ISSN : 2347 - 8446 (Online)
ISSN : 2347 - 9817 (Print)

An Enhanced Algorithm for Papr Reduction in MIMO OFDM/A

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Abstract
Orthogonal Frequency Division Multiplexing (OFDM) is a spectrally efficient multicarrier modulation technique[1] for high speed data transmission over multipath fading channel. The primary advantage of OFDM over single carrier schemes is its ability to cope with severe channel condition. This OFDM Signalsuffers from high Peak-to-average power ratios (PAPR)[1]. PAPR lead to power inefficiency in transmitter side.Constant Modulus Algorithm is one of the promising schemes proposed for alleviating the high peak-to-average power ratio.Using Complementary cumulative distribution function (CCDF), CMA results are compared with the results of various algorithms.

Keyword
Orthogonal frequency division multiplexing (OFDM), Peak-to-average power ratio (PAPR), constant modulus algorithm (CMA). Complementary cumulative distribution function (CCDF).

I. Introduction

Multi-carrier phenomena [1] is considered to be one of the major development in wireless communication and among them OFDM is becoming the importantstandard. However, high PAPR is the major drawback of OFDM [2], which results in lower power efficiency. To overcome the low power efficiency requires not only large back off and large dynamic range digital to analog converter but also highly efficient high power high power amplifiers and linear converters. Therefore to lessen the difficulty of complex hardware design it becomes imperative to employ efficient PAPR reduction techniques. The two factors that affect PAPR is Number of sub carrier and Modulation order. OFDM has been put into practice in digital television and high definition television. Over the past decade, an extensive amount of literature has been dedicated to PAPR reduction techniques. These techniques are associated with cost in terms of bandwidth and transmit power. Also, most of them require modifications to both the transmitter and the receiver which makes them non-compliant to existing standards. A new technique are proposed and the simulation results are compared using complementary cumulative Distribution function. Performance comparison, complexity comparison, BER performance and PAPR reduction performance are among them. The idea of using Multiple receive and multiple transmit antennas has emerged as one of the most significant technical breakthroughs in modern wireless communications.[6] Theoretical studies and initial prototyping of these MIMO system have shown order of magnitude spectral efficiency improvements in communications. As a result, MIMO is considered a key technology for improving the throughputs of future wireless broadband data systems.The simplest way to reduce the PAP ratio is to clip the signal, such that the peak amplitude becomes limited to some desired maximum level. Although clipping is definitely the simplest solution, there are a few problems associated with it. First by distorting the OFDM signal amplitude, a kind of self interference is introduced that degrades the BER. Second it increases the level of out–of-band radiation.The latter effect can be understood easily by viewing the clipping operation as a multiplication of the OFDM signal.

II. Related Work

S.H Han et al., suggested [1] that high peak-to-average power ratio of the transmit signal is a major drawback of multicarrier transmission such as OFDM. This article describes some of the important PAPR reduction techniques for multicarrier transmission including amplitude clipping and filtering,partial transmit sequence. PAPR reduction technique in MIMO OFDMA is addressed.

S.Muller et al., suggested [2] that a very effective and flexible peak power reduction scheme for orthogonal frequency division multiplexing with almost vanishing redundancy is proposed.The core of the proposal is to combine PTS to minimize the PAPR distortion.

Y.Shen et al., suggested [5] that a uplink channel estimation algorithm is proposed. Different Type of algorithm such as averaging algorithm, linear interpolation algorithm, Time domain interpolation algorithm are implemented.

Treichler et al., suggested [7] that an adaptive digital filtering algorithm that can compensate for both frequency-selective multipath and interference on constant envelope modulated signal is presented.Substantial improvements in noise power are observed.

J.Wang et al., Suggested [8] that a radio resource allocation scheme for MIMO-OFDMA system in order to achieve the optimal system throughput is proposed. It shows that the proposed algorithm significantly simplifies the scheduling process and achieves more throughput than round robin (RR) scheme.

III. Transmit Signal Model

A generic MIMO-OFDMA with one base station employing M_t antennas is considered. An OFDM block with N subcarrier is transmitted from each antenna. The N subcarriers include N_u useful subcarriers surrounded by two guard bands with zero energy. The useful subcarriers are further grouped in to M resource blocks, each consisting of $N_b = N_u/M$ subcarriers. Data of one or more users is placed in these resource blocks and mapped in to space time domain using an inverse discrete Fouriertransform. Channel estimation is done at receivers. In MIMO transmit data model, the data in q-th resource block is a matrix $D^{(q)} \in C^{Mt\times Nb}$. The resulting transmit sequence is $X^{(q)}=W^{(q)H} D^{(q)}$. Together with guard intervals, they are collected in a matrix X $X \in C^{Mt\times N}$ where the M_t rows of this represent the N symbols to be transmitted from the M_t antennas. The data model is $X=W^H D$

Matrix X represents the spatial data in the frequency domain. The time domain MIMO OFDM transmit data model is obtained by taking the IDFT of the data matrix X, resulting in

$$Y=XF^H=W^H DF^H$$

Y Contains the resulting transmit OFDM sequence for each of the M_t antennas. Denoting the total power in the data matrix D by $P_{d=||vec(D)||^2=\alpha N t}$. N_t is the total number of subcarrier or samples to be sent from all M_t antennas, and α is defined as the average transmit power per sample.

