

Adjacent Partitioning Based MIMO-OFDM System with Partial Transmit Sequence for PAPR Reduction

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Abstract—The multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) transmission approach has been chosen to be a standard of fourth-generation (4G) wireless communication systems, but it has to cope with the main disadvantages and challenges of OFDM-based techniques, including the high peak-to-average power ratio (PAPR). Peak to average power ratio (PAPR) being a predictable random variable in multicarrier system and it can be minimized by different techniques. Complementary cumulative distribution function (CCDF) is used to describe the PAPR appropriately. Partial transmit sequence (PTS) is an attractive distortion less peak-to-average power ratio (PAPR) reduction technique for orthogonal frequency division multiplexing (OFDM) system. In this paper the performance of one of scrambling technique called partial transmit sequence (PTS) in MIMO-OFDM system and adjacent partitioning(one of the partitioning technique) in MIMO-OFDM system with PTS are analyzed based on the characteristics of CCDF

Keywords- MIMO-OFDM, PAPR, STBC, Partial Transmit Sequences(PTS), Adjacent based Sub block Partition

I. INTRODUCTION

Multiple input multiple output (MIMO) orthogonal frequency division multiplexing (OFDM) system has been getting a great attention, since it is one of the solutions for achieving high speed, more efficient, and high quality of service for wireless communications [1]. MIMO can be used to improve the performance and increase the capacity of wireless communication systems. OFDM has been implemented as a standard for various high data rate wireless communication systems due to its high spectral bandwidth efficiency, and robustness to frequency selective fading channels [2]. OFDM technique is widely used in many wireless communication systems, such as Digital Audio Broadcasting (DAB), IEEE 802.11a standard for Wireless Local Area Networks (WLAN), and the IEEE 802.16a standard for Wireless Metropolitan Area Networks (WMAN) [9]. However implementation of the OFDM systems has several challenges, one of the major drawbacks is the high peak to average power ratio (PAPR), which results in inter carrier interference (ICI), high out of band radiation, and bit error rate performance degradation, mainly due to the nonlinearity of the High power amplifier (HPA) [3]. Since MIMO OFDM is based on OFDM, it suffers from high PAPR, demands expensive linear amplifiers with wide dynamic range. To avoid the occurrence of large PAPR of transmitted signals in OFDM-based systems, various schemes for PAPR reduction have been presented [4], including distortion and distortionless methods. Distortion method works by Distorting the signal to reduce the high peak power prior to amplification. clipping, peak windowing ,peak cancellation ,peak power suppression, companding, are the different PAPR reduction techniques present in this method.

In distortion less method PAPR can be minimized to low value but it is difficult to realize the system. These techniques are also called signal scrambling techniques. Tone reservation and injection, selected mapping and partial transmit sequence

,block codes are the different methods present in this technique. In clipping PAPR is reduced by clipping the signal level which exceeds the threshold limit. It is simple but it may cause in band and out of band interferences while destroying the orthogonality among the subcarriers. In coding technique data vectors are converted into code vectors such that PAPR is minimized. It causes no in band and out of band distortions but it suffers from complexity and band width efficiency. In scrambling the input data block of the OFDM symbol is scrambled ,and the minimum PAPR symbol is transmitted[8]. In tone reservation technique some subcarriers are reserved and peak reduction carriers transmitted in these carriers to reduce the PAPR. In SLM input data block is multiplied with different phase sequences which produces modified blocks and among all minimum PAPR block is selected and transmitted In the PTS method, input data symbols are divided into disjointed sub-blocks and the sub-blocks are separately phase-rotated by individually selected phase factors through the process of improving performance of the PAPR

Prabal gupta & al proposed a combination of higher ordered partitioned PTS sequence and Bose Chaudhuri Hocquenghem codes to reduce the PAPR significantly[1].

A.D.S.Jayalath & al proposed a reduced complexity PTS method and new sequences for SLM to reduce the PAPR of MIMO-OFDM system[11]

To alleviate the problem of high complexity Xinchun Wu & al proposed a technique in which real and imaginary parts are separately multiplied with phase factors, moreover PAPR is conjointly optimized in real and imaginary parts[2].

