

Hybrid combination of SLM, PTS and Clipping Technique for PAPR reduction in MIMO-OFDM

Vandana Pundir¹, Dr. Anwar Ahmad²

¹Research Scholar, Dept. of Electronics and Communication Engineering, Jamia Millia Islamia, Delhi, India

²Professor, Dept. of Electronics and Communication Engineering, Jamia Millia Islamia, Delhi, India

Abstract – High peak to average power ratio (PAPR) is one of the main challenges in orthogonal frequency division multiplexing (OFDM) or multiple-input multiple-output (MIMO) OFDM system. There are many PAPR reduction techniques to reduce the PAPR, out of which Selective Mapping (SLM), Partial Transmit Sequence (PTS) and Clipping are found out to be the potential candidates which greatly reduce the PAPR but with high computational complexity and degraded performance. In this paper, we have combined SLM, PTS and Clipping to reduce the PAPR problem in MIMO-OFDM with improved performance. Simulated results demonstrate that OFDMA signals using hybrid technique carried significant effects in reduction of PAPR in MIMO-OFDM system.

Key Words: Multiple input Multiple output (MIMO), Orthogonal Frequency Division Multiplexing (OFDM), Selective Mapping (SLM), Partial Transmit Sequence (PTS), Clipping, Peak to Average Power ratio (PAPR), CCDF, IFFT, BER

1. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is an efficient multicarrier modulation scheme in wireless communication. However, High Peak to average power ratio (PAPR) is considered to be the major detrimental aspect of OFDM and Multiple input Multiple output (MIMO) OFDM system. Large PAPR distorts the signal if the transmitter contains non-linear components like power amplifiers (PAs). Due to high peaks, the PA at transmitter enters into saturation region instead of being in linear region which causes distortion to the transmitted signal. This will further results in increased Bit error rate (BER) at the receiver. In other words, the nonlinear distortion will cause both in-band and out-of-band interference to signals. Therefore the PAs requires a back off that should be approximately equal to the PAPR for distortion-less transmission. This decreases the efficiency of amplifiers [1]. There are several techniques available in OFDM system to overcome and reduce PAPR such as Tone Reservation (TR), selective mapping (SLM), clipping, partial transmit sequence (PTS), etc.

In this paper, we are discussing about PAPR which affects the performance and efficiency of Power Amplifier (PA). The paper analyzes a hybrid combination of Selective

Mapping (SLM), Partial transmit sequence (PTS) and Clipping technique in MIMO-OFDM system for reduction of PAPR. Further, the simulation results are analyzed by using Complementary Cumulative Distribution Function (CCDF) for PAPR in dB.

2. PAPR problem

The peak to average power ratio for a signal $x(t)$ is defined as

$$papr = \frac{\max[x(t)x^*(t)]}{E[x(t)x^*(t)]}$$

where $x^*(t)$ is the conjugate of $x(t)$

$\max[x(t)x^*(t)]$ is the peak power value of signal

$E[x(t)x^*(t)]$ is the mean square value or average power of signal

The PAPR is expressed in decibels as

$$papr_{dB} = 10 \log_{10}(papr)$$

The high PAPR results in lower power efficiency and strongly affects the performance of power amplifier (PA). The high PAPR value of the transmitted signal also highly affects the power amplifiers complexity. High PAPR require linear amplifier but it is difficult to maintain linearity of the amplifier which produces nonlinear characteristic. This non-linearity plays a great role of undesired distortion like out of band radiation. The power amplifier of transmitter essentially requires operating in linear region. It is not possible to maintain specific limit to keep out of band power, if high power amplifier (HPA) do not operate in linear region with high back off. This condition is not suitable for amplification and the transmitter becomes expensive. Using a large linear range also results in saturation of the HPA. This saturation will create both in band distortion, increasing the BER and out of band distortion[1].

3. SELECTIVE MAPPING

Selective Mapping is a distortion-less Signal Scrambling technique which is used to reduce the PAPR in OFDM system without increasing the power requirement and causing data rate loss. In this technique, the phase rotation of the modulated data is performed before IFFT operation to obtain candidate signals [2]. And after performing phase

rotations, the candidate signal with lowest PAPR is selected [3]. The main advantage of this technique is that it does not affect the system performance in terms of Bit Error Rate (BER) and there is no distortion. The disadvantage of this technique is its high implementation complexity and it also requires side information to be transmitted along with lowest PAPR signal. The complexity of this technique increases exponentially upon increasing the number of phase sequence and number of subcarriers in OFDM system.

4. PARTIAL TRANSMIT SEQUENCE

Partial Transmit Sequence (PTS) is one of the promising technique that provides good PAPR reduction for OFDM systems [3]. The original data block is partitioned into V disjoint sub blocks. The subcarriers present in each of these sub blocks are rotated by the equal phase factor, so the PAPR of the combination is minimized. Also, the reverse operation is performed at the receiver, to recover the original data block. The conventional PTS has high complexity, as it extensively searches for all the combinations of allowed phase factors.

5. CLIPPING

This is the simplest technique used for PAPR reduction. In this technique, the amplitude of the input signal is clipped to a fixed value/level. The main advantage of this technique is its high PAPR reduction capability. Also, no side information is required. The main drawback of this technique is that it introduces distortion and degrades BER performance [4].

6. HYBRID COMBINATION AND SIMULATION RESULTS

In this paper, we simulate the combination of Selective mapping, partial transmit sequence and clipping technique. In our simulation results, it is clear from the CCDF plot that the PAPR performance improves for hybrid combination when it is compared to the conventional techniques in ordinary MIMO-OFDM systems. As shown in Fig-1, the PAPR performance of hybrid technique (SLM+PTS+Clipping) is much better than conventional SLM, PTS and Hybrid combination of SLM and PTS. There is 0.2 dB improvement of PAPR in proposed technique as compared to hybrid SLM and PTS. Also, the PAPR value of proposed technique is 0.5 dB better than PTS and 3.5 dB better than conventional SLM.

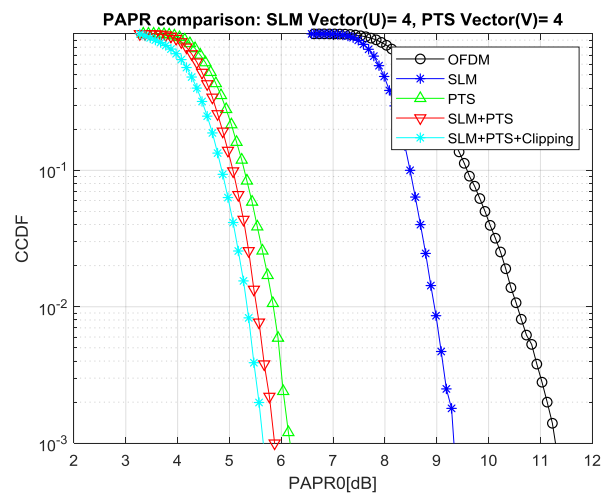


Fig -1: PAPR comparison of hybrid SLM, PTS and Clipping

7. CONCLUSION

The PAPR reduction problem of SLM, PTS and Clipping technique is analyzed. In this paper, we have simulated the hybrid combination of SLM, PTS and Clipping technique. The simulation results show that the PAPR performance of proposed hybrid SLM, PTS and Clipping is improved as compared to conventional techniques SLM, PTS and also hybrid combination of SLM and PTS.

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