ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2016

PAPR Reduction Based On Hadamard Technique in OFDM System

Kagga Yesu Babu[1], A.Vanaja [2]

P.G. Student, Department of ECE, SRKIT, Enikepadu, Vijayawada, India[1]

Assistant Professor, Department of ECE, SRKIT, Enikepadu, Vijayawada, India[2]

ABSTRACT*:* OFDM (Orthogonal frequency division multiplexing) technique has been adopted as the standards in the several high data rate applications, The OFDM signal has high PAPR because of the superimposition of multi-carrier signals with large number of sub-carriers. One of the biggest drawbacks of OFDM is its high peak to average power ratio (PAPR). High PAPR of OFDM makes it unusable in non-linear systems. So the results in signal distortion and recovered signal are distorted at receiver, so the performances of bit-error-rate (BER) and channel capacity drop severely. So to avoid those problems a new algorithm has been developed the selected mapping (SLM) technique is one of the technique to reducing the Peak-to-Average Power ratio. The proposed method Hadamard technique has lower computation complexity and reduces the PAPR performance.

KEYWORDS: OFDM (Orthogonal frequency division multiplexing), peak to average power ratio (PAPR), selected mapping (SLM), bit-error-rate (BER).

I.INTRODUCTION

OFDM is one of the multi-carrier modulation (MCM) techniques that transmit signals through multiple number of carrier signals .OFDM systems suffer a high peak- to-average power ratio of the transmitted signals, which causes significant in-band distortion and out-of-band radiation inter-symbol interference (ISI) , inter-carrier interference (ICI) problems, when the signals are passed through nonlinear power amplifier. OFDM is a promising candidate that eliminates the need of very complex equalization. To reduce the PAPR, many techniques have been proposed. Such as SLM, tone reservation(TR), Clipping and tone injection(TI), partial transmit sequence(PTS), hadamard transforms and other techniques etc. Hadamard transform may reduce PAPR of OFDM signal while the error probability of system is not increased. In this paper, an efficient reducing PAPR technique based on hadamard transform method is proposed. This scheme will be compared with the original system with hadamard technique for reduction PAPR. The rest of paper is organized as follows chapter II is RELATED WORK,Chapter III System model. Chapter IV. SLM-Technique,Chapter V. PROPERTIES OF OFDM SYSTEMS, Chapter VI. PROPOSED HADAMARD TECHNIQUE, Chapter VII.CCDF AND PAPR CALCULATIONS, Chapter VIII.SIMULATION RESULTS, Chapter IX.CONCLUSION.

II.RELATED WORK

Orthogonal Frequency Division Multiplexing is a digital transmission method developed to meet the increasing demand for higher data rates in communications. Major drawback is high PAPR. Analysis and simulation of PAPR that the occurrence of large peaks in OFDM. The effect on system performance in terms of the Bit Error Rate (BER) and Power Spectral Density (PSD) is simulated for an OFDM transceiver with a saturated High Power Amplifier. This is followed by a study of published PAPR reduction methods.

The first contribution is a low complexity variation of Partial Transmit Sequences (PTS). In PTS several alternate transmit signals are seeded from the same source, each alternate transmit signal has a reversible and different phase rotation performed on the data. The transmit signal with the lowest PAPR is chosen for transmission. In novel variations, called Cyclic Shifted Sequences (CSS) and Time Inversion (TI), different shifts of the data are performed which avoid the need for complex multiplications. In certain cases a whole IFFT operation can be removed with a negligible effect on performance when CSS is combined with PTS. Furthermore it is shown that the peak re-growth of

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2016

TI and CSS after pulse shaping filtering is considerably less than for PTS. Next clipping techniques are presented which reduce substantially the complexity of clipping algorithms by using novel methods to calculate the magnitude, avoiding the use of multiplications but existing more complex and also losing signal. And then for improving the PAPR reduction SLM technique used and explained below section IV.

