Optimized Evaluation of SLM and PTS Techniques for Obtaining the Accurate Papr Reduction in OFDM System

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Abstract

Orthogonal Frequency Division Multiplexing (OFDM) is an attractive and promising technique for fourth generation wireless communication due to high data rate. Even though with many advantages it has disadvantage that the time domain of OFDM signal is a sum of subcarrier sinusoidal, which gives high Peak to Average Power Ratio (PAPR).High Peak-to-Average Power Ratio (PAPR) is one of the major and important drawback of the Orthogonal Frequency Division Multiplexing. Both selected mapping (SLM) and partial transmit sequence (PTS) recognize as efficient PAPR reduction algorithms over traditional algorithms. A relative comparison between them is performed to understand the both algorithms reliability in PAPR reduction and both these algorithms belongs to distortion less PAPR reduction algorithms. In this work a comparison is carried out between SLM and PTS based on complementary cumulative distribution function (CCDF) and simulation results are defined based on probability. Simulation results show PTS system acts better in increasing probability scenario while SLM system gets impaired in same scenario.In the future work, OSLM is used as an extension for the proposed method to improve performance as well as reliability in OFDM system.

KEYOWRDS: OFDM, SLM, PTS, Probability, CCDF, OSLM.

1. INTRODUCTION

OFDM is a multi bearer tweak strategy which has been as of late broadly utilized as a part of various correspondence frameworks particularly the ones with high information rates. OFDM has gotten to be so well known these days because of its adaptable and proficient administration of between image obstructions (ISI)[1]. What's more, OFDM offers high ghastly productivity as an aftereffect of multicarrier orthogonality viewpoint. Such framework perspectives would progress general framework execution and correspondence join quality. Nonetheless, OFDM has a noteworthy disadvantage which is the high PAPR[2]. Having a framework with high PAPR will constrain the force speaker to work in the non-direct district where the force change is wasteful which influences, thus, the battery life in the portable specialized gadgets. This wasteful force change causes power development also bringing about significantly higher adequacy crests[3].

One of the real downsides of multicarrier transmission is the high peak to average power ratio (PAPR) of the transmit signal. On the off chance that the top transmit force is restricted by either administrative or application requirements, the impact is to reduce the normal force permitted under multicarrier transmission[3] in respect to that under consistent power balance strategies. This thusly decreases the scope of multicarrier transmission. Additionally, to avert ghastly development of the multicarrier signal as inter modulation among subcarriers and out-of-band radiation[4], the transmit power enhancer must be worked in its direct locale (i.e., with an extensive information backoff), where the force transformation is wasteful. This may deleteriously affect battery lifetime in portable applications. In numerous ease applications, the disadvantage of high PAPR may exceed all the potential advantages of multicarrier transmission systems.

In fact, the PAPR problem likewise emerges in numerous cases other than multicarrier transmission. Regularly, the PAPR is not an issue with steady abundance signals. With non constant sufficiency signals, be that as it may, it is imperative to manage the PAPR of those signs. For case, a DS-CDMA signal experiences the PAPR issue particularly in the downlink since it is the total of the signs for some clients. In this article, be that as it may, we confine our consideration regarding the PAPR issue in multicarrier transmission as it were.

OFDM partitions the data stream, should have been sent, into N singular sub-streams. These N sub streams are sent through L sub-channels with essentially lower information rate at every sub-channel. The frequencies of those N sub channels are orthogonal permitting them to cover with no impedance. Diminishing information rate at these sub-channels and covering transmission frequencies mean the framework would have lower ISI and less involved data transfer capacity fulfilling the wanted correspondence quality measure. Nonetheless, when including these sub-streams up together to frame the time space OFDM signals, the PAPR issue happens essentially. OFDM transmitter and recipient piece outline are appeared in Fig. 1 and 2 respectively. For a baseband OFDM signal:

$$X(t) = \left(\frac{1}{\sqrt{N}}\right)\sum_{n=0}^{N-1} Xne^{j2\pi n\Delta ft}, 0 \le t \le NT$$

Where N is number of blocks and Δf is subcarrier spacing.

2. BACKGROUND

OFDM is one of the most efficient multicarrier modulation techniques. Which provides high spectral efficiency, low implementation complexity, less vulnerability to echoes and non – linear distortion? Due to these advantages of the OFDM system, it is vastly used in various communication systems. The major problem faced by implementing this system is the high peak – to – average power ratio. A large PAPR increases the complexity of the analog – to – digital and digital – to – analog converter and reduces the efficiency of the radio – frequency (RF) power amplifier. Some applications are implemented to reduce the peak powers transmitted which in turn reduces the range of multicarrier transmission. This leads to the prevention of spectral growth and the transmitter power amplifier is no longer confined to linear region in which it should operate. This produces a harmful effect on the battery lifetime.

