each sub-block is taken into account to calculate the Inverse fast Fourier transform (IFFT). Finally, time domain signal is computed as follows:

$$x = IFFT\{\sum_{v=1}^{V} b^{v}X^{v}\}$$

$$x = \sum_{v=1}^{V} b^{v}IFFT(X^{v})$$

$$x = \sum_{v=1}^{V} b^{v}X^{v}$$

Xv represents the partial transmit sequence. Minimum PAPR for the corresponding phase vector is defined by,

$$\bar{b}^1, \bar{b}^2, \ldots, \bar{b}^V = \underset{[b^1, \ b^2, \ \ldots, \ b^V]}{\arg\min} \left(\max_{n=0, \ 1,\ldots, \ N-1} \left| \sum_{v=1}^{V} b^v X^v \ (n) \right| \right)$$

The Eq. (6) identifies the set of phases based on the computation of minimum PAPR. The time domain signal for each phase with minimum PAPR is defined by,

$$\tilde{x} = \sum_{v=1}^{V} b^{v}X^{v}$$

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue X, Oct 2018- Available at www.ijraset.com

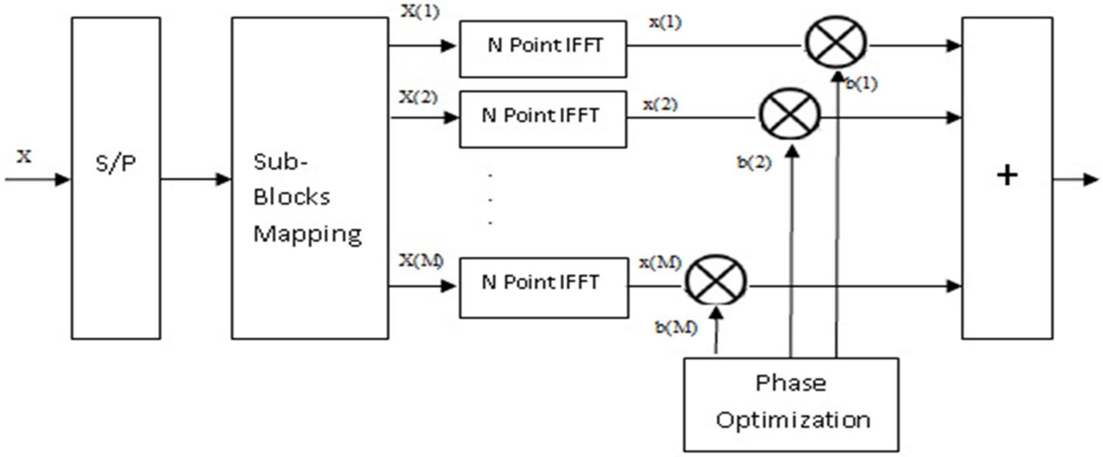


Fig. 1 PTS schemes

B. Clipping Technique

This is simple technique used for PAPR reduction of OFDM signal. A Clip is also called as non linear saturation which is employed about the peaks to reduce the peaks before high power amplifier to lessen PAPR and so is called Clipping Technique. This is simple technique but it commences Out Of Band Radiation and In Band Distortion in OFDM Signal. Joint filtering and clipping technique reduce the OOB radiation but IB distortion are still there since this method degrades OFDM system performance e.g. spectral efficiency and BER. Envelop scaling is used for PAPR reduction due to equality envelop properties of all subcarriers input [15]. Clipping means the amplitude of the signal is clipped at the predefined values which limit the peak value of the input signal to a predetermined value. Let Y[n] denote the input signal and Yc [n] denote the clipped signal of Y[n], which can be represented as, where B is the threshold or predetermines value of clipping level.

$$Yc[n] = \left\{ \begin{array}{ll} -B & [n] \le -B \\ [n] & |[n]| < B \\ B & [n] \ge B \end{array} \right\}$$

Clipping is simple but yet it has some drawback. Clipping cause signal distortion which enhance bit-error-rate performance. After filtering operation performed on the clipped signal, the clipping level may exceed the signal specified for the clipping operation.