III. SYSTEM MODEL

In an Orthogonal frequency division multiplexing (OFDM) system with N number of sub-carriers, and data vector X = [X[0],X[1], . . . ,X[N−1]]T the discrete-time OFDM signal can be written as

$$x[n] = 1/\sqrt{N}\sum_{k=0}^{N-1} X[k].\exp\left\{\frac{j\pi nk}{N}\right\}, \mathrm{n} = 0,1,\ldots\ldots \mathrm{N}-1 \qquad (1)$$

The Peak to Average power Ratio of the transmitted signal xn can be simply defined as the ratio of the average signal power to the maximum signal. Mathematically, the PAPR of complex pass band signal *xn* is given in equation

$$PAPR = \frac{P_{power}}{P_{Average}} \qquad (2)$$

$$PAPR(x_n) = 10\log_{10}\frac{\max|x_n|^2}{E\left[|x_n|^2\right]}(dB) \qquad (3)$$

Where $\max|x_n|^2$ is the peak signal power and $E\left[|x_n|^2\right]$ represents expectation operation of the average power signal.The peak values occurs in the system increases as the number of sub-carriers increases, therefore the peak values is directly proportional to the number of subcarriers in the system. For OFDM systems, the PAPR reduction performance is generally evaluated by means of the complementary cumulative distribution function (CCDF), which is defined as the probability that the PAPR of x exceeds a given clip level , i.e.,

$$CCDF_{PAPR(x)} = \Pr\left(PAPR(x) > \gamma\right) \qquad (4)$$

IV. SLM TECHNIQUE

The traditional SLM scheme, in which only frequency-domain phase rotation is used to generate the candidate signals, the method is proposed in this also applied frequency-domain cyclic shifting, complex conjugate, and sub-carrier reversal operations in order to increase the diversity of the candidate signals. Furthermore, to avoid the multiple-IFFT problem inherent in the traditional SLM method, all four frequency-domain operations are converted into time-domain equivalents. Of course, the time-domain equivalent operations should have a low computational complexity, which is the main challenge and contribution of this study. It is shown that through a careful partitioning and re-assembling of the sub-carriers, a low-complexity architecture can be successfully achieved. The theoretical analysis results show that the computational complexity of the proposed scheme is substantially lower than that of the traditional SLM method. Furthermore, the PAPR reduction performance of the method is within 0.001 dB of that of the SLM scheme.

V.PROPERTIES OF OFDM SYSTEMS

Property 1: Frequency-Domain Cyclic Shifting / Time-Domain Phase Rotation
Time domain Data vector x, is given to the phase rotation this data is equivalent to frequency domain of the cyclic shifting data vector X. i.e.,

$$F^{-1}\left\{X\left[(k-l)_N\right]\right\} = x(n).\exp\left\{\frac{j2\pi nl}{N}\right\}, \qquad \mathrm{l}=0,1,\ldots,\mathrm{N}-1 \qquad (5)$$

Where $F^{-1}\{\,\cdot\,\}$ denotes the IFFT operation, and l is the number of frequency-domain cyclic shifts. Time-domain equivalent operation on the right hand side of (5) does not require any complex multiplications or additions.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2016

Property 2: Frequency-Domain Phase Rotation / Time-Domain Cyclic Shifting
Performing phase rotation on the frequency-domain data vector X is equivalent to performing cyclic shifting on the corresponding time-domain data vector x, i.e.

$$F^{-1}\left\{X[k]\exp\left\{\frac{-j2\pi nl}{N}\right\}\right\}=x\left[(n-w)_N\right], \quad \text{w=0,1,….,N-1,} \qquad (6)$$

