Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X

IJCSMC, Vol. 3, Issue. 5, May 2014, pg.562 – 566

RESEARCH ARTICLE

Weighted Mean Scheme for PAPR Reduction of OFDM Signals

K. Rajesh[1], K. Suresh[2]

[1]Information Technology & Sri Venkateswara College of Engineering, Chennai, India

[2]Information Technology & Sri Venkateswara College of Engineering, Chennai, India

[1] rajeshkmessenger@gmail.com; [2] ksuresh@svce.ac.in

Abstract— In orthogonal frequency division multiplexing (OFDM) system, high peak-to-average power ratio (PAPR) is the main drawback. In this paper, a Weighted Mean scheme is proposed to reduce the high peak-to-average power ratio of the discrete OFDM signal without difficulty in removing the mean weight at the receiver section. In the proposed scheme, Weighted Mean scheme is imposed on every two successive positive and negative discrete OFDM signal point at the transmitter section and original discrete OFDM signal is completely regained without distortion in removing the Weighted Mean at the receiver section. The simulation result shows that bit-error-rate (BER) performance of the Weighted Mean scheme is enhanced compared to both weighted and clipping technique.

Keywords— Bit-error-rate (BER); peak-to-average power ratio (PAPR); orthogonal frequency division multiplexing (OFDM); weighted data

I. INTRODUCTION

OFDM is a bandwidth-efficient signalling scheme for wideband digital communications. OFDM is used for wideband digital communication, which is commonly used for digital television and audio broadcasting as well as broadband Internet access and wireless networking. Orthogonal frequency division multiplexing is a modulation technique for digital multi-carrier modulation that modulates multiple carriers simultaneously. Although their spectra overlap, the transmitted multiple carriers can be demodulated orthogonally. OFDM is a robust against narrowband interference, because such interference affects only a small percentage of subcarriers and it has high spectral efficiency.

Even though it has several advantages, the main drawback of OFDM-based systems is the high PAPR of a transmitted signal, which causes a distortion of a signal at the nonlinear high-power amplifier (HPA) of a transmitter and efficiency of the high power amplifier is greatly reduced. Hence, high peak to average ratio must be reduced to avoid signal distortion at the transmitter. To avoid the high PAPR, various techniques have been developed such as clipping and filtering technique [1]-[3]; companding [4], [5]; peak cancellation [6]; coding [7]; tone rejection [8]; partial transmit sequence [9]; weighted [10] and a Survey is presented in [11] which provides reader with a broader understanding of the high PAPR problem. The survey clearly defines the metrics based on which the performance of PAPR reduction schemes can be evaluated. The taxonomy of PAPR reduction schemes classifies them into signal distortion, multiple signalling and coding techniques.

In this proposed scheme, a PAPR reduction scheme based on a Weighted Mean OFDM signal scheme is proposed to reduce the high PAPR without difficulty in removing the mean weight at the receiver side. First, a mean value is calculated between first two positive and negative OFDM signal points. Second, among two signal points, first signal point is represented as it is and second signal point is replaced by Weighted Mean. It is evaluated for all the OFDM signal points and once again mean value is calculated between two signal points as above two steps but first signal point is replaced by Weighted Mean value and second signal point is represented as it is. Hence, the power is distributed uniformly and high peak-to- average power ratio is greatly reduced and mean weight is completely removed at the receiver section.

Gaussian function, sine function, and other functions were used as weighted functions to reduce high PAPR in the weighted scheme. When noise is not present, Gaussian function is used to reduce high PAPR of OFDM signal. When noise is present, BER performance of Gaussian function is greatly reduced. In the proposed scheme, Weighted Mean Scheme is introduced to enhance BER performance of OFDM signal.

II. OFDM SYSTEM

OFDM is a multi-carrier modulation that split high rate data streams into a number of lower rate data streams. OFDM is cyclically extended to avoid inter symbol interference. Inverse Fourier transform (IFFT) can be effectively utilized to generate OFDM signal and FFT is used to recover the OFDM signal orthogonally.

