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Comparative Analysis of OFDM Systems based on PAPR Reduction for Cyclic Shifted Partial Transmit Sequence and Conventional Partial Transmit Sequence for Different Shift Values Using different Modulation Schemes

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Abstract: ***High PAPR is one of the serious issues in OFDM Systems which affects the orthogonality of OFDM systems. This paper demonstrates the use of shift value sets in cyclically shifting the OFDM transmit sequence, which leads to generation of alternative transmit sequence by using cyclic shifts rather than phase rotations which forms the basis of conventional Partial Transmit Scheme. The two approaches are tested for QPSK and BPSK modulation. It is found that Cyclic Shifted Partial transmit scheme out performs the conventional Partial transmit Sequence in reducing the PAPR for both the modulations.***

Keywords: Orthogonal Frequency Division Multiplexing (OFDM), Cyclic Shifted sequence (CSS), Peak to average power ratio (PAPR), Partial transmit sequence (PTS).

1. Introduction

OFDM stands for Orthogonal Frequency Division Multiplexing. It is a revolutionary communication technology. OFDM is the basis for all 4G technology i.e. Fourth Generation Wireless Communication Systems. The examples of 4G Wireless Communication Systems are LTE and WiMAX. LTE stands for Long Term Evolution. It is a 4G Cellular Standard.

WiMAX is another competing 4G cellular standard. It stands for Worldwide Interoperability for Microwave Access. OFDM is a key broadband Wireless technology which supports data rates in excess of 100 Mbps. Not only are the cellular standards OFDM also basis for LAN standards.

PAPR is one of the critical issues in OFDM. PAPR in OFDM is directly proportional to the number of subcarriers. In OFDM the number of sub carriers can be as high as 1024. Many distorted and distortions less techniques are used to reduce the PAPR. Few of them are Clipping and Filtering, Partial transmit Sequence (PTS), Sequential Mapping etc.

2. Literature Review

Table 1: Literature Review

Year	*Authors*	*Description*
2016	Kee-Hoon Kim	On the Shift Value Set of Cyclic Shifted Sequences for PAPR Reduction in OFDM Systems.
2015	Jun-Young Woo, Hyun Seung Joo, Kee-Hoon Kim, Jong-Seon No, and Dong-Joon Shin	PAPR Analysis of Class-III SLM Scheme Based on Variance of Correlation of Alternative OFDM Signal Sequences
2015	V. Sudha; Bhukya Anilkumar; M. S. Samatha; D. Sriram Kumar	A low-complexity modified SLM with new phase sequences for PAPR reduction in OFDM system
2015	Seshanna Katam; P. Muthuchidambaranathan	Modified SLM method for reduction of PAPR in OFDM systems using decimal sequences
2015	Sudha; Bhukya Anilkumar; M.S. Samatha; D. Sriram Kumar	A low-complexity modified SLM with new phase sequences for PAPR reduction in OFDM system
2015	Sameh A. Fathy; Mohamed S. El-Mahallawy; Esam A. A. Hagras	SLM technique based on particle swarm optimization algorithm for PAPR reduction in wavelet- OFDM systems
2015	Ezmin Abdullah, Azlina Idris	Comparison between LDPC codes and QC-LDPC codes in term of PAPR in OFDM system with different encoding techniques
2014	Harshita Tiwari; Rakesh Roshan; Rajat Kumar Singh	, " PAPR reduction in MIMO- OFDM using combined Methodology of selected mapping (SLM) and partial transmit sequence (PTS)
2012	B. soomasekhar; K. Muralikrishna; A. MallikarjunaPrasad; T. Ravibabu	Selected Mapping, Clipping and Differential Scaling for reduction of PAPR in OFDM system
2011	Di-xiao Wu	Selected mapping and partial transmit sequence schemes to reduce PAPR in OFDM systems
2009	Ajit Jha; Md. Sohel Mahmud Sher; S.M.	Reduction in Peak to Average Power Ratio (PAPR) in Orthogonal Frequency

	Shamsul Alam; Md. Tariq Hasan; Md. Mizanur Rahman	Division Multiplexing (OFDM): A Novel Approach Based on Clipping and Amplification
2006	Biao Yan; Juan Yang;Hui Zhang; Yihuan Zhu; Haiyang Wang	Distribution Bound of PAPR in OFDM Signals
2006	V. Vijayarangan; R. Kalidoss; R. Sukhanesh	Low crest mapping for PAPR reduction in OFDM systems

3. Problem Definition

In OFDM systems PAPR is the function of Number of Sub Carriers. The direct proportionality of PAPR on number of sub carriers causes further challenges in OFDM systems; thereby PAPR reduction evolves out to be the major requirement of the OFDM system. Cyclic shifts were used in place of phase rotations in partial transmit sequence. Based on the variance of correlation cyclic shifts are used in the present work.