Where w is the number of time-domain cyclic shifts. The time-domain equivalent operation on the right hand side of (6) does not require any complex multiplications or additions.
Property 3: Frequency-Domain Complex Conjugate /Time-Domain Complex Conjugate of Time-Reversed Signals
Performing the complex conjugate operation on the time-reversed signals is equivalent to Performing the frequency-domain complex conjugate operation

$$F^{-1}\left\{X^*[k]\right\}=x^*\left[(-n)_N\right], \qquad (7)$$

Property 4: Frequency-Domain Sub-carrier Reversal /Time-Domain Signal Reversal
Performing time-domain reversal operation on data vector x is equivalent to Performing sub-carrier reversal on the frequency-domain data vector X. ,i.e.,

$$F^{-1}\left\{X[-k]_N\right\}=x\left[(-n)_N\right], \qquad (8)$$

VI. PROPOSED HADAMARD TECHNIQUE

Hadamard SLM technique is used to reduce the occurrence of the high peaks comparing the original OFDM system. The hadamard transform is to reduce the autocorrelation of the input sequence to reduce the peak to average power problem and it requires no side information to be transmitted to the receiver. We assume H is the hadamard transform matrix of N orders, and hadamard matrix is standard orthogonal matrix. Every element of hadamard matrix only is 1 or -1. The hadamard matrix of 2 orders is stated by

$$H_2=\frac{1}{\sqrt{2}}\begin{pmatrix}1 & 1\\ 1 & -1\end{pmatrix}$$

Hadmard matrix of N2 order may be constructed by $H_2N=\frac{1}{\sqrt{2N}}\begin{pmatrix}Hn & Hn\\ Hn & -Hn\end{pmatrix}$

The sequence X=[X1,X2,…..Xn] is transformed by hadamard matrix of N order, the new sequence is Y=HX For to reduce the PAPR of OFDM signal, in this paper we proposed a reduction PAPR scheme that hadamard transform are combined to adopt. The coming input data stream is firstly transform by hadamard transform then the transformed data stream is as input to IFFT signal processing unit.
The Hadamard transform is used in a number of applications, such as image processing, speech processing, filtering, and power spectrum analysis. It is very useful for reducing bandwidth storage requirements and spread-spectrum analysis. Compared to the FFT, the FWHT requires less storage space and is faster to calculate because it uses only real additions and subtractions, while the FFT requires complex values.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2016

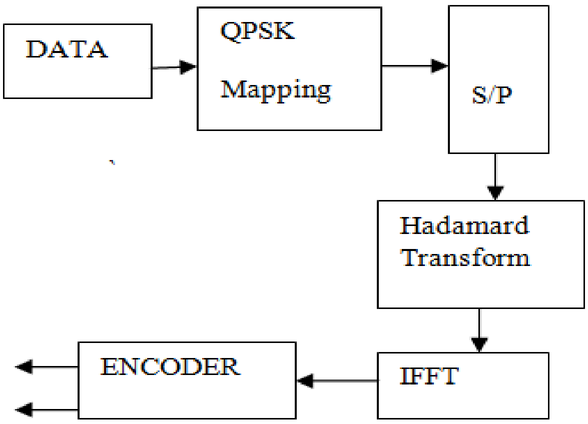

Fig.1. Block diagram of HADAMARD SLM

The signal processing steps are given below:
STEP1. The sequence X is transformed by hadamard matrix, i.e. Y = HX
STEP2. Apply IFFT. i.e y=IFFT (Y)
STEP3. Apply hadamard transform to y
STEP4. And then do inverse hadamard transform to received signal x(n)
STEP5. After that FFT transform to the signal y(n)
STEP6. Do inverse hadamard transform to the signal Y
STEP7. $X=H^TY$, Then the signal X is de-mapped to bit stream.

