

Comparison of PAPR Reduction of OFDM Signals Using Pseudo Random PTS and Clipping and Filtering Method

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Abstract

Many methods have been proposed to reduce the high PAPR problem. Partial transmit sequence (PTS) is one of the most popular peak-to-average power ratio (PAPR) reduction technique proposed for orthogonal frequency-division multiplexing (OFDM) systems. PTS is suffers from higher computational complexity and it requires several extra subcarriers for the transmission of side information. These extra subcarriers will degrade the OFDM system's spectrum efficiency and increase the bit error rate. Several proposals had taken for eliminating the need of side information in the paper, but these existing techniques rely on some reference symbols which increases the transmission power or higher the complexity of the detector. In this paper, Pseudo-random PTS which uses cyclic shifting of sub block sequences is proposed to eliminate the need of side information. Simulation shows that the proposed scheme performs very well in terms of PAPR. The proposed scheme achieves almost the same bit error rate (BER) performance as the C-PTS with perfect side information, under frequency selective fading condition. In this paper, instead of analyzing the clipped signal, we study the clipping noise and propose a simplified OICF algorithm

1. Introduction

Orthogonal frequency division multiplexing (OFDM) has received much attention for use in radio over fiber (RoF) system because of its high spectral efficiency, tolerance to dispersion and flexibility to dynamically bandwidth. However, the high PAPR of the OFDM modulation format has been cited as one of the main drawbacks [2]. As we know, interleaved segmentation, as an effective partial transmit sequence (PTS) segmentation method, is also a feasible technique for reducing PAPR [3]. In this work, a novel 60GHz RoF system is proposed and experimentally demonstrated with 16QAM-OFDM downlink signals, which are generated by interleaved segmentation method. This is the first experimental investigation using interleaved segmentation for PAPR reduction in the RoF system. The experimental results demonstrated this method provides a trade-off between PAPR and computational complexity.

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Meanwhile, the receiver sensitivity is effectively enhanced using this technique. Hence, it is a potential technique for future RoF system application. Moreover, the used self-mixing down-conversion in our experiment can simplify the system configuration

2. Principle

High peak- to- average power ratio has been recognized as one of the major problem involving OFDM modulation. High PAPR signal would require a large range of dynamic linearity from the analog circuit and high power consumption with lower efficiency.

The complex data block for the OFDM signal to be transmitted is given by

$$X(t) = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} X_n e^{j2\pi n \Delta f t} \quad 0 \leq t \leq NT$$

The PAPR of the transmitted signal is defined as

$$\text{PAPR}(x[n]) = \frac{\max|x[n]|^2}{E[|x[n]|^2]}$$

In this paper, we change the research focus from the clipped signal to the clipping noise. Our analysis shows that the optimization problem in the original

OICF algorithm can be transformed into an equivalent form, where a PAPR-reduction vector added to the subcarriers becomes the optimization parameter. Further analysis shows that the solution of the transformed problem can be approximately obtained by using simple algebraic operations with $O(N)$ complexity rather than by executing special software.

3. Proposed System Model

3.1. Proposed Pseudo Random PTS

In this paper, Pseudo-random PTS making use of the combination of cyclically shifting sub-block sequences is proposed to generate new candidates. The modulated OFDM signal is first converted from serial to parallel form and then partitioned into several sub-blocks. The sub-carriers are in the form of vectors which are individually modulated. IFFT operation is done at each sub blocks which produces the time domain signals [8]. Now the linear operation called cyclic shifting is performed instead of phase factor addition. This cyclic shift is done by circular convolution followed by linear shift of the sequences. Hence, the new candidates are produced. After that PAPR is calculated and the minimum PAPR value is chosen for the data transmission.

