ISSN (ONLINE): 2395-695X
ISSN (PRINT): 2395-695X

International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST)
Vol. 2, Issue 11, November 2016

Performance Analysis of PAPR Reduction in MIMO-OFDM

Jayaraman.G[1], VeeraKumar K[2], Selvakani.S[3]
Assistant Professor, Department of ECE, Francis Xavier Engineering College, Tirunelveli [1]
Associate Professor, Department of ECE, Francis Xavier Engineering College, Tirunelveli [2]
PG Scholar, Department of ECE, Francis Xavier Engineering College, Tirunelveli [3]

***Abstract*— In communication system, it is aimed to provide highest possible transmission rate at the lowest possible power and with the least possible noise. MIMO-OFDM has been chosen for high data rate communications and widely deployed in many wireless communication standards. The major drawback in OFDM signal transmission is high PAPR. In previous, use clipping technique to tackle this problem. In this paper, use EM-GAMP algorithm to reduce PAPR in considerable amount.**

***Index Terms*— MIMO-OFDM, EM-GAMP, PAPR, MUI, CCDF.**

I. INTRODUCTION

Communication is the act of conveying intended meanings from one group to another through the use of mutually understood signs and semiotic rules. Wireless communication is the transfer of information or power between two or more points that are not connected by an electrical conductor. The most common wireless technologies use radio. . In the communication world of today, high data rate information transmission along with high capacity and reliability are just some of the requirements which modern system have to meet in order to provide a good quality of service to the end user. The arenas where wireless communication systems are deployed, signals usually suffer phenomenon like multipath delay, fading and Inter Symbol Interference (ISI) due to the frequency selectivity of the channel at the receiver side, the result of which is the poor performance and high probability of errors.

In order to overcome the above mentioned issues channel coding and equalization techniques are implemented. But due to the cost of hardware and various technical issues like delays in coding and equalization process, it is not feasible to employ these techniques where desired bit rates and the reliability of data expectations are quiet high. The solution of this issue is to implement an effective scheme like OFDM where the high bit rate over the frequency selective channel is guaranteed to some extent.

MIMO-OFDM is an efficient technique for high throughput and Qos of upcoming generation wireless communication systems [1]. MIMO also have to improve the energy efficiency and power consumption with low power components. Major problem of multicarrier transmission is high Peak-to-average Power Ratio of the transmit signal [2]. Digital-to-analog converter and power amplifier are used at the transmitter to handle this high PAPR [3]. Many techniques are used to reduce the PAPR such as clipping [4], selected mapping (SLM) [5] and partial transmission sequence (PTS) [6]. PAPR reduction schemes are also used in MIMO

ISSN (ONLINE): 2395-695X
ISSN (PRINT): 2395-695X

International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST)
Vol. 2, Issue 11, November 2016

systems [7]. A new PAPR reduction method fast iterative truncation algorithm [8] was developed for MIMO-OFDM systems. This algorithm has low convergence rate. So in this paper, use an efficient algorithm to reduce PAPR in considerable amount. The proposed algorithm EM-GAMP result shows a performance improvement than existing methods of both PAPR reduction and computational complexity. The rest of this paper details are as follows. In Section II, system model and PAPR reduction are explained in detail. Proposed system is developed in Section III. Simulation results are provided in Section IV followed by conclusion in Section V.

II. System Model

The system model of the MIMO-OFDM downlink scenario is depicted in Figure 1, where the BS is assumed to have M transmit antennas and serve K independent single-antenna users (K ≪ M), and the total number of OFDM tones is N. Then normalize the data vector to satisfy E {‖sn‖22} = 1. For each tone n ∈ τ^c , set $s_n = 0_{k\times1}$such that no signal is transmitted in the guard band. Since cooperative detection among users is often impossible, precoding must be performed at the BS to remove multiuser interference (MUI). Usually, the signal vector on the nth tone is linearly precoded as

$$w_n = P_n s_n \tag{1}$$

where w_n belongs to $C^{M\times1}$is the precoded vector that contains symbols to be transmitted on the nth sub-carrier through the M antennas respectively and $P_n$belongs to $C^{M\times K}$ represents the precoding matrix for the nth OFDM tone.

