SURVEY PAPER ON PAPR REDUCTION FOR MIMO-OFDM SYSTEMS USING PTS SCHEME

Priyanka Singh Jadon[1], Prof. Pankaj Sharma[2]

[1]*Research Scholar, Trinity Institute of Technology & Research, Bhopal, India*
[2]*Faculty Electronics' & Communication Dept., Trinity Institute of Technology & Research, Bhopal, India*

Abstract - *In recent time, the demand for multimedia data services has grown up rapidly. One of the most promising multi-carrier system, Orthogonal Frequency Division Multiplexing (OFDM) forms basis for all 4G wireless communication systems due to its large capacity to allow the number of subcarriers, high data rate and ubiquitous coverage with high mobility. OFDM is significantly affected by peak-to-average-power ratio (PAPR). Unfortunately, the high PAPR inherent to OFDM signal envelopes will occasionally drive high power amplifiers (HPAs) to operate in the nonlinear region of their characteristic curve. The nonlinearity of the HPA exhibits amplitude and phase distortions, which cause loss of orthogonality among the subcarriers, and hence, inter-carrier interference (ICI) is introduced in the transmitted signal. Not only that, high PAPR also leads to in-band distortion and out-of-band radiation.*

This paper emphasis mainly on the PAPR reduction of OFDM system using partial transmits sequence (PTS) and precoding techniques. Some other techniques such as amplitude clipping have low-complexity; on the other hand, they suffer from various problems such as in-band distortion and out-of-band expansion. Signal companding methods have low-complexity, good distortion and spectral properties; however, they have limited PAPR reduction capabilities. Advanced techniques such as coding, partial transmit sequences (PTS) and selected mapping (SLM), have also been considered for PAPR reduction.

***Key Words*: PTS, STBC, MIMO, OFDM, PAPR**

1. 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]. This approach is applied in STBC MIMO-OFDM systems. The rest of the paper is organized as follows: in section II, PAPR theory in MIMOOFDM system is developed. Section III describes the proposed algorithm. The papers are concluded in section IV.

2. LITERATURE SURVEY

Owing to the signal structure difference between the filter bank multicarrier with offset quadrature amplitude modulation (FBMC/OQAM) and the orthogonal frequency-division multiplexing (OFDM) systems, the existing technologies to reduce the peak-to-average power ratio (PAPR) for OFDM systems are not suitable for the FBMC/OQAM systems. The main idea of this joint optimization scheme is clipping and filtering the processed FBMC/OQAM signal, whose probability of the peak value has been reduced by the IBPTS technique. Meanwhile, aided by the knowledge of convex optimization, the IBPTS-ICF joint optimization scheme can effectively reduce the signal distortion. The excellent PAPR reduction performance of the proposed scheme has been confirmed in our simulations by Junhui Zhao et al. [1].

The implementation of MIMO with OFDM is an effective and more attractive technique for high data rate transmission and provides burly reliability in wireless communication. It has lot of advantages which can decrease receiver complexity, provides heftiness against narrowband interference and have capability to reduce multipath fading. The major problem of MIMO-OFDM is high PAPR which leads to reduction in Signal to Quantization Noise Ratio of the converters which also degrades the efficiency of power amplifier at transmitter. In this paper we mainly focus on one of scrambling and non-scrambling technique Iterative clipping and filtering, and partial Transmit sequence (PTS) which results in better performance. The two techniques once united or combined in the system prove that along with trimming down the PAPR value, the power spectral density also gets smoother by Ashna Kakkar et al. [2].

