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Selective Mapping Technique for Reduction of PAPR by Generating New Methods for Pseudo-Random Sequences in OFDM Systems

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Abstract - *In wireless communication, the orthogonal frequency division multiplexing is the attractive technique. OFDM along with the Quadrature phase shift key mapping is used in these projects. High peak to average sum power ratio reduction is one of the challenging problem in OFDM. Selective mapping method along with that pseudo random sequence is developed to lower the PAPR.SLM needs a extra side information at the receiver end to retain the original signal. This technique is simply generated which is going to reduce the side information into single index value of the used column. Simulation results observed shows similar PAPR reduction when comparing with the conventional random sequences*.

Key Words: Orthogonal Frequency Division Multiplexing (OFDM), Selected Mapping (SLM), Peak to Average Power Ratio (PAPR), Random Sequence, Pseudo-random.

1. INTRODUCTION

As technology is increasing there is more demand for good quality of communication services required in 4g and 5g technology. Lowering the delay time and also upgrading the quality of service is the big task. So these needs can be easily obtained from a method called orthogonal frequency division multiplexing. OFDM is going to maintain high bandwidth, high data rate, reduces complexity of the system and also avoids multi path fading. American national defense department uses OFDM for military applications. Comparing the OFDM with frequency division multiplexing (FDM) it is noted OFDM allows the spectrum from different sub- carriers which are orthogonal to each other this will improvise the spectral efficiency of the orthogonal system. OFDM was first introduced by RW CHANG in 1965.SALTZBERG analyzed the performance of OFDM system. It was patented at the UPSD after these was used in military communication systems. Fast Fourier transform can be implemented to the DFT to modulate and demodulate which is very easier. In 1971, SB Weinstein and PM Ebert introduced the Discrete Fourier Transform. In the 1980s, Inter symbol Interference was decreased when Piled and Ruiz combined cyclic prefix into the basic OFDM signals to have the orthogonally maintenance between sub-carriers. OFDM system model has so many advantages; mainly the extension of symbol period is due to OFDM system model and is also considered to be robust against selective fading of different channels. Moreover, the high efficiency of bandwidth is attained due to parallel transmission over OFDM system model. Finally, OFDM is very flexible to adopt other systems such as Code Division Multiple Access. Consequently, OFDM systems is used in many communication applications, some of them includes wireless network, digital television, audio broadcasting and 4G mobile communication, video broadcasting. But model of OFDM system has some disadvantage that is peak to average power ratio which will be formed due to the variations in symbol with large amplitudes. Hence when the OFDM signal is passed onto a nonlinear device, which includes the High Power Amplifier at the transmitter. These will lower the performance of the system in the form of Bit Error Rates. To reduce PAPR many technique has been introduced. All the techniques which is used for reducing PAPR have some sort of advantage as well as disadvantage. One of the basic techniques is clipping method and Filtering method for reducing the PAPR where some part of transmitted signal will be lost. Along with that reduction of undesirable data rate using Coding scheme is made possible. Also Tone Reservation technique will allows the loss of data rates and also increases the power of the system. Another technique like Tone Injection and the Active Constellation Extension will also increases the power undesirably. If we compare for the different methods for better reduction of PAPR using SLM technique, we can conclude that other methods are quite complex than selective mapping technique. Selected mapping method is the promising technique and also simple to implement on any wireless systems. Which doesn't contain any distortion or noise at the transmitted signal, and then it is known as the Selective mapping technique. This method contain disadvantage while sending the extra SI added with the data which is transmitted. There are mainly three important analysis of this technique has been mentioned, firstly avoiding the extra information along with OFDM system for transmission, which is referred in the transmission of SI index. Another main analysis made in this technique is that the computational complexity must be reduced and also between the alternate vectors of phase which are used in this technique. One technique which has been proposed for reducing PAPR simultaneously along with computational complexity reduction in comparison to that of selective mapping technique. The proposed technique will avoids sending the SI to the receiver part.

2. System block diagram

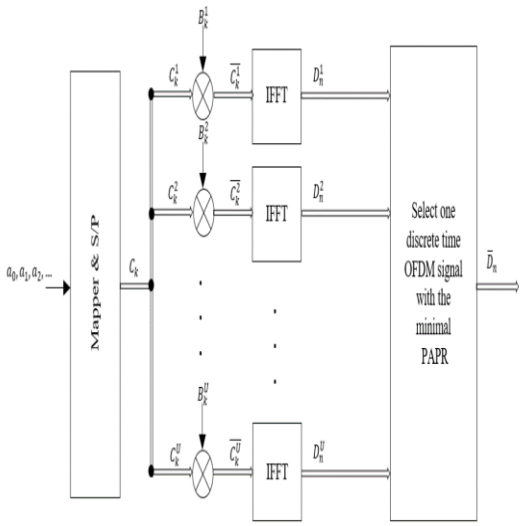


Fig.1. An block diagram of OFDM system along with SLM technique

3. Methodology

3.1 DEFINITION FOR OFDM SIGNAL MODEL AND PAPR

The orthogonal process must be defined through its model of OFDM, which includes a sum of all the independent number of signals will be modulated to the sub-carriers of equal bandwidth. The complex baseband signal, which is formed by adding N-subcarriers, is shown as:

