

A New PAPR Reduction Parameter to Evaluate SLM and PTS as MIMO-OFDM PAPR Reduction Schemes

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Abstract

In general, the high peak-to-average power ratio (PAPR) of transmitted signals for MIMO-OFDM systems reduces the system efficiency and hence increases the cost of the radio frequency (RF) power amplifier. In this paper, a modified hybrid algorithm is developed to obtain better PAPR reduction performance and reduce computational complexity compared with the conventional hybrid scheme. This proposed algorithm combines selected mapping (SLM) with partial transmit sequence (PTS) strategies, and further employs linear addition and exchange of various PTS sub-blocks to create more alternative MIMO-OFDM signal sequences. As a result, with the same numbers of IFFT and phase rotation sequences, our proposed algorithm has the potentials to provide better PAPR reduction performance with lower computational complexity.

Index Terms—MIMO-OFDM, PAPR, SLM, PTS.

I. INTRODUCTION

In wireless communication systems, the orthogonal frequency division multiplexing (MIMO-OFDM) [1]–[4] technique is a widely popular and attractive scheme for high-data-rate transmission because it can cope with frequency-selective fading channel. The modulators and demodulators of MIMO-OFDM systems can be simply implemented by employing inverse fast Fourier transform (IFFT) and FFT to make the overall system efficient and effective. Nowadays, it has been adopted as a powerfully potential candidate for next-generation mobile communications systems. For MIMO-OFDM-based systems, one of the main disadvantages is high PAPR problem. This phenomenon results from that in the time domain, an MIMO-OFDM signal is the superposition of many narrowband subcarriers. At certain time instances, the peak amplitude of the signal is large and at the other times is small, that is, the peak power of the signal is substantially larger than the average power of the signal. The influence of high PAPR reduces system efficiency and then increases the cost of the RF power amplifier. Therefore, how to find a solution to reduce high PAPR effectively is one of the most important implementation issues in MIMO-OFDM communications.

As a review of previous literature, the multiple signal representation is one of well-known PAPR reduction techniques for MIMO-OFDM systems. It has been described in [5]–[13] particularly. Several helpful schemes related to SLM-based and PTS-based techniques have been proposed for improving PAPR reduction performance or reducing the computational complexity. Those techniques included the conventional hybrid method [12] and the modified SLM scheme [13]. Based on the preceding survey results, a novel modified hybrid algorithm combining the additional hybrid with switching hybrid schemes is proposed to reduce the number of IFFT and obtain a significant PAPR reduction performance in MIMO-OFDM systems.

2. EXISTING SYSTEM

MIMO-OFDM is a multi carrier modulation technique which has been recently widely used in different communication systems especially the ones with high data rates [1]. MIMO-OFDM has become so popular nowadays due to its flexible and efficient management of inter- symbol interference (ISI). In addition, MIMO-OFDM offers high spectral efficiency as a result of multicarrier orthogonality aspect. Such system aspects would improve overall system performance and communication link quality [1]. However, MIMO-OFDM has a major drawback which is the high PAPR. Having a system with high PAPR will force the power amplifier to work in the non-linear region where the power conversion is inefficient which affects, consequently, the battery life in the mobile communications devices. This inefficient power conversion causes power growth as well resulting in even higher amplitude peaks [2].

Since the impact of high PAPR is severe on the system performance, many literatures have been published to focus on developing modified algorithms with low PAPR. Overviews of PAPR reduction techniques are covered in [3, 4]. In our paper we are focusing on two of these PAPR reduction techniques: selected mapping (SLM) and partial transmit sequences (PTS). SLM and PTS were published for the first time in [5] and [6], respectively. Since SLM and PTS were published, questions and discussions have raised to find out which one is the more practical, less complicated, and most efficient at the same time. Therefore, many comparison publications have been made for that purpose. Our area of interest in this paper is to develop a criterion to evaluate both SLM and PTS system performances based on their CCDF responses. In order to evaluate SLM and PTS techniques, we should cover the theory and mechanism used mostly to evaluate PAPR reduction in any PAPR reduction system. MIMO-OFDM divides the information stream, needed to be sent, into N individual sub-streams.

