

Algorithm for Decreasing the Large Peak to Average Power Ratio in Mimo-Ofdm



Yogeshver khandagre, Sanjeev kumar Gupta

Abstract: Every personal want to use high speed communication system but bandwidth is limited and users are unlimited in that case some of technologies are use for improving speed. One of the best technology called multiple inputs multiple outputs orthogonal frequency division multiplexing. Which provides very fast communication system but drawback of this technique is large maximum to average power ratio, these reduce efficiency of power amplifier. In this article developed new algorithm, for reduction of large maximum to average power ratio and improve bit or symbol error rate in MIMO-OFDM system. Proposed technique, called filter companding selected mapping algorithm technique (FC-SLM) to reduce PAPR using filtering and companding concept. In this techniques, after modulation of input data are converted into serial to parallel stream, phase mapping of all data from 0 to 360 degrees and perform IFFT operation, calculate PAPR and pass through desire range of filter and select minimum PAPR then perform companding and transmitted through an antenna. This scheme is reduce 2.3 dB PAPR and improve bit or symbol error rate. This is one of the most excellent promising techniques for next generation (5-G) communication system.

Keywords- BER, bit error rate; FC-SLM, filter companding selected mapping; PA, power amplifier; PAPR, Peak(maximum) to average (middle) power ratio.

I. INTRODUCTION

Digital wireless communications on the real scene are not in excellence. There are so many factors that may be a cause of distortion in a signal [1], such as fading, channel coding error, noise, and high PAPR etc. The famous technique called MIMO-OFDM has been seen to be efficient for very high speed communication over channels with frequency selective fading. OFDM technique efficiently utilizes the available channel bandwidth by dividing the channel into small bandwidth continuous channels [2, 6]. Orthogonal frequency division multiplexing (OFDM) technology is one of the most attractive candidates for fifth generation (5G) mobile radio communication. However the main drawback of OFDM technique is a high peak-to average power ratio (PAPR) for a large number of sub-carriers which reduces the efficiency of power amplifier.

Orthogonal Frequency Division Multiplexing (OFDM) transmission scheme has given the various advantages. It makes efficient use of the spectrum by allowing overlap by dividing the channel into narrowband flat fading sub-channels. OFDM is more challenging to frequency selective fading (FSF) than single carrier communication systems. By using the cyclic prefix eliminates ISI and IFI.

Using adequate channel coding and interleaving one can recover lost symbols due to the frequency selectivity of the channel. It is possible to use maximum likelihood decoding with reasonable complexity [7]. OFDM is computationally competent by using FFT techniques to implement the modulation and demodulation functions. It is less sensitive to sample timing offsets than single carrier systems as it provides good protection against co-channel interference and impulsive parasitic noise. On the other hand, an MIMO-OFDM system have tremendously elevated peak-to average, power ratio (PAPR) [8] and elevated bit and symbol error rate, at the transmitter end and receiver end area respectively which is move toward about the elevated signal falsification such as the in-band deformation and the out-of-band deformation due to the nonlinearity characteristics of class-C push pull power amplifier (HPA) [10, 20].

Objective: In previous section describes a main scenario of different challenges in MIMO-OFDM systems. Considering the main challenges, each of the problem areas can be treated, separately. Therefore this article planned to improve the performance of the MIMO-OFDM system. Firstly, design and simulation of desire PAPR pass filter which is pass minimum to maximum PAPR in MIMO-OFDM system. Secondly, design and simulation of PAPR reduction algorithm which is reduce peak to average power ratio and improve bit error rate in MIMO-OFDM system.

In this article total prearranged as follows- describes literature survey, transmission model of SIMO, SISO, MISO and MIMO system, reduction of PAPR, and proposed new FC-SLM algorithm in section II, results discussion in section III, conclusion and future scope in IV and V respectively.

II. LITERATURE SURVEY, MATERIALS & METHODS

In the field of digital communication, one of the most efficient technique for reducing high PAPR value in OFDM. Here given various PAPR reduction techniques in literature. Paper by Bauml et al. [13] proposes a probabilistic based coding technique called selected mapping (SLM) for minimization of PAPR in 1996 and upgrade in 2007. In this method original data, multiplication of different phase sequence, perform IDFT operation and select minimum PAPR then transmitted to the channel.

Manuscript received on February 10, 2020.

Revised Manuscript received on February 20, 2020.

Manuscript published on March 30, 2020.

