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PAPR Reduction for Massive MIMO Systems for 5G Application: A Review

KM Soniya¹, Anand Singh Rajput², Santosh Kumar Yadav³

M. Tech. Scholar, Department of E&C Engineering, Millennium Institute of Technology and Science, Bhopal, India¹
Assistant Professor, Department of E&C Engineering, Millennium Institute of Technology and Science, Bhopal, India²
Head of Dept., Department of E&C Engineering, Millennium Institute of Technology and Science, Bhopal, India³

ABSTRACT: Massive system is of great interest for researchers and research laboratories all over the world. OFDM is widely used in contemporary communication systems for its good robustness in multipath environment, and its high spectral efficiency. The capacity of wireless system can be increased dramatically by employing Multiple Input Multiple Output, (MIMO) antennas. The combination of MIMO and OFDM system is found to be very beneficial. A major drawback of OFDM-MIMO System is its high Peak to Average Power Ratio (PAPR) Reduction. The peak power of a signal is a critical design factor for band limited communication systems, and it is necessary to reduce it as much as possible. Many PAPR reduction techniques have been used to reduce PAPR. Partial transmit sequence (PTS) is one of the most well-known peak-to-average power ratio (PAPR) reduction techniques proposed for MIMO-OFDM systems. However the computational complexity of traditional PTS method is tremendous. In this paper studied of partial transmit sequence (PTS) technique, based on two antennas STBC MIMO-OFDM system, which can achieve better PAPR performance at much less complexity. The main idea behind this is to separate the input data vector, generated by Alamouti algorithm, into real and imaginary parts and separately multiplied with phase factors. The optimum weighting coefficient of antenna two can be directly obtained by appropriating mapping from that of antenna one which leads further to reducing complexity computation.

KEYWORDS: PTS, STBC, MIMO, OFDM, PAPR

I. INTRODUCTION

A combination of multiple input multiple output (MIMO) and orthogonal frequency division multiplexing (OFDM) (MIMO-OFDM) is an emerging technology for high speed data multi-carriers transmission in future wireless communication network systems such as digital audio broadcasting (DAB), digital video broadcasting (DVB), medical body area networks (MBANs) applications, the fourth and the fifth generation (4G,5G) of mobile network. In MIMO-OFDM system, the output is the superposition of multiple sub-carriers. Whenever, the phases and frequencies of these carriers match coherently, instantaneous power outputs may increase greatly and become higher than the mean power of the high power amplifier (HPA) resulting in large PAPR [1]. Lot of research work has been done for solving the problem of PAPR that concerns all kind of multicarrier signals. So, many techniques have been proposed such as clipping [2], tone reservation [3], nonlinear transformations [4], coding [5], selecting mapping (SLM) [6] and partial transmit sequence (PTS). Modified approaches of PTS are proposed in that produce better results; however, the computational complexity is still remaining unsolved totally. In this paper an approach is proposed to reduce the PAPR in STBC MIMO-OFDM systems with less computational complexity. So, the mean idea is based on separating the input vector data into real and imaginary parts for computational simplification reasons and then C-A-PTS is applied individually on these parts, moreover, PAPR is conjointly optimized in real part and imaginary part for the first antenna and by symmetry property the optimum weighting coefficient is deduced for the second antenna without any extra optimization which leads to decreasing of the complexity of the computation [7].

II. SYSTEM MODEL

MIMO in combination with OFDM is widely used nowadays due its best performance in terms of capacity of channels, high data rate and good outcome in frequency selective fading channels. In addition to this it also improves reliability of link. This is attained as the OFDM can transform frequency selective MIMO channel to frequency flat MIMO channels [8]. So it is widely used in future broadband wireless system/communications. Cyclic prefix is the copy of last part of OFDM symbol which is appended to the OFDM symbol that is to be transmitted. It is basically 0.25% of the

