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A Low Complexity Selective Mapping Technique Scheme for PAPR Reduction in OFDM Systems

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Abstract— Orthogonal Frequency Division Multiplexing (OFDM) is one of the prominent multicarrier modulation technique used for high speed data transmission in communication system. The PAPR problem is one of the most important issues for OFDM transmission systems. PTS and SLM are two very common schemes use for the PAPR reduction. PTS technique has higher computational complexity due to phase optimization. Some techniques have been proposed earlier for the reduction in the complexity by the use of new phase sequence. In this article we have proposed new SLM methods based on the use of new phase sequence and clipping to get reduction in complexity with reduced PAPR.

Key words: Orthogonal Frequency Division Multiplexing, SLM methods, PTS technique

I. INTRODUCTION

Today OFDM is widely used in many applications like Digital Audio Broadcasting (DAB), Digital Video Broadcasting (DVB), High Definition Television (HDTV), etc, because of its high program broadcasting capacity and end-to-end transmission system.

OFDM is an attractive technique for achieving high-bit-rate wireless data communication [1]. It has been applied extensively to digital transmission, such as in wireless local area networks and digital video/audio broadcasting systems. Moreover, it has been regarded as a promising transmission technique for fourth-generation wireless mobile communications. However, due to its multicarrier nature, the major drawback of the OFDM system is the high peak-to-average power ratio (PAPR), which may cause high out-of-band radiation when the OFDM signal is passed through a radio frequency power amplifier. Consequently, the high PAPR is one of the most important implementation challenges that face designers of OFDM[2]–[6].

OFDM has a comparatively large peak-to-average power ratio (PAPR), which tends to condense the power efficiency of RF amplifiers. Framing up of OFDM signals with lower crest-factor is predominantly significant if the number of subcarriers is more because the peak power of a sum of N sinusoidal signals can be as large as N times the mean power. Furthermore, output peak extracting produces out of band transmission due to inter-modulation distortion[7-9].

Multicarrier systems are naturally more vulnerable to phase noise and frequency offset. Doppler shift and Frequency jitter between the transmitter and receiver causes inter-carrier-interference (ICI) which humiliates performance of the system unless suitable compensation techniques are employed. OFDM remains a chosen modulation scheme for upcoming broadband radio area systems because of its inherent flexibility in power loading across the subcarriers and concerning adaptive modulation[11-12].

Various methods for PAPR reduction have been proposed in the literature to avoid the occurrence of high PAPR of OFDM signals. Among these methods, the partial transmit sequence (PTS) technique is the attractive scheme because of good PAPR reduction performance and no restrictions to the number of the subcarriers. The PTS technique significantly reduces the PAPR, but unfortunately, finding the optimal phase factors is a highly complex problem. In order to reduce the search complexity, the selection of the phase factors is limited to a set of finite number of elements. To minimize this problem the technique is proposed in which the new PTS scheme has been used, which have the new phase sequence, Further in this technique the clipping is applied within the PTS. We could get the more reduction in the complexity that's why we have used the SLM technique and used it with new phase sequences and clipping as in the [13]. SLM have lesser complexity problem and PAPR can be an accepted to an acceptable level that's why with the application of these techniques for SLM.

II. OFDM SYSTEM MODEL AND PAPR DEFINITION

In an OFDM system with N subcarriers, the discrete-time transmitted OFDM signal is given by:

$$x_k = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_n e^{j2\pi nk/PN}, \quad k = 1,2,\ldots,PN-1 \tag{1}$$

Where $j = \sqrt{-1}$, $X_n, n = 0,1, \ldots N-1$. are input symbols modulated by PSK or QAM, and P is an integer that larger or equal 1 called over-sampling factor. When $P = 1$, the samples are achieved by use of the Nyquist rate sampling. We shall write the input data block as a vector, $X = [X_0\, X_1 \ldots . X_{N-1}]$. The PAPR of the transmitted signal in (1), defined as the ratio of the maximum to the average power, can be expressed by

$$\text{PAPR} = 10\log_{10} \frac{\max |x_k|^2}{E\left[|x_k|^2 \right]} \ (\text{dB}) \tag{2}$$

Where $E[.]$ denotes the expected value operator.

