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WEIGHT ROTATION TECHNIQUE FOR PAPR REDUCTION IN OFDM

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***Abstract*— In this paper we propose Weight Rotation Technique for peak to- average power ratio (PAPR) reduction in OFDM systems. It is based on selected mapping (SLM) algorithm. The main drawback of the conventional SLM technique is their high signal processing complexities due to the use of multiple inverse fast Fourier transform (IFFT) operations per OFDM block. In the proposed PAPR reduction is based on a preset threshold value and the phase sequence is modified accordingly. Simulation results show that this technique gives a performance close to SLM technique with considerable reduction in complexity.**

***Index Terms*— PAPR reduction, Weight rotation technique, SLM.**

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) has been widely used for high data rate transmission applications. The major advantages are its high spectral efficiency and robustness to narrowband interference and multipath fading channels [6]. One major drawback of OFDM is the high peak to- average power ratio (PAPR) of the output signal. The occurrence of high peak to average power causes the High Power Amplifier (HPA) to work in the nonlinear region. This introduces nonlinearities in the HPA output. The resulting spectrum will have severe in-band distortion and out-of-band radiation. The increase in BER results in performance degradation. Hence there is a mandatory requirement of going in for expensive High Power Amplifier designs.

Several PAPR reduction techniques have been proposed in the literature [1]. Some of the PAPR reduction schemes are clipping [4], coding, SLM, tone injection, tone reservation and partial transmit sequence [5]. The simplest of these is the clipping technique, but it is found to cause both in-band and

Out-of-band distortion. Among them, SLM scheme is relatively significant since it can obtain better PAPR by modifying the OFDM signal without distortion [2]. Selecting of proper phase sequences to achieve good PAPR reduction is very important in SLM technique. The Phase sequence can be random sequence or Hadamard sequence. But it has a high signal processing complexity due to the use of multiple inverse fast Fourier transform (IFFT) operations per OFDM block. Similar to the SLM technique, the PTS technique requires several IFFT operations per OFDM symbol. To optimize both complexity and PAPR reduction ability, we provide a novel PAPR reduction technique called Weight Rotation Technique that operates based on setting a threshold PAPR value and manipulation of phase sequence accordingly.

II. WEIGHT ROTATION TECHNIQUE

SLM technique has a high complexity due to the use of multiple inverse fast Fourier transform (IFFT) operations per OFDM block. The main objective of the Weight Rotation Technique is to reduce the number of IFFT operations performed and to obtain a good PAPR performance.

A. Transmitter

The Block diagram of the transmitter is shown in Figure 1.The input data stream is modulated and converted into time domain by taking IFFT operation. The PAPR value is calculated and compared with the predefined threshold value. If it is less than the threshold the OFDM symbol is transmitted, else the phase sequence is rotated to the left once and the process is repeated again till the threshold condition is satisfied. The side information contains details about the number of times the phase sequence was rotated.

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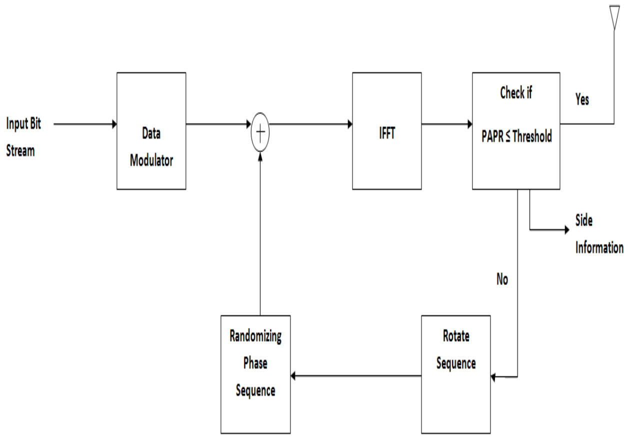