$$D(t) = \frac{1}{N}\sum_{k=0}^{N-1} C_k e^{j2\Pi f_k t}, 0 \leq t \leq T_s \quad (1)$$

Where, j= √-1, T_s is symbol duration of OFDM model, [C_0, C_1...C_{N-1}] represents the complex data block of length-N,

$f_k = \frac{k}{T_s}$, k = 0, 1...N-1, are number of total sub-carrier of length-N frequencies. For mapping of QPSK signal model, we represent as $C_k \in \{\pm 1, \pm j\}$,

T_s = 2T_b N, where, T_b represents the duration of bit. When the signal of OFDM model in (1) is sampled at t= n2T_b, then we obtain:

$$D_n = D(n2T_b) = \frac{1}{N}\sum_{k=0}^{N-1} C_k e^{\frac{j\Pi nk}{N}}, n = 0, 1 \ldots N-1 \quad (2)$$

The PAPR for the continuous OFDM model in equation (1) is calculated as follows:

$$PAPR_{db} = 10 \log \left(\frac{\max[x(t)x*(t)]}{E[x(t)x*(t)]}\right)$$

3.2 Introduction to Selective Mapping Technique

A block diagram of OFDM system model transmitter along with SLM technique applied is shown in Fig. 1. Let us consider M number of the complex data vector C^U=[C_0^U, C_1^U ,.....C_{N-1}^U], and B^U is an distinct vectors of length M i.e., B^U= [B_0^U, B_1^U ...B_{N-1}^U], U = 1, 2 ...M, where, $B_k^U = e^{j\varphi_k^U}$, and

$\varphi_k^U \in (0, 2\Pi)$, k = 0, 1 ....N-1.Hence, the multiplications between the chosen phase vectors and the data vectors is expressed as,

$$C_K^U = C_k^U . B_k^U$$

Where, U = 1, 2...M, and k= 0, 1 ....N-1

Therefore, we obtain time-domain data vectors are

$$D_n^U = IFFT \{\overline{C_k^U}\}$$

In SLM technique, to obtain the sequences of same information we have to multiply the OFDM symbols of original data with sequences of phase rotation values. Among with this, the PAPR which contains low peak to average power must be selected for the purpose of transmission.

4. PROPOSED SCHEME FOR PHASE SEQUENCES

By working on [6], SLM technique needs to be proposed on the concatenation matrix which is based upon the pseudo-random sequence generation. Firstly, we need to define matrix $A_0 \in \{1\ -1, +j, -j\}$. One possible combination of A_0 can be denoted as:

$$A_0 = \begin{bmatrix} 1 & -1 \\ -j & j \end{bmatrix}$$

Fig. 2 Possible patterns of all A_0patterns

$\begin{bmatrix} 1 & -1 \\ -j & j \end{bmatrix}$	$\begin{bmatrix} 1 & -j \\ j & -1 \end{bmatrix}$	$\begin{bmatrix} 1 & j \\ -1 & -j \end{bmatrix}$	$\begin{bmatrix} 1 & -1 \\ j & -j \end{bmatrix}$	$\begin{bmatrix} 1 & j \\ -j & -1 \end{bmatrix}$	$\begin{bmatrix} 1 & -j \\ -1 & j \end{bmatrix}$
$\begin{bmatrix} -1 & 1 \\ -j & j \end{bmatrix}$	$\begin{bmatrix} -j & 1 \\ j & -1 \end{bmatrix}$	$\begin{bmatrix} j & 1 \\ -1 & -j \end{bmatrix}$	$\begin{bmatrix} -1 & 1 \\ j & -j \end{bmatrix}$	$\begin{bmatrix} j & 1 \\ -j & -1 \end{bmatrix}$	$\begin{bmatrix} -j & 1 \\ -1 & j \end{bmatrix}$
$\begin{bmatrix} -1 & j \\ -j & 1 \end{bmatrix}$	$\begin{bmatrix} -j & -1 \\ j & 1 \end{bmatrix}$	$\begin{bmatrix} j & -j \\ -1 & 1 \end{bmatrix}$	$\begin{bmatrix} -1 & -j \\ j & 1 \end{bmatrix}$	$\begin{bmatrix} j & -1 \\ -j & 1 \end{bmatrix}$	$\begin{bmatrix} -j & j \\ -1 & 1 \end{bmatrix}$
$\begin{bmatrix} -1 & j \\ 1 & -j \end{bmatrix}$	$\begin{bmatrix} -j & -1 \\ 1 & j \end{bmatrix}$	$\begin{bmatrix} j & -j \\ 1 & -1 \end{bmatrix}$	$\begin{bmatrix} -1 & -j \\ 1 & j \end{bmatrix}$	$\begin{bmatrix} j & -1 \\ 1 & -j \end{bmatrix}$	$\begin{bmatrix} -j & j \\ 1 & -1 \end{bmatrix}$