The block diagrams for an OFDM system with the mean weighted scheme is shown in figure 1. Fig. 1 shows the multi-carrier modulation is done over the multiple carriers by the IFFT and the weighted block reduces the high PAPR of OFDM signal. The mean weighted scheme is applied to all signal points based on the consecutive two positive or negative signal points. Fig. 2 shows the demodulation is done over the multiple carriers by the FFT. In the system description, for a discrete data $\{p_k\}$ k=o to N-1, multicarrier-modulated signal X_N is represented by

$$X_N(\mathrm{m})=\frac{1}{\sqrt{N}}\sum_{k=0}^{N-1}\left(p_k \mathrm{e}^{\mathrm{i}2\pi \mathrm{f_k m}}\right)$$

Where, N is the number of subcarriers, T is the original symbol period, F is the frequency

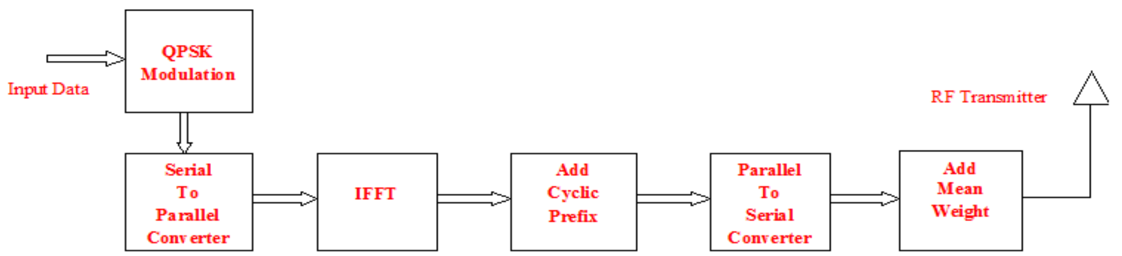

Fig. 1 OFDM Transmitter- Weighted Mean Scheme

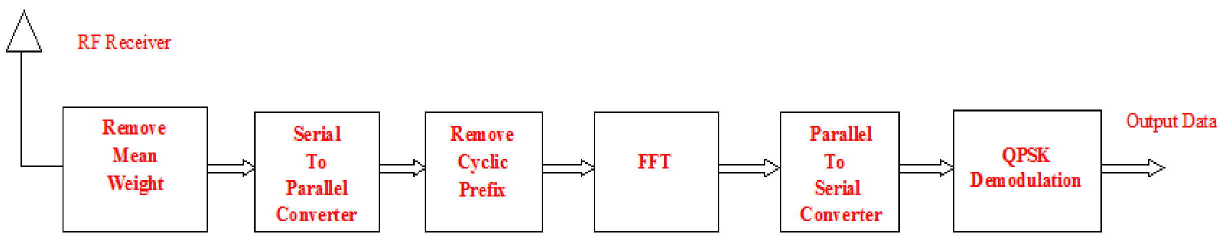

Fig. 2 OFDM Receiver- Weighted Mean Scheme

When N signals are added with the same phase, they produce a peak power that is N times the average power. The peak power is defined as the power of sine wave with amplitude equal to the maximum envelope value. The PAPR of X_n over the time interval [0, *NT*] is defined by

$$\text{PAPR } (X_N) = \frac{\max_{0\le t\le NT}(|X_N(m)|)^2}{E(|X_N(m)|)^2}$$

Where, E (·) is the expectation operator.

III. WEIGHTED MEAN ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING SYSTEM

In the mean weighted OFDM signal scheme, mean weight is imposed on multicarrier-modulated signal X_N to reduce the high PAPR of the OFDM signal.

First, a mean value is calculated between first two positive and negative OFDM signal points. The mean value between two signal points $X_N(m)$ & $X_N(n)$ is calculated as

$$X_N(\text{n}) = \frac{X_N(m)+X_N(n)}{2} \quad X_N(m), X_N(n) \geq 0 \ \& \ n > m$$
$$X_N(\text{n}) = \frac{X_N(m)+X_N(n)}{2} \quad X_N(m), X_N(n) < 0 \ \& \ n > m$$

$$\text{Where,} \quad X_N(\text{m}) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} \left(p_k \mathrm{e}^{\mathrm{i}2\pi \mathrm{f_k m}}\right)$$

Second, among two signal points, first signal point is represented as it is and the second signal point is replaced by Weighted Mean $X_N(n)$. The mean value is calculated for all the remaining OFDM signal points as stated in the above condition. This mean value reduces the high peak value of all the OFDM signal Points $X_N(n)$.