Numbers of techniques are introduced to deal with the problems of PAPR. Some of them are 'amplitude clipping, 'clipping and filtering', 'coding', 'partial transmit sequence (PTS)', 'selected mapping (SLM)' and 'interleaving'. These techniques achieve PAPR reduction at the expense of transmit signal power increase, bit error rate (BER) increase, data rate loss, computational complexity increase, and so on.

A) PEAK – TO – AVERAGE POWER RATIO

In an OFDM, large number of independent modulated sub-carriers is present. Due to this the peak value of the system can be very high as compared to the average of the whole system. The ratio of the peak to average power value is termed as Peak-to-Average Power Ratio. Coherent addition of N signals of same phase produces a peak which is N times the average signal.

The major disadvantages of a high PAPR are-

1. Increased complexity in the analog to digital and digital to analog converter.

2. Reduction is efficiency of RF amplifiers.

B) PAPR OF A MULTICARRIER SIGNAL

Let the data block of length N is represented by a vector= $[X_0, X_1, \ldots\ldots, X_{N-1}]^T$. Duration of any symbol X_k in the set X is T and represents one of the sub – carriers $\{f_n, n = 0,1, \ldots, N-1\}$ set. As the N sub – carriers chosen to transmit the signal are orthogonal to each other, so we can have $f_n = n\Delta f$, where $n\Delta f = 1/NT$ and NT is the duration of the OFDM data block X. The complex data block for the OFDM signal to be transmitted is given by

$$x(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_n . e^{j2\pi n \Delta f t}, \qquad 0 \leq t \leq NT$$

C) CUMULATIVE DISTRIBUTION FUNCTION

The Cumulative Distribution Function (CDF) is one of the most regularly used parameters, which is used to measure the efficiency of any PAPR technique. Normally, the Complementary CDF (CCDF) is used instead of CDF, which helps us to measure the probability that the PAPR of a certain data block exceeds the given threshold.

By implementing the Central Limit Theorem for a multicarrier signal with a large number of sub-carriers, the real and imaginary part of the time – domain signals have a mean of zero and a variance of 0.5 and follow a Gaussian distribution. So Rayleigh distribution is followed for the amplitude of the multicarrier signal, where as a central chi-square distribution with two degrees of freedom is followed for the power distribution of the system.

The CDF of the amplitude of a signal sample is given by

$$F(z) = 1 - exp(z)$$

The CCDF of the PAPR of the data block is desired is our case to compare outputs of various reduction techniques. This is given by

$$P(PAPR > z) = 1 - P(PAPR \leq z)$$

$$= 1 - F(z)^N$$

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017

$$= 1 - \left(1 - exp(-z)\right)^N$$

3. LITERATURE REVIEW

A. Joint ICI Cancellation and PAPR Reduction in OFDM systems without side information[5].

In this paper, researchers have proposed the mathematical analysis of PAPR performance for ICI self-cancellation, new ICI self cancellation and ICI conjugate cancellation schemes. It demands the requirement of PAPR reduction because PAPR performance of these schemes are either very nearer to or poorer than the OFDM signal. Here in this paper, researchers has introduced a multipoint partial transmit scheme (PTS), which progress the PAPR performance the PAPR performance of the ICI cancellation scheme.

B. An SDP approach for PAPR reduction in OFDM using partial transmit sequence [6].

The Partial transmit sequence algorithm has been broadly used to lessening the influence of peak to average power ratio in OFDM system. The important phase in PTS is the practice of a finite set of phase factor "bv" to rotate the data or information signal before transmission to decrease the effect of PAPR. In this paper, researchers propose a semi definite programming which discoveries the optimal set of phase rotation factors recycled in the PTS technique.

C. Reduction of PAPR in OFDM system by intelligently applying both PTS and SLM algorithm [7]

In OFDM system PAPR is the key problem. Selective mapping and partial transmit sequence (PTS) existing scheme are effective, but on the other hand it is very hard to gadget due to the high complication. The characteristic algorithm in this research area is the multi-time clipping algorithm SLM algorithm, PTS algorithm and golay complement sequence algorithm. In this paper, researcher found that both SLM and PTS algorithm have good performance in dropping the PAPR than the golay complement sequence algorithm than the clipping algorithm. Thus a new PAPR reduction algorithm is offered, by using both PTS and SLM algorithm, which tries lessen the PAPR problem.