OFDM symbol. We can say that one fourth of the OFDM symbol is taken as CP (cyclic prefix) and appended to each OFDM symbol. IFFT is used at the transmitter and FFT is used at the receiver which substitutes the modulators and demodulators. Doing so eliminates the use of banks of oscillators and coherent demodulators. Moreover the complex data cannot be transmitted as it is; therefore it is first converted to analog form which is accomplished by IFFT. It basically converts the signal from frequency domain to time domain. Prior to IFFT operation symbol mapping is performed which is nothing but the modulation block. Any of the widely used modulation techniques can be applied like BPSK, QPSK, QAM, PSK etc. Further there are higher order modulations are also available which provide more capacity at little expense of BER performance degradation. After IFFT block pilot insertion is done and then CP (cyclic prefix) is added. Figure 1 below shows the block diagram constituting MIMO and OFDM. Any antenna configuration for the MIMO can be used according to the system requirement. Higher the configuration more will be the capacity and more will be the computational complexity of the transceiver design. It is seen that in the case of estimating channel the computational complexity is increased. Mapper defines the modulation to be used. Symbol encoder takes the shape of the STBC (Space Time Block Code) if spatial diversity is to be used and it takes the shape of the demultiplexer/multiplexer if spatial multiplexing is to be used.

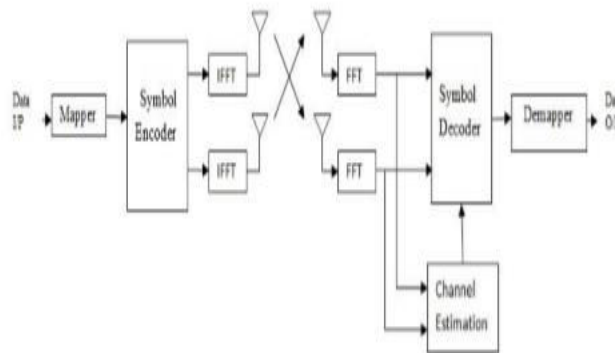


Figure 1: MIMO-OFDM system model

The received signal at j^{th} antenna can be expressed as

$$R_j[n,k] = \sum H_{ij}[n,k] X_i [n,k] + W[n,k] \quad (1)$$

Where H is the channel matrix, X is the input signal and W is noise with zero mean and variance. Also $b_i[n,k]$ represents the data block i^{th} transmit antenna, n^{th} time slot and k^{th} sub channel index of OFDM. Here i and j denoted the transmitting antennas index and receiving antenna index respectively.

The MIMO-OFDM system model [9] with N_R receives antennas and N_T transmits antennas can be given as:

$$\begin{bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_N \end{bmatrix} = \begin{bmatrix} H_{1,1} & H_{1,2} & \dots & H_{1,N_T} \\ H_{2,1} & H_{2,2} & \dots & H_{2,N_T} \\ \vdots & \vdots & \ddots & \vdots \\ H_{N_R,1} & H_{N_R,2} & \dots & H_{N_R,N_T} \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \\ \vdots \\ A_{N_T} \end{bmatrix} + \begin{bmatrix} M_1 \\ M_2 \\ \vdots \\ M_{N_T} \end{bmatrix} \quad (2)$$

Where, Z represents O/P data vector, H denotes Channel matrix, A denotes I/P data vector and M represents Noise vector. The wireless channel used is AWGN channel. After receiving the signal the CP is removed then the pilots are also removed from main signal received. After this the signal that is in time domain can be again converted to frequency domain by taking FFT of the received signal.

The sequence on each of the OFDM block is then provided to channel estimation block where the received pilots altered by channel are compared with the original sent pilots. Channel estimation block consists of the algorithms that are applied to estimate the channel.

III. LITERATURE REVIEW

Zhitong Xing and others [1], isolated balanced repeat division multiplexing (f-OFDM) is seen as one of the competitor for future compact correspondence because of its versatile limit arrangement for different circumstances. Regardless, the unique handset structure of f-OFDM makes impedance testing extremely challenging, particularly in the uplink with non-ideal synchronization. This review examines the uplink obstruction of f-OFDM frameworks under non-ideal synchronization; taking into account the transporter recurrence offset (CFO) and timing offset (TO) of numerous client equipment (UE). A few sub-impedances separate the obstruction. After inferring the close structure articulations of each sub-obstruction and its distinction, reproductions are used to validate the inferences. First, the effects of non-ideal variables and framework boundaries like CFO, TO, watch band (GB), and subcarrier dividing (SCS) on the uplink impedance of f-OFDM frameworks are reproduced and examined on the basis of the inferred shut structure articulations. This study is affirmed by automatic encounters, and the speculative derivation of hindrance agrees with the multiplication result. Second, previous f-OFDM frameworks utilized Hanning window channels, which resulted in piece blunder rate (BER) awkwardness between subgroups. Accordingly, the effect of waveform channel on the impedance and BER is similarly analyzed in this assessment. Results show that ideal hindrance and BER displays over Hanning window channels can be gotten by using reasonable channel settings. Plus, a couple of channel design rules are shut. By and large, the assessment and reenactments uncover various normal impedance ascribes of f-OFDM, which will help the future f-OFDM system plans.

