International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Low PAPR by Weighted OFDM

Devi Radhakrishnan[1], Nijina A[2]

[1]M.tech student, Department of Electronics and Communication Engineering,
Mount Zion College of Engineering, Kadammanitta, Pathanamthitta, Kerala, India

[2]M.tech student, Department of Electronics and Communication Engineering,
Mount Zion College of Engineering, Kadammanitta, Pathanamthitta, Kerala, India

Abstract: ***Orthogonal frequency division multiplexing is a technique which is used in next generation mobile radio communication system. OFDM signals bandwidth efficiency is increased since here serial data is multiplexed in to large number of orthogonal sub channels. The disadvantage of OFDM system is that it has got high PAPR .In this paper to overcome this weighted orthogonal frequency division multiplexing (OFDM) signal is used without causing any distortion in weight removing at receiver side. The performance is analyzed through simulations. According to numerical results obtained PAPR of proposed scheme is reduced compared to convolution method and BER performance is compared to clipping and filtering method and PTS technique.***

Keywords: PAPR, Clipping and filtering, orthogonal frequency division multiplexing, PTS, BER

1. Introduction

OFDM is a modulation technique used to modulate multiple carriers simultaneously .Even though the spectrum of multiple carriers overlap they can be demodulated orthogonally. It has one of the important feature that it is robust against inter symbol interference. It has been widely used in audio/video broadcasting and local area network standards and metropolitan area network standards. In addition to all this advantage it has got an important disadvantage of high PAPR. Because of this high PAPR it leads to non-linear distortions in high power amplifiers in transmitters. High PAPR can also leads to performance degradation.

There are different methods for reducing the PAPR .They include clipping and filtering method.PTS technique, selective mapping ,tone reservation, companding, active signal constellation .In this paper ,PAPR reduction based on weighted OFDM is proposed which does not cause distortion when removing weight at the receiver side. The idea here used is a convolution process. Here the modulated signal is convoluted with a special kind of signal Φ. The signal is chosen in such a way that its Fourier transform has no zero on the real line. The weighted OFDM signal is the given convoluted signal.

In this method time taken to transmit the weighted OFDM signal is same as that it takes to transmit the OFDM signal in convolution method. This method requires 2N complex multiplications to recover data at the receiver side. The weighted OFDM with modified weight improve the BER performance if the additive Gaussian noise is considered.

2. Motivation and Related Works

Clipping and Filtering [1] reduces PAPR when compared to conventional OFDM systems. Here the signal is clipped at transmitter and filtered at the receiver. In band distortion and out of band distortion occurring at HPA. The advantage is out of band distortion is avoided but disadvantage is that it has got in band distortion unavoided.

In partial Transmit Sequence(PTS)[3] it reduces the PAPR in addition it does not reduces the computational complexity. Here OFDM signals are partitioned in each iteration.

In Selected Mapping Method (SLM) it requires a bank of inverse Fast Fourier Transform (IFFT).hence the computational complexity increases .Low complexity based SLM also been adopted. To reduce this entire disadvantage we use weighted OFDM method which has better computational complexity reduction compared to other method and low PAPR.

3. OFDM Convolution Scheme

OFDM has an important feature of orthogonal multicarrier modulation. For frequency-selective fading channel this is the most efficient method of data transmission. This method is based on IFFT.

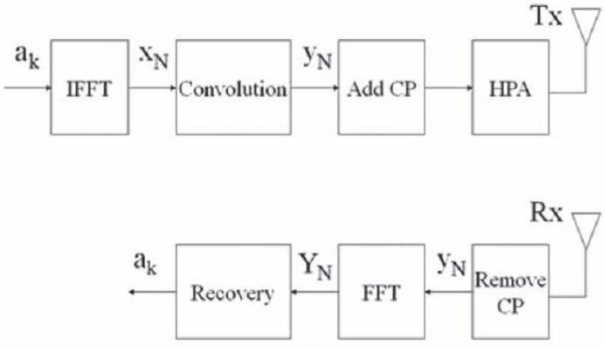

Figure 1 (a): Convolution scheme in OFDM system

In this block diagram modulated signal is given IFFT block where signal is converted from frequency domain to time domain. Then cyclic prefix is added to reduce ISI.Then it is given to HPA and is finally transmitted. In the receiver the reverse of transmitter side takes place. Here both real and imaginary part are uncorrelated and orthogonal. Therefore the distribution of both real and imaginary approaches Gaussian with zero mean according to Central Limit Theorem.

4. PAPR Reduction Motivation

The PAPR of the OFDM signal sequence is defined as the ratio of the maximum power of signal divided by the average power of the signal. There are different types of PAPR.In Continuous time PAPR of OFDM signal it is defined as the ratio of maximum instantaneous power to its average power. The discrete time PAPR determines the complexity of digital circuitry and it can be expressed as ratio of number of bits to achieve the desired signal to quantization noise for both digital operation and DAC.The base band PAPR is approximately half that of pass band PAPR.