P.Mukunthan & al proposed a technique based on modified PTS using forward error correcting codes such as turbo codes, and Golay codes are employed in the modified PTS radix FFT, where the PAPR is jointly optimized in both real and imaginary parts separately multiplied with phase factors when dividing the subcarriers into 4 subgroups[3]

Lingyin wang & al proposed a technique based on the properties of IFFT ,and low complexity IFFTs are used for

reducing computational complexity of CPTS in MIMO-OFDM systems[10].

Saly S.Hassaaneen & al proposed a modified PTS which is again merged with circular shifting with phase rotations to provide more PAPR reduction[4].

Shameema Hameed L& al proposed a technique based on the joint use of weighting, and PTS. In this technique initially a weight is imposed on each discrete OFDM signal via a certain kind of a band limited signal, and PTS is done on weighted discrete data and is then considered before a high power amplifier (HPA) to reduce PAPR[5].

Sheng-ju ku proposed a new PTS scheme, it uses sample powers of subblocks derived from the input blocks to generate a set of cost functions. with the help of cost functions and the similarity among the subblocks, peak powers of candidate signals are estimated to reduce PAPR[6].

Shuyan Ding & al proposed a low complexity PTS algorithm which uses Hamming-tabu-search to achieve the reduction of computational complexity with no loss of PAPR performance[7].

Mohsen Kazemian&al proposed a technique that is serial combination of Enhanced partial transmit sequence(EPTS) and cross correlation-PTS methods to reduce the PAPR. EPTS is a low complexity technique compared to conventional PTS and cross correlation PTS technique has more efficient BER performance[8].

Qingsong Wen & al proposed a modified PTS technique which is based on selecting a subset of candidate signals with relatively low correlation so as to achieve a desirable PAPR reduction performance with low complexity[9].

Among all the existing schemes, partial transmit sequence (PTS) [5] is very attractive because of its good PAPR reduction performance without any signal distortion. In this paper, we compared the performance of PAPR reduction of conventional PTS and PTS with adjacent partitioning for MIMO-OFDM system. The paper is organized as follows: In Section II, the basic concept of MIMO- OFDM system, definition of PAPR problem, and explain of PTS scheme are discussed, Section III presents the different partitioning schemes for the PTS. In Section IV, the simulation and numerical results are shown. Finally, conclusions are presented in Section V.

II. PAPR IN MIMO-OFDM SYSTEM AND CONVENTIONAL PTS

A.MIMO-OFDM SYSTEM

The MIMO-OFDM system [6] adopted in this paper depends on the Alamouti STBC scheme [8] with N subcarriers, transmit and n_r receive antennas. In Alamouti scheme two successive symbols x_1 and x_2 are encoded with the following space-time code vector matrix: space-time code vector matrix:

$$X = \begin{bmatrix} x_1 & -x_2^* \\ x_2 & x_1^* \end{bmatrix}$$

Alamouti encoded signal is transmitted from the two transmit antennas over two symbol periods. In the first symbol period two symbols x_1 and x_2 are transmitted simultaneously by the transmitting antennas of two in number. In the next time interval, $-x_2^*$ is transmitted by first antenna at the transmitter and x_1^* is transmitted by the second antenna of transmitter. In the discrete time domain, a MIMO-OFDM signal of N subcarriers can be written as

$$x_i(n) = \left(\frac{1}{\sqrt{N}}\right) \sum_{k=0}^{N-1} X_i(k) \exp\left(\frac{j2\pi kn}{N}\right)$$

$$j \quad 0 \leq n \leq N - 1, 1 \leq i \leq n_i$$

B.PAPR in MIMO-OFDM system

Linear amplifiers impose a nonlinear distortion at the output due to their saturation characteristics caused by an input much larger than its threshold value. Due to this out-of-band radiation that effects in adjacent bands and in-band distortion that result in rotation, attenuation and offset on the received signal[7]. In order to reduce these problems the peak to average power ratio (PAPR) of the input symbol must be minimized. The PAPR of an OFDM signal is defined as follows

$$PAPR_i = PAPR\{x_i(n)\} = \max_{0 \leq n \leq N-1} \{|x_i(n)|^2\} / E\{|x_i(n)|^2\}$$

Where the denominator represents the average power of the i th transmit antenna and the numerator represents the maximum envelope power. In MIMO-OFDM system, the PAPR is defined as the maximum PAPR value of all the transmit antennas.[10] That is $PAPR = \max(PAPR_1, PAPR_2, \dots, PAPR_m)$ The distribution of PAPR has stochastic characteristics in a practical system. The cumulative distribution function (CCDF) is usually used to evaluate the performance of PAPR. The CCDF is given by

$$CCDF = P(PAPR > PAPR_0) = 1 - (1 - e^{-PAPR_0})^N$$

Where $PAPR_0$ is a certain value of PAPR.