4. Methodology

Based on the literature review, it is identified that the previous papers that used selective Mapping (SLM) and Partial transmit sequence (PTS) schemes for PAPR reduction are based on phase rotations. Phase rotations were used to create the sub-blocks. In the proposed methodology Cyclic Shifted Sequence (CSS) are used instead of phase rotations. The use of cyclic shifts outperforms the use of phase rotations. The use of Cyclic Shifted Sequence is advantageous because it reduces the complexity. In case phase rotations are used, the larger number of phase rotations are not feasible as it involves a number of complex multiplications and additions thereby increasing the complexity of the circuit. This problem can be solved by using the cyclic shifts. If there are N sub carriers then N/2 shifts can be done before the outcome of the same original signal. Thus the number of alternative transmit sequences are considerably increased by use of cyclic shifts. Shift values are decided based on the variance of correlation.

5. Implementation

5.1 Simulation Model

The proposed methodology is based on the use of cyclic shifted sequences. The previous papers related to Sequential Mapping (SLM) and Partial Transmit Sequences (PTS) schemes were based on the phase rotations. In other words, phase rotations were used to create the sub blocks. The proposed methodology makes the use of Cyclic shifted Sequences (CSS) instead of phase rotations. There are many advantages of using the cyclic shifts in place of phase rotations. First of all, it reduces the complexity. Larger numbers of phase rotations are not feasible as it involves a number of complex multiplication and additions thereby increasing the complexity of the circuit. By using the cyclic shifts this problem can be solved. If there are N sub carriers then N/2 shifts can be done before the outcome of the same original signal. Thus the number of alternative transmit sequences are considerably increased by the use of cyclic shifts. The implementation of the methodology is best explained by the following block diagram.

The diagram below shows the Cyclic Shifted Sequences Scheme which is used for testing u alternative OFDM sequences. Random partitioning is used to divide X into V disjoint sub blocks. Thus the input symbol sequence is $X_{1,}$ X_{2}.................X_v. IFFT is performed on the input signal sequence. Because of IFFT V subblocks in frequency domain is converted to V OFDM signal subsequences in the time domain. The time domain OFDM signal subsequences is given by $x_{1,}$ $x_{2,}$ ....x_v. Here x_v = { x_v (0), x_v(1)...................... x_v(N-1) where 1<=v<=V. N and V are taken as the integers of powers of 2. The V OFDM signal subsequences go

5.2 Cyclic Shift

The Cyclic shifting keeps intact the orthogonality between X(k)'s which are the input symbols. In the figure T_v^u is taken as the shift values and the SVset is defined as
$\tau^u = \{\tau_1{}^u, \tau_2{}^{u \cdots\cdots} \tau_V{}^u\}$

This defines the SV set for uth alternative OFDM signal sequence. The partition method used is the random partition method. The previous research reveals that random partition method gives the best performance in PAPR reduction.

5.3 Simulation Parameters

MATLAB is used as the simulation tool. The performance of Cyclic shifted PTS and Conventional PTS is evaluated on different modulation schemes such as BPSK and QPSK.

Table 2 Simulation Parameters

Simulation Tool	MATLAB 7.7.0
Channel	Rayleigh
Modulation Technique	BPSK,QPSK, 8PSK,16 PSK
Number of Sub Carriers	128
Number of IFFT Points	Number of Sub Blocks

Number of FFT Points	Number of Sub Blocks
Number of Sub Blocks	4
Shift Value Sets	{0,0,0,0} {1,2,3,4} {2,4,6,8} {3,6,9,12}

6. Results

Simulation Result 1: PAPR analysis of Cyclic Shift PTS and Conventional PTS using BPSK.

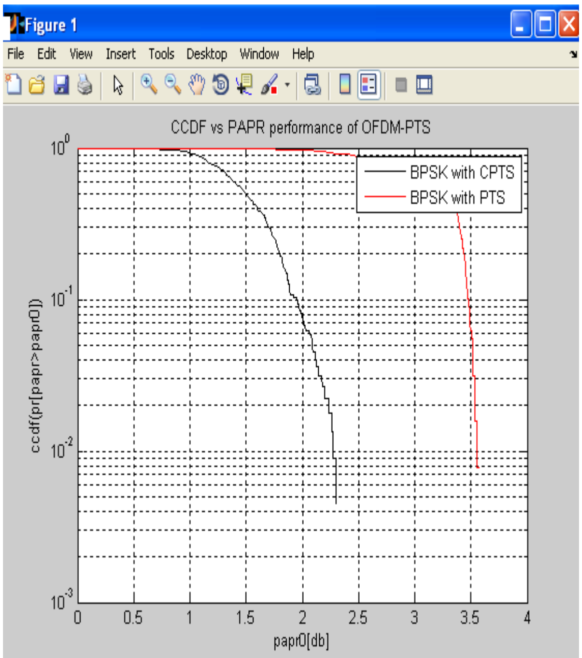

Figure 2: PAPR analysis of Cyclic Shift PTS and Conventional PTS using BPSK.

Figure 2 shows that Cyclic Shifted PTS shows the better reduction in PAPR than Conventional PTS. It can be seen that PAPR ranges up to 2.315 for cyclic shifted PTS and increases up to 3.553 for conventional PTS.