4.1 HPA and ADC nonlinear characteristics

To obtain sufficient transmission power HPA is employed in most transmitter sections in most radio systems.HPA is usually operated at or near the saturation region to achieve maximum output power efficiency. High PAPR of OFDM signals cause inter modulation between different subcarriers and also cause interference. To keep low BER and to reduce distortion linear amplifier should operate in its linear amplifier region with large dynamic range. In wireless communication power efficiency is necessary for providing adequate area coverage. Hence a nonlinear HPA having power efficient operation is needed .Hence occurrence of interference can be prevented by reducing the PAPR of the transmitted signal. Gaussian distribution is shown by large number of subcarriers in OFDM hence ADC does not provide uniform quantization. In band distortion and out of band radiation is produced while clipping.

The best solution is before transmission of OFDM signal into HPA and DAC reduce PAPR

4.2 Saving Power

HPA exhibits poor power efficiency when it has got high dynamic range. Power is saved when PAPR is reduced where net power is directly proportional to the desired average outpower.Consider HPA with a linear model linear amplification is achieved up to saturation point. Thus we obtain

$$\eta = \frac{0.5}{PAPR} \quad (1)$$

where η is the HPA efficiency .It is defied as $p_{out,avg}/p_{DAC}$ where $p_{out,avg}$ is the average of out power

and p_{DAC} is the constant amount of power.

5. PAPR Reduction Techniques

We discuss two typical techniques in existing techniques to reduce PAPR.

5.1 Clipping and Filtering

This is the simplest and widely used technique for PAPR reduction. Here the signals are clipped above a threshold value. One clipping occurs per one OFDM symbol and two parameters are estimated by receiver :size of the clip and location. It creates both in band and out of band radiation into OFDM signals thus system performance is degraded

Filtering can remove the out of band radiation. Repeated clipping–and-filtering method increase the cost of computational complexity. In band distortion can cause BER performance degradation. The simplest and widely used method for PAPR reduction is amplitude clipping. There are different clipping techniques. They are repeated clipping, least square method, iterative clipping &filtering technique ,recursive clipping and filtering with bounded distortion

5.2 PTS Technique

In this technique IFFT is used which is divided in to two parts. An intermediate sequence is formed by the partial transformation of input symbol sequence using the first L stages of IFFT.This intermediate sequence is partitioned in to intermediate subsequence. In this intermediate signal sub sequence remaining (N-L) stages are applied thus formed subsequences are summed to OFDM symbols. This method has a disadvantage of high computational complexity since each iteration signals are partitioned.

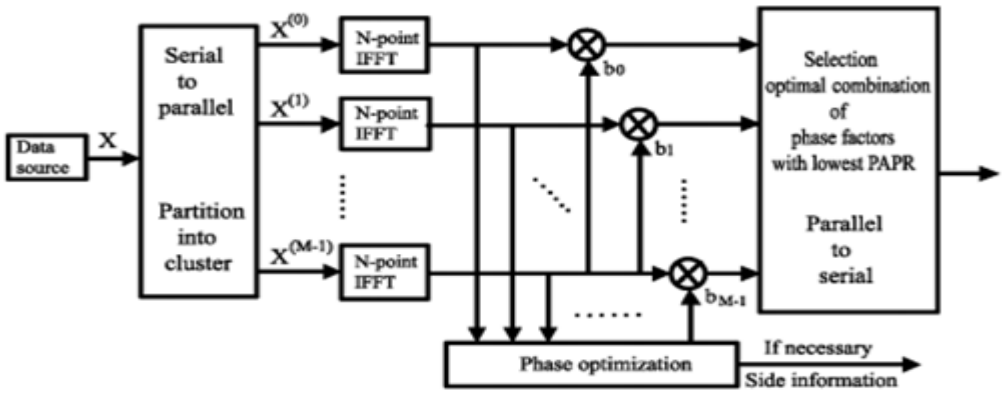

Figure 2(a): Block diagram of PTS technique

6. Weighted OFDM system

The idea here used is a convolution process. Here the modulated signal is convoluted with a special kind of signal Φ.The signal is chosen in such a way that its Fourier transform has no zero on the real line. The weighted OFDM signal is the given convoluted signal. In this proposed scheme the weighted modulated signal is given to the IFFT block where signal is converted from frequency domain to time domain. Then cyclic prefix is added to reduce ISI.Then

it is given to HPA and is finally transmitted. In the receiver the reverse of transmitter side takes place. For discrete data $\sum_{K=0}^{N-1} a_k$ modulated signal is given by

$$X_N(t)=\frac{1}{N}\sum_{K=0}^{N-1} a_k\, e^{j2\pi fkt} \qquad (2)$$

N is the number of subcarriers is the symbol period,Δf=1/N T ,and f_k=kΔf, k=0,...,N−1.