Figure 1. Transmitter Block Diagram

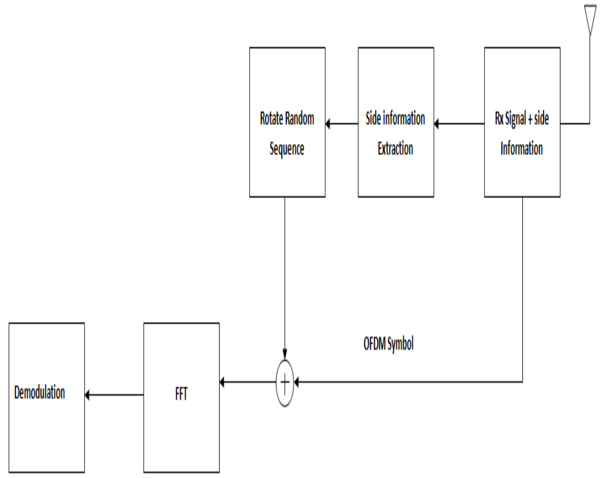

Figure 2. Receiver Block Diagram

B. *Phase Sequence*

The phase sequence B is initially selected using the formula, $B= ej\Theta$,where $\Theta \in \{ -\Pi$ to $+ \Pi\}$.The angle Θ is chosen randomly. . If 64 point IFFT is used there are 64 symbols in each block. Therefore 64 random angles are chosen to generate the initial phase sequence.

C. *Algorithm*

The algorithm is as follows:

1) The sequence of data bits are mapped to constellation points MQAM or BPSK to produce sequence symbols X0, X1, X2…

2) These symbol sequences are divided into blocks of length N. N is the number of subcarriers.

3) Each block X=[X0, X1, X2….XN-1] is multiplied (Point wise multiplication) by phase sequence.

B = [B (0), B (1) …B (N-1)].

4) Transform the OFDM data block obtained into time domain by taking IFFT.

5) Calculate the PAPR and If PAPR < = Threshold, transmit the modified OFDM symbol else rotate B once to left and repeat from step 3.

D. *Receiver*

The block diagram of the Receiver is shown in Figure 2. Based on the side information transmitted the corresponding phase sequence used at transmitting end is generated by rotating the initial phase sequence in the opposite direction. The Received OFDM symbol is multiplied by the rotated phase sequence. Then FFT operation is performed and demodulated to get the transmitted bits.

III. Results And Discussion

OFDM with 64 subcarriers and BPSK modulations is used for analysis. The CCDF plot obtained by setting different levels of threshold value is shown in Figure 3.

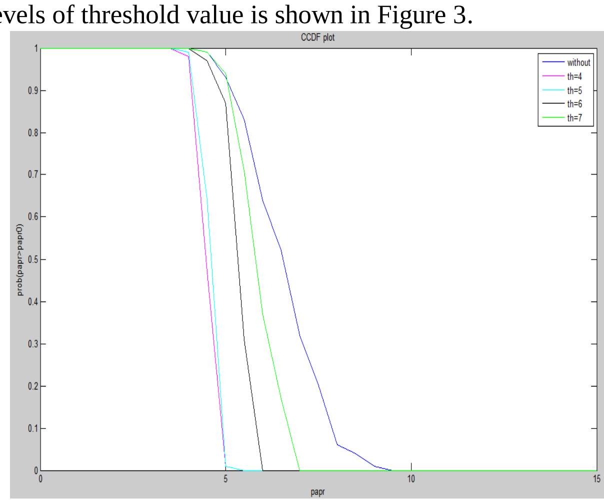

Figure 3.CCDF Plot

Thus by decreasing the threshold value the PAPR value obtained can be reduced. The CCDF plot in Figure 4 and BER plot in Figure 5 compares the performance of Weight Rotation Technique with SLM technique.

