A NOVEL TECHNIQUE BASED ON SELECTIVE MAPPING AND ITERATIVE FLIPPING PARTIAL TRANSMIT SEQUENCE ALGORITHM FOR PAPR REDUCTION IN OFDM SYSTEM

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ABSTRACT

The most serious issue of orthogonal frequency division multiplexing is high peak to average power ratio (PAPR). In this paper we proposed a new PAPR reduction technique that is developed by using new phase sequence selective mapping technique and Iterative flipping PAPR reduction technique for different numbers of sub blocks. This new technique (proposed technique) shows better PAPR reduction in comparison to new phase sequence SLM and iterative flipping partial sequence.

Key Words: Complementary Cumulative Distribution Function (CCDF), Orthogonal Frequency Division Multiplexing (OFDM), Partial Transmit Sequence (PTS), Peak To Average Power Ratio (PAPR), Selective Mapping Technique (SLM).

I INTRODUCTION

Now a day's OFDM become very attractive and promising technology for high rate wireless communication system. The first OFDM scheme is introduced by Chang in 1966 [1] for dispersive fading channels. OFDM was selected as high performance local area network's (HIPERLAN) transmission technique and it become the part of IEEE 802.11a wireless local area (WLAN) standard.

OFDM is a multicarrier modulation technique which provides high spectral efficiency, multipath delay spread and confrontation to frequency selective fading channels [2,3]. Despite of these advantages OFDM system has many drawbacks like high peak to average power ratio, co-channel interference in cellular OFDM and it is very sensitive to both time and frequency synchronization errors. One of the challenging issues in OFDM is high peak to average power ratio. Peak to average power ratio is proportional to the number of subcarriers. As subcarriers are add up coherently, large number of subcarriers cause high peak to average power. High PAPR also makes the implementation of analog to digital converter (A/D) and digital to analog converter (D/A) very complex. High PAPR also reduce the efficiency of RF amplifier. The high PAPR increase the in-band distortion and out-of-band distortion when the OFDM signal is fed into a nonlinear high power amplifier. In order to reduce the distortion caused by a high power amplifier, several techniques have been introduced in literature that limits the peak of the envelope of the signal [3]. These techniques are referred as peak-to-average power ratio (PAPR) reduction techniques [4]. Mainly PAPR reduction techniques divided into two classes, Signal Scrambling and Signal Distortion Techniques. Signal scrambling techniques are all variations on how to scramble the codes to decrease the PAPR. Some signal scrambling techniques are selective mapping, partial transmit sequences, iterative flipping partial sequence transmit, interleaving, tone injection and tone reservation. The signal distortion techniques like peak windowing, clipping, companding etc. introduce both in-band and out-of-band interference and complexity to the system. These techniques reduce high peaks by distorting the signal prior to amplification directly.

The main objective of this paper is to design a new algorithm that will reduce PAPR of the OFDM system. In this paper, we propose a new PAPR reduction technique that is combination two existing techniques. First technique is SLM technique having new phase sequence generated by Riemann Matrix and second technique is iterative flipping. However, this technique is compared with conventional SLM technique, partial sequence transmit (PTS) technique, iterative flipping and original (without PAPR reduction).

The organization of this paper is as follow. Section 2 presents conventional SLM technique. Section 3 presents Riemann matrix based new phase sequence SLM technique. In. Section 4 presents iterative flipping technique. Section 5 &6 presents proposed technique and their simulation results. Section 7 draws conclusion and future scope.

II SELECTIVE MAPPING TECHNIQUE

The SLM technique was first introduced by Bauml.et.al.In the SLM, the input data sequences are multiplied by each of the phase sequences to generate alternative input symbol sequences [5]. IFFT operation is made on each of these alternative input data sequences. The signal having lowest PAPR is selected from a set of sufficiently different signals which all represents the same information. To allow the receiver to recover the original data, the multiplying sequence can be sent as side information [6].This technique is very flexible as it does not inflict any restriction on modulation applied or on number of sub-carrier [12].