A combination of multiple-input multiple output (MIMO) signal processing with orthogonal frequency division multiplexing (OFDM) is regarded as a promising solution for enhancing the performance of next generation wireless local area network (WLAN) systems. However, like OFDM, one main disadvantage of MIMO-OFDM is that the signals transmitted on different antennas might exhibit a prohibitively large peak-to-average power ratio (PAPR). Partial transmit sequence (PTS) provides attractive PAPR reduction performance in OFDM or MIMO-OFDM. Unfortunately, it leads to prohibitively large computational complexity. In this paper, types of low-complexity PTS schemes are proposed to reduce the PAPR for MIMO-OFDM systems that use Firefly algorithm (FA) and space-frequency block codes (SFBC). Simulation results show that FA based on PTS can reduce computational complexity dramatically and achieve better PAPR reduction performance compared to ordinary PTS by Ho-Lung Hung et al. [3].

Multiple-Input multiple-output (MIMO) orthogonal frequency division multiplexing (OFDM) is reliable and most attractive technique for high data rate communications. MIMO uses spatial diversity to accept multiple "best" signals simultaneously. Each antenna is able to transmit or receive signals, where the legacy system can only accept the single "best" signal. The main drawback of orthogonal frequency division multiplexing systems is high Peak to Average Power Ratio (PAPR), which results in poor power efficiency, degradation in bit-error-rate (BER) performance, and spectral spreading efficiency. The needed measure for better wireless communication is to reduce PAPR. The proposed system introduces Adaptive Selected mapping (ASLM) techniques. In this technique, the sums of separated data blocks are created from an OFDM data block using a set of phase sequence. It chooses lowest PAPR and selects sequences for transmission. As an outcome, the adaptive selected mapping increases the power efficiency and reduces the impulse interference by P. Kothai et al. [4].

The two related optimization problems, maximizing the minimum of weighted rates under a sum-power constraint and minimizing the sum-power under rate constraints, are considered. They assumed that the Gaussian input and that each signal is decoded at no more titan one receiver. The complexity is high because the steepest ascent algorithm for the weighted sum-rate maximization needs to be solved repeatedly for each weight vector searched by the ellipsoid algorithm. Then the solution does not satisfy the single-user water-filling structure. They can be used in admission control and in guaranteeing the quality of service. In, finally the mappings were used for many other optimization problems by Muhammet et al. [5].

The real and imaginary parts of complex factor corresponding to in-phase components and quadrature components of OFDM symbols, respectively. It is to be noted that in ideal cases, the demodulation is performed based on the assumption of perfect symbol timing, carrier frequency, and phase synchronization. This is usually not practically possible to achieve; therefore, the demodulated signal will not be the exact replica of input signal; resulting in bit error rate (BER). The term BER can be mathematically expressed as the difference of the received demodulated data and the input data by P. Mukunthan et al. [6].

3. 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 de-multiplexer/multiplexer if spatial multiplexing is to be used.

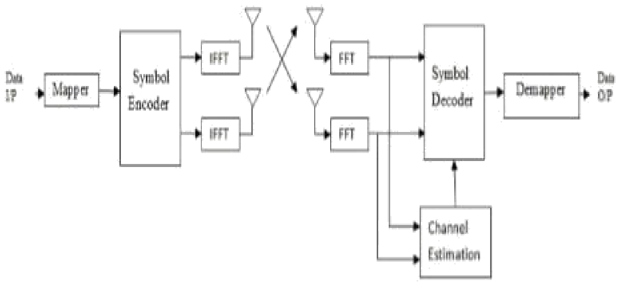

Fig -1: MIMO-OFDM system model

The received signal at jth antenna can be expressed as

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

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 NR receives antennas and NT transmits antennas can be given as:

$$\begin{bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_N \end{bmatrix} = \begin{bmatrix} H_{1,1} & H_{1,2} & \cdots & H_{1,NT} \\ H_{2,1} & H_{2,2} & \cdots & H_{2,,NT} \\ \vdots & \vdots & \ddots & \vdots \\ H_{NR,1} & H_{NR,2} & \cdots & H_{NR,NT} \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \\ \vdots \\ A_{NT} \end{bmatrix} + \begin{bmatrix} M_1 \\ M_2 \\ \vdots \\ M_{NT} \end{bmatrix} \qquad (2)$$

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.