VII.CCDF AND PAPR CALCULATIONS

In the case of two transmit antennas, the each of *N*-dimensional OFDM symbol is transmitted from antenna 1 and antenna 2 respectively. Generally, the PAPR of the transmitted OFDM signal is defined as

$$PAPR^1 = \frac{\max |x_n|^2}{E\left[|x_n|^2\right]}$$

When calculating PAPR using discrete sampled signals, we cannot find the accurate PAPR because the true peak of continuous time OFDM signal may be missed in the Nyquist sampling. So, we use 4 times over-sampling to improve accuracy of discrete PAPR. Besides, to show statistical characteristics of PAPR, we use CCDF (Complementary Cumulative Distribution Function), which is the probability that PAPR of OFDM/CIOFDM signal exceeds a certain threshold $PAPR_0$. The CCDF is defined as

$$\begin{aligned} CCDF^l &= \Pr\left(PAPR^l > PAPR_0\right) \\ &= 1-\Pr\left(PAPR^l \le PAPR_0\right) \\ &= 1-\prod_{n=1}^{N}\left[1-\exp\left(-PAPR_0 \times \frac{P^l_{avg}}{P^l_n}\right)\right] \\ &= 1-\left(1-\exp\left(-PAPR_0\right)\right)^{\alpha N} \end{aligned}$$

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2016

Where P_n^l is the average sample power of l^{th} transmit antenna signal, $P_{avg}^l = (1/T)\int_0^T |S^l(t)|^2 dt$ is the average power of l^{th} transmit antenna signal, here, when oversampling is done, $P_n^l = P_{avg}^l$ is nearly satisfied. Commonly, α is 2.8 in most cases. We define the observed CCDF of MIMO transmitter is

$$CCDF = \max_{0<l\leq L}\left(CCDF^{\ l}\right)$$

VIII.SIMULATION RESULTS

The OFDM system we used in the simulations has N = 256 subcarriers with QPSK modulation format, where L = 4 times oversampling is used to approximate the true PAPR. The phase rotation vectors adopted in our simulations were randomly selected from the set {±l, ±j} and perfectly known at the receiver, i.e., the side information was assumed to be correctly detected at the receiver. For comparison, we considered both simplified SLM and hadamard SLM in our simulations.

The traditional SLM scheme requires M N-point IFFTs to generate M different candidate signals, where each N-point IFFT requires N/2.log2 N complex multiplications and N.log2 N complex additions. Therefore, the total number of complex multiplications and complex additions are MN/2.log2 N and MN.log2 N, respectively. The total of input signals ,N-point IFFTs and CSGBs are required to generate M candidate signals in order to maximize the PAPR diversity. Therefore, the sub-carriers are partitioned into S = U.V sets .In the below figure has taken on x-axes is Number of Candidate Signals M on y-axes Number of Complex Additions and multiplications.

$$CCRR = \left\{1 - \frac{\text{complexity of proposed scheme}}{\text{complexity of traditional SLM}}\right\}.100$$

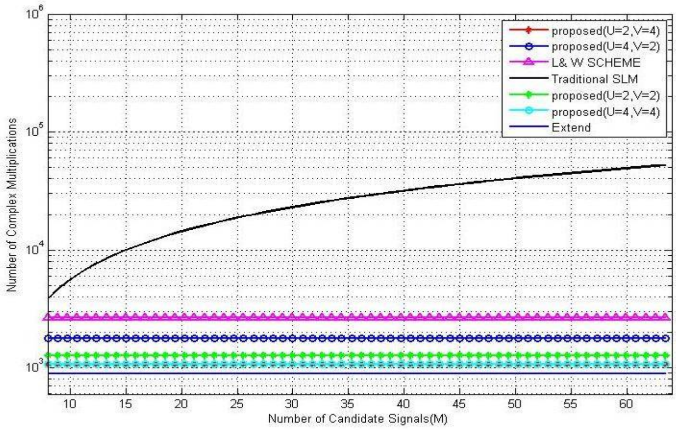

Fig2:-Number of complex multiplications as function of number of candidate signals M (N = 256).