III RIEMANN MATRIX BASED NEW PHASE SEQUENCE SLM TECHNIQUE

Selected Mapping technique is one of the promising PAPR reduction techniques for Orthogonal Frequency Division Multiplexing [10]. But this reduction technique results in a huge amount of computation complexity which is costly and time consuming. In SLM technique selecting of proper phase sequence is very important. Phase sequence set was chosen randomly from set[$\pm1,\pm j$] by Bauml, who first introduced SLM technique. In 2009, N. V.Irukulapati, V. K.Chakka and A. Jain projected a new technique for PAPR reduction using Riemann Matrix. This method is called SLM based new phase sequence technique [7,8].In this approach, rows of normalized Riemann matrix are used as phase rotation vectors. The Riemann matrix [9] is obtained by removing the first row and first column of the matrix A, where

$$A(\mathrm{i},\mathrm{j}) = \begin{cases} i-1 if, i-divides-j \\ -1, otherwise \end{cases}$$

(1)

Using Equation (1), Riemann Matrix (R) of order 4 can be written as:

$$R = \begin{bmatrix} 1 & -1 & 1 & -1 \\ -1 & 2 & -1 & -1 \\ -1 & -1 & 3 & -1 \\ -1 & -1 & -1 & 4 \end{bmatrix} \quad (2)$$

This technique is to make optimum use of the amplifier and to reduce the computation complexity of the selection of the data block. A threshold value of PAPR is decided based on the RF Power amplifier (PA) with a certain constant clipping threshold (not adaptive biased).If the Riemann matrix (R) is of size M * M, the entries in the normalized Riemann matrix (B) will be (1/M) R. In this technique the rows of the normalized Riemann matrix B is used as a phase sequence for SLM technique.

IV ITERATIVE FLIPPING PTS

Cimini and Sollenberger's Iterative flipping technique is developed as a sub-optimal technique for the PTS algorithm [11]. In PTS technique, to find the optimum set of phase factor, we need to evaluate all the combinations of phase factors. Due to this search complexity is increased. Thus a new simplified technique called iterative flipping algorithm has been introduced in which the computation complexity reduces to be linear with the number of sub-blocks M. In the iterative flipping algorithm, one keeps only one phase set in each sub-block. Even though the phase set chosen in the first sub block shows minimum PAPR in the first sub block that is not necessarily minimum if we allow it to change until we continue the procedure up to the end sub block [12,13].

For simplicity, the phase factor here is chosen as [1,-1]. These can be expanded to more phase factors. The algorithm is as follows. After dividing the data block into M disjoint sub blocks, one assumes that $b^{(m)}$ = 1; (m = 1, 2…M) for all of sub-blocks and calculates PAPR of the OFDM signal. Then one changes the sign of the first sub-block phase factor from 1 to -1 ($b^{(1)}$= -1), and calculates the PAPR of the signal again. If the PAPR of the previously calculated signal is larger than that of the current signal, keep $b^{(m)}$= -1. Otherwise, revert to the previous phase factor, b^{m}= 1. Suppose one chooses b^{m}= -1. Then the first phase factor is decided, and thus kept fixed for the remaining part of the algorithm. Next, we follow the same procedure for the second sub-block. Since one assumed all of the phase factors were 1, in the second sub-block, one also changes $b^{(2)}$ = 1 to $b^{(2)}$ = -1, and calculates the PAPR of the OFDM signal. If the PAPR of the previously calculated signal is larger than that of the current signal, keep $b^{(2)}$ = -1. Otherwise, revert to the previous phase factor, $b^{(2)}$ = 1. This means the procedure with the second sub-block is the same as that with the first sub-block. One continues performing this procedure iteratively until one reaches the end of sub-blocks (M^{th} subblock and phase factor $b^{(m)}$) [12].