Simulation Result 2: PAPR analysis of Cyclic shift PTS and Conventional PTS using QPSK

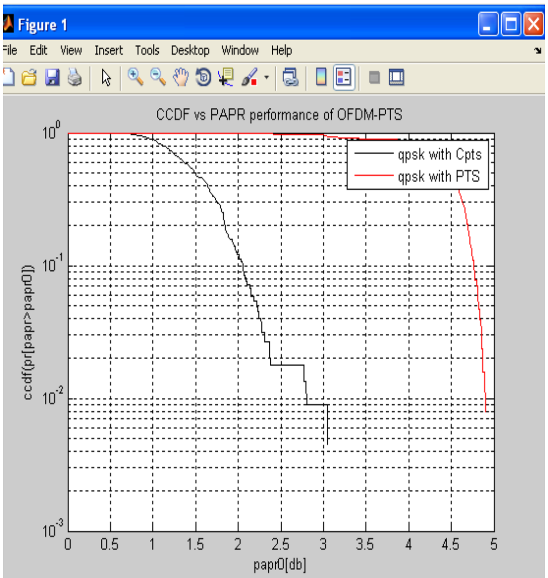

Figure 3: PAPR analysis of Cyclic Shift PTS and Conventional PTS using QPSK.

Fig 3 shows that Cyclic Shifted PTS shows the better reduction in PAPR than Conventional PTS. It can be seen that PAPR ranges up to 3.048 for cyclic shifted PTS and increases to 4.896 for conventional PTS.

Simulation Result 4: PAPR analysis of Cyclic shift PTS and Conventional PTS using 16PSK.
Simulation Result 3: PAPR analysis of Cyclic shift PTS and Conventional PTS using 8PSK.

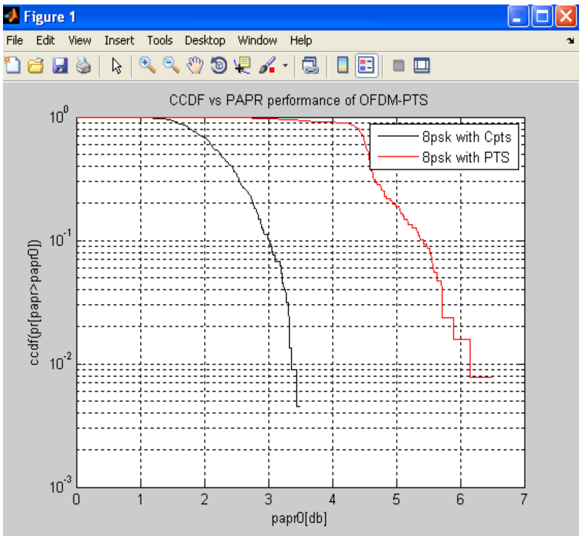

Figure 4: PAPR analysis of Cyclic shift PTS and Conventional PTS using 8PSK.

Figure 4 shows that Cyclic shifted PTS show better results than conventional PTS in case of PAPR Reduction. It is seen that PAPR ranges up to 3.519 in case of Cyclic shifted PTS which increases to 5.712 in case of conventional PTS.

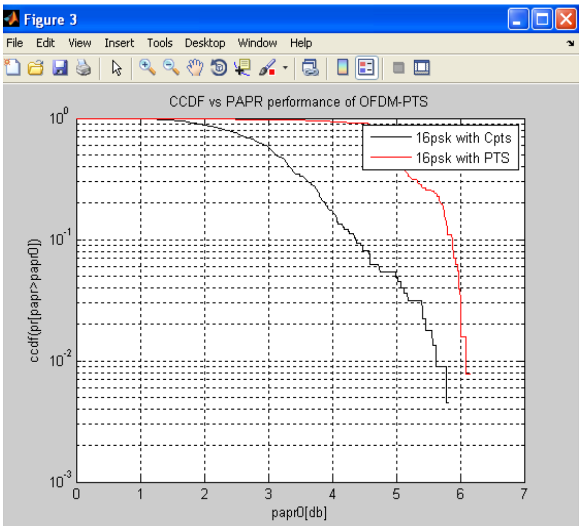

Figure 5: PAPR analysis of Cyclic shift PTS and Conventional PTS using 16PSK.

Figure 5 shows that as we increase the number of phases the PAPR performance degrades. Nevertheless, in case of cyclic shifted PTS it ranges up to 5.72 and increases to 6.02 in case of conventional PTS.

7. Conclusion & Future Scope of Work

High PAPR is one of the concerning issues in OFDM Systems. Many techniques were used to solve the problem of high PAPR in OFDM systems. One of the techniques is Partial Transmit Sequence. The conventional PTS uses phase rotations to generate alternative transmit sequence. In cyclic Shifted PTS, cyclic shifts are used instead of phase rotations to generate alternative transmit sequence.

It can be concluded that the use of Cyclic shifted sequence in Partial transmit sequence give better results as compared to Conventional Partial transmit sequence without cyclic shifts as far as PAPR is concerned. The two mentioned techniques were tested for different modulation schemes namely BPSK and QPSK. In all the cases PTS with cyclic shift out performs the conventional PTS without cyclic shifts.

In future, the technique can be used for PAPR reduction in other systems such as MIMO- OFDM.

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[16] Ntpel Lectures

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