* Correspondence Author

Yogeshver khandagre*, Research Scholar, Dept. of Electronics & Communication, Rabindranath Tagore University, Bhopal, Madhya Pradesh, India. E-mail: yogesh.khandagre@gmail.com

Dr. Sanjeev kumar Gupta, Professor, Dept. of Electronics & Communication, Rabindranath Tagore University, Bhopal, Madhya Pradesh, India. E-mail: sanjeevgupta75@yahoo.com

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

The selected mapping method is reducing 2 dB to 6 dB additional peak to average power without sending any side information. SLM is one of the primary probabilistic approached methods for reduction of PAPR in MIMO-OFDM. The SLM scheme generates more computational complexity.

The paper by **Fang et al.** [14] proposes a probabilistic based coding technique called Partial Transmit Sequences (PTS) for minimization of PAPR.

In partial transmit sequences (PTS) scheme the all data signal is divided into non-overlapping small packet called sub block and each packet is rotated clockwise or anti clockwise with a statistically self-determining rotation factor. This rotation factor is sends side information for receiver with lowest PAPR which is the time domain data to be transmitted. More PAPR reduction is found where PTS schemes perform better than SLM schemes, but large bit error rate and more computational complexity of both transmitter and receiver. No side information send from transmitter.

The paper by **Filbert H. Juwono et al.** [9] proposes a new called clipping and filtering. In this scheme the main concentration of magnitude peaks are correct or signal is customized till the certain threshold amplitude of the signal. In this scheme signal is corrected by a corrective function $s(t)$ with limit X_0 to X_n for amplitude and No out-of-band interference occurs.

The article given by **Heung et al.** [20] proposes a novel scheme for minimization of PAPR called random phase updating algorithm. This technique is generation and allocation of random phases to each carrier. The random phase update by the random phase algorithm is continued till the high value is less than the desired value of signal. The threshold should be dynamic and random phase update to limited iteration. The PAPR calculated after that random phase update till the maximum number of iterations or minimum threshold level has been reached. This random phase increment should be uniform and about phase increment is known to transmitter as well as receiver.

The paper by **Neha Therkar et al.** [17] proposes a low-complexity, simple and effective technique for PAPR reduction based on companding scheme in MIMO-OFDM. The companding technique can be used to get better OFDM transmission performance by using compressing the OFDM signal of large PAPR signal occurs while transmission. Two types of companding technique are used, μ -law companding and A-law companding. In companding technique compress the OFDM signal before it is converted into analog signal. After taking IFFT of OFDM signal is companded, quantized and converts from digital to analog then transmitted. At the receiver side process are vice versa.

1. SISO means single- input, single- output type of communication system, which is used in only one single antenna inaccessible at the transmitter end side and only one single antenna at receiver end side. SISO models [19] is featured with a reduction of multifaceted than MIMO model. Figure 1 shows that while using a single antenna on the transmitter side and receiving side data rate get down. SISO-Model

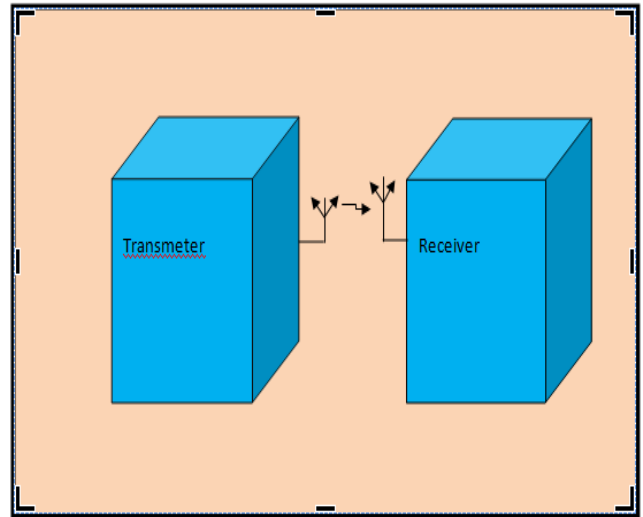


Figure 1.SISO Model

2. SIMO means, single input, multiple outputs [19] is type of communication, system in which only one antenna is associated at transmitter end side and more than one antenna at the receiving end side. This is a very useful antenna technology for wireless communications system. This system uses a variety of antenna at the objective end side. These antennas are collective to diminish error and increase the speed of data in communication system.