Here both real and imaginary part are uncorrelated and orthogonal. Therefore the distribution of both real and imaginary approaches Gaussian with zero mean according to Central Limit Theorem.

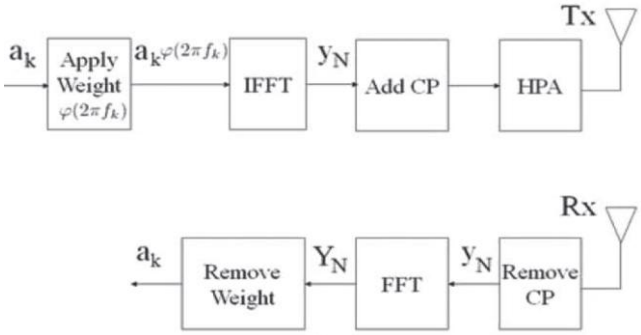

Figure 3(a): Proposed weighting scheme

When adding weight it is non uniforrm , it cause degradation to bit error performance. So to avoid that in this scheme a positive constant is added to the orginal weight. This constant is taken randomly. Convoluted signal can be written as a weighted OFDM signal .It can be expressed as

$$Y_N\ (t) = \frac{1}{\sqrt{N}} \sum_{K=0}^{N-1} a_k\, \varphi(2\pi f_k)\, e^{j2\pi f_k t} \qquad (3)$$

The modified weight after a constant α can be expressed as

$$\varphi_\alpha\ (x) = \varphi(x) + {}^{\alpha}/_{\log N} \qquad (4)$$

Hence the weighted OFDM signal with modified weight can be expressed as

$$Z_N\ (t) = \frac{1}{\sqrt{N}} \sum_{K=0}^{N-1} a_k\, \varphi_\alpha(2\pi f_k)\, e^{j2\pi f_k t} \qquad (5)$$

7. Simulation Results

The proposed scheme is analyzed through simulations. The graph is obtained between PAPR and signal to noise ratio. It is found that PAPR is reduced for weighted OFDM and for unprocessed data it is high. PAPR is defined as the ratio between maximum power of signal and average power of the signal. As weight is applied max power of signal get reduced thus PAPR get reduced.

The graph in figure 4 (b) is between BER and SNR of proposed method has better BER performance than old method .It has low BER .Thus system is improved.

This graph in figure 4(c) is between PAPR and SNR of different techniques. It is shown that PTS technique has low PAPR than proposed method, but it has high BER .so it is not good. So we prefer weighted OFDM method