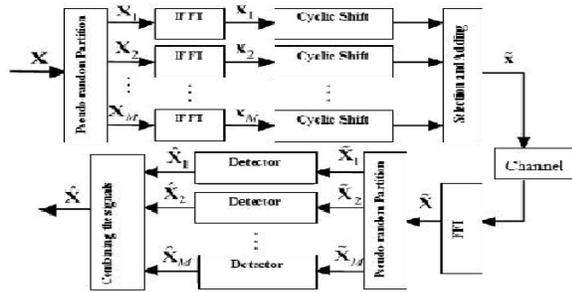


Fig: 1. Block Diagram of the Proposed System

3.2. Clipping and Filtering Model

The EVM is widely adopted to quantify the amount of in-band distortion that occurs at the transmitter, which directly affects the BER performance at the receiver. For an OFDM block, each data symbol is mapped to a constellation point. However, various transmitter impairments or some deliberate modifications will cause the actual constellation point to deviate from the ideal location. The difference between the ideal constellation point and the deviated point is called the error vector. The EVM is equal to the square root of the ratio of the mean error vector power to the mean reference power. For a single OFDM symbol, its EVM is defined as

$$EVM = \frac{\|C^m\|_2}{\|X\|_2}$$

$$\text{Where } C^m = X^{(m)} - X_1^{(m)}$$

$$X^{(m+1)} = X^m - C^{m+1}$$

$X^{(k)}$ is here defined only for $k=0,1,\dots,N-1$, which guarantees no out-of-band radiation

An example of a normalized and circularly shifted vector ds (128 subcarriers, QPSK, $L = 16$).

4. PAPR performance comparison between the proposed PTS, C-PTS and clipping and filtering method

Table: 1.

SIMULATION PARAMETERS

Parameters	Value
Simulation Tool	MATLAB 7.12.0 (R2011a)
Modulation	QAM
Order of Modulation (M)	16
Number of Subcarriers (Nc)	128
Sub-block Partition (v)	8
Oversampling Rate (L)	4
Maximum Symbols	10000

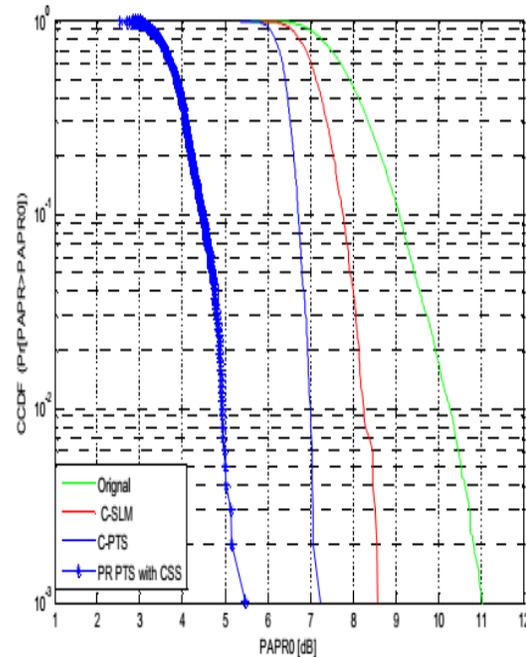


Fig: 2. Graph comparison between PR-PTS and OICF

The modulation used here is Quadrature Amplitude Modulation. BER versus SNR is calculated and plotted for both transmitted OFDM

signal and proposed PTS are also obtained. The following sections provide the results and discussions of the proposed system. The simulation is done to obtain the PAPR versus CCDF and BER versus SNR of proposed scheme and compared with the other techniques. The simulation parameters are summarized in the TABLE I.

The Peak to Average Power Ratio (PAPR) is calculated and PAPR versus CCDF curve is obtained. Fig. 2 shows the PAPR performance comparison between the proposed PTS, and OICF. From Fig. 2 it is observed that the pseudo random PTS with cyclic shift Sequence gives better performance than compared to OICF. The conventional PTS and SLM are having the

PAPR values of 8.5dB and 7.1dB. The Peak to Average Power Ratio (PAPR) is calculated and PAPR

versus CCDF curve is obtained for different PTS schemes with the simulation parameters listed in the Table 1

5. Conclusion

Pseudo-random PTS make use of cyclic shift sub-block sequences is proposed to generate new candidates. This scheme reduces the computational complexity without any side information. The advantages of the proposed scheme are firstly, pseudo random partition gives better PAPR reduction, secondly utilizing cyclically shifted sub-block sequences and IFFT property, and the proposed scheme will generate a set of candidates with different phase constellation without multiplication.

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