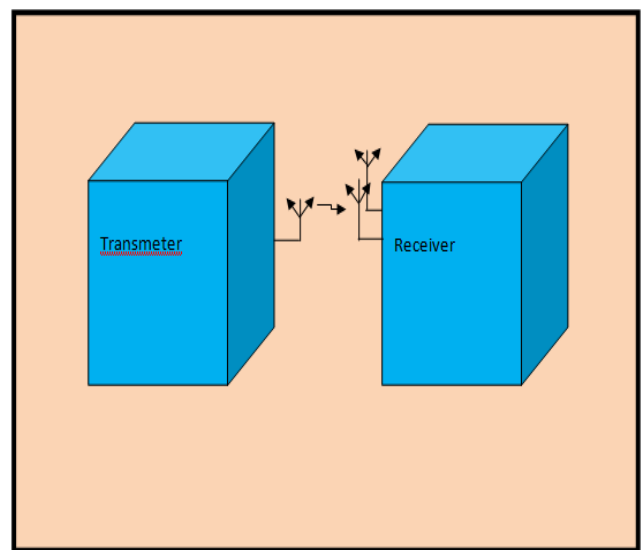


Figure 2.SIMO Model

Figure 2 shows that more antenna are use at the receiver end to increase the receiving capacity of receiver, by this data rate of single input, multiple outputs (SIMO) is more than single- input, single- output (SISO) but it result in increase of bit error rate.

3. MISO means multiple inputs, single output, [19], in this model, more than one number of antenna are associated with the transmitter end and only one single antenna associated with the receiver end. The various antenna are join to increase data rate or speed and decrease bit error rate of communication system. The objective end side has only one single antenna accumulate to increase error. This is a more graceful antenna, technology, than others individual, SISO and SIMO.

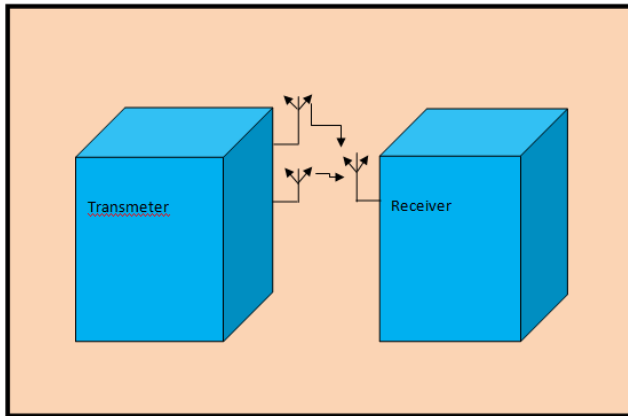


Figure 3. MISO Model

Figure 3 shows that more antenna can be used at the transmitter side to improve the transmitting capacity of the transmitter, by this data rate of multiple inputs, multiple outputs (MISO) is more than single inputs, single outputs (SISO) but the bit error rate is increase.

4. MIMO means multiple inputs, multiple outputs [18], is a type of communication system.

In this system more than one antenna are associate with transmitter end side and more than one associate with receiver end side. In such type of arrangement conventional signal is achieved and this additional arrangement improves the efficiency of communication system.

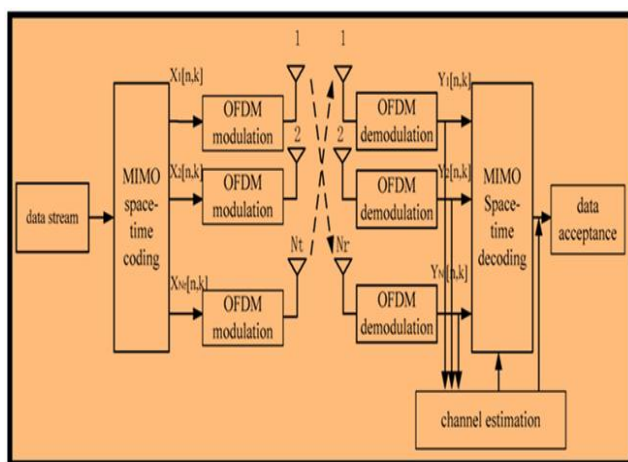


Figure 4. MIMO-OFDM system

Figure 4 shows predictable, model, of multiple inputs, multiple outputs (MIMO) system. In earlier period most of the researchers have proposed numerous approaches for most favorable reduction of PAPR and bit or symbol error rate in MIMO-OFDM. It can be further reduce PAPR for improving performance of the system. In the literature studied of various techniques for decreasing PAPR and bit or symbol error rate in improve SLM algorithm scheme is good to all performance and focus on that scheme.