3. PROPOSED SYSTEM

In order to improve the PAPR reduction performance in CH scheme, we have to generate a large number of alternative MIMO-OFDM signal sequences without increasing the number of IFFT to avoid high computational complexity. Here, a new additional hybrid (AH) scheme by combining the modified SLM scheme with CH scheme. The system performance is desirable that the number of IFFT is reduced but the PAPR reduction performance is not compromised. The block diagram of AH scheme is shown in Fig. 1. Clearly, the first U signals $x^{\wedge}(u)$, where $u = 1, \dots, U$, are the same as the signals (6) in the CH scheme. Furthermore, the alternative MIMO-OFDM signal sequences are generated by the linear combination of the sub-block signals from different PTS blocks after IFFT operation. Using the linear property of Fourier transform, the linear combination of these sequences can be obtained by

$$x(u) v = c(i) x(i) v + c(k) x(k) v \quad (1)$$

where $U + 1 \leq u \leq U2$, $1 \leq i, k \leq U$, $1 \leq v \leq 2$, and $c(i)$ and $c(k)$ are some coefficients to be chosen later. That is to say, if we have MIMO-OFDM signal sequences $x(i) v$ and $x(k) v$, the other alternative MIMO-OFDM signal sequences in (9) can be obtained without performing IFFT operation. Now, we would investigate how to make each element of $x(i) v$ and $x(k) v$ to have unit magnitude under the condition that each element of the phase sequences $P(i)$ and $P(k)$ has unit magnitude.

Basically, the elements of the sequence $x(i) v$ and $x(k) v$ have unit magnitude if the following conditions are satisfied:

$$c(i) = \pm(1/\sqrt{2}) \text{ and } c(k) = \pm(1/\sqrt{2})j, \text{ and}$$

Each element of $P(i)$ and $P(k)$ takes the value in ± 1 . Since $|c(i)|^2 = |c(k)|^2 = 1/2$, the average power of $x(u)$ is equal to one half of the sum of average power of $x(i)$ and $x(k)$. From U binary phase rotation sequences, we can obtain 2^{U-1}

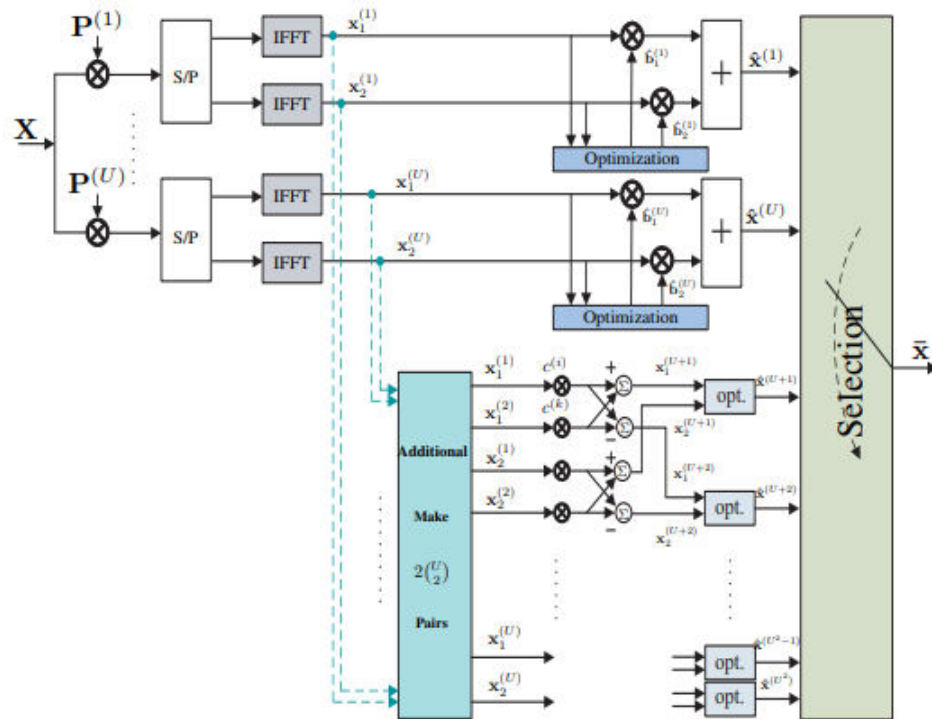


Fig. 1. The block diagram of slm scheme

2^{U-1} excessive pair sub-blocks sequences, thus, there are total 2^{U-1} pair sub-blocks sequences for AH scheme.