IV. Proposed CMA Approach

A. Constant Modulus Algorithm

The most commonly used adaptive algorithm is constant modulus algorithm, which uses the constant modularity of the signal as the desired property. CMA assumes that the input to the channel is a modulated signal that has constant amplitude at every instant in time. Any deviation of the received signal amplitude from the constant value is considered a distortion, introduced by channel. The distortion is mainly caused by band-limiting or multi-path effects in the channel. Both this effects results in inter-symbol interference and thus distorts the received signal. CMA can also used for QAM signals where the amplitude of modulated signal is not the same at every instant. The error e(n) is then determined by considering the nearest valid amplitude level of the modulated signal as the desired value. The most commonly used blind equalization is constant modulus algorithm which uses constant modularity as the desired property of the output. Generally the error equation used with CMA is defined as

$$e(n)=|y(n)|^2-A^2$$

A is the desired amplitude level. This algorithm is extremely easy to implement. Many communication signals have the constant modulus property:FM,PM, Frequency shift keying, Phase shift keying.

B. Steepest Descent (SDCMA)

The Steepest Descent is a block iterative algorithm in which full data matrix is taken in to account and update ω until it converges. For convergence the algorithm is initialized with $\omega^0=1$. The algorithm should be run until cost function J(ω) converges; in practice convergence is fast and the algorithm is run for a fixed small number of iterations. A difference with the standard CMA is that, here, a good solution does not necessarily exist. The application of CMA is for a linear combination of constant modulus sources for which, without noise, a perfect beamformer exist. There are no existence results for other methods.

C. Unit-circle CMA (UC-CMA)

In order to restrict the solution to be on the unit-circle,a normalization step is added .to each iteration. This alternative updating algorithm is called unit-circle CMA.

D. Partial Transmit Sequence

PTS algorithm is an effective method to reduce the peak-to average power ratio of OFDM system.[2] However, it needs a special channel to transmit side information.[5]So, grouped phase control method based on PTS technology has been proposed to improve it. In PTS, initially portioning of data block in to non-overlapping sub block is done. Then this sub blocks are rotated with rotating factor which are statistically independent. The generated, lowest peak amplitude in time domain is transmitted to receiver. The simulation result of PTS for reduction is better as compared to other techniques. A white Gaussian noise channel is commonly used to simulate background noise of the channel under study, in addition to multipath, terrain blocking, interference. PTS and Selected Mapping are known as multiple signal representation methods. Selected mapping is also a peak-to-average power ratio reduction method in OFDM System. With SLM, multiple sequences are generated by multiplying independent phase sequence with the original data and the sequence with the lowest PAPR is chosen for transmission. Hence to determine the selected sequence at the transmitter side, information must be sent along with the data. The resulting schemes are denoted as ordinary, simplified and directed PTS. The directed approach gains with multiple antennas. In simplified approach of PTS the transmit antennas are not treated individually. Ordinary PTS is the independent application of the PAR reduction schemes to each of the transmit antennas.

V. Simulation Results

Complementary cumulative Distribution Function (CCDF) curves present vital information regarding the OFDM signal to be transmitted. The CCDF curves are applied for many other design applications such as to combine several signals through system components, visualize the effects of modulation formats, evaluate spread spectrum systems, and design and test RF components. The curves also provide the PAPR data needed by component designer. The main use of power CCDF curves is to identify the power characteristics of the signals which are amplified, mixed and decoded. The plot of relative power levels of signal against their probability of occurrence is called CCDF curve.

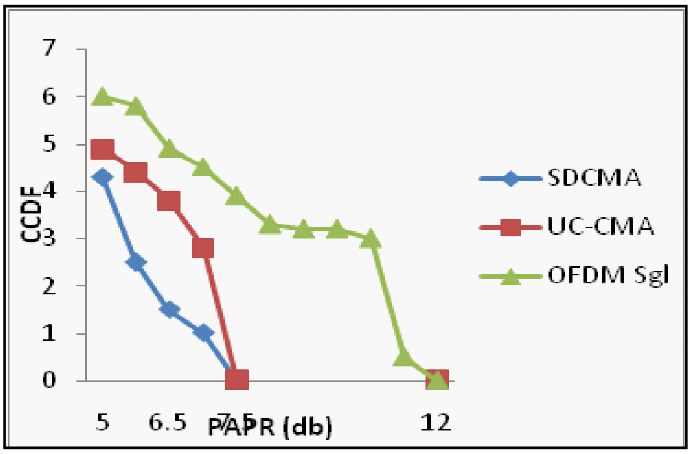

Figure 1: PAPR reduction performance in MIMO OFDMA for both SDCMA and UC-CMA.

