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PAPR Reduction in SFBC MIMO OFDM System using AMS Scheme

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***Abstract:* - Increased data rates and reliability are the two key factors required to support emerging multimedia applications and new communications technologies. The two techniques used in high data rate transmission are orthogonal frequency division multiplexing (OFDM) and multiple-input multiple-output (MIMO) scheme. The OFDM is used to mitigate the problem of inter symbol interference (ISI) and provides good protection against co-channel interference and noise. MIMO system helps to reduce fading and can be used for decreasing bit error rate that is spatial diversity or to increase the data rate that is spatial multiplexing. The combination of MIMO and OFDM is MIMO OFDM system. MIMO-OFDM system converts frequency selective MIMO channel into multiple parallel flat fading channels. One of the major drawbacks of in MIMO-OFDM systems is that the transmitted signal exhibits a high PAPR when the input sequences are correlated. In this paper, ACE and AMS schemes have been used to reduce peak to average power ratio (PAPR) in multiple input multiple output orthogonal frequency division multiplexing (MIMO OFDM) system with space frequency block coding (SFBC). The ACE scheme reduces the computational complexity and when ACE scheme is used with quadrature amplitude modulation (QAM). Simulation and results show that the AMS scheme reduces PAPR more efficiently than the AMS scheme.**

1. INTRODUCTION

The basic idea of multicarrier modulation is to divide the transmitted bit stream into many different sub streams and send these over many different sub channels. Typically the sub channels are orthogonal under ideal propagation conditions, in which case multicarrier modulation is often referred to as orthogonal frequency division multiplexing (OFDM). The data rate on each of the sub channels is much less than the total data rate, and the corresponding sub channel bandwidth is much less than the total system bandwidth. The number of sub streams is chosen to insure that each sub channel has a band width less than the coherence bandwidth of the channel, so the sub channels experience relatively flat fading. Thus, the ISI on each sub channel is small. Moreover, in the discrete implementation of OFDM, often called discrete multi tone (DMT), the ISI can be completely eliminated through the use of a cyclic prefix. The sub channels in OFDM need not be contiguous, so a large continuous block of spectrum is not needed for high rate multicarrier communications. Recently, various algorithms of the PAPR reduction have been proposed for single-input single-output (SISO) OFDM systems in the literature, including clipping, nonlinear commanding transform, coding technique , selected mapping (SLM), go lay sequence and the weighting factor estimation Method. However, when these methods are employed directly to reduce the PAPR in MIMO-OFDM systems, it results in increasing of the complexity and redundancy with the increasing number of antennas. Therefore, several new schemes have been proposed specially for MIMO-OFDM systems, such as the method of the poly-phase interleaving and inversion (PII). The best advantage of both the ACE/AMS and PII schemes is that they could provide a good PAPR reduction without signal distortion. However, the computational complexity of the ACE/AMS and PII schemes is very high because they need to implement some extra inverse discrete Fourier transform (IDFT) operations and iterations of phase optimization. Obviously, the computational complexity of the scheme proposed in is reduced, which is at the cost of losing PAPR reduction.

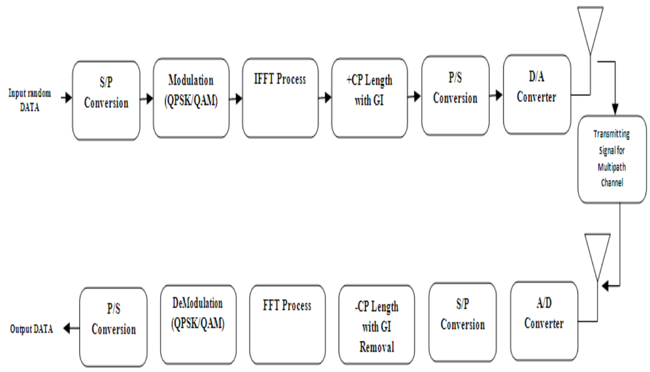


Fig: 1 OFDM Block Diagram

Moreover, its optimal phase rotation vectors also need to be transmitted as side information to the receiver, resulting in loss of the data rate. In this paper, we propose partial transmit sequences (PTS) scheme to reduce the PAPR of MIMO-OFDM signals. For convenience and simplicity, the space time block coding (STBC) is employed in MIMO-OFDM systems in this paper. For the proposed ACE method, original data sequences at two antennas are partitioned into several pairs of sub blocks, and each pair of sub blocks multiplies by different factors to generate different pair of sub blocks. Then,

International Journal of Advanced Research Foundation
Website: www.ijarf.com, Volume 3, Issue 1, January 2016)

the obtained new sub blocks are combined to generate AMS, which keep the structure and the diversity capability of the SFBC. Finally, the pair of alternative sequences with the smallest PAPR is chosen to be transmitted. Obviously, the factors of the selected pair of sequences have to be transmitted as side information. However, if the factors are chosen particularly, the transformed pair of the constellation points corresponds to only one pair of original constellation points. As a result, the received pair of the constellation points could determine its corresponding original data without side information at the receiver. Simulation results show that the proposed ACE scheme could provide good PAPR reduction, and the ACE-SFBC method without side information could provide the same bit error rate (BER) performance as that of the AMS scheme with MIMO-OFDM with 4-QAM and 16-QAM, respectively.