Reduction of PAPR

In the process of digital data transmission signal is amplified after modulation at the transmitter end. One major observation is at transmitter to operate a power amplifier in the linear region because the signal will be clipped or distorted from nonlinear region. For this situation provide minimum PAPR at transmitter end, so PAPR is very important factor in MIMO-OFDM.

Peak to Average power ratio (PAPR)= Maximum signal power to Average signal power.

$PAPR = \frac{\text{Max. Power of } X(t)}{\text{Avg. power of } X(t)}$

Ultimate goal is how to reduce maximum $|x(t)|^2$ in time domain signal.

Proposed Method

The proposed technique named filter companding selected mapping (FC-SLM) helps again in improving PAPR and bit error rate of selected mapping scheme. In filter companding selected mapping techniques, after modulation input data are converted into serial to parallel steam, phase mapping of all data and perform IFFT operation, calculate PAPR and pass through desire range of filter and select minimum PAPR then perform companding and transmitted through an antenna. The filter characteristics are defined according to selection of minimum to maximum PAPR. It is decrease 2.3 dB PAPR and improve bit or symbol error rate. In filter companding selected mapping (FC-SLM) not investigation after PAPR is less than or higher than threshold value because already pass through minimum PAPR to filter. Other method reduce the PAPR of the data signal but efficiency of class-C power amplifier will not increase so west of time and circuitry for additional mapping to increase cost of communication system.

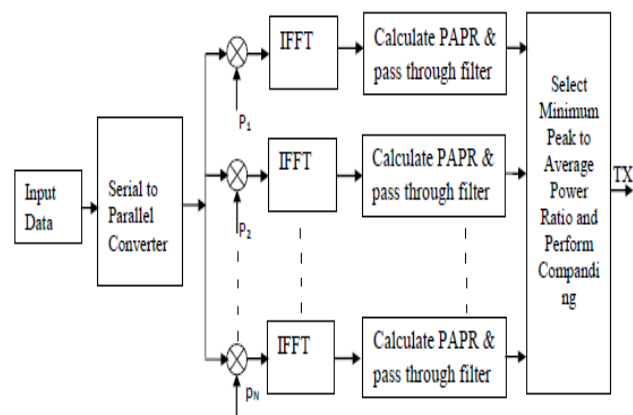


Figure 5 Filter Companding Selected Mapping scheme block diagram

Algorithm

The main focus of this article is decreasing maximum to average power ratio without any complex procedure and minimum calculation time.

1. Initially taken X- independent data sequences.
2. Divide N- subcarrier into non-overlapping sub blocks.
3. Apply add cyclic, modulation and convert serial to parallel.
4. Assume that phase sequence $P = P_1, P_2, P_3, \dots, P_N$ are multiply with data sequence and IFFT operation perform.
5. Calculate PAPR value of each signal and pass through filter ($PAPR_{min} < PAPR_{pass} < PAPR_{max}$).
6. Select minimum PAPR and perform Mu-law companding on it.
7. Transmit companded signal.

III. RESULTS AND DISCUSSION

Each and every part of the, simulation results accomplished on MATLAB 7.10 environments. This simulation has been shown to estimate capability of the predictable method, performance, like PAPR and symbol error rate, consider number of transmitted symbol is 256 , sampling factor 8 and modulation scheme QPSK, is employed.

Showing simulation, result of SLM and FC-SLM in table 1.1 as:

Table 1 - 256-Number of transmitted symbol

Number of transmitted symbol (N)	256
PAPR of SLM in(dB)	8.2
PAPR of FC-SLM in(dB)	5.9

The above table shows different values of PAPR (dB) for MIMO-OFDM of filter companding-selected, mapping consider transmitted symbol is 256 number, which is reducing PAPR from 8.2 dB to 5.9 dB. The total PAPR reduce is 2.3 dB by using Filter Companding -Selected Mapping technique.

