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Research paper

Side Information Mitigation with new Phase Sequence for Hybrid PTS Scheme

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Abstract:

This paper focus on presenting a new phase sequence based hybrid PTS approach for OFDM systems to mitigate the problem of PAPR without use of side information. The proposed approach is the exponential constant multiplied for each phase vector so that it can accommodate more number of sub carriers. The modified phase vectors are then multiplied to the original phase vectors so as to obtain a modified version of phase vectors that includes an offset. Experimental results shows that the PAPR is reduced about 04~0.8 db when compared against the traditional PTS scheme deployed for Hybrid systems.

Keywords: *OFDM, PAPR, Hybrid PTS, Side information, Rotating phase vectors.*

1. Introduction

Various wireless communication standards adopted OFDM (orthogonal frequency division multiplexing) as it can transmit the data at higher rate [1] [2]. Despite of many advantages the OFDM has few limitations like high PAPR which occurs due to the superposition of sub carriers. To mitigate this problem in OFDM systems different algorithms have been proposed so far by multiple researchers some of them like clipping [3], coding techniques [4], selective mapping techniques [5], partial transmit sequence [6] [7], tone reservation [8], active constellation [9].

Among these algorithms and approaches PTS (partial transmit sequence) is well known probabilistic approach without causing the signal distortion, in which the candidate signal is selected which has minimum PAPR value among 'U' alternative signals generated by summing the multiplied phase factors for V disjoint sub blocks. To recover the input symbol sequences the selected signal index termed as side information should be transmitted to the receiver. If the index is not detected properly at the receiver then the BER of the system is degraded, hence there is a great need to represent these index signals properly or to propose a approach which doesn't require the side information.

In this paper, a new phase factor sequence is presented which enable to minimize the PAPR without the knowledge of side information at the cost of traditional PTS schemes. The entire work of this paper concentrates on Hybrid PTS schemes [10].

The paper is organized as follows, section 1 presents the introduction to the research work and the need of it, section 2 presents a brief literature survey of the earlier methods which are related to this work and section 3 presents the background related concepts like traditional PTs scheme and hybrid PTS scheme. Section 4 presents the proposed modified phase vector analysis and section 5 presents the experimental results obtained with the proposed approach ending with conclusions.

Ofdm-Papr Description

An OFDM system with N- sub carriers is considered without loss of generality the linear property of the system is assumed for these 'N' sub carriers then the discrete OFDM signal can be written as

$$x(n) = \sum_{k=0}^{N-1} X(k) e^{j2\pi kn/N} \qquad (1)$$

Where n = 0, 1,...,N − 1.

In general, the above equation can be written as X=iift(x) where X = [X(0), ..., X(N − 1)]T and x = [x(0), ..., x(N − 1)]T.

Thus obtained OFDM symbols are statistically independent and follows Gaussian distribution. Complementary cumulative distribution function (CCDF) of the PAPR is one of the prevalent parameter that is used for measuring the performance of the PAPR reduction method. This parameter represents the probability of the PAPR that exceeds a given threshold $PAPR_0$, and the CCDF is therefore written as

$$CCDF(PAPRo) = Pr(PAPR > PAPRo) \qquad (2)$$

2. Related Work

In recent years a lot of research is done on presenting innovative and low complex approaches for the reduction of PAPR in OFDM systems, the concepts and approaches that are related to the current work is presented in this section.

In [11] Y. Zhang et al presented an approach to reduce PAPR and also to detect the transmission errors. This approach depends mainly on sub coding however its extension is based on the bit location that can be classified as optimized sub block and its combination.

In [12] Bauml.et.al presented an SLM approach. In this approach the parallel data is convolved with the pre defined phase vectors and there by generates alternate signals which are orthogonal to each other. The orthogonal signal which has the least PAPR is selected for transmission. In order to extract and signal at the receiver the side information can be sent along with the information in the sub carriers. However, this method becomes more complex as the number of phase vectors increases.

In [13] K. D. Choe et al, presented an scrambling approach that involves data reversal concept. In this method the positions of the data symbols were reversed and the detection at the receiver is performed using a correlator. At the measurement the symbols were inversed before IFFT operation thereby decreasing the PAPR value. This method is very simpler in implementation and also it attains a reasonable PAPR which is far lower than the PTS scheme.