Similarly, the above procedure is followed once again that is mean value is calculated between two signal points but first signal point is replaced by Weighted Mean $X_N(m)$ and the second signal point is represented as it is. This mean value reduces the high peak value of all the OFDM signal Points $X_N(m)$. The mean value is calculated as

Similarly, the above procedure is followed once again that is Mean value is calculated between two signal points but first reduces the high peak value of all the OFDM signal points $X_N(n)$. The mean value is calculated as

$$X_N(\text{m}) = \frac{X_N(m)+X_N(n)}{2} \quad X_N(m), X_N(n) \geq 0 \ \& \ n > m$$

$$X_N(\text{m}) = \frac{X_N(m)+X_N(n)}{2} \quad X_N(m), X_N(n) < 0 \ \& \ n > \text{m}$$

Hence, high PAPR of the OFDM signal is greatly reduced and the Power is distributed uniformly. The mean weight is completely is removed easily at the receiver section. At the receiver section, the OFDM signal is recovered by using a simple mathematical function. The mean weight is removed for positive OFDM signal points as

$$X_N(\text{m}) = 2 * X_N(m) - X_N(n) \quad X_N(m), X_N(n) \geq 0 \ \& \ n > m$$

$$X_N(\text{n}) = 2 * X_N(n) - X_N(m) \quad X_N(m), X_N(n) \geq 0 \ \& \ n > m$$

The mean weight is removed for negative OFDM signal points as

$$X_N(\text{m}) = 2 * X_N(m) - X_N(n) \quad X_N(m), X_N(n) < 0 \ \& \ n > m$$

$$X_N(\text{n}) = 2 * X_N(n) - X_N(m) \quad X_N(m), X_N(n) < 0 \ \& \ n > m$$

This mean weighted scheme is simple to implement in the OFDM system in which Weighted Mean is added at the transmitter and it is easily removed at the receiver without any distortion.

IV. SIMULATION RESULTS

The performance of Weighted Mean scheme is analysed based on simulations. In the simulation, quadratic-phase-shift-keying (QPSK) modulation is used in which 128 symbols are randomly generated and IFFT block generates discrete OFDM signal. A mean weight is added for all Signal Points of the discrete OFDM and original signal is completely recovered at the receiver.

Fig. 3 shows the output of IFFT block that has high peak- to- average power ratio. The peak power is reduced by adding corresponding Mean weight for all the discrete OFDM symbols. The weight is added based on successive positive and negative points. The weight is different for all the Discrete OFDM signals and power is distributed uniformly. Fig 4 shows the modified discrete OFDM symbols that has reduced peak power.

Fig. 4 shows the performance analysis of weighted, Weighted Mean and clipping technique. In the performance analysis, clipping technique is simulated with various clipping ratio CR = 0.8, 1.2, 1.6 for N= 128 symbols. Weighted scheme is simulated with a fixed shift parameter m = 0.03 for $N=10^3$ symbols and Weighted Mean scheme is simulated with mean weight $X_N(n)$ for N=128 symbols.