Extension of these algorithms to multiple antenna system is not straight forward. Another combined precoding has been proposed for multiuser MIMO systems. [3] Precoding is the generalization of beamforming to support multistream transmission in multi antenna wireless communication. When the receiver has multiple antennas, single stream beamforming cannot simultaneously maximize the signal level at all of the receive antennas. In order to maximize the throughput in multiple receive antenna system, multistream transmission is generally required. Beamforming is a signal processing technique used in sensor arrays for directional signal transmission or reception.

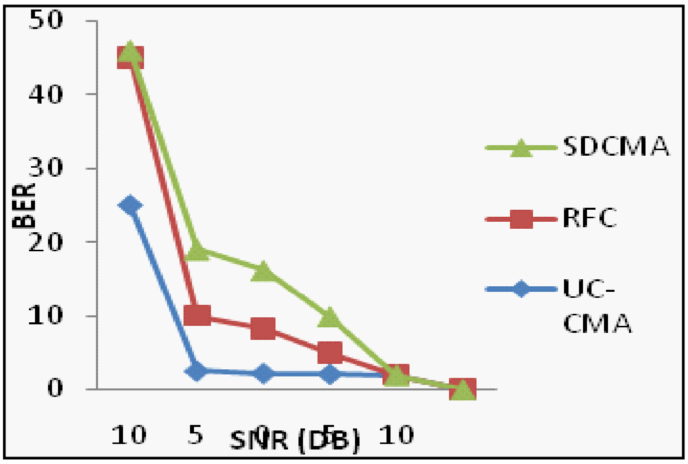

Figure 2:BER performance of the proposed algorithm in comparison with AWGN and Rayleigh fading channels for single antenna QPSK-OFDM system.

The number of bit errors is the number of received bits of a data stream over a communication channel that has been altered due to noise, interference, distortion or bit synchronization errors. BER is a unit less performance measure, often expressed as percentage. The BER may be improved by choosing a strong signal strength, by choosing a slow and robust modulation scheme or line coding scheme and by applying channel coding schemes such as redundant forward error correction code.

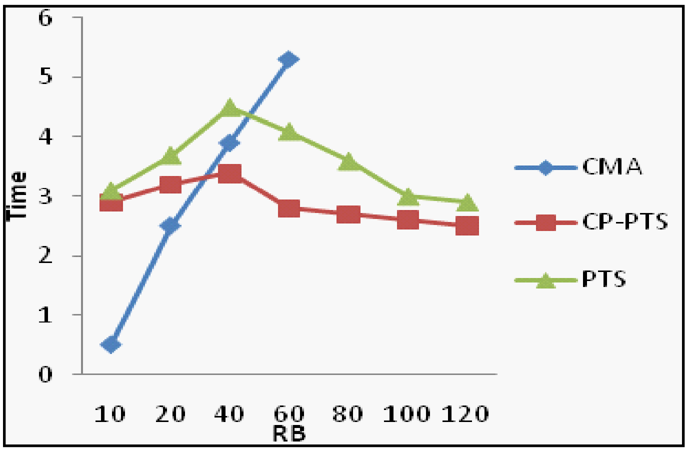

Figure 3:Complexity comparison between CMA,CP-PTS and PTS using Matlab runtime evaluation.

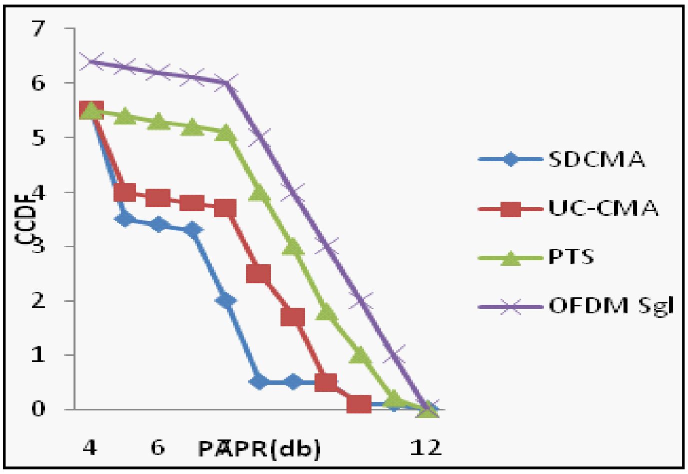

Figure 4: Performance comparison for the proposed CMA PAPR reduction algorithm.

Fig.1 shows the performance of SDCMA and Unit-circle CMA. From Fig 2, the effect of non-modified SDCMA is analogous to a Rayleigh fading channel in terms of BER performance so the same error correcting codes can be used. As expected the UC-CMA does not influence the BER performance. This motivates the use of UC-CMA technique.From Fig. 3 it is clear that CMA is about a factor 50 faster than PTS. Moreover,the CCDF curves in Fig.4 show the superior performance compared to other types of algorithm.

VI. Conclusion

In this paper, a proposed method known as CMA which is known for the reduction of PAPR value in MIMO OFDMA is used. It provides the simple result. The result was compared with various techniques. This algorithm provides efficiency above 90% and it is extremely simple to implement. Future work lies in several areas. One of the future research objective is to develop algorithm for complete reduction of PAPR.

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