PAPR is a random variable because it is a function of the input data, and the input data are random variable. Therefore PAPR can be calculated by using level crossing rate theorem that calculates the average number of times that the envelope of a signal crosses a given level. Knowing the amplitude distribution of the OFDM output signals, it is easy to compute the probability that the instantaneous amplitude will be above a given threshold and the same goes for power. This is performed by calculating the complementary cumulative distribution function (CCDF) for different PAPR values as follows:

$$CCDF = Pr(PAPR > PAPR_0) \quad (3)$$

III. SELECTIVE MAPPING TECHNIQUE (SLM)

Many methods are there to reduce the PAPR, but both complexity and redundancy are high and only small gains in PAPR are achieved[12]. When the phases of different sub-carriers add up in phase the possibility of PAPR being high is for sure. Hence one method to reduce the in-phase addition is to change the phase before converting the frequency domain signal into time domain [13]. Hence before taking the N point IDFT each block of input is multiplied by an φ vector of length N. Now there is a possibility that the PAPR may turn low.

SLM (selective mapping) method is a kind of phase rotation methods. Phase data of the lowest PAPR will be selected to transmit.

Fig.1 is block diagram of SLM method. Let's define data stream after S/P conversion as $X = [X0,X1,...,XN-1]^T$. Then phase-rotated data due to the phase rotation factor $B^{(u)}$ can be written as:

$$X^{(u)} = IFFT(X \otimes B^{(u)}) \quad (4)$$

where

$$B^{(u)} = [B_0^{(u)}, B_1^{(u)} \ldots\ldots B_{N-1}^{(u)}]^T \quad (5)$$

(U: - lies from 1 to U-1.)

is the phase weighting sequence with

$$B_0^{(u)} = 1$$

and usually selected from $\{\pm 1\}$ for avoiding the complexity for complex multiplications. The modified data for the uthphase sequence

$$X^{(u)} = [X_0 B_0^{(u)}, X_1 B_1^{(u)} \ldots\ldots X_{N-1} B_{N-1}^{(u)}]^T \quad (6)$$

u=0,1,2….U-1. After the PAPR comparisons among the U data sequence $x^{(u)}$, the optimal mapped one ˆx with the minimum PAPR is selected for transmission. Then

$$\hat{X} = \arg\min_{0 \le u \le U} [PAPR(X^{(u)})] \quad (7)$$

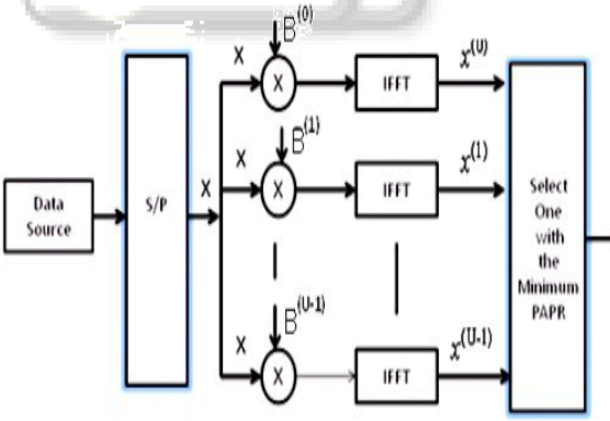

Fig. 1: Scheme of a Modulator with Selective Mapping

PAPR reduction effect will be better U is increased. SLM method can effectively reduce PAPR without any signal distortion. Here we have used SLM technique without explicit side information.

IV. SLM WITH NEW PHASE SEQUENCE

In this scheme, new phase sequence is generated from the possible phase factors. The possible phase factors or weights depend on the mapping used as in SLM. For example in the case of number of allowed phase factors W=4(QPSK), then phase sequence can be chosen from {1,j,-1,-j} and let the phase sequence consist of N random values. The phase sequences can be random, adjacent or interleaved [10]. The random phase sequence provides better PAPR reduction compared to the adjacent and interleaved phase sequences [1],[4]. The new phase sequences form the phase sequence matrix. Thus the new phase sequence matrix has different values in each row.

The new phase sequences are multiplied with each of the sub sequences correspondingly to obtain the time domain signal. The phase factors from the phase sequences which produce the signals with smallest PAPR is chosen as the optimum values.