D. Partial Transmit Sequence for PAPR reduction of OFDM signal with Stochastic Optimization technique [8].

A high PAPR is a major drawback in orthogonal frequency division method. The conventional PTS technique is very effective in PAPR reduction in OFDM, but the complexity is more in pratical. To diminish the complexity still improving the PAPR statistics. So in this paper, researchers has presented a stochastic optimization technique to lessen the PAPR of an OFDM system.

4. PROPOSED METHOD

A) SLM

The hypothesis behind SLM is to represent the data blocks at the transmitter by different data blocks which all contain the same information as the original. These new data blocks results subsequent to increasing the first information obstruct by a grouping of stages produced at the transmitter. At that point the basis of which information obstruct among others ought to be chosen for transmission is

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017

to pick the one which gives the most minimal PAPR [8, 9]. SLM square graph is appeared in Fig. 4.

The SLM scenario is summarized as;

1. The transmitter produces F unique phase sequences whose length is L
2. The first information piece is duplicated by these F stage arrangements to produce F remarkable representations of the unique information piece.
3. The Inverse Fast Fourier Transform (IFFT) is connected on each of these adjusted information hinders as it is appeared.
4. Finally, the changed information piece which gives the most minimal PAPR is chosen for transmission. At the beneficiary side, with a specific end goal to recover the first information, side data ought to be sent from the transmitter to educate the beneficiary which stage succession has been chosen for transmission.

In the SLM system, the transmitter produces an arrangement of adequately distinctive hopeful information hinders, all speaking to the same data as the first information square, and chooses the most great for transmission [30, 31]. A piece outline of the SLM strategy is appeared in Fig. 4. Every information piece is duplicated by U distinctive stage arrangements, each of length N, B(u) = [bu,0 , bu,1 , … , bu,N–1] T , u= 1, 2, … , U, bringing about Unmodified information squares. To incorporate the unmodified information hinder in the arrangement of changed information squares, we set B(1) as the every one of the one vector of length N. Give us a chance to signify the changed information obstruct for the u th stage arrangement X(u) = [X0bu,0 , X1bu,1 , … , XN–1bu,N–1] T , u= 1, 2, … , U.

Among the altered information squares X(u) , u= 1, 2, … , U, the one with the least PAPR is chosen for transmission. Data about the chose stage grouping ought to be transmitted to the recipient as side data. At the collector, the reverse operation is performed to recuperate the unique information piece.. This methodology is material with a wide range of regulation and any number of subcarriers.

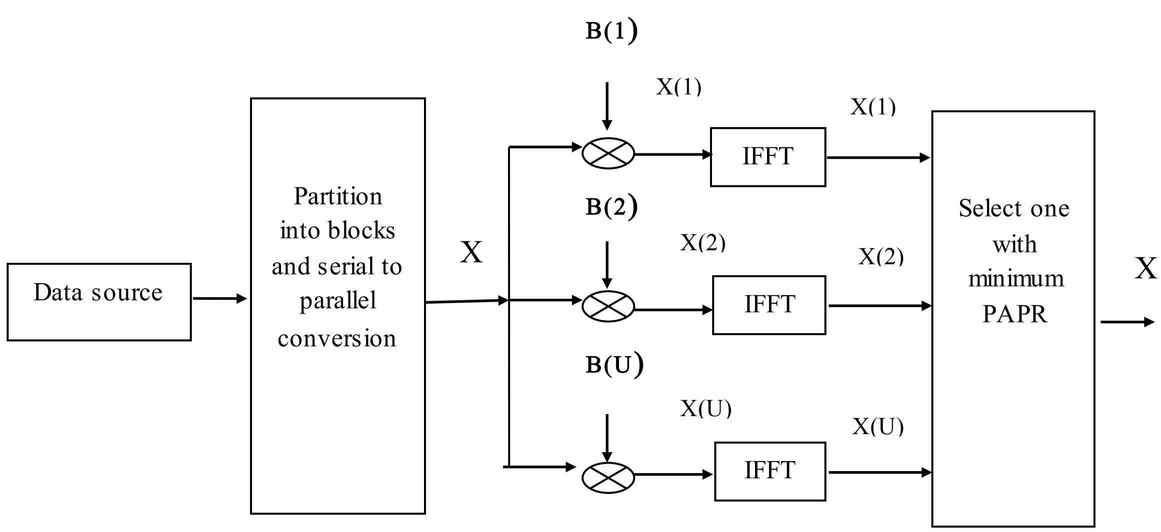

Figure 1: Selective Mapping Method

B) PTS

As indicated by the hypothesis of PTS, which was initially displayed, the information square is isolated into sub-pieces. Subcarriers of each those sub-squares ought to be planned to a stage component. Those stage elements were outlined in such way so that PAPR is minimized while recombining sub-pieces to frame the fundamental information hinder an increase. The PTS piece chart is appeared in Fig. 5. The PTS situation upheld with numerical expressions is abridged in the accompanying strides:

1. The input data piece X is isolated and separated into M sub-pieces,
2. The second step is to change over the sub-squares to the time area utilizing opposite quick Fourier change (IFFT) to shape the sign $\chi_m$from X_m
3. To the reason of minimizing PAPR, every sub-square in time area is turned by the stage component
4. The last stride is to include all the sub-obstructs structure the last time area signal.

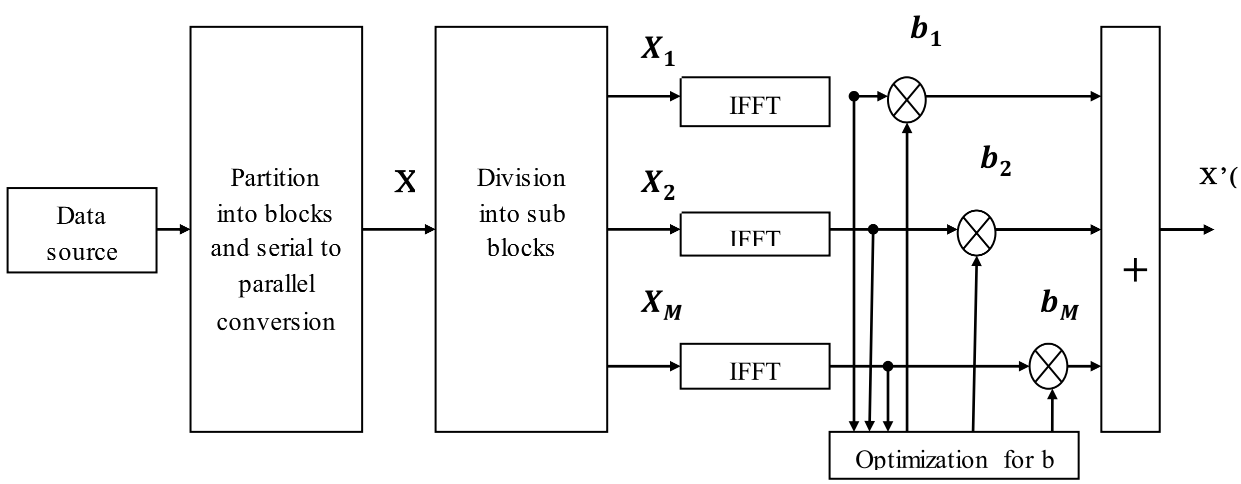

Figure 2: Partial Transmit Sequence

OSLM

The key element for OSLM is the length of the pulse shape. Indeed, the shortest pulse shapes are the simplest to implement and in the meantime they provide the best results, even slightly better than the ones obtained with SLM for OFDM[9]. On the other hand, a study of various FIR pulse shapes, i.e. prototype filters, shows that, for a given length, the shape itself does not have a significant impact as long as the prototype filter is orthogonal or nearly orthogonal. where it was shown that a discrete optimization was an appropriate way to get a short prototype to be well localized in time and frequency, with the present study, we can conclude that with the OSLM technique[10], this prototype is also of particular interest to get OFDM/OQAM signals with low PAPR.

International Journal of Research
Available at
https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 04 Issue 05
April 2017