In order to further improve the PAPR reduction performance without increasing the number of IFFT, the pts algorithm is proposed by combining AH and SH schemes to generate more and more alternative MIMO-OFDM sequences. Those $\{x(u)_1, x(u)_2\}$ pairs, where $1 \leq u \leq U$, are the signal inputs of the additional block and switching block respectively and simultaneously. The block diagram of MH scheme is shown in Fig. 2.

Using the linear property of Fourier transform, the linear combination of U phase rotation sequences can obtain excessive 2^{U-1} alternative MIMO-OFDM sequences. After optimization blocks, those overall lowest PAPR $\hat{x}(u)$ can be written as the same as (11). Using the switching technique among PTS blocks, the signals of U phase rotation sequences can obtain excessive 2^{U-1} alternative MIMO-OFDM sequences. After optimization blocks, those overall lowest PAPR $\hat{x}(u)$ can be written as the same as (14). In the MH scheme, if $V = 2$ and U phase rotation sequences are considered, the original signals $x(u)_v$ can generate excessive 2^{U-1} pairs of sequences respectively and simultaneously by either additional block or switching block. Therefore, there are total $2^{U-1} - U$ MIMO-OFDM sequences with the lowest PAPR in the MH scheme.

In order to recover the transmitted data information, the number of required side information bits can be obtained by

$$NMH = \log_2(2U^2 - U) + (V - 1)\log_2 W \quad (2)$$

Instead of generating alternative MIMO-OFDM sequences with linear combination, a new switching hybrid (SH) scheme by combining the switching technique with the CH scheme. The system performance is desirable that the number of IFFT is reduced but the PAPR reduction performance is not compromised. By the switching block, we can use original U pairs $\{x(u)_1, x(u)_2\}$ to generate excessive $2U^2$ pairs of MIMO-OFDM sequences without increasing the number of IFFT units. Thus, there are total U^2 pairs $\{x(u)_1, x(u)_2, \dots, x(u^2)_1, x(u^2)_2\}$ are operated by each optimization unit. Obviously, the first U signals $\hat{x}(u)$, where $u = 1, \dots, U$, are the same as the signals (6) in the CH scheme.

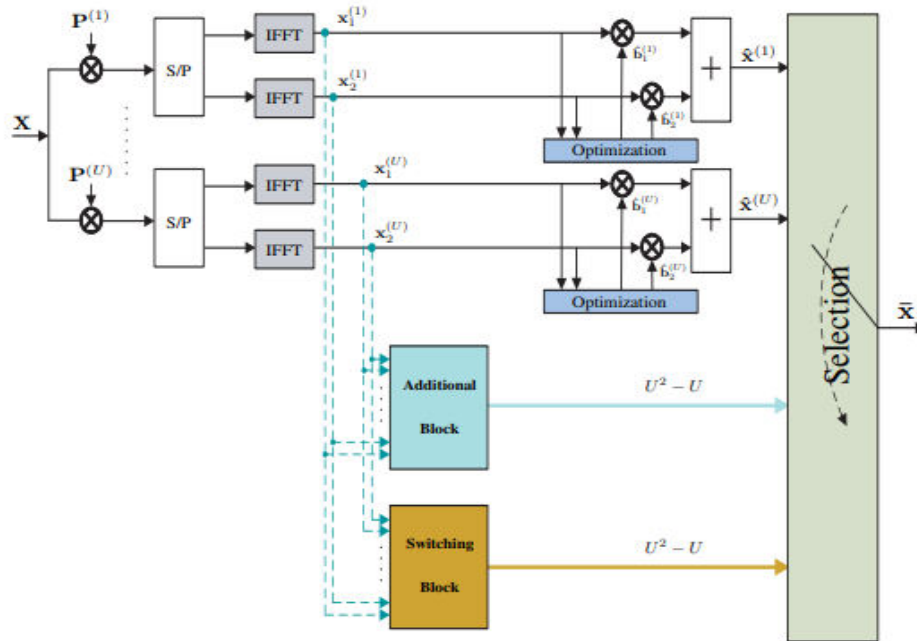
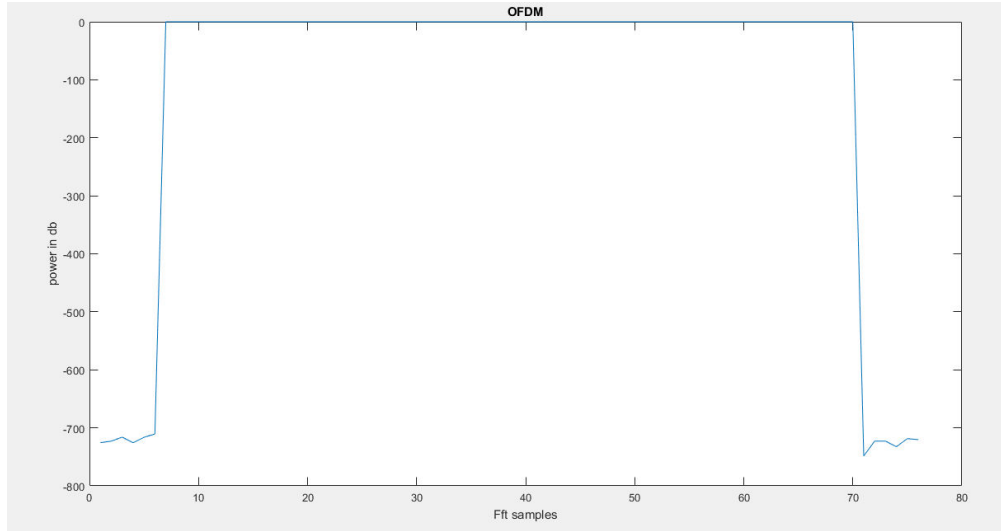


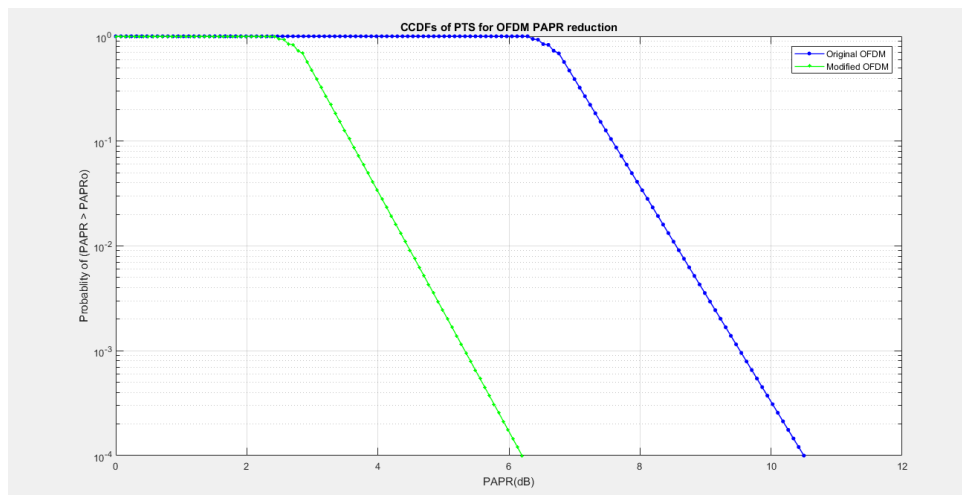
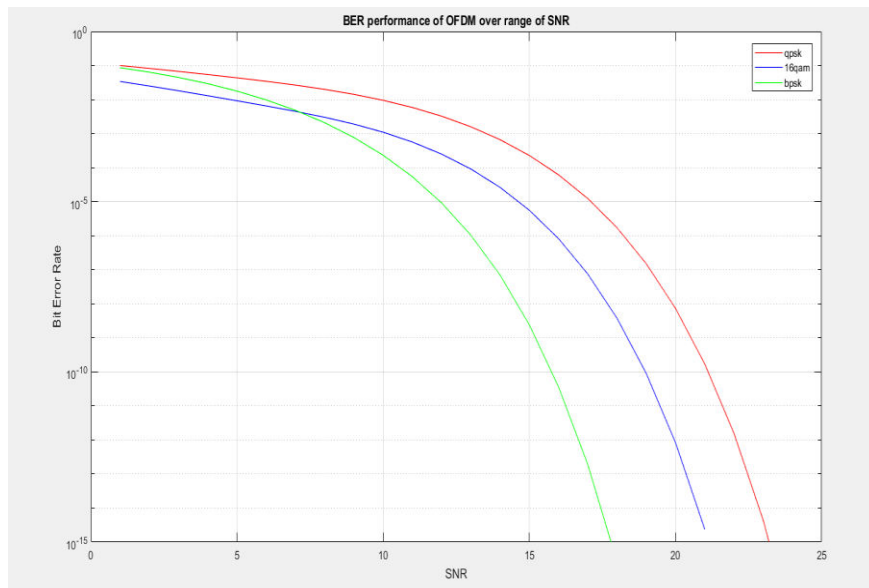
Fig. 2. The block diagram of pts scheme