4. PTS SCHEMES

4.1 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 Xv (v = 1, 2... M) as follows.

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

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

$$X' = \sum_{v=1}^{M} b_v X_v \qquad (4)$$

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].

4.1 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.

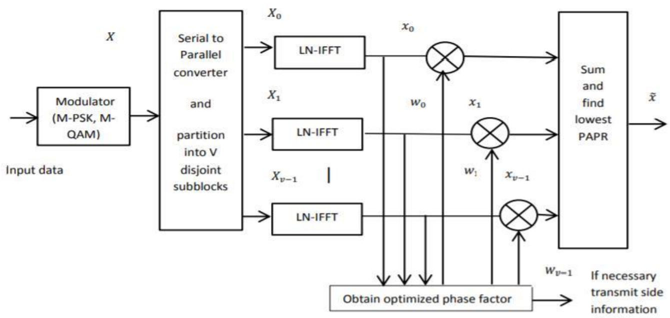

Fig -2: Block diagram of the PTS scheme with two transmit antennas

5. EXPECTED OUTCOME

This research project expects to have the following outcomes by the end of the project.

- The PAPR of the MIMO-OFDM signal can also be reduced by using PTS with DWT and DCT technique.
- Analysis of the 2×1, 2×2 MIMO-OFDM system for wireless communication.
- Analysis of the bit error rate (BER) for the different modulation technique and PTS with DWT and DCT technique.
- Analysis of the space time block code (STBC) used in MIMO-OFDM system and achieved better result.

6. CONCLUSION

An extended approach cooperative and alternate partial transmit sequence named PTS was proposed for STBC MIMO-OFDM - 4G 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. The proposed method performs well in terms of simulation results as well as the complexity of computation.

REFERENCES

[1] Junhui Zhao, Shanjin Ni and Yi Gong, "Peak-to-Average Power Ratio Reduction of FBMC/OQAM Signal Using a Joint Optimization Scheme", Received March 24, 2017, accepted April 26, 2017, date of publication May 19, 2017, date of current version August 29, 2017.

[2] 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.

[3] 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.

[4] 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.

[5] Muhammet Nuri Seyman, Necmi Taspmar, "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.

[6] P. Mukunthan and, P Dananjayan," PAPR Reduction based on a Modified PTS with Interleaving and Pulse Shaping method for STBC MIMO-OFDM System", IEEE ICCCNT'12 , 26th _28th July 2012, Coimbatore, India.

[7] Tarokh, N. Seshadri, and A. R. Caderbank, " SPACE-TIME Codes for High Data Rate Wireless Communication: Performance Criteria and Code Construction," IEEE Trans. Inform. Theory, pp. 744-764, Mar. 1988.

[8] H. Ochiai and H. Imai. Performance of the deliberate clipping with adaptive symbol selection for strictly band-limited OFDM systems. IEEE Journals on Selected Areas in Communications, 18(11) :2270–2277, November 2000.

[9] Jose Tellado. Peak to Average Power Ratio Reduction for Multicarrier Modulation. PhD thesis, University of Stanford, Stanford, 1999.

[10] Tao Jiang and Guangxi Zhu. Nonlinear companding transform for reducing peak-to average power ratio of OFDM signals. Broadcasting, IEEE Transactions on, 50(3):342 – 346, sept. 2004.

[11] S. B. Slimane. Reducing the peak-to-average poser ratio of OFDM signal through precoding. IEEE Trans Vehicular Technology, 56(2) 686–695, mar 2007.

[12] R.W. Bauml, R.F.H. Fisher and J.B. Huber, Reducing the peak-to average power ratio of multicarrier modulation by selected mapping[J] IEEE Electronic Letter, 1996, 32(22): 2056-2057.

[13] S.H. Muller and J.B. Huber, OFDM with reduced peak-to-average power ratio by optimum combination of partial transmit sequences [J]. IEEE Electronic Letter, 1997, 33(5): 368-369.

[14] 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, June 2011.