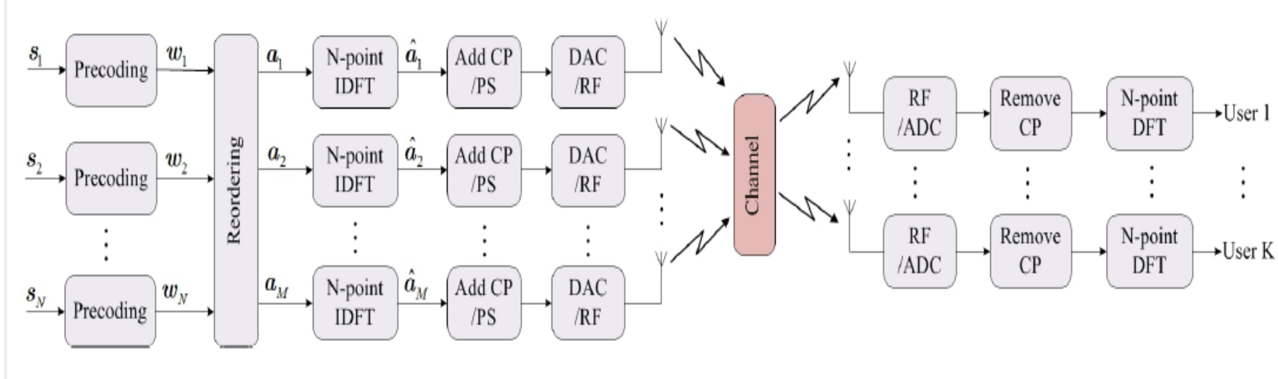

Fig 1. System model for MIMO-OFDM

After precoding, all precoded vectors are reordered to M antennas for OFDM modulation,

$$[a_1 \dots\dots a_M] = [w_1 \dots\dots w_N]^T \tag{2}$$

Where $a_m$belongs to $C^{N\times1}$represents the frequency-domain signal to be transmitted from the mth antenna. The time-domain signals are obtained through the inverse discrete Fourier

ISSN (ONLINE): 2395-695X
ISSN (PRINT): 2395-695X

International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST)
Vol. 2, Issue 11, November 2016

transform (IDFT), i.e., $\hat{a}_m = F_N^H a_m$, ∀m. Then, a cyclic prefix (CP) is added to the time-domain samples of each antenna to eliminate inter symbol interference (ISI). Finally, these samples are converted to analog signals and transmitted via the frequency selective channel.At the receivers, after removing the CPs of the received signals, the DFT is performed to obtain the frequency-domain signals.

III. PROPOSED SYSTEM

To facilitate proposed algorithm development, introduce a noise term to model the mismatch between y and Ax, i.e.

$$y = Ax + \epsilon \tag{3}$$

where ϵ denotes the noise vector. To reduce the PAPR associated with each transmit antenna, aim to find a quasi-constant magnitude solution to the above underdetermined linear system. To encourage a quasi-constant magnitude solution, propose a hierarchical truncated Gaussian mixture prior for the signal x. In the first layer, coefficients of x are assumed independent of each other and each entry xi is assigned a truncated Gaussian mixture distribution.

$$p(x_i) = \begin{cases} \Pi \frac{\mathcal{N}(x_i; v, \alpha_{i1}^{-1})}{\eta_{i1}} + (1-\Pi)\frac{\mathcal{N}(x_i; v, \alpha_{i2}^{-1})}{\eta_{i2}} & if\ x_i \\ 0\ otherwise \end{cases} \in [-v, v] \tag{4}$$

The second layer specifies Gamma distributions as hyper priors over the precision parameters α_1, α_2

$$p(\alpha_1, \alpha_2; a, b) = \prod_{l=1}^{2}\prod_{i=1}^{I} Gamma(\alpha_{li} \mid a, b) \tag{5}$$