FIG.2:The HPM partitioning method [13] is adopted in order to maximize the PAPR diversity. Therefore, the sub-carriers are partitioned into S = U ・V sets.In the SLM architecture, most elements of the inputs to the IFFT. The number of complex multiplications remains constant, irrespective of the number of candidate signals. The method proposed the least number of complex multiplications, followed by the scheme proposed in this study with (U,V) = (2, 4) and (U, V) = (2, 2). By contrast, the proposed scheme with (U,V) = (2, 2) requires the minimal number of complex additions, followed by Li and Wang's method and the proposed scheme with (U, V) = (2, 4).

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2016

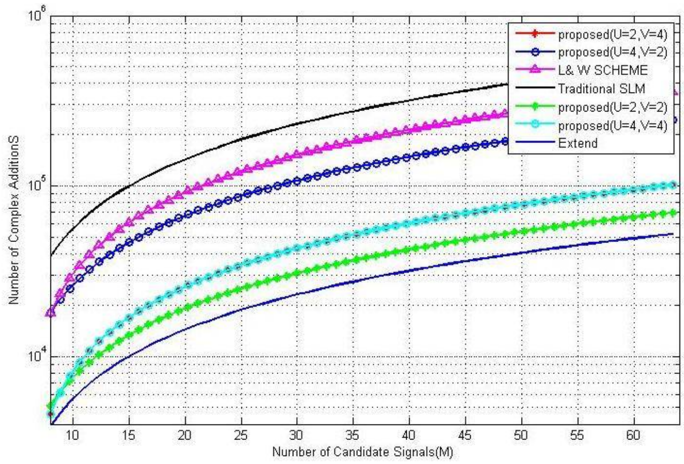

Fig3:-Number of complex additions as function of number of candidate signals M (N = 256).

FIG.3:Regarding the computational complexity of each CSGB, Property 1 demonstrates that the time-domain equivalent operation on the right hand side does not require any complex multiplications or additions when the number of frequency-domain cyclic shifts belongs to U = 2 or U = 4 should be adopted. Furthermore, Property 5 indicates that V = 2, 4 yields a significant reduction in the computational complexity. Therefore four different combinations of U and V are considered in the remainder of this study, i.e., (U, V) ∈{(2, 2), (2, 4), (4, 2), (4, 4)}. Since U = 2, 4 and V = 2, 4 were adopted, the first three blocks[13] of the CSGBs in the proposed scheme, i.e., the time-domain phase rotation, time-domain cyclic shifting, and time-domain complex conjugate operations, do not require any complex multiplications or additions, as indicated in Property 1, 2, and 3.

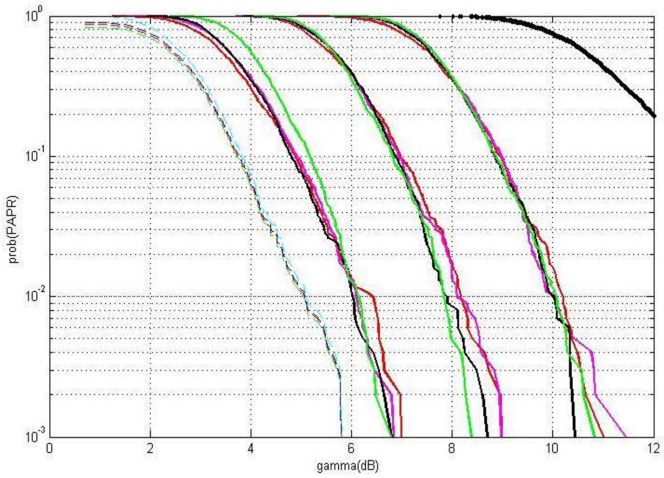

Fig4: Comparison of PAPR reduction performance of various schemes (16-M, N =256) and hadamard SLM.