5. RESULTS

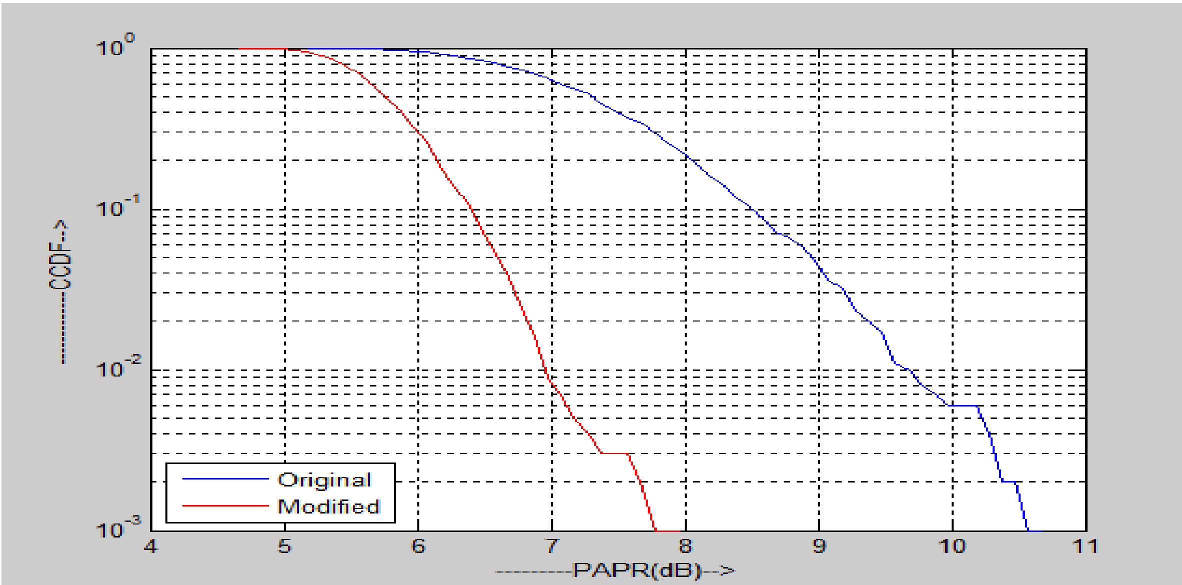

Figure 3: CCDFs of SLM for OFDM PAPR reduction

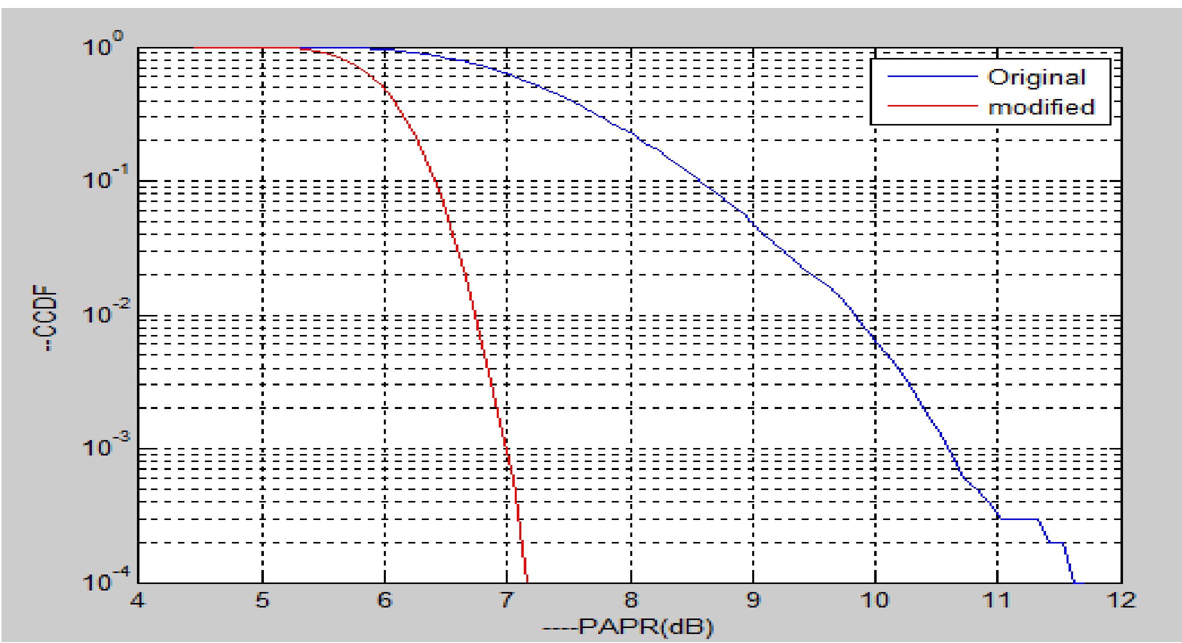

Figure 4: CCDFs of PTS for OFDM PAPR reduction

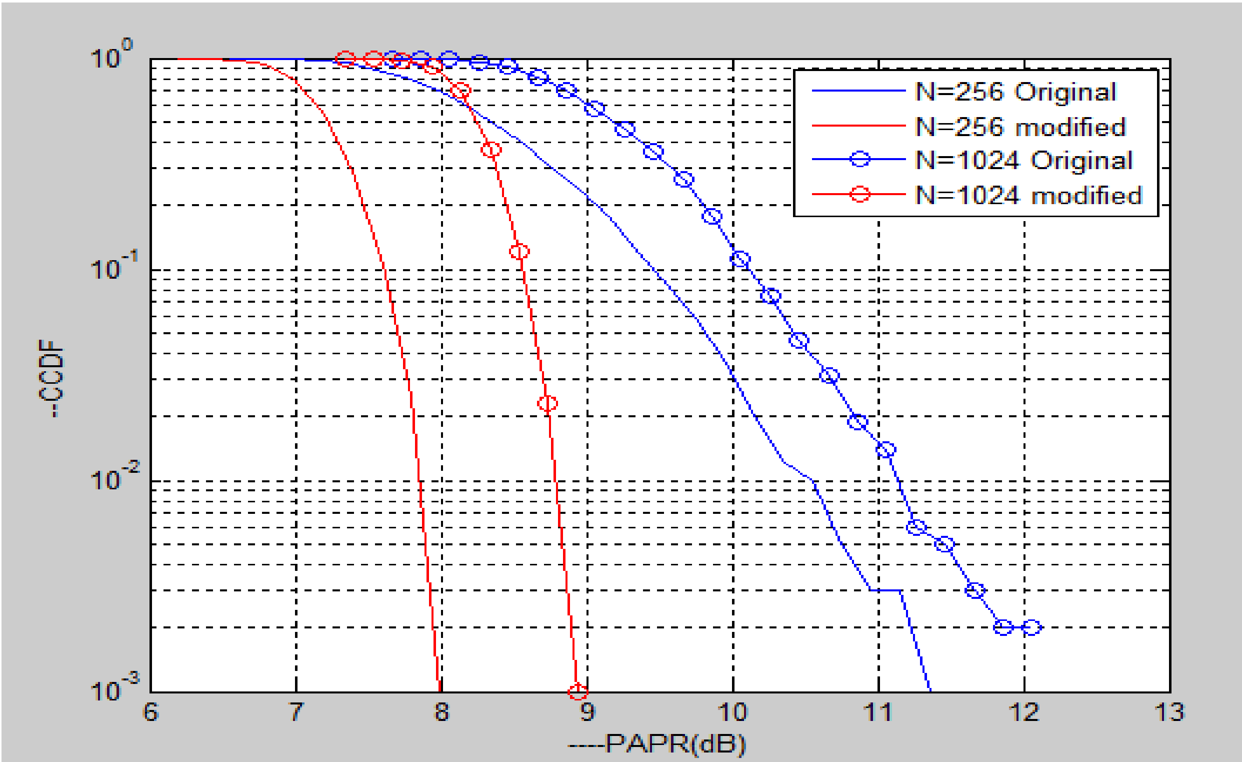