Where

$$Gamma\left(\alpha \mid a, b\right) = \Gamma(a)^{-1} b^a \alpha^{a-1} e^{-b\alpha} \tag{6}$$

As a result, the associated entries xi will eventually lie on one of the two boundary points, leading to a quasi-constant magnitude solution. A variational expectation maximization (EM) strategy is employed for the Bayesian inference. In proposed model, z ≜{x,α1,α2,κ} are treated as hidden variables. The noise variance β and the boundary parameter v are unknown deterministic parameters, i.e., θ≜ {β, v}.It is straightforward to show that the marginal probability of the observed data can be decomposed into two terms

$$\ln p(y; \theta) = F(q, \theta) + KL(q \,\|\, p) \tag{7}$$

ISSN (ONLINE): 2395-695X
ISSN (PRINT): 2395-695X

International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST)
Vol. 2, Issue 11, November 2016

where

$$F(q,\theta) = \int q(z) \ln \frac{p(y,z;\theta)}{q(z)} dz \tag{8}$$

and

$$KL(q\,\|\,p) = -\int q(z) ln \frac{p(z\,|y;\theta)}{q(z)} dz \tag{9}$$

Where q(z) is any probability density function, KL(q‖p) is the Kullback-Leibler divergence between p(z|y; θ) and q(z). Since KL(q‖p) ≥ 0, it follows that F(q, θ) is a lower bound of ln p(y; θ), with the equality holds only when KL(q‖p) = 0, which implies p(z|y; θ) = q(z). The EM algorithm can be viewed as an iterative algorithm which iteratively maximizes the lower bound F(q, θ) with respect to the distribution q(z) and the parameters θ. Consider the calculation of q(x).

Since the variables {xi} in the joint likelihood function p(y|x; β) are non-factorizable, obtaining the posterior q(x) is rather difficult. To overcome this difficulty, we employ the generalized approximate message passing (GAMP) technique to obtain an amiable approximation of the joint likelihood function p(y|x; β).Here we approximate the joint likelihood function p(y|x; β) as a product of approximate marginal likelihoods computed via the GAMP, i.e.

$$p(y\,|x;\beta) \approx \hat{p}(y\,|x;\beta)\alpha \prod_{i=1}^{I} \mathcal{N}(x_i\,|\widehat{r_i}, \tau_i^r) \tag{10}$$

Where $\mathcal{N}(x_i\,|\widehat{r_i}, \tau_i^r)$ is the approximate marginal likelihood obtained by the GAMP algorithm PAPR is defined as the ratio of the peak power of the signal to its average power. Specifically, the PAPR at the mth transmit antenna is defined as

$$\mathrm{PAPR_M} \triangleq \frac{2N\|\hat{a}_M\|^2}{\|\hat{a}_M\|_2^2} \tag{11}$$

Where the operator $\|\,\|^2$ is used because RF-chains often process and modulate the real and imaginary part of time domain samples independently.

The complementary cumulative distribution function (CCDF) is used to evaluate the PAPR reduction performance. The CCDF denotes the probability that the PAPR of the estimated signal exceeds a given threshold PAPR0, i.e.

$$\text{CCDF (PAPR0)} = \Pr(\text{PAPR} > \text{PAPR0}) \tag{12}$$

Also, to evaluate the multiuser interference of the transmit signals, we define the MUI as

$$\mathrm{MUI} = \frac{\sum_{n\in\tau} \|s_n - H_n w_n\|_2^2}{\sum_{n\in\tau} \|s_n\|_2^2} \tag{13}$$

ISSN (ONLINE): 2395-695X
ISSN (PRINT): 2395-695X

International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST)
Vol. 2, Issue 11, November 2016

IV. SIMULATION RESULTS

OFDM is mainly designed to combat the effect of multipath reception, by dividing the wideband frequency selective fading channel into many narrow flat sub channels. OFDM offers flexibility in adaptation to time varying channel condition by adopting the parameters at each sub carriers accurately. To avoid ISI due to multipath, successive OFDM path, successive OFDM symbols are separated by guard band. This makes the OFDM system resistant to multipath effects.