Fig. 2 Possible patterns of A_0

For the generation of phase sequences for the OFDM model with selective mapping technique. Then A_0 will be the seed for the pseudo-random sequence generation.

$$A_m = \begin{bmatrix} A_{m-1} & A_{m-1} \\ A_{m-1} & A_{m-1}^T \end{bmatrix}, \text{ m} = log_2\text{N-1} \quad (8)$$

Where, A_m^T is the transpose of Hermitian matrixA_{m-1}, and number of sub-carriers is denoted by N, N = 2^n , n = 2, 3, 4.....

Considering an example, for OFDM model with the help of SLM technique N = 4, it requires M, B_k for each of which is length 4. Therefore, by concatenating A_0 as controlled by eqn8. We construct A_1 as:

$$A_1 = \begin{bmatrix} A_0 & A_0 \\ A_0 & A_0^T \end{bmatrix}$$

In the similar manner we have to generate the phase sequence matrix for N = 8, as

$$A_2 = \begin{bmatrix} A_1 & A_1 \\ A_1 & A_1^T \end{bmatrix}$$

As we mention the matrix A_m is $l \times l$ matrix, where l denotes the value for possible number of sub-carriers. Therefore, it has been represented by its columns number as, A_m = [a_{m1}, a_{m2} ...a_{ml}]. Thus, the possible number of phase sequences must be limited to$M = l$, thus, $M = N$, and needs to be much sufficient for the reduction of PAPR upon above mentioned sets of sub-carriers.

$$\overline{C_k^U} = C_k^U . a_{mk}^U$$

Where, $U = 1,2, \ldots \ldots . M$ and $k = 1,2, \ldots \ldots N-1$

With the selective mapping method technique it is known that, the SI is sent at the receiver end. For example, assuming N=8 and $B_k \in \{1, -1, +j, -j\}$,$k = 0,1, \ldots \ldots N-1$, then the number of possible combinations of phases is $4^8 = 65536$. Hence, a possible range of phase sequences exists from, which optical vector is proposed to reduce the PAPR for the subcarriers of$N = 8$. It also requires SI to be sent to carrier. But with proposed system method, it is mentioned that the column of the only index value to be send to the receiver side of SI. For a poly phase sequence foe AC source, the phase sequence is order in which it would reach their respective peaks referred. In the three-phase system, it requires only the two Phase sequences in alternator rotations with respect to the different directions.

5. RESULTS

The PAPR calculations for OFDM applying SLM technique with QPSK mapper are considered. The random sequence and phase generated sequences. From the simulations results, it is mentioned that all the above patterns proposed will not perform, 16- above listed patterns will perform the same as those mentioned.

In Fig. 3, The CCDF plots for N = $16, 32, 64$, and 128 sub-carriers in OFDM to be provided for performance calculation of PAPR,M = 16.

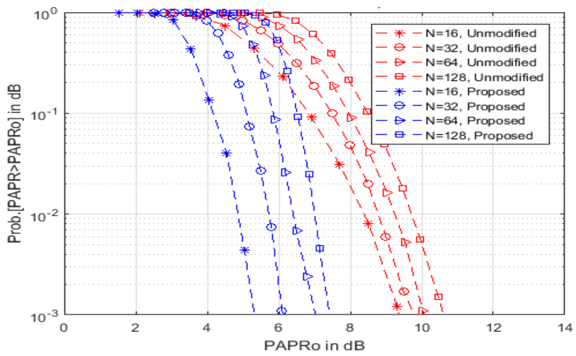
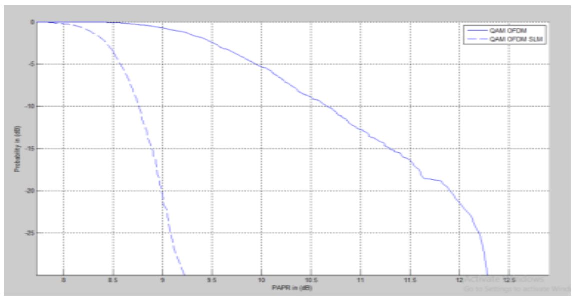