In [14] Muller et.al presented partial Transmit sequence (PTS), this method depends on phase rotating vectors and their shifting. At first the data is converted into non overlapping sub blocks and then the data in each sub block is multiplied with the respective phase vectors. The sub block whose PAPR value is least is chosen to construct the signal for transmission. This approach is a modified version of SLM approach but it has more flexibility in choosing the data symbols. This approach doesn't require any side information which makes it more feasible practically than SLM approach.

In [15] wang et.al presented a method that involves oversampling with a factor of 4 for which the discrete OFDM symbols are used to approximately estimate the value of PAPR. Oversampling increases the complexity but this is mitigated by searching the peak components in the original signal with respect to the up sampled signal. It is also a good idea to integrate this approach with traditional SLM approach and it might decrease the complexity at the little expense of performance.

In [16] Zhou et al, presented a Multi- point-square mapping (MPSM) based PTS scheme

The method employs an extended version of quadrature constellation that could provide the disjoint points for mapping. This method provides promising results than that of traditional PTS approach without the use of side information. It provides low BER which is good indication for better utilization of bandwidth.

In [17] Wu .et.al presented a portioned partial transmit sequence (PTS) approach. This method has very attractive features but it is more prone to adjacent partitioning scheme of PTS since the candidate signal generated in this method is not independent. This approach completely analyzes the independence of candidates and finds appropriate effective phase vectors. Simulation results shows that the conjugate PTS scheme is yielding better results than traditional PTS scheme with very low complexity.

In [10] a hybrid scheme was introduced in which the side information is the sum of SLM and PTS parts and the computational complexity also less than the conventional PTS scheme. In [18], proposed a hybrid scheme integrating it with dummy signal insertion and achieved a considerable decrease in PAPR with low complexity.

3. Background

a) Conventional PTS (C-PTS)

The below diagram depicts the functionality of the conventional PTS scheme for OFDM systems

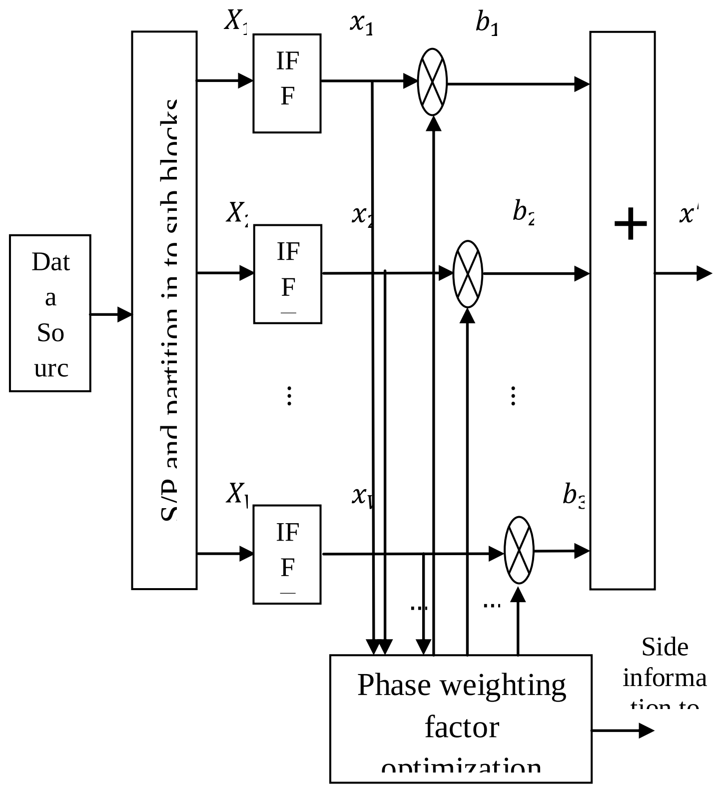

Figure 1: Conventional PTS scheme approach block diagram

The Partial transmit sequence (PTS) is intended to apply on the input data block for performing the partition process on input block to number of disjoint sub-blocks and each partitioned sub block are padded with zeros and weighted by that individual disjoint sub block phase factor.