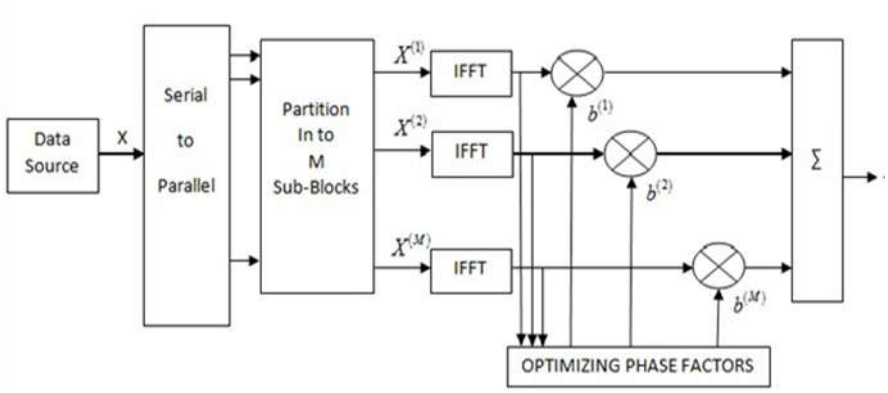

Figure: 2. Block diagram of partial transmit sequence technique

V PROPOSED TECHNIQUE

The novel technique (Proposed Technique2) is also based on new phase sequence SLM and Iterative flipping technique. In Proposed technique2 the rows of the normalized Riemann matrix are used as phase sequence set for PAPR reduction Here, in Proposed2, first SLM technique using rows of normalized Riemann matrix as a phase sequence set is applied to select the best combination of phase and input data which gives the minimum PAPR. After selecting the best combination of phase sequence and input data, apply this combination to the iterative flipping PTS technique using columns of normalized Riemann matrix as a phase sequence set for further reduction of PAPR.

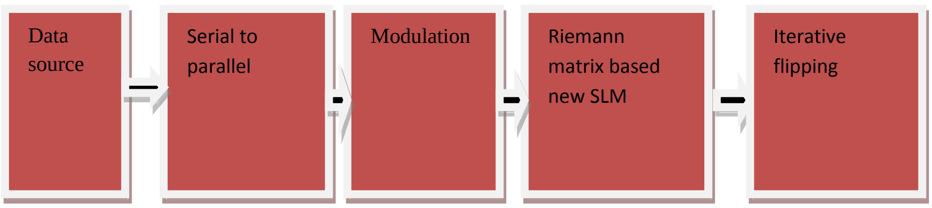

Figure 3: Block Diagram of Proposed Technique 2

The algorithm for this technique is described in following steps:

1: Sequences of data bits are mapped to constellation points M-QAM or BPSK to produce sequence symbols X_o, X_1,X_2…….

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

3: Each block X = $[X_0, X_1, X_2 \dots\dots\dots. X_{N-1}]$ is multiplied (point wise multiplication) by U different phase sequence vectors $[B^{(u)} = B_0^{(u)}, B_1^{(u)}, B_2^{(u)}, \dots\dots\dots\dots\dots\dots\dots\dots\dots.. B_{N-1}^{(u)}]^T$ where each row of the normalised Riemann matrix B is taken as $B^{(u)}$, u =1,2, . . ., U.

4: A set of U different OFDM data blocks $X^{(u)}$= $[X_0^{(u)}, X_1^{(u)} \dots\dots\dots\dots\dots\dots\dots\dots\dots.. X_{N-1}^{(u)}]^T$ are formed, where $X_n^{(u)} = X_n * B_n^{(u)}$, n = 0, 1, . . ., N -1, u = 1, 2, . . . ,U.

5: Transform $X^{(u)}$ into time domain to get $x^{(u)}$ = IDFT {$X^{(u)}$}.

6: Select the one from $x^{(u)}$, u ¼ 1, 2, . . .,U, which has the minimum PAPR .