IV. PROPOSED METHOD

In this scheme, the PTS and the Clipping scheme are collectively used. Fig.2 shows a block diagram of PAPR reduction scheme using the proposed PTS-Clipping algorithm. The main idea of PTS-Clipping is to use the merit of PTS method and then use simply nonlinear clipping method to cut the high power value of these minority symbols, considering the out-of-band power leakage, we add filtering after clipping, so we can improve the BER performance of the system.

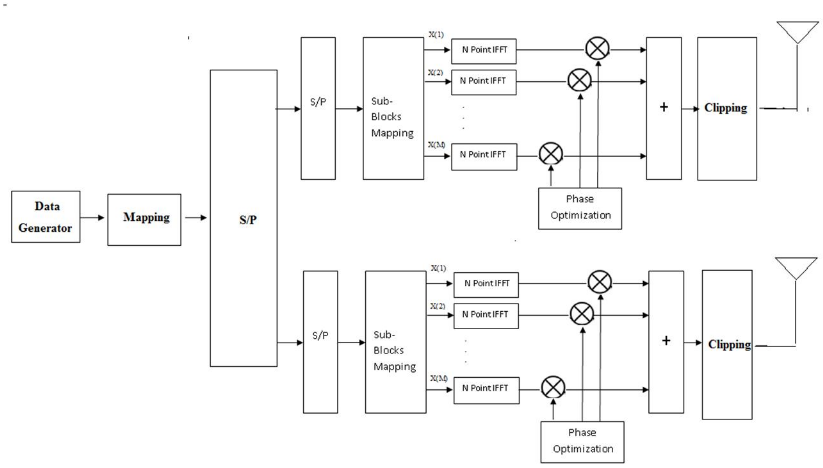


Fig. 2 PTS-Clipping schemes transmitter

The random data stream is generated first, and then employs BPSK modulation. Then it is divided into two signals X1 & X2 for each antenna. Each signal before transform the sequence from serial to parallel we add the pilot, which will help us to accurately recover the data at the receive part. First PTS and then clipping method to process the modulated sequence, and then add cyclic prefix to removal the interference between each OFDM sub-carriers. The signal is transmitted into the wireless channel. The exactly reversed process is carried out at the receiver end.

V. SIMULATION RESULT

The analysis of PTS-Clipping scheme has been carried out using MATLAB 10.a version. The 2 X 2 MIMO-OFDM system under consideration, PTS-Clipping scheme based on 64 subcarrier and 4 sub blocks applied to encoded information modulated by BPSK modulation scheme was simulated. The oversampling factor is 4.

Figure3 illustrates the PAPR performances that use Original, PTS and PTS-clipping**.** Let's compare the PTS-Clipping curves between figure 3, PAPR at CCDF 10^{-2} is 8.7 dB, 8 dB and 6 dB for Original, PTS and PTS-clipping scheme respectively. It shows that 31% improvement as compared to original scheme and 25% improvement as compared to PTS scheme.

Let's compare the PTS-Clipping curves between figure4, we see that the superior BER for PTS-clipping as compared to Original, PTS. Although PTS technique has reduced the probability that high PAPR values occur. The proposed system PTS clipping technique which can fatherly process MIMO-OFDM symbols to reduce the PAPR.