Ebubekir Memisoglu and Associates [2], due to its numerous advantages, OFDM will probably continue to be utilized in previous 5G (B5G) correspondence frameworks in addition to being sent in 5G frameworks. However, the high top-to-average power proportion (PAPR) of OFDM systems is a major drawback, particularly when transmitting large amounts of data. A regularization improvement based adaptable cross breed companding and cutting plan (ROFHCC) for reducing PAPR in OFDM frameworks is presented in this paper. The companding capacity has two sections to simplify the plan. It restricts the sign examples with amplitudes greater than a predetermined value to a consistent incentive for both low power pay and peak power loss. For signals with tests under a given sufficiency, they are stretched out by a direct companding limit. For bit error rate (BER) and power unearthly thickness (PSD) execution, we develop a regularization enhancement model to mutually improve the companding contortion as well as the congruity of the companding capacity. The reproduction results show that the proposed companding plan outperforms the referred to companding plans for the same PAPR execution. For example, when the typical sign power is normalized to be 1, we pick both PAPR for ROFHCC plan and two-piecewise companding (TPWC) scheme as 4 dB, then, we can find that at BER=10⁻⁴, the base required E/bN₀ for ROFHCC plot is around 2.3 dB lower than TPWC contrive.

S. Rajasekaran et al. [3], in the field of current remote correspondences, symmetrical recurrence division multiplexing (OFDM) is one of the most common advancements. However, the framework's high top to average power proportion (PAPR) issue has severely restricted its application range, making it impossible to present. For the purpose of further improving the PAPR execution of OFDM frameworks, incomplete send succession (PTS) was proposed. Nevertheless, its presentation significantly increases the framework's computational complexity. In light of the majority of time-area tests, a low-intricacy PTS plot is proposed and two new measurements for selecting these examples are presented in this paper. Additionally, a gathering strategy has been employed with the proposed conspire to reduce computational complexity. Reenactment results show that the proposed low-complexity PTS plan can outfit an ideal PAPR decline execution with more computational multifaceted design save reserves.

Z. Zhou et al. [4], for the chosen planning (SLM)-based unevenly cut optical symmetrical recurrence division multiplexing (ACO-OFDM) visible light correspondence (VLC) framework, a novel low-intricacy least sufficiency contrast (MAD) decoder is proposed. With the proposed plot, a specific plan of symmetric vectors is expected to restrict the top to-average power extent (PAPR) of sign without the transmission of side information (SI) and recover SI capriciously by the proposed Frantic decoder. Reproduction results demonstrate that the proposed plot actually reduces the PAPR, and the cycle error rate execution of an ACO-OFDM framework equipped with a MAD decoder is very similar to that of a traditional chosen planning (CSLM) conspire equipped with the greatest probability decoder, albeit at a much lower level of complexity.

W. Hu et al. [5], this paper propose a different actual layer design for uplink different access using symmetrical recurrence division multiplexing (OFDM). With fixed decoder inactivity, it focuses on immediate low-inertness remote applications, such as the transmission of control data in machine-to-machine (M2M) and device-to-gadget (D2D)

exchanges. For high coding gain and recurrence variety and low top to average power proportion (PAPR) flagging, our proposed framework uses a well-balanced combination of subcarrier bouncing and super-symmetrical convolutional codes. The low PAPR nature enhances the transmission range upgrade and further develops the power effectiveness at a power intensifier (PA).