C. Conventional PTS

For an MIMO- OFDM system with N subcarriers, the input data sequence is firstly partitioned into V disjoint Sub blocks $X^{(v)}, v = 1, 2, \dots, V$, where all the subcarriers which are occupied by the other blocks are set to zero. The frequency domain sequence can be shown as $X = \sum_{v=1}^V X^{(v)}$ By applying a phase weighting factor $b^{(v)} = \exp(j\phi^{(v)})$, $\phi^{(v)} \in [0, 2\pi]$ to the v th sub block $X^{(v)} = [X_1^{(v)}, X_2^{(v)}, \dots, X_N^{(v)}]^T, v = 1, 2, \dots, V$. Alternate frequency domain sequence is given by $X' = \sum_{v=1}^V b^{(v)} X^{(v)}$ By employing IFFT, the candidate sequence is obtained by

$$x^i = IFFT \left\{ \sum_{v=1}^V b^{(v)} X^{(v)} \right\} = \sum_{i=1}^V b^{(v)} \cdot IFFT\{X^{(v)}\}$$

$$= \sum_{v=1}^V b^{(v)} x^{(v)}$$

Finally the candidate sequence is obtained with the lowest PAPR is selected for transmitting

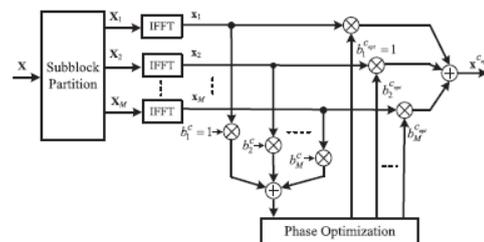


Fig 1. Block diagram of MIMO-OFDM with PTS

III. SUB-BLOCK PARTITIONING FOR PTS METHODS

There are three types of partitioning the data into disjoint blocks **1. Interleaved Partition: 2. Adjacent partitioning 3. Pseudorandom Partition**[12]

In the interleaved partitioning[11] based partial transmit sequence (IP-PTS) scheme, every subcarrier signal equally spaced apart is allocated at the same sub-block.

$$P_0 = [P_0^{(1)} 0 \dots 0 P_0^{(2)} 0 \dots 0 P_0^{(M)} 0 \dots 0]$$

$$P_1 = [0 P_1^{(1)} 0 \dots 0 0 P_1^{(2)} 0 \dots 0 0 P_1^{(M)} 0 \dots 0]$$

.....

$$A. P_L = [0 0 \dots 0 P_L^{(1)} 0 \dots 0 P_L^{(2)} 0 \dots 0 P_L^{(M)}]$$

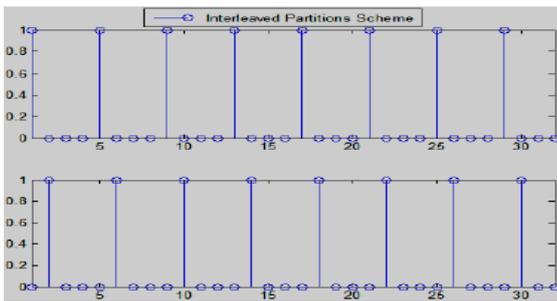


Fig2. interleaved partitioning technique

In the adjacent partitioning based partial transmit sequence (AP-PTS) scheme, successive subcarriers are assigned into the same sub-block sequentially. AP-PTS provides significant PAPR reduction performance with quite less computational complexity.