Figure4 shows the PAPR reduction performance of the SLM Scheme for an OFDM system with 256 sub-carriers and the 16-quadrature amplitude modulation or 16-Quadrature Phase Shift Keying modulation (16-QAM&16-QPSK) scheme. It can be seen that the PAPR reduction performance of the proposed scheme with (U, V) = (4, 4) is extremely close to that of the traditional SLM method.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2016

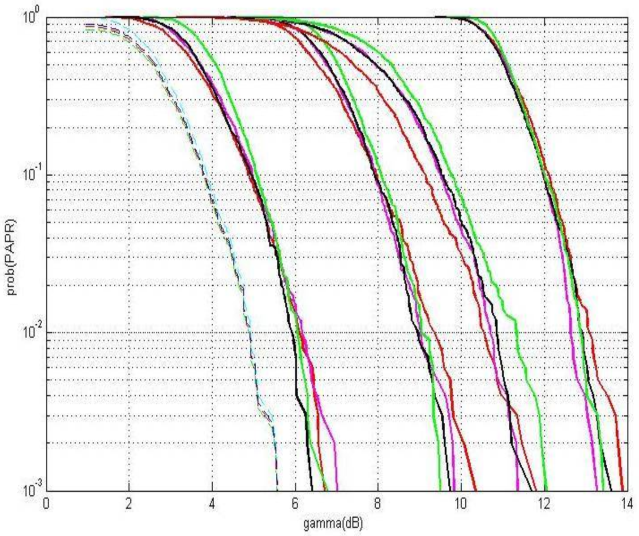

Fig5:- Comparison of PAPR reduction performance of various schemes (M-16,, N =512, 1024).and hadamard SLM

Fig.5 Can be seen that OFDM system with 512,1024 sub-carriers and M=16 used. The hadamard SLM has comparable PAPR reduction performance to the simplified SLM-scheme . Since the simplified SLM employs more phase rotation vectors, PAPR reduction performance of the hadamard SLM is slightly better than that of the simplified SLM scheme while V is small. Furthermore, it is evident that the greater the number of phase rotation vectors, the less the difference in PAPR reduction performance of hadamard SLM.

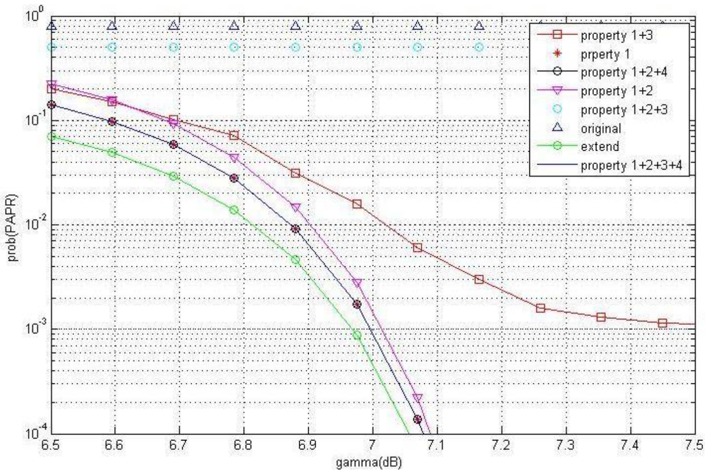

Fig6:-comparison of PAPR reduction performance for the SLM operations (1M = 16,32, N = 256, U = 4, V = 4). and hadamard SLM with 4×4

Fig6 has used PAPR reduction performance of Properties 1+2+3+4 is better than that of Properties 1+2+4, though the improvement is only marginal. The computational complexity of Properties 1+2+3+4 is the same as that of Properties 1+2+4.Thus, all properties should be adopted to obtain the best PAPR reduction performance. PAPR reduction performance of the extend hadamard SLM is slightly better than that of the SLM scheme while V is small. Furthermore, it is evident that the greater the number of phase rotation vectors, the less difference in PAPR reduction performance between the simplified SLM and the simplified hadamard.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2016

IX.CONCLUSION

In this paper, a PAPR reduction scheme based on hadamard SLM is proposed. Simulation results state that the PAPR reduction performance is improved compared with SLM and Hadamard SLM. The hadamard SLM has lower computational complexity, the proposed scheme achieves comparable PAPR reduction performance to the simplified SLM and Hadamard-SLM scheme.