Figure 1 shows the original OFDM signal. It has lots of high peak signal. The peak of original signal is continuously varying. So the largest magnitude produces high Peak to average power ratio which intrudes the system performance.

Figure 2 shows the OFDM clipped signal. Clipping scheme is the method of clipping the high peaks of the OFDM signal before passing it through the power amplifier (PA). This is done with the help of clipper.

Figure 3 shows the EM-GAMP signal. Simulation result shows the proposed algorithm achieves a substantial performance improvement over existing methods in terms of both the PAPR reduction and computational complexity.

Figure 4 shows the CCDF of the PAPR in MIMO-OFDM system. In Existing system, the zero forcing produces PAPR near to 10.6 dB and Clipping produces PAPR near to 6 dB. The Proposed system produces PAPR near to 0.8dB.

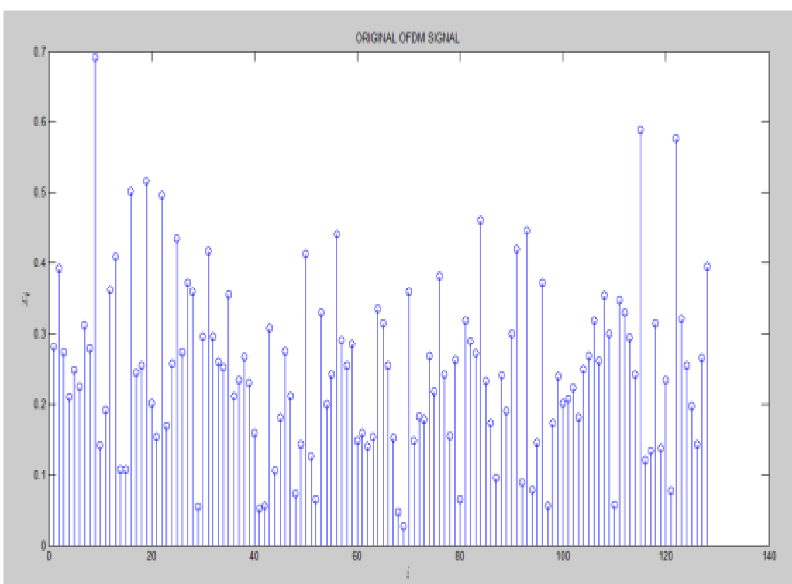

Fig 2. Original signal

ISSN (ONLINE): 2395-695X
ISSN (PRINT): 2395-695X

International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST)
Vol. 2, Issue 11, November 2016