Figure 5: CCDFs of PAPR of two OFDM signals after being modified using SLM scheme

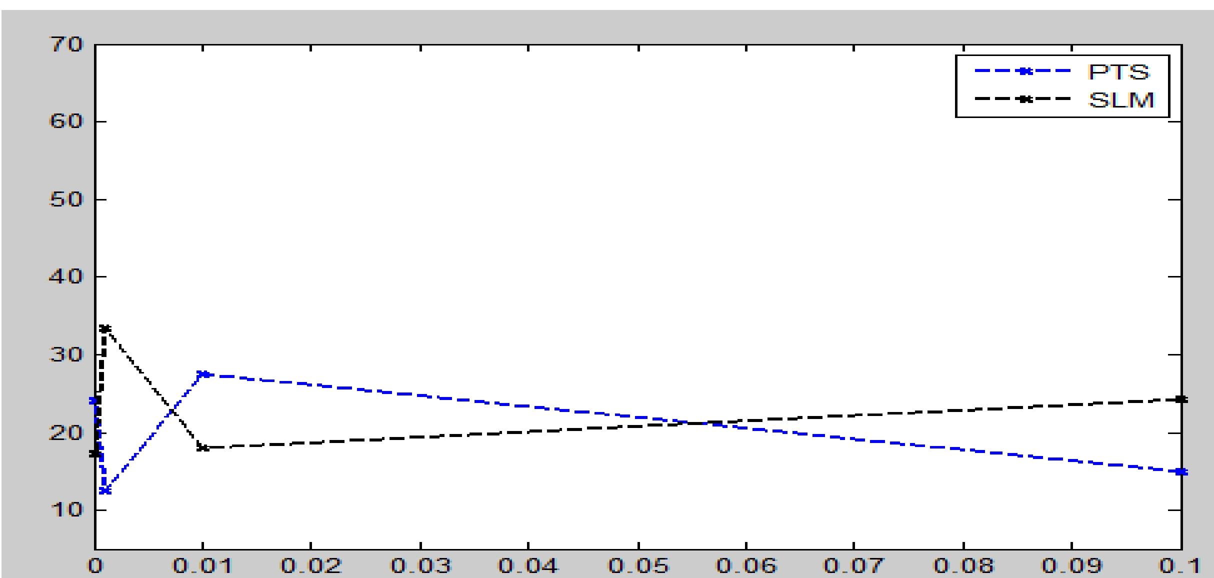

Figure 6: SLM and PTS PAPR reduction efficiencies versus probability of (PAPR > PAPR°)