The input data block taken is $X = [X_0,\ X_1,\ X_2,\ \ldots\ldots X_{N-1}]^T$ and the partition process is applied on taken input data block is to divide it in V disjoint sets$\{x_v,\ \ v = 1,2, \ldots\ldots v\}$. Subcarriers taken in each group is same and it is maintained same in all groups and the representation of alternative frequency domain signal is given as follow notation

$$X' = \sum_{v=1}^{v} X_v\, b_v \quad (3)$$

The variables used in above notation is meant for phase factors $X' = e^{j\emptyset_v}$ and$\emptyset_v = \frac{2\pi i}{W}$, i= 0, 1 … W-1. Partial transmit sequence is represented as X_v (IFFT) and the phase factor selected for such phase factor is minimal for PAPR candidate signal. The possible candidate's navigation from V sub-blocks and W phase weights and possible candidates are represented as WV-1 and the phase factor block is chosen as 1 and V-1 additions and multiplications are carried out for calculation of each candidate.

b) Hybrid PTS scheme

This scheme uses the advantages of both SLM and PTS schemes, this was initially proposed Pushkarev et.al in [10] . The scheme is illustrated in figure 2, in this the original OFDM symbols are multiplied with ‘U’ phase rotation sequences and then each of the OFDM symbols is partitioned in to V disjoint sub blocks. These sub blocks are selected based on optimization with PTS scheme. This can be written as

$$\left\{\widehat{b_1^{(u)}}, b_2^{(u)}\right\} = argmin\{\sum_{v=1}^{2} b_v^{(u)} X_v^{(u)} \qquad (4)$$

Where 1≤u≤U and V=2, Obtain the block which has retained a lower PAPR by using PTS optimization. Lower PAPR from PTS block is statistically independent with each other.

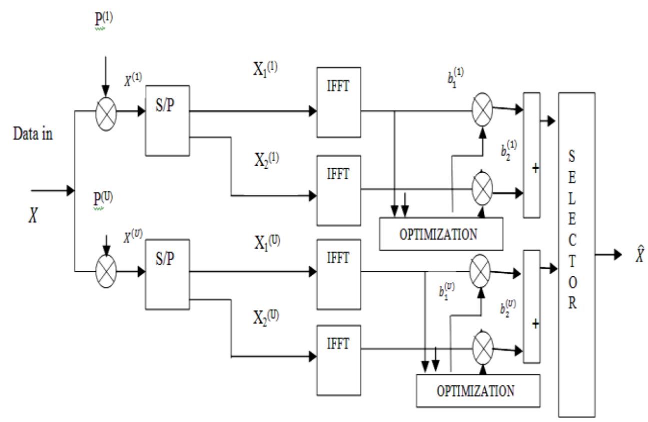

Figure 2: Hybrid approach of PTS scheme

4. Proposed Approach

To mitigate the transmission of side information a method to embed the SI into phase rotating vectors is presented. Let us consider a V-tuple phase vector is defined as

$$S^u = [S_0^u \; S_1^u \; \dots . S_{V-1}^u \qquad (3)$$

Where $S_V^u \in \{0,1, \dots Z\}$ and $0 \leq v \leq V-1$ and $0 \leq u \leq U-1$, for instance $S_V^u = 0$ implies phase offset of 0, in order to embed side information into u[th] rotating vector b[u] , then each rotating factor is multiplied by $e^{j\theta s_v^u}$ where θs_v^u is the phase offset $0 \leq \theta s_v^u < 2\pi$, then the modified phase rotating vector can be represented as

$$\overline{b^u} = [\overline{b_0^u}\, \overline{b_1^u} \dots \overline{b_{V-1}^u}]$$
$$= [b_0^u e^{j\theta s_0^u} \; b_1^u e^{j\theta s_1^u} \; \dots \dots \; b_{V-1}^u e^{j\theta s_{v-1}^u} \;] \qquad (4)$$

The modified alternative signal modifies the equation (3) and can be represented as

$$X'^u = \sum_{v=1}^{v} X_v \overline{b^u}_v \qquad (5)$$

In this scheme, X'^u with minimum PAPR is selected as the candidate signal. The modified phase vectors for U=8 is tabulated in table 1