Y. Hori et al. [6], in addition, ghostly effectiveness can be elevated to a higher level by presenting non-symmetry among clients through the task of arranging subcarriers in a similar manner for various clients. Multiuser discovery (MUD) is used to reduce different access impediments caused by clients switching in an unsymmetrical way. Speculative explanations of vague piece screw up rate for the proposed system with MUD are moreover advanced. Numerical results uncover that our proposed system achieves higher immovable quality and higher absurd viability than the standard balanced repeat division different access (OFDMA)- based structure.

Ashna Kakkar et al. [7], MIMO-OFDM, or multiple input, multiple output orthogonal frequency division multiplexing, is an appealing transmission method for systems with high bit rates. Like OFDM, one principal inconvenience of MIMO-OFDM is the high top to-average power proportion (PAPR) of the transmitter's result signal on various radio wires. The best performance for PAPR reduction is provided by the partial transmit sequences (PTS) method. However, the traditional PTS method has a tremendously high computational complexity. In this paper, a helpful and substitute PTS (C-A-PTS) plot for STBC MIMO-OFDM framework is proposed which can accomplish almost ideal PAPR execution at significantly less intricacy. The advanced algorithm's effectiveness is demonstrated by the simulation results.

Ho-Lung Hung et al. [8], they concentrated on the effect of nonlinear gadgets on OFDMA signals. As a result, they employ FDMA (Frequency Division Multiple Access) and OFDM modulation simultaneously. The nonlinear interference levels on the received signals and an analytical spectral analysis of the transmitted signals are made possible by their findings. They thought about nonlinear signal processing methods that work with OFDM signals that have been sampled. For the analytical characterization of the transmitted signals, they will make use of the Gaussian nature of OFDMA signals with numerous subcarriers. In, they presented an analytical tool for assessing the effects of nonlinear distortion on OFDMA signal-based systems.

P. Kothai et al. [9], they proposed the novel transceiver schemes for the MIMO interference channel based on the mean square error (MSE) criterion. Their goal is to optimize the system performance under a given feasible degree of freedom. They also proposed tire robust MSE based transceiver schemes that take channel estimation error into account. In specific, two types of MSE were studied. One is the total MSE among all users without considering user fairness, and the other is the maximum per-user MSE when user fairness is concerned. In, the channel model used in the simulations is a quasi-static flat Rayleigh fading channel. They also proposed robust Sum-MSE Minimization and Min-Max algorithm in the presence of channel estimation errors.

Muhammet Nuri Seyman et al. [10], they provided analytical framework for calculating the large-system throughput of a MIMO cellular network with channel estimation errors. The studies assumed that each AP only decodes the users in its service region without AP cooperation. If the average path gain of one link is relatively low, ignoring its contribution is worth consideration while slightly sacrificing system performances but greatly reducing system complexity. In addition to the optimal MMSE detector, this study also utilizes the suboptimal but simple linear MMSE (LMMSE) detector. It finally, they have reported that the weak path hardly contains useful information, and the additional training segment seems to be wasted and decrease the available data transmission period.

IV. PTS SCHEMES

1. SISO PTS Scheme

In the SISO-PTS scheme, the original data sequence in the frequency domain is partitioned into M disjoint, equal length sub blocks X_v ($v = 1, 2, \dots, M$) as follows.

$$X = \sum_{v=1}^M X_v \quad (3)$$

By multiplying some weighting coefficients to all the subcarriers in every subblock, we can get the new frequency sequence.

$$X' = \sum_{v=1}^M b_v X_v \tag{4}$$

Finally, at each transmitting antenna, there are (V-1) sub blocks to be optimized, and the candidate sequence with the lowest PAPR is individually selected for transmitting. Assume that there are W allowed phase weighting factors. To achieve the optimal weighting factors for each transmitting antenna, combinations should be checked in order to obtain the minimum PAPR [10].

2. Alternate PTS (A-PTS)

In, the idea of alternate optimization is introduced, and it can be also applied to PTS in multiple antennas OFDM systems, denoted as alternate PTS (A-PTS). Different from ordinary PTS, phase weighting factors are needed only for half of the sub blocks in A-PTS. That is to say, starting from the first sub block, every alternate sub block is kept unchanged and phase weighting factors are optimized only for the rest of the sub blocks, which leads to the reduction of computational complexity. In this way, the computational complexity is greatly reduced at the expense of PAPR performance degradation [11]. Employed spatial sub block circular permutation for A-PTS scheme to increase the number of candidate sequences which improves the PAPR performance further.