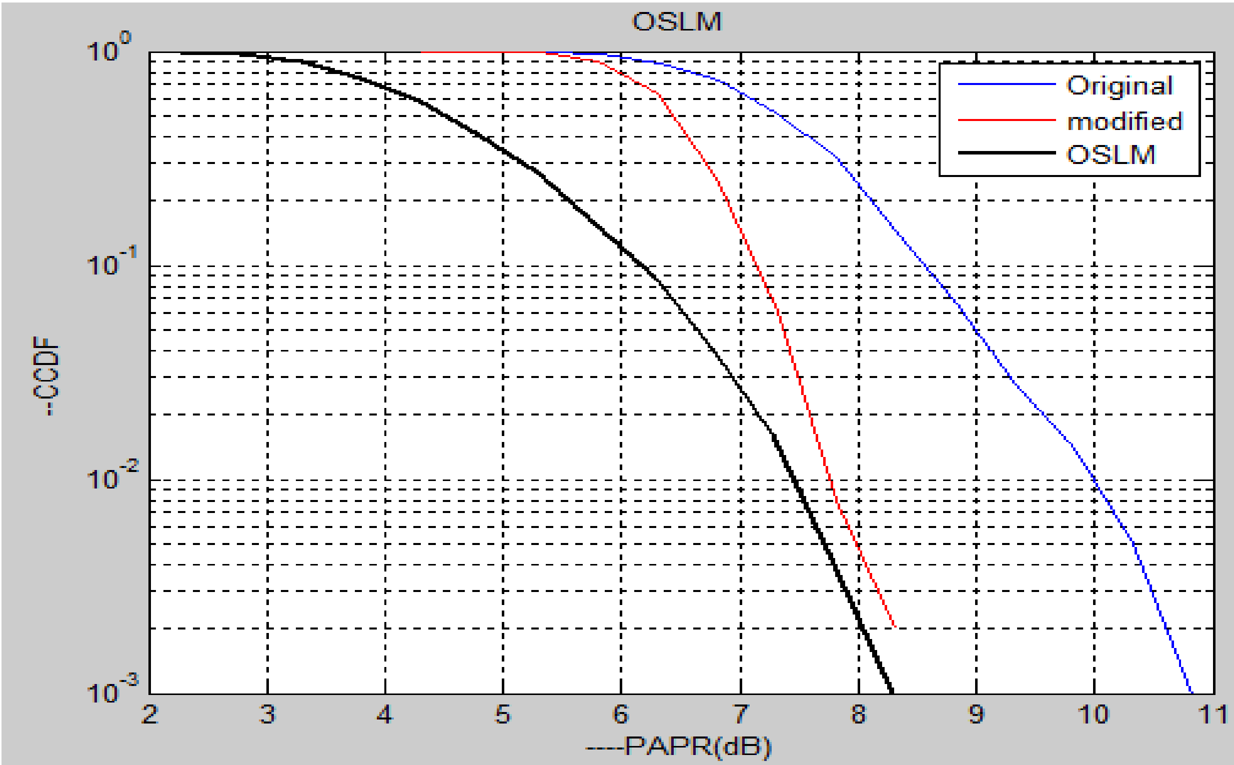

Figure 7:CCDF of PAPR of two OFDM signals proposed and OSLM method.