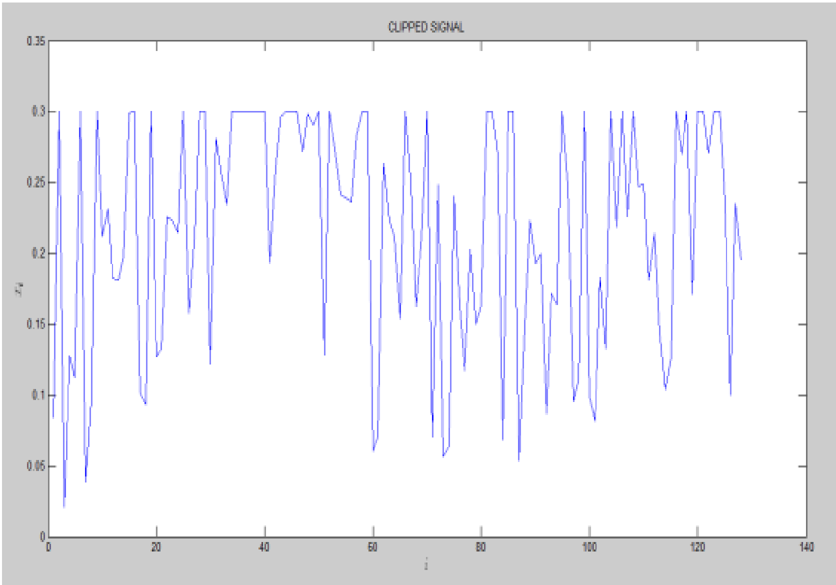

Fig 3. clipped signal

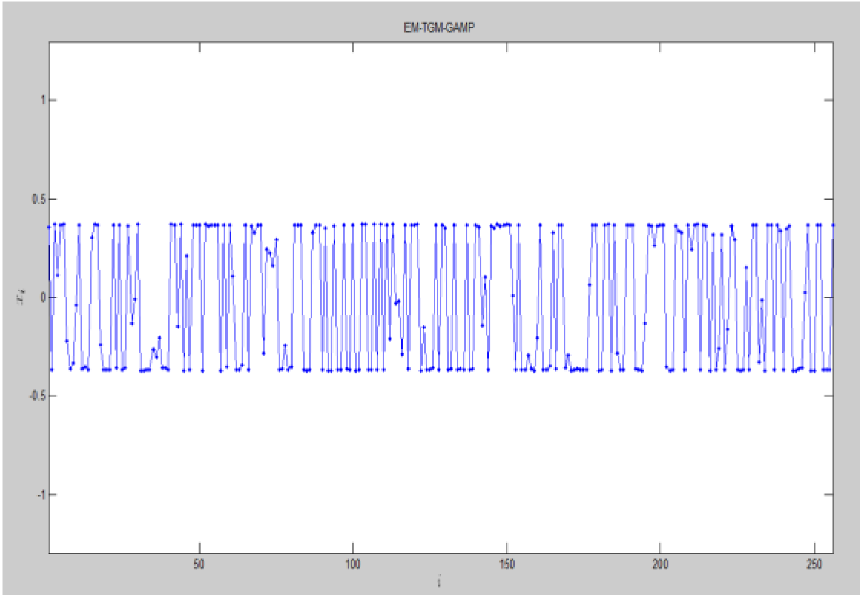

Fig 4. EM-GAMP signal

ISSN (ONLINE): 2395-695X
ISSN (PRINT): 2395-695X

International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST)
Vol. 2, Issue 11, November 2016

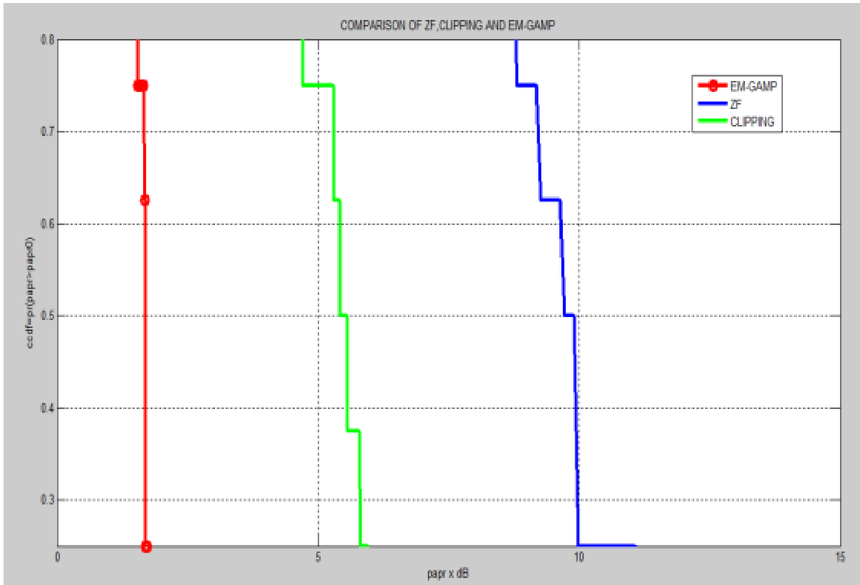

Fig 5. CCDF of PAPR

V. Conclusion

Considered the problem of joint PAPR reduction and multiuser interference (MUI) cancellation in OFDM based massive MIMO downlink systems. A hierarchical truncated Gaussian mixture prior model was proposed to encourage a low PAPR solution/signal. A variational EM algorithm was developed to obtain estimates of the hyper parameters associated with the prior model, as well as the signal. Specifically, the GAMP technique was embedded into the variational EM framework to facilitate the algorithm development. The proposed algorithm only involves simple matrix vector multiplications at each iteration and thus has a low computational complexity. Simulation results show that the proposed algorithm achieves notable improvement in PAPR reduction as compared with the Zero forcing and clipping-filtering algorithm and meanwhile renders better MUI cancellation and lower out-of-band radiation. The proposed algorithm also demonstrates a fast convergence rate, which makes it attractive for practical real-time systems.