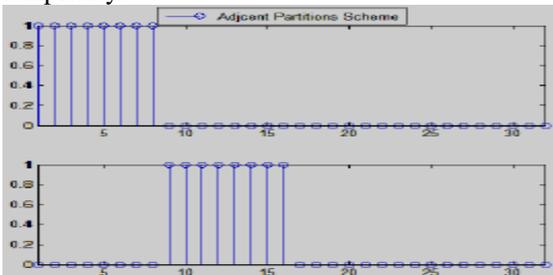


Fig3: adjacent partitioning technique

$$X = [P_0 P_1 P_2 \dots P_{M-1}]$$

$$P_0 = [P_0, 0000, \dots, 0]$$

$$P_1 = [0000, \dots, 0, P_1, 0000, \dots, 0]$$

.....

$$P_{M-1} = [0000, \dots, 0, P_{M-1}]$$

In pseudorandom partitioning partial transmit sequence (PRP-PTS) scheme, each subcarrier signal is assigned into any one of the sub blocks randomly.

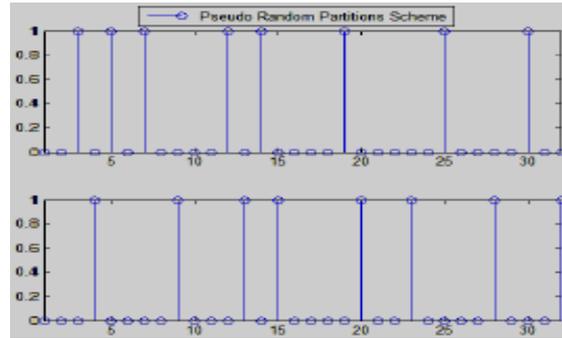


Fig4: pseudorandom partitioning technique

Interleaved partitioning has lower computational complexity when compared with adjacent partitioning based PTS (AP-PTS) and pseudorandom partitioning based PTS (PRP-PTS)[12] However, the PAPR reduction performance of (APPTS) is the more efficient than other schemes when the number of generated candidates are the same

IV. SIMULATION AND RESULTS

The analysis of the MIMO-OFDM with conventional PTS and adjacent partitioning based PTS has been carried out using MATLAB 7.0. The simulation parameters considered in this analysis is listed in Table 1. In the MIMO-OFDM systems adjacent partitioning based PTS is applied to the sub blocks of un coded information which is modulated by QPSK and the phase rotations are transmitted to receiver with the help of sub block. The performance of these techniques are evaluated with the help of complementary cumulative distributive function

SIMULATION PARAMETERS

SIMULATION PARAMETERS	VALUES
Number of ofdm blocks	10000
Number of subcarriers	128
Number of subblocks	2
Roll -off factor	0.6
Number of antennas	2
Modulation scheme	QPSK
Phase weighting factor	1, -1, j, -j

Fig 5. shows the performance of MIMO-OFDM without PTS and MIMO-OFDM with conventional PTS with number of subcarriers=128. From the results the PAPR is reduced from that 11dB (MIMO-OFDM without PTS) to 9.2dB in MIMO-OFDM with conventional PTS.

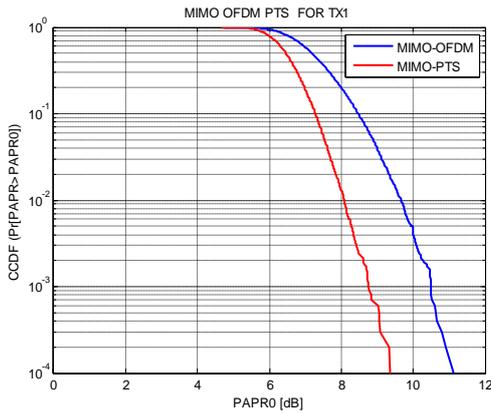


FIG 5 .PAPR reduction in MIMO-OFDM with PTS

In fig 6 shows the performance of MIMO-OFDM without PTS, MIMO-OFDM with conventional PTS and adjacent partitioning based PTS MIMO-OFDM system. It is observed from the results that PAPRs of MIMO-OFDM, conventional PTS in MIMO-OFDM system and interleaved MIMO-OFDM system with PTS, interleaved MIMO-OFDM system of different partitioning length with PTS, and adjacent partitioning in MIMO-OFDM system with PTS are 19 dB, 15dB and 14dB respectively