EXTENSION RESULTS

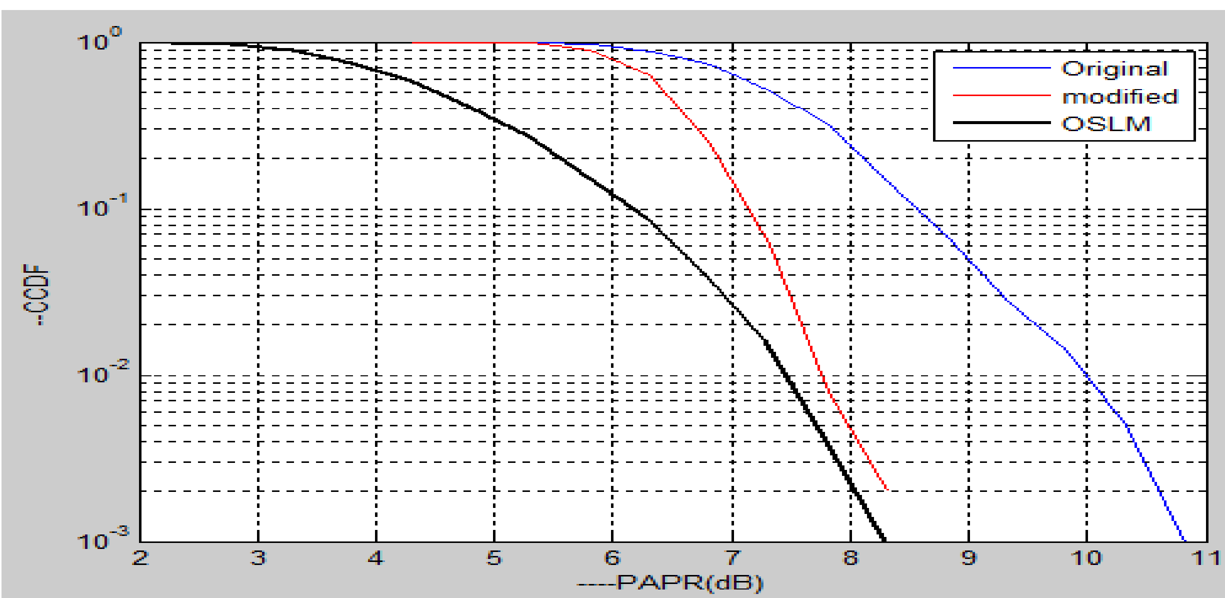

Figure 8: CCDFs of OSLM for OFDM PAPR reduction

6. CONCLUSION

It has been dependably a questionable theme to assess SLM what's more, PTS calculations for OFDM PAPR lessening. Writing productions have demonstrated that PTS PAPR lessening framework is more mind boggling than SLM PAPR lessening framework is. In this paper, in the wake of reenacting both PAPR diminishment plans SLM and PTS, a proposed way is executed to assess both SLM what's more, PTS procedures from the point of the framework proficiency while expanding the likelihood of getting high PAPR values. Results have demonstrated that PTS method overweighs SLM method while expanding the likelihood of having ($PAPR > PAPR_0$). In the future work, OSLM is used as an extension for the proposed method to improve performance as well as reliability in OFDM system.

REFERENCES

[1] Seung Hee Han; Jae Hong Lee, "An overview of peak-to-average power ratio reduction techniques for multicarrier transmission," Wireless Communications, IEEE , vol.12, no.2, pp. 56- 65, April 2005.

[2] Behravan, A.; Eriksson, T., "PAPR and other measures for OFDM systems with nonlinearity," Wireless Personal Multimedia Communications, 2002. The 5th International Symposium on , vol.1, no., pp. 149- 153 vol.1, 27-30 Oct. 2002.

[3] J. Tellado, Multicarrier Modulation with Low PAR: Applications to DSL and Wireless. Norwell, MA: Kluwer Academic Publishers, 2000.

[4] R. W. Bauml, R. F. H. Fischer, and J. B. Huber, “Reducing the peak to average power ratio of multicarrier modulation by selected mapping,” IEE Electronics Letters, vol. 32, no. 22, pp. 2056–2057, Oct. 1996.

[5] A. Goel · Prerana Gupta · M. Agrawal “Joint ICI Cancellation and PAPR Reduction in OFDMSystemsWithout Side Information” Wireless Pers Communication (2013) Published online: 12 December Springer Science+Business Media New York 2012

[6] Ahmad Rushdi, Chen Meng, and Jamal Tuqan “An SDP Approch For PAPR Reduction in OFDM Systems using patial transmit Sequence”2007 IEEE.

[7] ChunjiangDuanmu , Hongtao Chen”Reduction of the PAPR in OFDM Systemsby Intelligently Applying Both PTS and SLM Algorithms” Wireless PersCommun (2014), Springer.

[8] Jung-Chieh Chen “Partial Transmit Sequences for PAPR Reduction of OFDM Signals with Stochastic Optimization Techniques” IEEE Transactions on Consumer Electronics, Vol. 56, No. 3, August 2010.

[9] S. Ben Slimane, "Peak to Average Power Ratio Reduction of OFDM Signals using Pulse Shape," in Globecom '00, November 2000, pp. 1412 - 1416.

[10] S. H. Muller and J. B. Huber, "A Novel Peak Power Reduction Scheme for OFDM," in PIMRC '97, September 1997, pp. 1090-1094.