7: Select corresponding combination of phase sequence and input data before the IDFT operation i.e. $X^{(u)}$.

8: Apply $X^{(u)}$ as an input data to Iterative flipping technique with normalized Riemann matrix used as a phase sequence set.

9: Obtain signal with reduced PAPR after applying the iterative flipping technique with Riemann matrix.

VI SIMULATION & RESULTS

In this paper we have presented hybrid of two techniques to reduce the problem of higher PAPR in OFDM systems. Here New SLM technique is also compared with existing SLM technique and PTS is also compared with iterative flipping PTS. The PAPR reduction performance of the Proposed Technique2 is analysed by comparing with the New SLM, PTS, iterative flipping techniques & PAPR of original signal. In this method, the rows of the normalized Riemann matrix are used as phase sequence set.The programs implementing the PAPR reduction and comparison were written in MATLAB (Version 7.6.0.424). The different parameters considered for simulation purpose are shown below in Table 1.

Table 1: Simulation Parameters for the proposed techniques

Simulation Parameters	Value
Number of Sub carriers (N)	256
Number of Sub blocks	2,4,8,16
Oversampling Factor	4
Modulation Type	BPSK
Phase Factor	[1,-1]

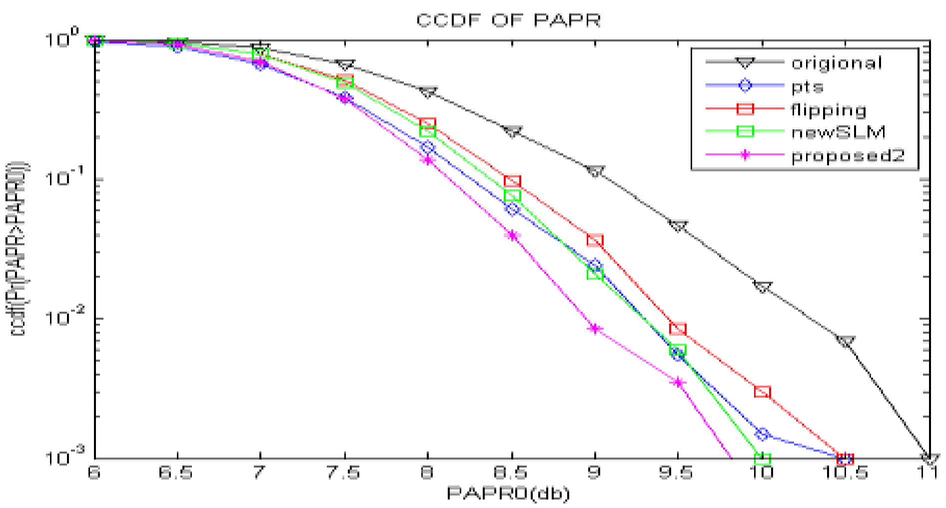

Figure 4: CCDF for comparison of PAPR reduction techniques for M=2 sub-blocks.

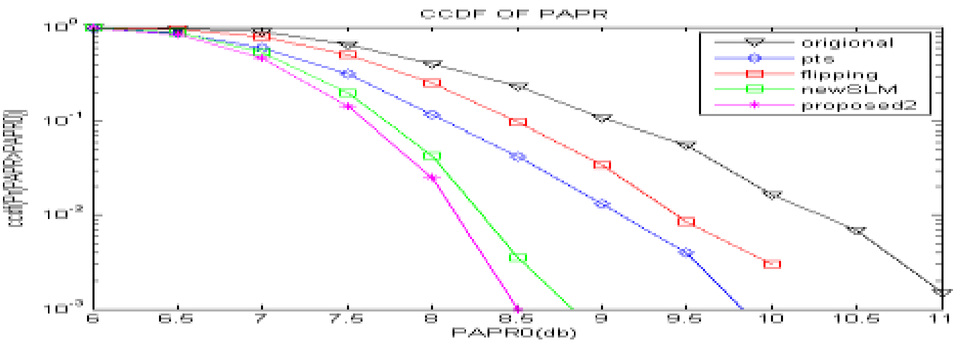

Figure 5: CCDF for comparison of PAPR reduction techniques for M=4 sub-blocks.