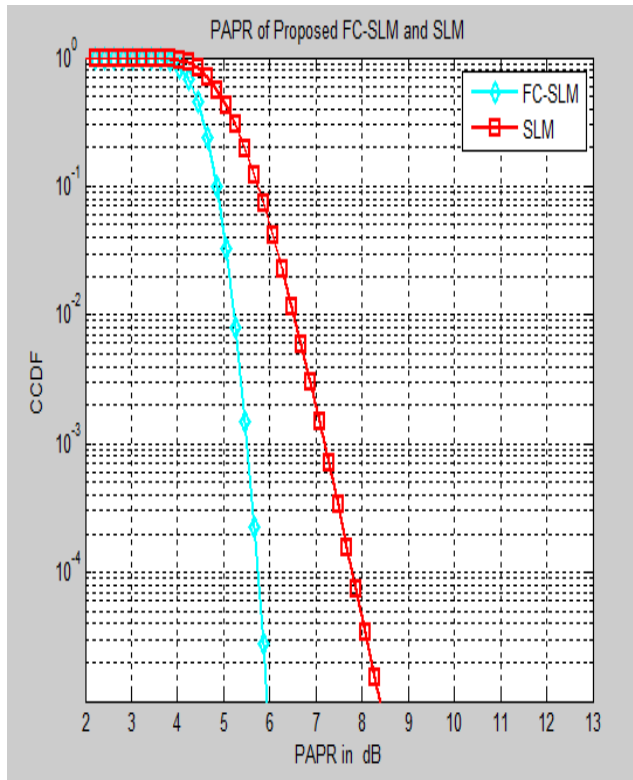


Figure 6 CCDF of FC-SLM and SLM in MIMO-OFDM system

Figure 6 Shows the CCDF of normal, selected mapping and filter companding selected mapping (FC-SLM) technique with respect to PAPR in dB. From the figure it is analyzed that, in FC-SLM to transmit the data by using 10^{-5} carriers it requires power is 5.9 dB for $M=16$ with constant $N=256$ and Selected mapping is 8.2 dB for $M=16$ with constant $N=256$. It is proved that by PAPR results filter companding selected mapping technique is good for orthogonal frequency division multiplexing (OFDM).

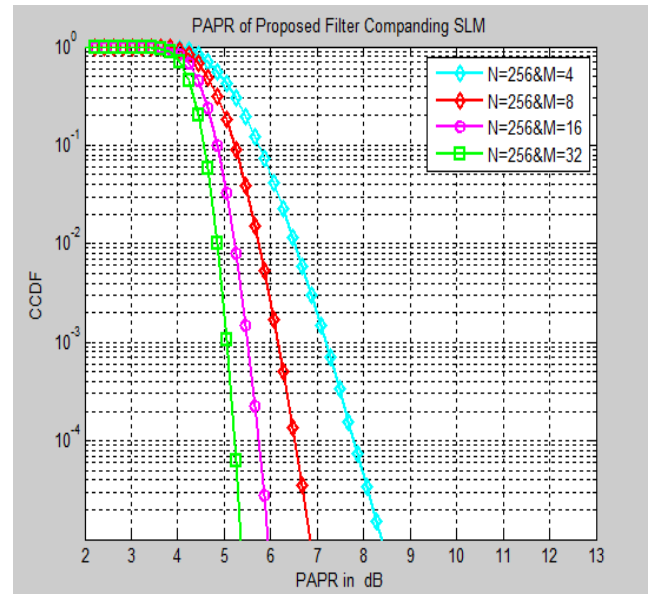


Figure 7 PAPR of FC-SLM for N = 256 M=4, 8, 16 & 32.

Figure 7 Shows CCDF of FC-SLM techniques with respect to PAPR in dB for different value of M. From the figure it is analyzed that, in FC-SLM to transmit the data by using 10^{-5} carriers it requires power from 5.3 dB to 8.3 dB for $M=4, 8, 16$ and 32 with constant $N=256$. It is proved that increases the value of phase mapping then reduces the maximum to average power by filter companding selected mapping technique.