3. Cooperative and Alternate PTS (C-A-PTS)

Based on the A-PTS and C-PTS schemes, the C-A-PTS is proposed to reduce the computational complexity in STBC MIMO-OFDM system. On the one hand, apply the APTS algorithm in a single antenna, and employ the linear property of inverse discrete Fourier transform (IDFT) to increase the number of candidate sequences so as to achieve better PAPR performance. On the other hand, utilize the conjugate and symmetric property to get the weighting coefficient of the other antennas in order to reduce the complexity. According to the linear property of IDFT, it can be deduced that the conjugate operation in frequency domain is equivalent to the circular permutation and conjugate operation in time domain.

The characteristics can be exploited to ameliorate the PAPR performance. At antenna 1, we adopt the optimal alternate PTS scheme to get the optimum weighting coefficient a ($a_v: v = 1, 2... M$) which achieves the minimum PAPR value. The linear property of IDFT is used for all the odd sub blocks (except the first one) to increase the number of the candidate signals. The transformed data in time domain can be obtained by performing the circular permutation and conjugate operation on all the odd sub-blocks (except the first one) instead of the IDFT or IFFT operation. Since the odd sub-blocks (except the first one) are transformed, the number of candidate sequences is increased which improves the PAPR performance of the single antenna, while the number of complex multiplications is not increased. It has been proved that the data on two antennas have the same PAPR statistical characteristics simultaneously. The correlation is utilized to reduce the complexity of MIMO PTS plan. The optimum weighting coefficient of antenna 2 can be directly obtained by appropriate mapping from that of antenna 1. Moreover the process of IFFT operation and optimum PTS weighting coefficient search can be omitted for the data at antenna 2. A block diagram of the C-A-PTS scheme with two transmit antennas is shown in Figure 2.

Next, the conversion of the optimum weighting coefficient is discussed. In order to maintain the conjugate and symmetric relations between the two antennas after scrambling sequence methods, we should convert the optimum weighting coefficient $a(\text{opt})$ at antenna 1 into that of antenna 2 denoted as $b(\text{opt})$ by the inverse conjugate and symmetric transformation. For example, when the optimum weighting coefficient $a(\text{opt})$ is $[1, 1, j, -j]$, the optimum weighting coefficient for antennas 2 is $b(\text{opt}) = [1, 1, -j, j]$. The advanced C-A-PTS scheme can be also applied to the STBC MIMO-OFDM system with more transmit antennas.

Based on C-A-PTS, an approach to solve the contradiction between the PAPR performance and computational complexity in STBC MIMO-OFDM system is proposed. Let us consider a STBC MIMO-OFDM system that employs Alamouti scheme. The coding matrix is:

$$G = \begin{pmatrix} x_1 & -x_2^* \\ x_2 & x_1^* \end{pmatrix} \tag{5}$$

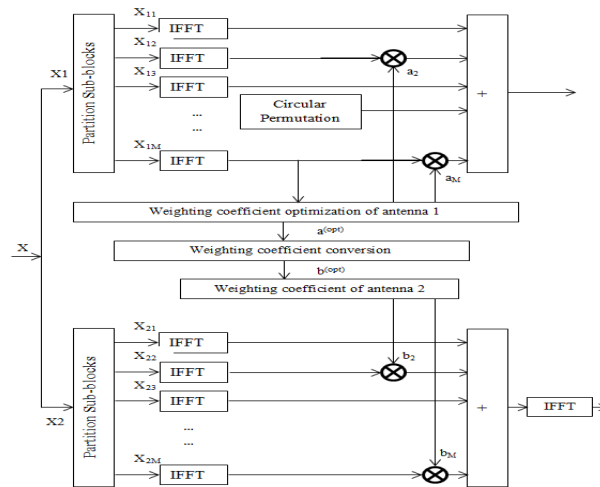


Figure 2: Block diagram of the C-A-PTS scheme with two transmit antennas

V. CONCLUSION

An extended approach cooperative and alternate partial transmit sequence named C-A-PTS was studied for STBC MIMO-OFDM which makes uses of conjoint optimization of the PAPR for both real and imaginary parts. A high PAPR, between the two antennas, is selected to be transmitted. This method performs well in terms of simulation results as well as the complexity of computation will be reduced.