V. LOW COMPLEXITY SLM WITH CLIPPING

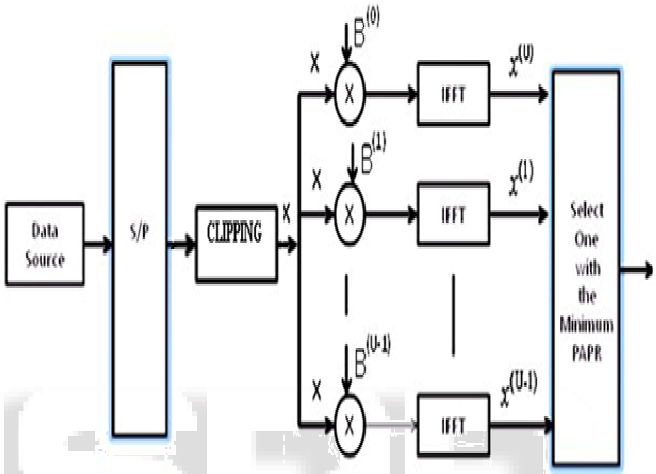

Fig. 2: Scheme of a Modulator with Low Complexity Selective Mapping with clipping

The New Phase SLM technique can be further improvised, when it is used with the clipping. Here we have proposed a new strategy for the same. In this proposed method separate clipping is done for the sequence. The peak clipping can be performed only on time domain signal. Hence clipping is introduced in the new phase sequence applied to SLM scheme .

As clipping is a PAPR reduction technique which is simple in implementation, the introduction of clipping to a low complexity SLM scheme does not increase the complexity of the system. For the Better PAPR reduction, the combined effect of clipping and SLM with new phase sequence scheme reduces PAPR considerably. Enhancement of power efficiency and therefore less power consumption and more battery life can be obtained through this scheme.

VI. SIMULATION RESULTS & OBSERVATIONS

The simulation is performed with 64 sub band OFDM symbols. PAPR reduction of OFDM with QPSK and BPSK mapping and the computational complexity of SLM scheme with different number of sub blocks in [2] are examined. Over sampling factor selected for the various PAPR reduction simulations is, L=4.

The threshold value set for peak clipping depends on the OFDM system and the input signal. The clipping at amplitude of 0.4 strictly depends on the OFDM system and input signal used in this work. The test is achieved on 10000 OFDM symbols and the following results are obtained.

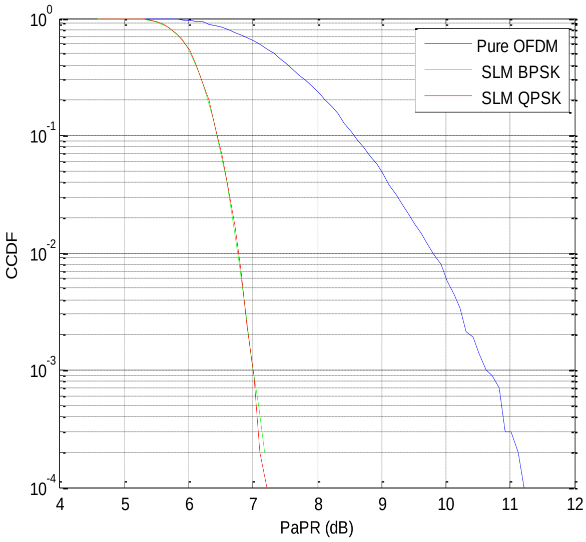

Fig. 3: PAPR reduction of SLM Scheme with BPSK and QPSK modulation

From the above results we found that the graph is almost overlapped for the SLM BPSK and SLM QPSK. In difference to the PTS, SLM has the similar characteristics for both. For the further experimentation we have taken the SLM QPSK.

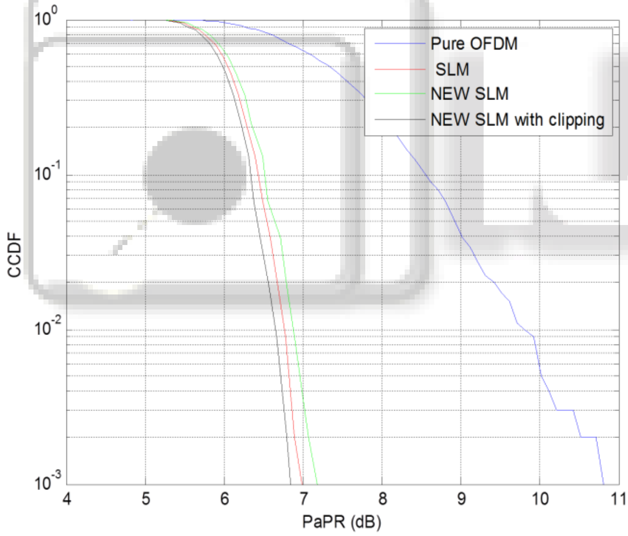

Fig. 4: PAPR Reduction of SLM scheme, new phase sequence applied to SLM Scheme and SLM Scheme with both New Phase Sequence and clipping