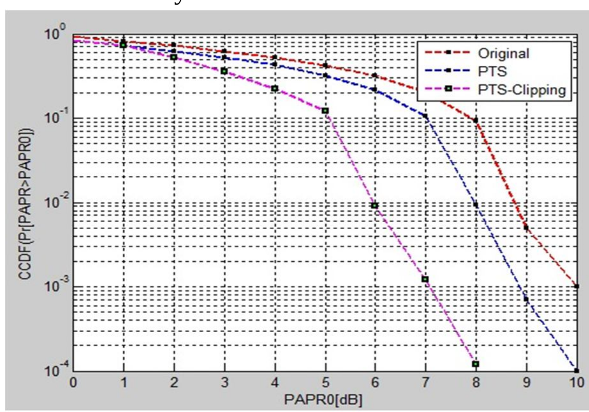


Fig. 3 CCDF Vs PAPR Curve

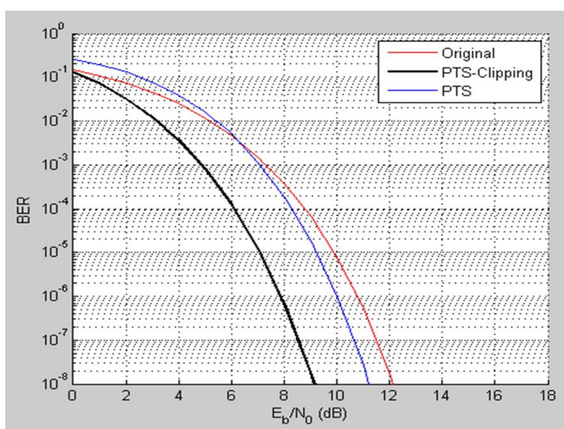


Fig. 4 BER Vs SNR Curve

VI. CONCLUSION

Here in this paper the PTS and clipping techniques have been implemented on MIMO-OFDM system. Comparisons are performed in terms of the PAPR reduction and BER performances to express the advantages of the proposed schemes. The proposed system PTS clipping technique which can fatherly process MIMO-OFDM symbols to improve the BER. PAPR at CCDF 10^{-2} is 8.7 dB, 8 dB and 6 dB for Original, PTS and PTS-clipping scheme respectively. It shows that 31% improvement as compared to original scheme and 25% improvement as compared to PTS scheme.

REFERENCE

[1] Soo, Y., Kim, J., Yang, W. Y. and Kang,C.G “MIMO–OFDM Wireless Communications with Matlab”, 2010.

[2] Tao Jiang, Guangxi Zhu, "Nonlinear Companding Transform for Reducing PAPR of OFDM Signals", IEEE Transactions on Broadcasting, vol. 50, no. 3, Sept. 2004.

[3] M. Iwasaki and K. Higuchi, “Clipping and filtering-based PAPR reduction method for precoded OFDM-MIMO signals,” in Proc. IEEE VTC2010-Spring, Taipei, Taiwan, May 2010.

[4] Y.L. Lee, Y.H. You, and W.G. Jeon, (2003) “Peak-to-Average Power Ratio in MIMO-OFDM Systems Using Selective Mapping”, IEEE Communications Letters, Vol.7, No.12, pp.575-577.

[5] S. H. Han, and J. H. Lee, “PAPR Reduction of OFDM Signals Using a Reduced Complexity PTS Technique”, IEEE Signal Processing Letters, Vol.11, November 2004.

[6] A.D.S. Jayalath, C. Tellambura and H. Wu, “Reduced complexity PTS and new phase sequences for SLM to reduce PAP of an OFDM signal,” In Proceedings of IEEE 51st Vehicular Technology Conference, Tokyo, Japan, 2000, pp. 1914-1917

[7] J.H. Wen, S.H. Lee, Y.F. huang and H.L. Hung, “A suboptimal PTS algorithm based on particle swarm optimization technique for PAPR reduction in OFDM systems,” EURASIP Journal on Wireless Communications and Networking, vol. 2008, Article ID 601346, pages1-8, doi:10.1155/2008/601346.

[8] M.Sharif, M.Gharavi-Alkhansari, and B.H. Khalaj, “On the peak-to-average power of OFDM signals based on oversampling”, IEEE Transactions on Communications, vol.51, no.1, pp.72-78, January 2003.

[9] Harish Reddy and Tolga M.Duman, “Space-time coded OFDM with low PAPR‖, Proceedings of Global Telecommunications Conference”, San Francisco, USA, 1-5 December 2003, vol. 2, pp. 799-803.