The EM-GAMP approach produce an efficient result as low PAPR compared to other PAPR reduction techniques. Therefore, in future, the channel estimation is an area which required a lot of attention and improper channel estimation degrades the performance of system. In this work, it is assumed that channel is estimated perfectly. Hence one can evaluate the performance of proposed work with different channel estimation method. To reduce the PAPR other precoding techniques may be used for the future work.

ISSN (ONLINE): 2395-695X
ISSN (PRINT): 2395-695X

International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST)
Vol. 2, Issue 11, November 2016

REFERENCES

[1] F. Rusek, D. Persson, B. K. Lau, E. G. Larsson, T. L. Marzetta, O. Edfors, and F. Tufvesson, “Scaling up MIMO: Opportunities and challenges with very large arrays,” IEEE Signal Process. Mag., vol. 30, no. 1, pp. 40–60, Jan. 2013.

[2] G. Wunder, R. F. Fischer, H. Boche, S. Litsyn, J. No, "The PAPR problem in OFDM transmission: New directions for a long-lasting problem", IEEE Signal Process. Mag., vol. 30, no. 6, pp. 130-144, Jan. 2014.

[3] T. Jiang and Y.Wu, “An overview: Peak-to-average power ratio reduction techniques for OFDM signals,” IEEE Trans. Broadcasting, vol. 54, no. 2, pp. 257–268, June 2008.

[4] R. ONeill and L. B. Lopes, “Envelope variations and spectral splatter in clipped multicarrier signals,” in Proc. IEEE PIMRC 95, Toronto, Canada, Sept. 1995, pp. 71–75.

[5] R. W. Bäuml, R.F. Fischer, J. B. Huber, "Reducing the peak-to-average power ratio of multicarrier modulation by selected mapping", IEE Electron. Lett., vol. 32, no. 22, pp. 2056-2057, Oct. 1996.

[6] S. H. Muller and J. B. Huber, “OFDM with reduced peak-to-average power ratio by optimum combination of partial transmit sequences,” IEE Elec. Letters, vol. 33, no. 5, pp. 368–369, Feb. 1997.

[7] S. H. Han, J. H. Lee, "An overview of peak-to-average power ratio reduction techniques for multicarrier transmission", IEEE Wireless Commun., vol. 12, no. 2, pp. 56-65, Apr. 2005.

[8] C. Studer and E. G. Larsson, “PAR-aware large-scale multi-user MIMO-OFDM downlink,” IEEE J. Sel. Areas Commun., vol. 31, no. 2, pp.303–313, Feb. 2013.

[9] D. Wulich, “Definition of Efficient PAPR in OFDM”, IEEE Communications Letters, vol. 09, no. 9, pp. 832_834, 2005.

[10] J. Vila and P. Schniter, “Expectation-maximization Gaussian-mixture approximate message passing,” IEEE Trans. Signal Process., vol. 61, no. 19, pp. 4658–4672, Oct 2013.

[11] A.Venkataraman, H. Reddy, and T. M. Duman, “Space-Time Coded OFDM with Low PAPR”, EURASIP Journal on Applied Signal Processing, pp. 1_9, 2006.

[12] D. G. Tzikas, A. C. Likas, and N. P. Galatsanos, “The variational approximation for Bayesian inference,” IEEE Signal Process. Mag., vol. 25, no. 6, pp. 131–146, Jan. 2008.

[13] M. Tipping, “Sparse Bayesian learning and the relevance vector machine,” Journal of Machine Learning Research, vol. 1, pp. 211–244, 2001.