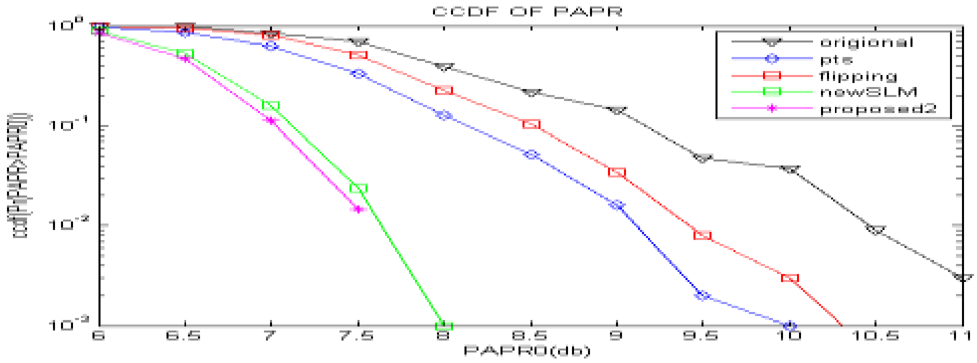

Figure 6: CCDF for comparison of PAPR reduction techniques for M=8 sub-blocks.

Figure 4 to Figure 7 show the graphs for the complement cumulative distribution function (CCDF) of PAPR in original, PTS, New SLM, Iterative flipping and Proposed 2 techniques for the different cases of M = 2; 4; 8; 16 sub-blocks respectively.

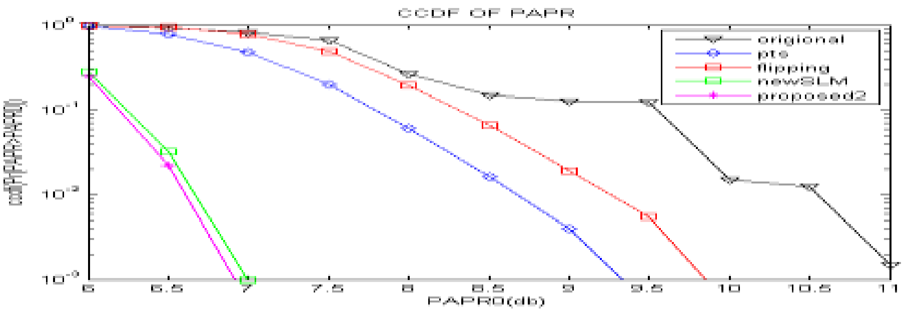

Figure 7: CCDF for comparison of PAPR reduction techniques for M=16sub-blocks.

VII CONCLUSION AND FUTURE SCOPE

From the simulation results, it can be seen that all these PAPR reduction techniques can reduce the PAPR of OFDM Signals. It is evident that the proposed technique2 based on Riemann matrix exhibit better PAPR reduction performance than the PTS, New SLM & iterative flipping techniques. However, because the Riemann matrix has been used to generate phase sequence set in Proposed technique2, therefore, the Proposed technique2 is more computationally complex. From Figure 4 to Figure 7, it is clear that as the number of sub-blocks increase, the PAPR reduction performance of the Proposed2 and New SLM techniques improves significantly. The performance of PTS & Iterative flipping techniques, however, is not affected much with the increase in number of sub-blocks. From the simulation results, it is clear that Proposed Technique2 can achieve more PAPR reduction when compared to PTS, Iterative flipping and New SLM techniques. Moreover, the performance of Proposed Technique2 becomes better & better as the number of sub-blocks increase.

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