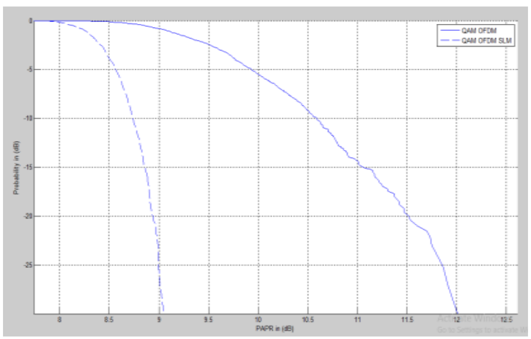
Fig. 3.PAPR performance for$N = 16,32,64$, and 128-subcarrier and CCDF plots for OFDM system and phase sequences for proposed random sequences, with QPSK mapper M = 16.

The graph of 128sub-carriers in OFDM models to be provided with performance of peak to average power ratio when$M = 16,32,64$, and 128. According to the PAPR achieved performance, the sequences numbering two is similarly approximate.

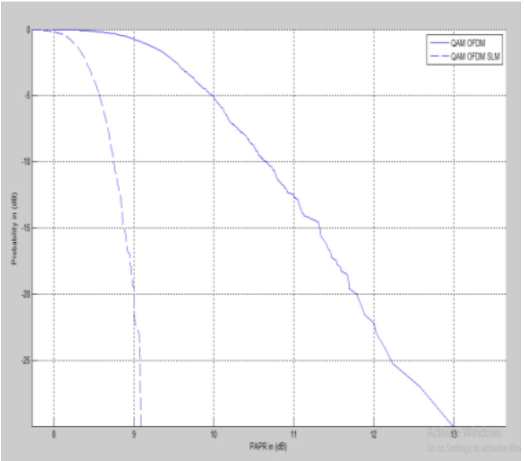
5.1 Output Graph



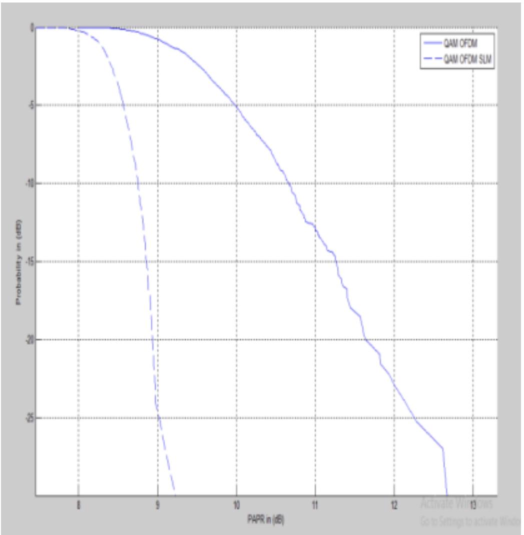
(a) M = 16



(b) M =32



(c) M =64



(d) M = 128

Fig. 4 (a-d) performance of PAPR for 128sub-carriers in OFDM system model with QPSK mapper applying the Selected mapping method for the random and proposed sequences of phase for the different ranges of M.

TABLE: PAPR achieved for 128sub-carriers in OFDM model with mapper of QPSK with Selected mapping method for the random and proposed sequences of phases.

Sub-carriers (M)	Random PAPR achieved in dB	Proposed PAPR achieved in dB	Unmodified PAPR achieved in dB
16	9.218	12.762	13.274
32	9.206	12.542	
64	9.148	12.372	
128	9.436	12.204	

For the above mentioned that the SI requires the huge number of bits needs to be sent at the receiver part of the proposed scheme must needs to be reduced to its index value of $log_2(N)$ bits taken for comparison for $log_2(M)$ where, $< M$ .And search for complexity in the proposed method will limits to N.

6. Conclusion

We have proposed a new method in proposed method generating sequence of phases using the (SLM) method in the OFDM model with respect to mapping of QPSK is tested for performance calculations of PAPR. A pseudorandom sequencing is based upon a matrix, $A_0 \in \{1, -1, +j, -j\}$ is proposed. The very simplistic sequence of phase generation is offered by proposed scheme and also it is required only the minimum SI needs to be sent at the receiver part. The search for complexity must also reduce to N. The Simulation results also show closely similar results of performance of PAPR for the conventional random schemes are compared with the proposed sequences.

7. References

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