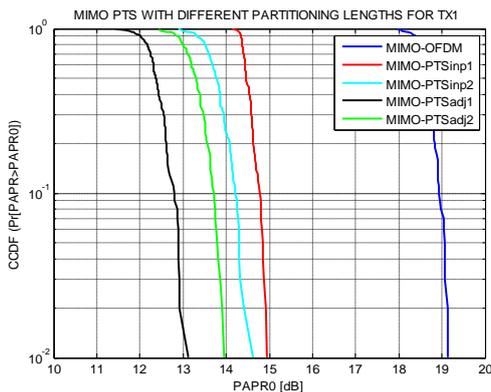


Fig6: PAPR reduction of MIMO-OFDM with different partitioning techniques and PTS

V. CONCLUSIONS

MIMO-OFDM is a very attractive technique for wireless communications due to its spectrum efficiency and channel robustness. In this paper, PAPR reduction technique based on adjacent partitioning based PTS in MIMO-OFDM system is analyzed. Simulation results shown that adjacent partitioning based PTS gives better PAPR performance when compared with the conventional PTS in MIMO-OFDM systems.

REFERENCES

- [1] Prabal gupta, B. Arun Kumar, Sandeepkumar jain, "peak to average power ratio reduction in OFDM using higher order partitioned PTS sequence and Bose Chaudari Hocquenghem codes, SPACES-2015, IEEE International conference, 2015, guntur, pp no 443-447
- [2] Xinchun Wu, Zhigang Mao, Jinxiang Wang, Bin Zho, "A novel PTS technique with combinative optimisation in real and imaginary part for PAPR reduction in OFDM systems", in proceedings of third international conference on next generation mobile applications, services and technologies, cardiff, Wales, UK, pp. 215-218, september 2009
- [3] P. Mukunthan and P. Dananjayan, "Modified PTS with FECs for PAPR reduction in MIMO-OFDM system with different subcarriers" IEEE International conference on Humanities, Science & Engineering Research, 2011, pp no 89-94
- [4] Saly S. Hassaneen, Heba Y. Soliman, Khairy A. Elbarbary, Adel E. Elhennawy, "modified PTS with circular shifting for PAPR Reduction in MIMO-OFDM systems" IEEE international conference on JEC_ECC, 2013, pp no 1-6.
- [5] Shameema Hameed L, "A combined weighting and PTS technique for PAPR Reduction in OFDM signals" IEEE 2nd International conference on Current Trends in Engineering & Technology, 2014, DOI: 10.1109/ICCTET2014.6966292.
- [6] Sheng_ju ku, "A Low-complexity PTS scheme for PAPR Reduction in SFBC MIMO-OFDM Systems" Vehicular Technology conference 2014 IEEE 80th DOI 10.1109/VTC FALL 2014.6965817, pp no 1-5
- [7] Shuyan Ding, Shibao Li, Jianhang Liu, Haiyan Wang, Zhaozhi Gu, Lihong GU, "A low complexity PTS Algorithm for PAPR Reduction in OFDM system based on Hamming Distance" IEEE Communications and information technologies (ISCIT), 2014, 14th International symposium on DOI 10.1109/ISCIT.2014.7011963, pp no 499-502
- [8] Mohsen kazemian, Pooria Varahram and Borhanuddin M Ali, "A peak to Average Power Ratio Reduction scheme to increase power efficiency in Broadband Communication Systems" Communications (APCC), 2014, ASIA-Pacific conference on DOI 10.1109/ADCC.2014.7091599, 2014, pp no 26-29.
- [9] Qingsong Wen, Yue Xiao, Peng Cheng, Lilin Dan and Shaoqian Li. "A Modified Partial Transmit sequence Scheme for PAPR Reduction in OFDM System" vehicular technology conference, IEEE 2008, pp. 1-5.
- [10] Lingyin Wang, Xinghai Yang and Yutai Wang "PTS with low complexity IFFTs for PAPR Reduction in SISO/MIMO OFDM", ICEIEC 2013, IEEE conference, pp. 181-184
- [11] A.D.S. Jayalath, C. Tellambura and H. Wu, "Reduced complexity PTS and new phase sequences for SLM to reduce PAP of an OFDM signal" Vehicular Technology Conference Proceedings, 2000. VTC. 2000 spring Tokyo. 2000 51st, pp no 1914-1917 vol3.
- [12] Zeyid T. Ibraheem, Md. Mijanur Rahman, S.N. Yaakob, Rasim A. Kadhim, S.N. Yaakob, Mohammad Shahrzazel Razalli, Kawakib K. Ahmed "Performance of PTS Techniques with varied Partition size in PAPR Reduction of OFDM System", IEEE international conference 2014, pp. 21 - 25.