REFERENCES

- [1] Zhitong Xing, Kaiming Liu, Aditya S. Rajasekaran, Halim Yanikomeroglu and Yuanan Liu, "A Hybrid Companding and Clipping Scheme for PAPR Reduction in OFDM Systems", IEEE Access 2021.
- [2] Ebubekir Memisoglu, Ahmet Enes Duranay and Hüseyin Arslan, "Numerology Scheduling for PAPR Reduction in Mixed Numerologies", IEEE Wireless Communications Letters, Vol. 10, No. 6, June 2021.
- [3] H. Chen, J. Hua, J. Wen, K. Zhou, J. Li, D. Wang, and X. You, "Uplink interference analysis of F-OFDM systems under non-ideal synchronization," IEEE Trans. Veh. Technol., vol. 69, no. 12, pp. 15500–15517, Dec. 2020.
- [4] S. Rajasekaran, M. Vameghestahbanati, M. Farsi, H. Yanikomeroglu, and H. Saeedi, "Resource allocation-based PAPR analysis in uplink SCMA-OFDM systems," IEEE Access, vol. 7, pp. 162803–162817, 2019.
- [5] Z. Zhou, L. Wang, and C. Hu, "Low-complexity PTS scheme for improving PAPR performance of OFDM systems," IEEE Access, vol. 7, pp. 131986–131994, 2019.
- [6] W. Hu, "SLM-based ACO-OFDM VLC system with low-complexity minimum amplitude difference decoder," Electron. Lett, vol. 54, no. 3, pp. 141–146, 2018.
- [7] Y. Hori and H. Ochiai, "A new uplink multiple access based on OFDM with low PAPR, low latency, and high reliability," IEEE Trans. Commun., vol. 66, no. 5, pp. 1996–2008, May 2018.
- [8] Ashna Kakkar, Sai Nitesh Garsha, Ojasvi Jain and Kritika, "Improvisation in BER and PAPR by using hybrid reduction techniques in MIMO-OFDM employing channel estimation techniques", 7th International Advance Computing Conference, IEEE 2017.
- [9] Ho-Lung Hung, Yung-Fa Huang, Ching-Chuan and Rung-Ching Chen, "Performance of PTS-Based Firefly Algorithm Scheme for PAPR Reduction in SFBC MIMO-OFDM Communication Systems", International Symposium on Computer, Consumer and Control, IEEE 2016.
- [10] P. Kothai and R. Prabhu M.E., "PAPR Reduction in MIMO OFDM Using Adaptive SLM Scheme", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol. 03, No. 05, pp. 729-735, May 2015.
- [11] Muhammet Nuri Seyman, Necmi Taspamar, "Channel estimation based on neural network in space time block coded MIMO-OFDM system", Digital Signal Processing, Vol. 23, No.1, pp. 275-280, Jan. 2013.
- [12] P. Mukunthan and, P Dananjayan, "PAPR Reduction based on a Modified PTS with Interleaving and Pulse Shaping method for STBC MIMO-OFDM System", IEEE ICCNT'12 , 26th _28th July 2012, Coimbatore, India.



- [13] L. Yang, K. K. Soo, S. li, and Y. M. SU, “PAPR Reduction Using Low Complexity PTS to Construct of OFDM Signals Without Side Information”, IEEE Transactions on Broadcasting, Vol. 57, No. 2, pp. 4532-4539, June 2011.
- [14] Anushree Neogi and Abhijit Mitra “MAP Estimation of CFO and STO for a Convolutionally Coded OFDM System” National Conference on Communications (NCC), pp. 01-05, IEEE 2011.
- [15] Chin-Liang Wang and Shun-Sheng Wang and Hsiao-Ling Chang, “A Low-Complexity SLM Based PAPR Reduction Scheme for SFBC MIMO-OFDM Systems”, 978-1-61284-254-7/11 IEEE 2011.



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