Fig.4 shows the PAPR of original OFDM system, the PAPR of OFDM system which has undergone the SLM Scheme, SLM with New Phase sequence scheme and SLM Scheme with both New Phase Sequence and clipping. It can be observed that the PAPR reduction of the SLM with clipping scheme offers better PAPR reduction than the conventional and "SLM with New Phase sequence scheme" at the expense of slight reduction in system performance.

VII. Conclusion

In this paper we have seen the Basics of OFDM. We have seen the OFDM system model and problem in the OFDM system. We have also seen the defination and significance of PAPR in OFDM. Then we have discussed the SLM technique in detail.

In [13] a method is used in which the Altered Phase Sequence Based PTS Techniques and Low Complexity PTS with Clipping is used in a combined way. We have implemented the same technique for the SLM. We have discussed the proposed techniques in detail. We have seen the graphical results for New SLM and New SLM with ciliping techniques. Its performance is found better than the SLM in the practical expects.

But the clipping technique introduces distortion in the signal. However peak clipping of signal below a particular threshold can maintain the BER in the tolerable range. Therefore the system can be used only where the OFDM system can tolerate slight reduction in performance, ie less power consumption and more battery life are the major concern. In the future we may try to get some more better technique for the PAPR reduction.

References

[1] Prasad R., OFDM for Wireless Communications Systems. Ark tech House, Inc., 2004.

[2] L. J. Cimini, Jr., "Analysis and simulation of a digital mobile channel using orthogonal frequency division multiplexing," IEEE Trans. Commun., vol. 33, pp. 665–675, Jul. 1985.

[3] X. Li and L. J. Cimini Jr., "Effect of clipping and filtering on the performance of OFDM," IEEE Commun. Lett., vol. 2, pp. 131–133, May 1998.

[4] L. J. Cimini Jr. and N. R. Sollenberger, "Peak-to-average power ratio reduction of an OFDM signal using partial transmit sequences," IEEE Commun. Lett., vol. 4, pp. 86–88, Mar. 2000.

[5] E. Jones, T. A.Wilkinson, and S. K. Barton, "Block coding scheme for reduction of peak to mean envelope power ratio of multicarrier transmission scheme," Electron. Lett., vol. 30, no. 25, pp. 2098–2099, Dec. 1994.

[6] T. Jiang, W. Yao, P. Guo, Y. Song, and D. Qu, "Two novel nonlinear companding schemes with iterative receiver to reduce PAPR in multicarrier modulation systems," IEEE Trans. Broadcast., vol. 52, p. 268, Mar. 2006.

[7] S. H. Müller and J. B. Huber, "OFDM with reduced peak-to-average power ratio by optimum combination of partial transmit sequences", Electron. Lett., vol. 33, no. 5, pp. 368–369, Feb. 1997.

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

[9] B.M. PopoviC, "Synthesis of power efficient multitone signalswith flat amplitude spectrum," IEEE 'hns. Comrnun., vol.COM-39, no. 7, pp. 1031-1033, July 1991.

[10] S.B. Miiller and J.B. Auber, "A novel peak power reductionscheme for OFDM," PVOC. 8th IEEB ers son. lndoor Mobile RadioCommun., Helsinki, Finland, vol. 3, pp. 1090-1094, Sep. 1997.

[11] Pooria Varahram, Borhanuddin Mohd Ali, "A Low Complexity Partial Transmit Sequence for Peak to

Average Power Ratio Reduction in OFDM Systems”, Radio-engineering, vol. 20, no. 3, September 2011.
[12] Pooria Varahram, Borhanuddin Mohd Ali, “Partial Transmit Sequence Scheme with New Phase Sequence for PAPR Reduction in OFDM Systems”, IEEE Transactions on Consumer Electronics, Vol. 57, No. 2, May 2011.
[13] Amrutha.V.Nair, T.Sudha, A Low Complexity Partial Transmit Sequence Scheme For Better Papr Reduction In OFDM Systems.