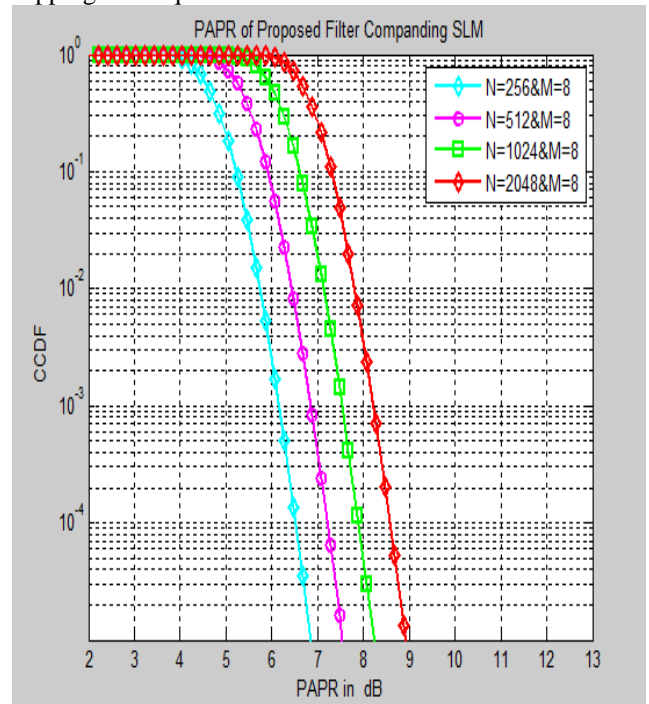


Figure 8 PAPR of SLM & FC-SLM for M=8

Figure 8 Shows CCDF of FC-SLM techniques with respect to PAPR in dB for different value of N. From the figure it is analyzed that, in FC-SLM to transmit the data by using 10^{-5} carriers it requires power from 6.9 dB to 8.9 dB for $N=256, 512, 1024$ and 2048 with constant phase mapping $M=8$. It is proved that increases the value of subcarrier then reduces the maximum to average power by filter companding selected mapping technique.

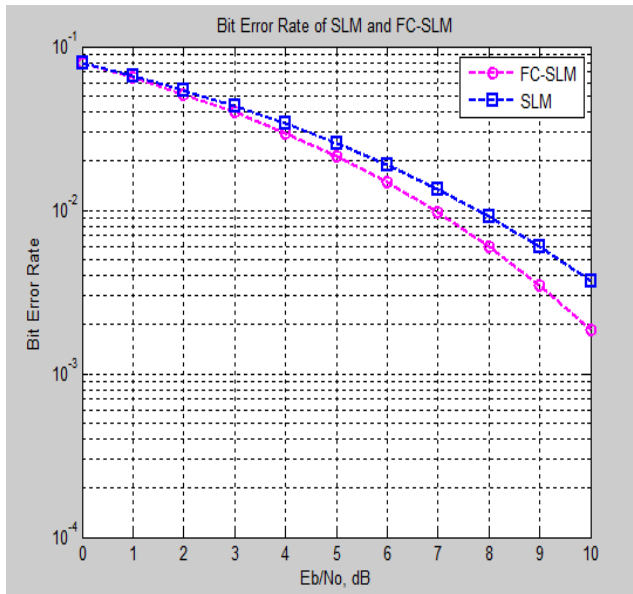


Figure 9 BER of SLM & FC-SLM for N=256

Figure 9 shows BER of the selected mapping (SLM) and filter companding selected mapping (FC-SLM) technique. From the figure it is analyzed that, calculate bit error rate of selected mapping and filter companding selected mapping with respected to E_b/N_0 (dB). The bit error rate curves conclude that filter companding selected mapping (FC-SLM) technique is better than another technique.

IV. CONCLUSION

From the simulation results indicate that the overall response of proposed technique is better than other. In this paper proposed filter companding selected mapping to describe the reduction of PAPR, increase bit error rate and efficiency of MIMO-OFDM. In filter companding-selected mapping technique to reducing the PAPR using desire filtering and companding and to be reduce 2.3 dB PAPR and improve bit, error rate. This new algorithm is strong reduction of PAPR and increase bit error rate with signal pass through a desire filter this perform minimum and maximum boundary condition before selection of PAPR and companding operation compress the PAPR signal according to mu-law companding and expanded at receiver side which improve the bit error rate.

V. FUTURE SCOPE

In future this technique can be applied on the basis of selection of PAPR with minimization of additional computational cost. This technique can be improved for decreasing of maximum to middle power ratio (PAPR) with small change in filter characteristics.

REFERENCES

1. Muller-Wein et al. (2004) "Selected mapping peak-power reduction without explicit side information" IEEE Communications Letters vol.-5 pp. 239-241.
2. Baxley R J. et al.. (2006) "peak-to-average power ratios for communications applications" Proc. IEEE MILCOM Conference.
3. Jiang et al. (2008) "An overview of PAPR Reduction Techniques for OFDM Signals" IEEE Transactions on Broadcasting vol. 54, no. 2, pp. 257-268.
4. A. Omri et al. (2011) "New transmission scheme for mimo-ofdm System. International Journal of Next-Generation Networks (IJNGN) Vol.3, No.1.