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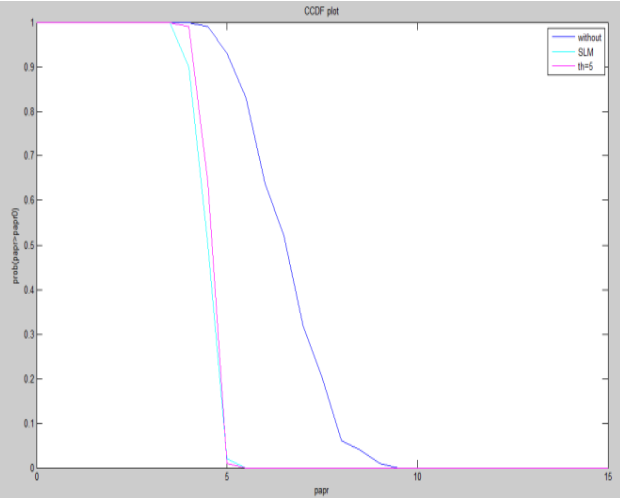

Figure 4. PAPR Comparison of SLM and Weight Rotation Technique.

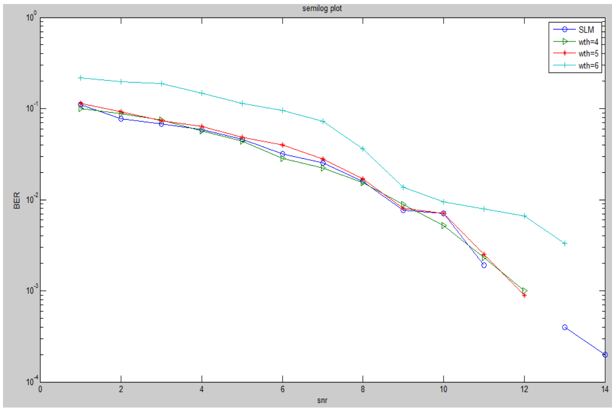

Figure 5. BER Comparison of SLM and Weight Rotation Technique

	PAPR Value in dB					
	Without any PAPR reduction technique	Weight Rotation Technique Threshold PAPR in dB				SLM
		Th=7	Th=6	Th=5	Th=4	
Mean	6.7492	6.0757	5.5426	4.8012	4.7324	4.7299
Variance	1.1034	0.3070	0.1090	0.0436	0.0588	0.0920
Max	9.3368	6.9978	5.9989	5.2553	5.2553	5.3226
No. of IFFT operations (count)	-	96	348	3110	6400	6400 (U)

Table 1. Comparison between Weight Rotation Technique and SLM

Thus the performance of Weight Rotation technique is close to that of SLM technique. Table 1 shows the comparison of PAPR value obtained and the number of IFFT operations required in Weight Rotation technique with those of SLM technique.

From Table 1 it can be inferred that the number of IFFT operations performed in Weight Rotation Technique is less when compared to that of SLM technique. By increasing the Threshold PAPR value the number of IFFT operations can be decreased.

IV. Complexity Comparison

The minimum number of multiplications MIFFT and additions AIFFT required for an IFFT operation is Given by

$$M_{IFFT} = N.\frac{\log_2 N}{2}$$

$$A_{IFFT} = N.\log_2 N$$

If SLM requires U IFFT operations then the number of multiplications MSLM and additions ASLM are

$$M_{IFFT} = N.U.\frac{\log_2 N}{2}$$

$$A_{IFFT} = N.U.\log_2 N$$

Weight Rotation Technique requires fewer IFFT operations when compared to the SLM technique as indicated in Table 1 as count. The number of multiplications and additions are given by

$$M_{WRT} = N.count.\frac{\log_2 N}{2}$$

$$A_{WRT} = N.count.\log_2 N$$

When 64 point IFFT is taken SLM requires 819200 multiplications and 2457600 additions .On the other hand Weight Rotation technique with threshold value of 6 dB (count=348) requires 66816 multiplications and 133632 additions. Thus there is a considerable reduction in number of arithmetic operations required. Thus Weight Rotation Technique is less complex.

V. CONCLUSION

Thus the Weight Rotation Technique provides PAPR reduction close to that of SLM technique. It involves lesser number of arithmetic operations when compared to SLM. Hence it is less complex with good performance.

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