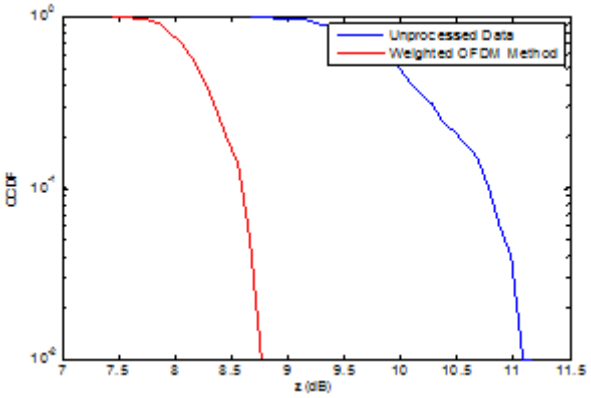

Figure 4(a): PAPR and SNR comparison of unprocessed and weighted OFDM data

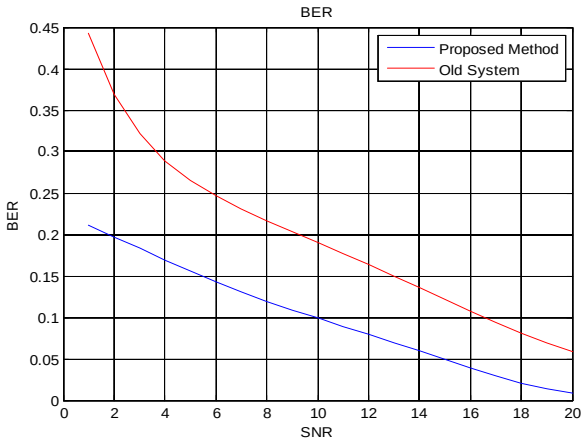

Figure 4(b): BER and SNR comparison of old and proposed method

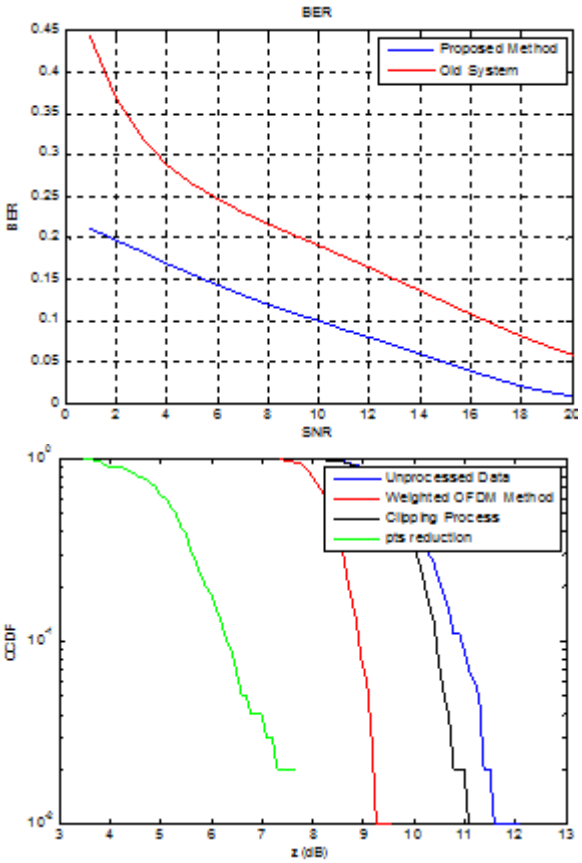

Figure4(c): PAPR and SNR comparison of different techniques

8. Conclusion

Channel robustness and spectral efficiency make OFDM very attractive to wireless communications. A very high PAPR is exhibited when the input sequences are highly correlated which is the drawback of the OFDM system. .In this paper ,PAPR reduction based on weighted OFDM is proposed which does not cause distortion when removing weight at the receiver side. In the simulation result shown weighted OFDM has better BER performance when compared to conventional method . PAPR is better for PTS technique.In future we can combine both this method to obtain low PAPR and BER.

References

[1] Y.-C. Wang and Z.-Q. Luo, "Optimized iterative clipping and filtering for PAPR reduction of OFDM signals," IEEE Trans. Commun., vol. 59, no. 1, pp. 33–37, Jan. 2011.
[2] Y. J. Kou, W. S. Lu, and A. Antoniou, "A new peak-to-average power-ratio reduction algorithm for OFDM systems via constellation extension," IEEE Trans. Wireless Communications, vol. 6, no. 5, pp 1823–1832, May 2007
[3] H. Chen and H. Liang, "PAPR reduction of OFDM signals using partial transmit sequences and Reed- Muller codes," IEEE Communications Letters, vol.11no. 6, pp. 528–530, Jun. 2007.
[4] S. Yoo, S. Yoon, S. Y. Kim, and I. Song, "A novel PAPR reduction scheme for OFDM systems: Selective mapping of partial tones (SMOPT)," IEEE Trans. Consum. Electron., vol. 52, no. 1, pp. 40–43, Feb. 2006.
[5] T. Jiang, W. Yao, P. Guo, Y. Song, and D. Qu, "Two novel nonlinear companding schemes with iterative receiver to reduce PAPR in multi- carrier modulation systems," IEEE Trans. Broadcasting, vol. 52, no. 2, pp. 268–273, Mar. 2006.
[6] D. W. Lim, S. J. Heo, J. S. No, and H. Chung, "A New PTS OFDM Scheme with Low Complexity for PAPR Reduction," IEEE Trans.Broadcasting, vol. 52, no. 1, pp. 77–82, Mar. 2006
[7] T. Jiang, Y. Yang, and Y. H. Song, "Exponential companding technique for PAPR reduction in OFDM systems," IEEE Trans. Broadcast., vol. 51, no. 2, pp. 244–248, Jun. 2005.
[8] X. Huang, J. Lu, J. Zheng, K. B. Letaief, and J. Gu, "Companding transform forreduction in peak-to-average power ratio of OFDM signals," IEEE Trans. Wireless Comuun., vol. 3, no. 6, pp. 2030–2039,Nov. 2004.

Author Profile

Devi Radhakrishnan received the B.Tech degree in Electronics and Communication Engineering from M.G University, Kerala at Mount Zion College of Engineering in 2012. And now she is pursuing her M.Tech degree in Communication Engineering under the same university in Mount Zion College of Engineering.

Nijina A received the B.Tech degree in Electronics and Communication Engineering from kerala University at SHM College of Engineering in 2013. And now she is pursuing her M.Tech degree in Communication Engineering under M.G university in Mount Zion College of Engineering.