5. M. F. Naeiny et al. (2010) "Selected mapping algorithm for PAPR reduction of space-frequency coded OFDM systems without side information," IEEE Trans. Veh. Technol., vol. 60, no. 3, pp. 1211-1216.
6. E. Hong et al. (2011) "PAPR reduction for MISO-OFDM systems with adaptive all-pass filters," IEEE Trans. Wireless Commun., vol. 10, no. 10, pp. 3163-3167.
7. Dongwon-Bai et al. (2012) "LTE-Advanced Modem Design Challenges and Perspectives," IEEE Communication Magazine, Vol. 50, Issue 2, pp. 178-186.
8. Tao Jiang et al.. (2013) "A Novel Phase Offset SLM Scheme for PAPR Reduction in Alamouti MIMO-OFDM Systems without Side Information", IEEE signal processing letters, vol. 20, no. 4.
9. Maham Kamil Naji et al. (2014) "The Analysis of MIMO/OFDM Networks with group-selected Arrays signal Processing" International Journal of Current Engineering and Technology, Vol.4, No.3.
10. Monica Lamba et al. (2014) "Challenges and Future Direction for MIMO Communication System" SOP transactions on wireless communications ISSN (Print): 2373-8618 ISSN (Online): 2373-8626 Volume 1.
11. Varahram et al. (2014) "A crest factor reduction scheme based on recursive optimum frequency domain matrix," IEEE, vol. 60, no. 2, pp. 179-183.
12. M. Gay et al. (2014) "An adaptive PAPR reduction scheme for OFDM using SLM with clipping at the transmitter, and sparse reconstruction at the receiver," IEEE International Conference on Signal and Information Processing (China SIP), pp. 678-682.
13. Y.H. Cheng et al. (2015) "PAPR reduction in TD-SCDMA system via peak-cancellation", ICAETIE.
14. Mamta Bisht et al. (2015) "Various techniques to reduce PAPR in OFDM systems", Intl. J. of signal processing and image processing, vol. 8, pp. 195-206.
15. Z. Ding et al. (2017) "Random beam forming in millimeter wave networks," IEEE Access, vol.5, 7667-7681.
16. Bhadra Prajapai et al. (2016) "Analysis of techniques for PAPR reduction in MIMO-OFDM", International Journal of Electronics and Communication (IJEC), vol. 4, issue 5.
17. Neha Therkar et al. (2017) "A Novel CMP-SLM Technique to Reduce Peak to Average Power Ratio in MIMO-OFDM" Gjra - Global Journal for Research Analysis issue-3, ISSN No 2277 - 8160.
18. Guilherme Pedro Aquino et al. (2017) "PAPR Reduction and Performance Improvement in OFDM Systems using WHT-based Schemes" JCIS, VOL. 32,
19. Y.-C. Huang et al. (2017) "Construction πA and πD lattices: Construction, goodness, and decoding algorithms," IEEE Trans. Inf. Theory, vol. 63, no. 9, pp. 5718-5733.
20. Z. Ding et al. (2017) "Application of non-orthogonal multiple access in LTE and 5G networks," IEEE Commun. Mag., vol. 55, no. 2, pp. 185-191.

AUTHORS PROFILE



Yogeshver Khandagre, Male, 38, has been pursuing a Ph.D. degree at the Rabindranath Tagore University, Bhopal M.P. India. He belongs to Bhopal, Madhya Pradesh. He graduated with Bachelor of Engineering in Electronics and Communication in 2006 and Post Graduated with Master of Technology in Digital Communication in 2011. His graduation and post graduation has been both from Rajeev Gandhi Proudhyogiki Vishwavidyalaya (RGPV) Bhopal, Madhya Pradesh. His research interests include OFDM, Wireless Communication, and Biomedical Instrumentation.



Dr. Sanjeev Kumar Gupta is working as Associate professor in Department of Electronics and Communication, Rabindranath Tagore University, Bhopal M.P. India. He has 20 years of teaching experience. He has completed PhD in Electronics and Communication from Barkatulla University Bhopal. He has published 20 papers in various International journals including journals indexed in Scopus. His research interest lies in the area of Antenna, Communication and Microwave.