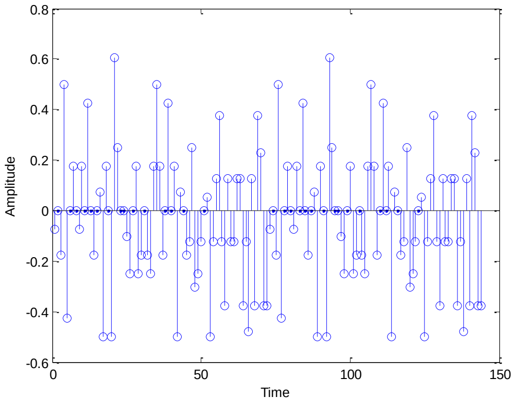

Fig. 3 OFDM Signal-Without PAPR Reduction

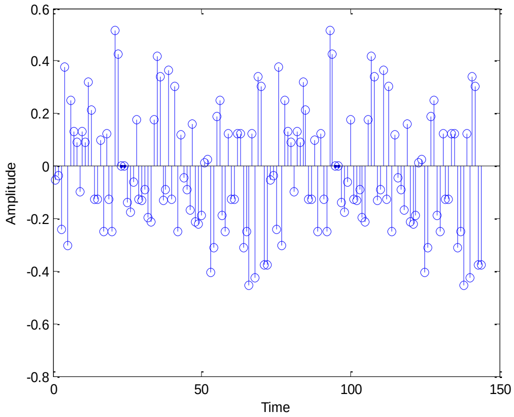

Fig. 4 OFDM Signal-With PAPR Reduction

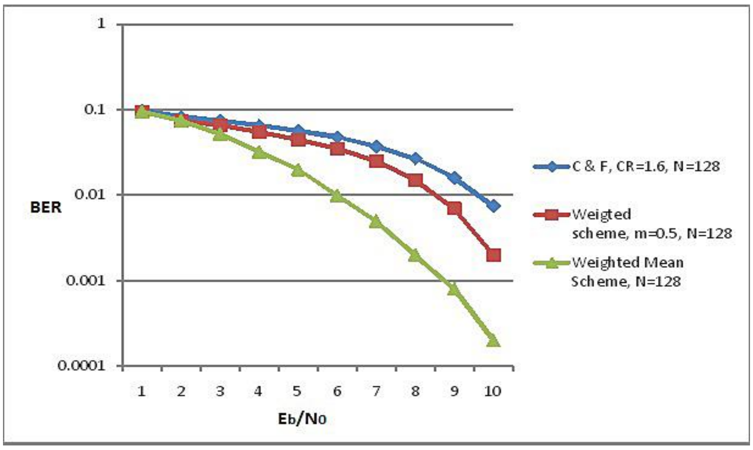

Fig. 5 BER of the C & F & Weighted Mean Method

The BER performance of all the technique (weighted, Weighted Mean and clipping technique) is analysed over the Additive White Gaussian Noise channel. As shown in the figure, compared to weighted and clipping technique, BER performance of Weighted Mean is enhanced.

V. CONCLUSION

In the proposed scheme, a Weighted Mean scheme is introduced to reduce the high peak-to-average power ratio of the Discrete OFDM signal in which mean weight $X_N(n)$ is added at the transmitter and it is completely removed by using a simple mathematical function at the receiver. The mean weight $X_N(n)$ is different for every symbols and it is calculated based on successive positive or negative symbol. The simulation results show that, the BER performance of Weighted Mean is superior compared with weighted and clipping and filtering technique.

REFERENCES

[1] J. Armstrong, “Peak-to-average power reduction for OFDM by repeated clipping and frequency domain filtering,” Electronic Letter, vol. 38, no. 5, pp. 246–247, 2002.

[2] Xiaodong Zhu, Wensheng Pan, Hong Li, and Youxi Tang, “Simplified Approach to Optimized Iterative Clipping and Filtering for PAPR Reduction of OFDM Signals ” IEEE Transactions On Communications, Vol. 61, No. 5, 2013

[3] 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, 2011.

[4] X. Huang, J. Lu, J. Zheng, K. B. Letaief, and J. Gu, “Companding transform for reduction in peak-to-average power ratio of OFDM signals,” IEEE Trans. Wireless Comuun., vol. 3, no. 6, pp. 2030–2039, 2004.

[5] Tao Jiang & Yang Yang,“ Exponential Companding Technique for PAPR Reduction in OFDM Systems”, IEEE Transaction On Broadcasting, Vol. 51, No. 2, 2005.

[6] Hyun-Bae Jeon, Jong-Seon No, and Dong-Joon Shin, “A New PAPR Reduction Scheme Using Efficient Peak Cancellation for OFDM Systems” IEEE Transactions on broadcastings, Vol. 58, No. 4, 2012

[7] Slimane Ben Slimane, “Reducing the Peak-to-Average Power Ratio of OFDM Signals Through Pre-coding”, IEEE Transactions On Vehicular Techonology, Vol. 56, No. 2, 2007.

[8] Seungsoo Yoo, Seokho Yoon & Sun Yong Kim,“A Novel PAPR Reduction Scheme for OFDM Systems: Selective Mapping of Partial Tones”, IEEE Transactions on Consumer Electronics, Vol. 52, No. 1, 2006.

[9] S. H. Muller and H. B. Huber, “OFDM with reduced peak-to-mean power ratio by optimum combination of partial transmit sequences,” Electronics Letter, vol. 33, no. 5, pp. 368–369, 1997.

[10] Chang Eon Shin, Kyung Soo Rim, and Youngok Kim, “A Weighted OFDM Signal Scheme for Peak-to-Average Power Ratio Reduction of OFDM Signals” IEEE Transactions on Vehicular Technology, Vol. 62, No. 3, 2013

[11] Yasir Rahmatallah and Seshadri Mohan,“ Peak-To-Average Power Ratio Reduction in OFDM Systems: A Survey and Taxonomy” IEEE Communications Surveys & Tutorials, Accepted For Publication,2013