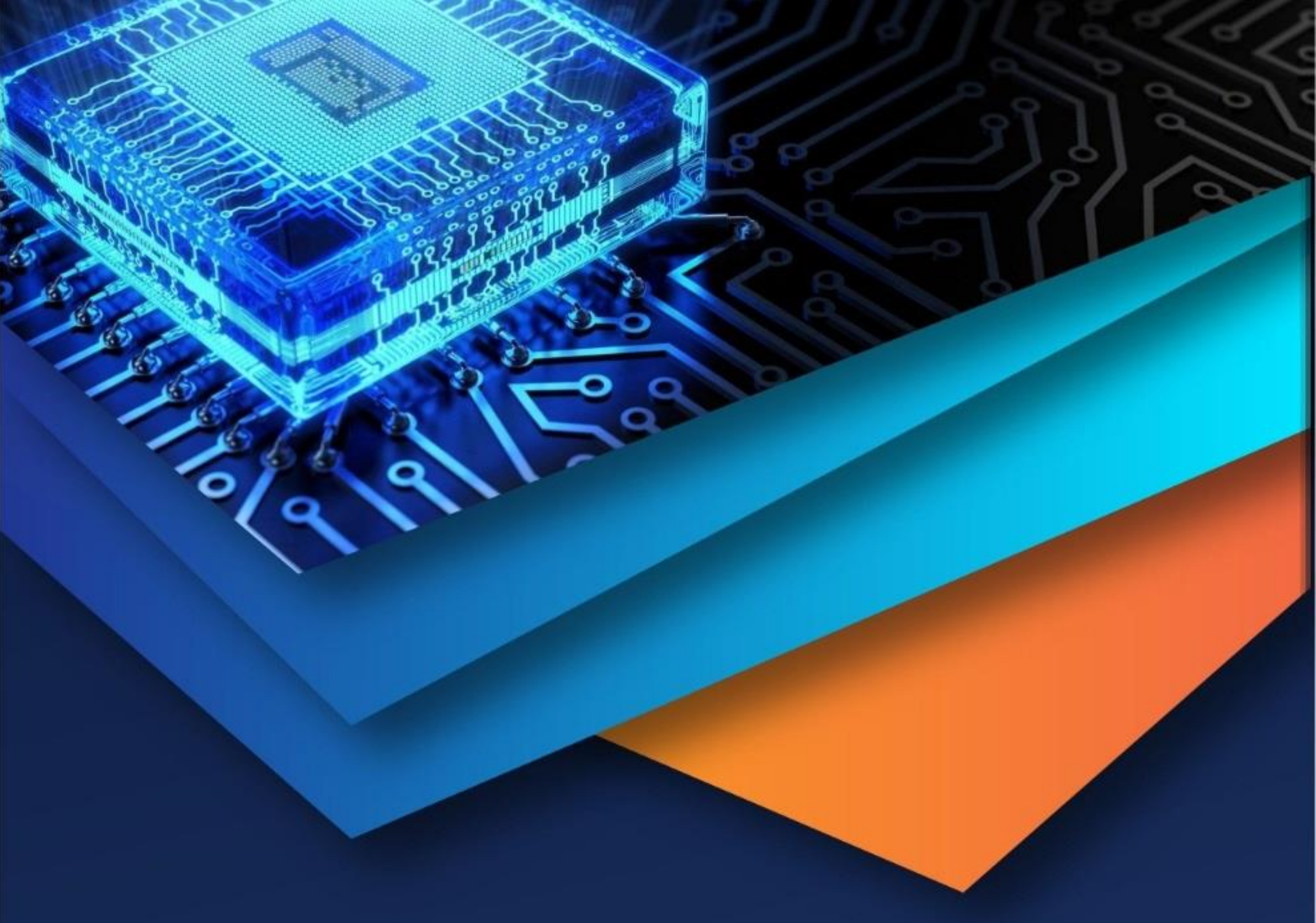
[10] Vittal MVR, Ramanaidu K, Subhas C (2013), “PAPR analysis of single carrier FDMA signals with Gaussian pulse shaping”. In: International conference on communications and signal processing (ICCSP). IEEE, pp 776–780.

[11] Vittal MVR, Naidu KR (2017a) “A novel reduced complexity optimized PTS technique for PAPR reduction in wireless OFDM systems”. Egyptian Inform J 18(2):123–131.

[12] Vittal MVR, Naidu KR (2017b) “Modified alternative-signal technique for sequential optimisation for PAPR reduction in OFDM-OQAM systems”. Defence Sci J 67(3):1–9.

[13] Wang Y, Chen W, Tellambura C (2010) “A PAPR reduction method based on artificial bee colony algorithm for OFDM signals”. IEEE Trans Wirel Commun 9(10):2994–2999.

[14] Yuan JG, Shen Q, Wang JX, Wang Y, Lin JZ, Pang Y (2017) ‘A novel improved SLM scheme of the PAPR reduction technology in COOFDM systems”. Optoelectron Lett 13(2):138–142.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY