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REDUCTION OF PEAK POWER AVERAGE RATIO IN OFDM SYSTEM

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ABSTRACT

In OFDM technique, splitting of higher data streams into a number of lower data streams simultaneously. But the major complication in OFDM is very high peak to average power ratio (PAPR). In this paper we have suggested two techniques for reducing the PAPR are Selected Mapping (SLM) and Constant Modulus Algorithm (CMA). By considering, the OFDM with QAM modulation, simulation results shows that both methods perform well in reducing PAPR and achieve the PAPR reduction up to 6.4 and 5.8 dB respectively for 10^{-2} PAPR level. The results demonstrate that CMA has superior performance over SLM in reducing PAPR for the same number of subcarriers by rejecting of explicit of side information, which is very crucial factor for the performance of the OFDM communication system.

KEYWORDS: OFDM, PAPR, CCDF, SLM, CMA.

1. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) is one of the multi-carrier modulation (MCM) techniques that transmit signals through multiple carriers. These carriers (subcarriers) have different frequencies and they are orthogonal to each other. It is observed that the crosstalk was the severe problem in OFDM system [1]. Although each subcarrier in the principal OFDM systems overlapped with the neighborhood subcarriers, the orthogonality can still be preserved through the staggered QAM (SQAM) technique. However, the difficulty will emerge when a large number of subcarriers are required [2]. In early OFDM applications, the number of

subcarriers can be chosen up to 34. Such 34 symbols will be appended with redundancy of a guard time interval to eliminate inter symbol interference. However in case of more subcarriers, the modulation, synchronization, and coherent demodulation would induce a very complicated OFDM system, which also brings the additional hardware cost during implementation.

2. ISSUE WITH PEAK AVERAGE POWER RATIO IN OFDM SYSTEM

Major challenge of the OFDM system is high peak to average power ratio (PAPR), showing the ratio of peak values to the average value. The PAPR define as follows

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

Where E denotes the expectation operator and x(t) represents the signal information. In OFDM technique, the signal is composed of large numbers of independent modulated subcarriers, on the other hand these advantages also induced the problem of high value PAPR. It is difficult to send this high peak signals from the transmitter without reducing peaks for efficient and low power communication system [3]. The high value of PAPR could be serious issue when the signal is applied to a transmitter which contains non-linear components such as high power amplifier (HPA) in the transmitter chain. The non-linear effects on the transmitted OFDM symbols are carried spectral spreading, inter-modulation and changing the signal constellation. Which shows the nonlinear distortion causes both in-band and out-of-band interference to signals. The in band interference increases the Bit error Rate (BER) of the received signal, while the out-off-band interference causes adjacent channel interference through spectral spreading [4]. Here authors try to bring the better solution to prevent the occurrence of such nonlinear distortion by reducing PAPR of the transmitted signal with some manipulation of the OFDM signal.

To reduce the PAPR, several approaches have been suggested such as clipping and Filtering, coding, peak windowing, Tone Reservation and Tone Injection, Selecting Mapping (SLM), partial transmit sequences (PTS), Constant Modulus Algorithm (CMA). But most of these methods are unable to balance between large reduction in PAPR and low complexity in OFDM system. The author also considered the challenge

deals in when reduction of PAPR are low coding overhead and conserve the performance of the system.

3. PROPOSED TECHNIQUES FOR REDUCTION OF PAPR IN OFDM SYSTEM

In this paper mainly proposed the improvement of two techniques, which are Selecting Mapping (SLM) and Constant Modulus Algorithm (CMA).

3.1 SELECTING MAPPING

Selective Mapping (SLM) method proposed by Bauml for reduction of peak transmitting power of multicarrier transmission system with selected mapping. A complete set of signal is created signifying the same information in selected mapping. In the SLM the input data structure is multiplied by random series and resultant series with the lowest PAPR is chosen for transmission. To allow the receiver to recover the original data to the multiplying sequence can be sent as side information [6].

3.2 CONSTANT MODULUS ALGORITHM

In frequency or phase modulated signals, the amplitude should ideally be a constant. Thus the signal is said to have a constant modulus, the authors devise the algorithms that restore or equalize the amplitude of the original signal. The CMA is efficient blind algorithm and it is used in many practical applications because it does not require carrier synchronization. Dominique Godard introduced the used a cost function called a dispersion function [7] of order p which is define as,

$$J(k) = E[(|y(k)|^p - R_p)^q]$$

Where y (k) = W^H X (k) is the array output at the time k, p and q is the positive integers. The gradient of this cost function is zero when R_p is defined by

$$R_p = \frac{E[|s(k)|^{2p}]}{E[|s(k)|^p]}$$

Where s (k) is the zero-memory estimate of y (k)

4. RESULT AND DISCUSSION

The work also carried by different researcher across the globe, but in this work author improve the PAPR without the increasing the complexity of OFDM system. The fig-1 shows the result of reference paper using SLM technique.

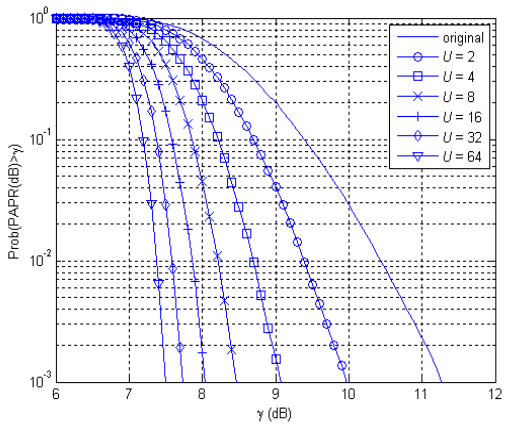

Figure 1: Result of PAPR reduction using SLM Technique in reference paper [8]

According to figure 1, it shows that the PAPR value in nearby likely to 7.5 - 7.6 dB, while according to figure 2, it shows PAPR reduced to likely to 7.2 dB. It justify to means PAPR reduces due to opt of QAM and iterative process instead of QPSK.

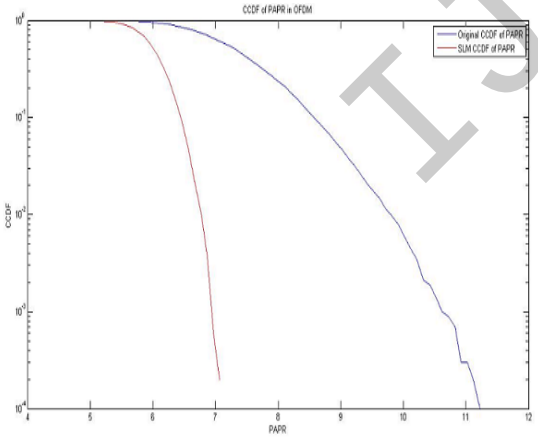

Figure 2: Result of PAPR reduction using SLM Technique [presented work]

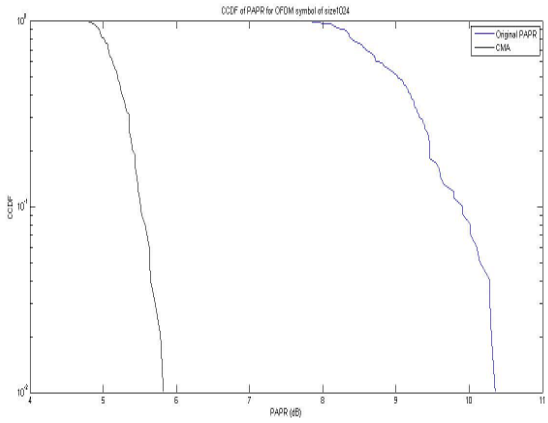

Figure 3: Output of PAPR reduction using CMA Technique

The result of figure 3 based on Constant Modulus Algorithm (CMA) technique which shows the reduction in PAPR in OFDM signal nearby 5.8 dB.

In the figure 4 or table 1 showed the comparison between SLM and CMA technique. There are two PAPR levels i.e. 10^{-2} and 10^{-4}. When the PAPR level is 10^{-2}, then Reduction using SLM and CMA are 6.4 dB and 5.8 dB respectively. While the PAPR level is 10^{-4}, then Reduction using SLM and CMA are 7.2 dB and 6.9 dB respectively.

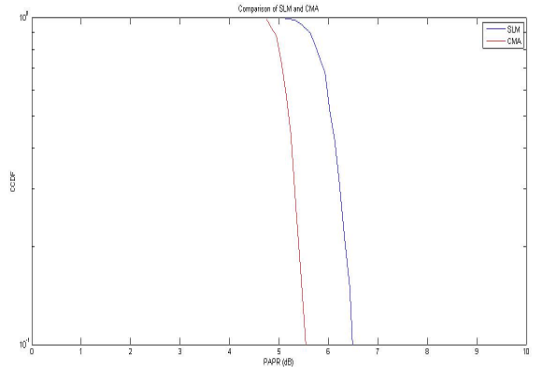

Figure 4: Result of Comparison between SLM and CMA

The work showed CMA reduction technique is better than the SLM technique used for PAPR reduction which results non linear signal distortion and less requirement of power amplifiers circuit.

Table 1: Comparison between SLM and CMA

METHOD	PAPR0 (10^{-2} PAPR LEVEL)	PAPR0 (10^{-4} PAPR LEVEL)
SLM	6.4	7.2
CMA	5.8	6.9

5. CONCLUSION

The challenge of the OFDM system is high peak to average power ratio, so presented work showed the two way of reduction PAPR, i.e. Selecting Mapping (SLM) and Constant Modulus Algorithm (CMA). Comparison with the previous related studies and work, the presented work reduced the PAPR value up to 5.8 dB, which help in reduced of transmitting power of OFDM signal using QAM Modulation. The more reduction of PAPR is possible by increasing the iteration process, but it's again increase the complexity of the system during implementation. So there should be tradeoff between numbers of iteration process and achieved PAPR value.

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