REFERENCES

1. J.-C. Chen and C.-P. Li,"Tone reservation using near-optimal peak reduction tone set selection algorithm for PAPR reduction in OFDM systems," IEEE Signal Process. Lett., vol. 17, no. 11, pp. 933–936, Nov. 2010.
2. H. Li, T. Jiang, and Y. Zhou, "An improved tone reservation scheme with fast convergence for PAPR reduction in OFDM systems," IEEE Trans Broadcast., vol. 57, no. 4, pp. 902–906, Dec. 2011.
3. S.-H.Wang, K.-C. Lee, C.-P. Li, and H.-J. Li, "A low-complexity symbol interleaving-based PAPR reduction scheme for OFDM systems," in Proc.IEEE International Conference on Communications (IEEE ICC 2013),June 2013.
4. C.-P. Li, S.-H. Wang, and C.-L. Wang, "Novel low-complexity SLM schemes for PAPR reduction in OFDM systems," IEEE Trans. Signal Process., vol. 58, no. 5, pp. 2916–2921, May 2010.
5. Li, Y.G.; Winters, J.H.; Sollenberger, N.R.; "MIMO-OFDM for wireless communications: signal detection with enhanced channel estimation" Communications, IEEE Transactions on, vol. 50 Issue: 9, pp. 1471 –1477, Sep. 2002
6. J.-C. Chen and C.-K. Wen, "PAPR reduction of OFDM signals using cross-entropy-based tone injection schemes," IEEE Signal Process. Lett., vol. 17, no. 8, pp. 727–730, Aug. 2010.
7. B. S. Krongold and D. L. Jones, "PAR reduction in OFDM via active constellation extension," IEEE Trans. Broadcast., vol. 49, no. 3, pp.258–268, Sep. 2003.
8. K. Bae, J. G. Andrews, and E. J. Powers, "Adaptive active constellation extension algorithm for peak-to-average ratio reduction in OFDM," IEEE Commun. Lett., vol. 14, no. 1, pp. 39–41, Jan. 2010.
9. W.-W. Hu, S.-H. Wang, and C.-P. Li, "Gaussian integer sequences with ideal periodic autocorrelation functions," IEEE Trans. Signal Process., vol. 60, no. 11, pp. 6074–6079, Nov. 2012.
10. Redfern, A.J.; "Receiver window design for multicarrier communication systems ", Selected Areas in Communications, IEEE Journal on, vol. 20 Issue: 5, pp. 1029 –1036,Jun. 2002
11. Wang, Sen-Hung, Lee, Kuan-Chou, Chih-Peng Li, A Low-Complexity Architecture for PAPR Reduction in OFDM Systems with Near-Optimal Performance, 0018-9545 (c), 10.1109/TVT.2015.2395818,IEEE 2015.
12. H. V. Sorensenand and C. S. Burrus, "Efficient computation of the DFT with only a subset of input or output points," IEEE Trans. Signal Process., vol. 41, no. 3, pp. 1184–1200, Mar. 1993.

BIOGRAPHY

Kagga Yesu Babu received B.Tech degree in Electronics and communication Engineering from Vikas College of Engineering and Technology, Nunna in 2014 and pursuing M.Tech in SRK Institute of Technology, Vijayawada, Andhra Pradesh, India. Research interests are Cellular and Mobile Communications, Wireless Communications.

A.Vanaja received B.Tech Degree in Electronics and communication engineering from Nimra college of Engineering and Technology, jupudi in 2009 and M.Tech Degree in communications and signal processing from V.R.Siddhartha Engineering college Vijayawada, Andhrapradesh, India in 2011.Now She is working as Asst.Professor in S.R.K Institute of Techology,Vijayawada, Andhrapradesh, India. research interests are Digital image processing, Digital signal processing, wireless communications and Networks.