Table 1: modified Phase vectors with proposed approach

	b_0^u	b_1^u	b_2^u	s_0^u	s_1^u	s_2^u	$\bar{b}_0^u$	$\bar{b}_1^u$	$\bar{b}_2^u$
u=0	1	1	1	0	0	0	1	1	1
u=1	1	1	-1	0	0	1	1	1	$-e^{j\frac{\pi}{6}}$
u=2	1	1	j	0	1	0	1	$e^{j\frac{\pi}{6}}$	j
u=3	1	1	-j	1	0	1	$e^{j\frac{\pi}{6}}$	1	$-e^{j\frac{\pi}{6}}$
u=4	1	-1	1	2	1	0	$e^{j\frac{\pi}{3}}$	$-e^{j\frac{\pi}{6}}$	1
u=5	1	-1	-1	1	1	1	$e^{j\frac{\pi}{6}}$	$-e^{j\frac{\pi}{6}}$	$-e^{j\frac{\pi}{6}}$
u=6	1	-1	j	0	1	2	1	$-e^{j\frac{\pi}{6}}$	$e^{j\frac{\pi}{3}}$
u=7	1	-1	-j	1	2	2	$-e^{j\frac{\pi}{6}}$	$-e^{j\frac{\pi}{3}}$	$-e^{j\frac{\pi}{3}}$
u=8	1	j	1	0	2	0	1	$e^{j\frac{\pi}{3}}$	1

5. Experimental Results

The proposed approach is tested with N=256 sub carriers and 10^4 symbols with 4-QAm modulation. The proposed approach is tested for different ‘U’ values and the response of it is depicted in the figures below.

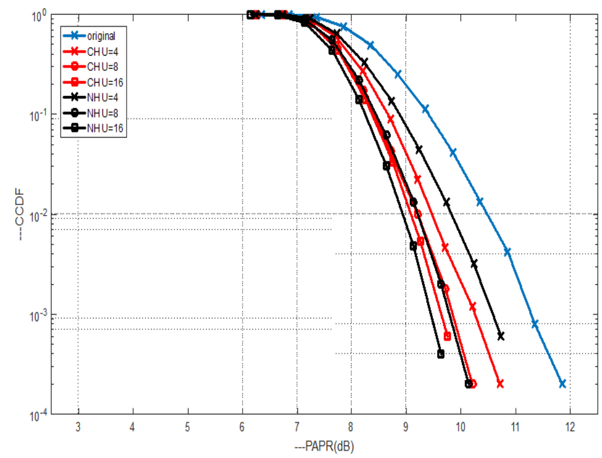

Figure 3: PAPR performance analysis of the proposed and conventional hybrid PTS schemes under U=4, 8, 16

It can be observed from the figure that the approach is attaining higher PAPR for lower U values like 4 which gradually decreases when the value of U is higher. It is also observed that at U=16 a decrement of 04~0.8 db of PAPR is obtained for the proposed approach. From figure 4 it can be observed that the interference is compatibly lower than the C-PTS approach.

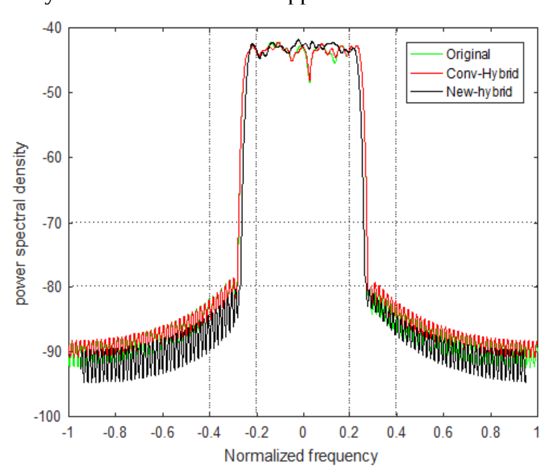

Figure 4: OBI performance of the proposed approach

6. Conclusion

A new phase sequence based hybrid PTS scheme for PAPR reduction is proposed in this paper. The sequence of the phase vectors are modified with exponential angle offset which is considered as offset is multiplied with the traditional phase rotating vector. The results obtained with the modified phase rotating vectors shows considerable improvement in the reduction PAPR with cost of minimizing the interference. This work can be further extended with implementation of likelihood detector at the receiver and estimating the BER performance under different channeling environments.

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