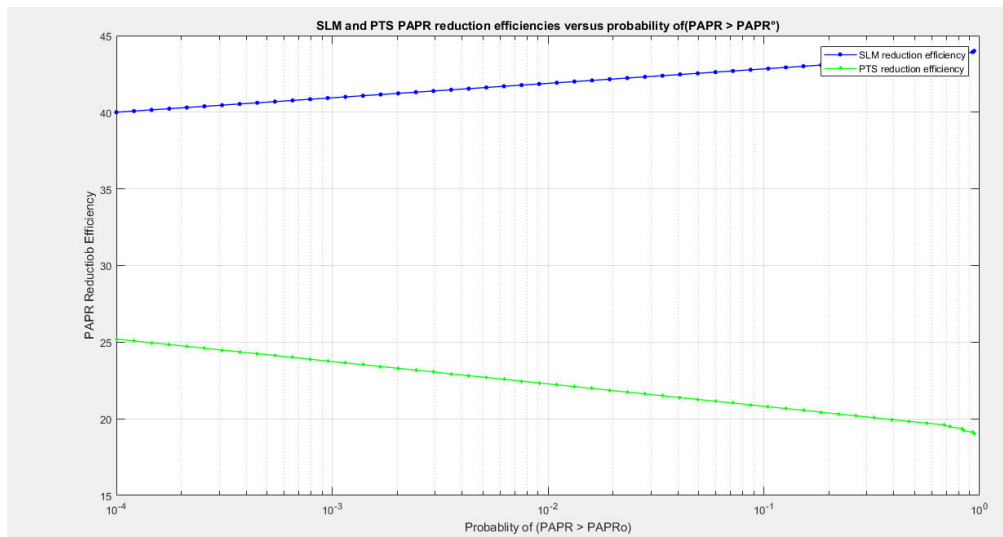
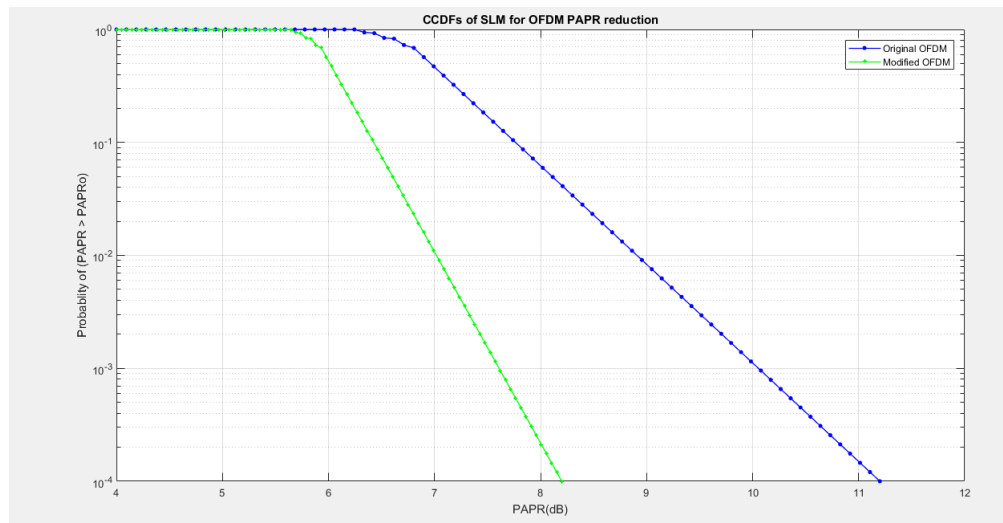
4.SIMULATION RESULTS

4.1 MIMO-OFDM spectrum:



4.2 BER ANALYSIS





5.CONCLUSION

It has been always a controversial topic to evaluate SLM and PTS algorithms for OFDM PAPR reduction. Literature publications have shown that PTS PAPR reduction system is more complex than SLM PAPR reduction system is. In this paper, after simulating both PAPR reduction schemes SLM and PTS, a proposed way is implemented to evaluate both SLM and PTS techniques from the angle of the system efficiency when increasing the probability of getting high PAPR values.

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