2. PEAK-TO-AVERAGE POWER RATIO IN OFDM SYSTEM

It is defined as the large variation or ratio between the average signal power and the maximum or minimum signal power. Theoretically, large peaks in OFDM system can be expressed as Peak-to Average Power Ratio (PAPR) and it is usually defined as

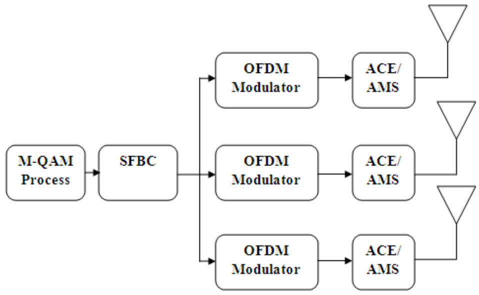
$$\mathrm{PAPR} = \frac{P_{Peak}}{P_{Average}} = 10\log_{10}\frac{\max\,[|x_n|^2]}{E|x[n]|^2}$$

Where **P peak** represents peak output power, **P average** means average output power [**E**]. Denotes the expected value, represents the transmitted OFDM signals which are obtained by taking IFFT operation on modulated input symbols. Mathematical, is expressed as

$$x_n = \frac{1}{\sqrt{N}}\sum_{k=0}^{N-1} X_k\ W_N^{nk}$$

For an OFDM system with sub-carriers, the peak power of received signals is N times the average power when phase values are the same. The PAPR of baseband signal [2] will reach its theoretical maximum at **PAPR (db) =10logN.** Another commonly used parameter is the Crest Factor (CF), which is defined as the ratio between maximum amplitude of OFDM signal x (t) and root-mean-square (RMS) of the waveform. In this MIMO OFDM system, SFBC codes are used as a channel coding technique to do error correction and detection and ACE/AMS scheme is employed to reduce PAPR. The input bits are given to modulator where modulation of input bits takes place using M-QAM complex constellation. The modulated signal is given by:

Sm (t) =Am g (t) Cos (2πfct)-As g (t) Sin (2πfct)



Am and As are information bearing signal amplitudes of quadrature carriers and **g (t)** is the input-signal pulse. M-QAM modulated symbols are passed through the STBC encoder and complex matrix Z is generated such that symbols are coded through space and time. So, replicas of modulated symbols for block coding are sent through two transmit antennas and over two time slots.

The encoded sequence can be found by

Max (z (n))=sum(max(z(n)));
Zn_r=real (Z (n));
Zn_i=imaginary (Z (n));

The encoded bits are given to the OFDM modulator where the bits are mapped with the orthogonal carriers. An inverse FFT is computed on each set of symbols, giving a set of complex time-domain samples.

$$z(n) = \frac{1}{\sqrt{N}}\sum_{k=0}^{N-1} Z(k)\,e^{\frac{j2\pi nk}{N}}$$

Where j = and n= 0, 1… (N-1).

After OFDM modulation, ACE or AMS scheme is applied to reduce PAPR. Finally, the signal with minimum PAPR is transmitted through its respective antennas.

PAPR of MIMO-OFDM system is defined by

$$PAPR\big(z(n)\big) = \frac{max\{|z(n)|^2\}}{E\{|z(n)|^2\}}$$

Where E {.} is the mathematical expectation.

Complementary cumulative density function (CCDF) for PAPR is given by:

$$CCDF\left(PAPR\big(z(n)\big)\right) = P_r\left(PAPR\big(z(n)\big) > PAPR_0\right)$$

AMS Scheme

The AMS scheme is after STBC encoder, the coded data is partitioned into sub blocks, and IFFT operation is performed on each sub block where the frequency domain signals are converted into time domain signals. Finally, AMS scheme is implemented, in which two inputs are given to the AMS block one input is from IFFT block and another input to AMS block is the conjugate of the output of the IFFT block.

Suppose the output of the IFFT block is **Y (m); [m=0, 1, 2 ...m-1],** then the two inputs to the AMS block will be **t1**and **t2**where,

t2=t1*

AMS scheme will generate new sequences which are given by

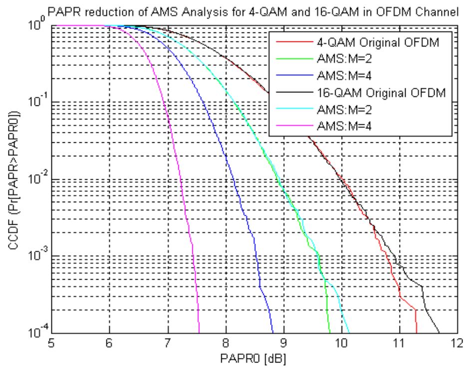
T1'= [a (t1) c] ^m+ [bt2] ^m
T2'= [a (t2) c] ^m- [bt1] ^m

International Journal of Advanced Research Foundation
Website: www.ijarf.com, Volume 3, Issue 1, January 2016)

Where a^m and b^m are positive integers with a^m ≠ 0 c^m and 1 and 2 respectively. Then the alternate transmitted signals are given by:

$$t_i = \sum_{m=0}^{M-1} t_i^m$$

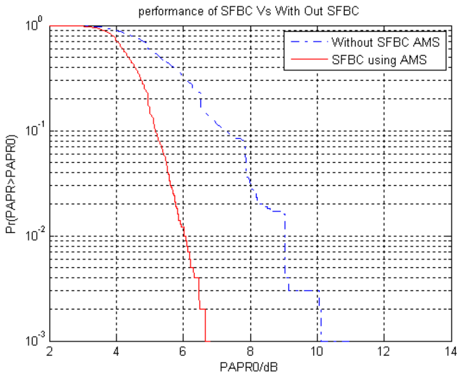
Where. i=1, 2, 3....
Finally, the signal with the lowest PAPR is chosen for transmission.



		PAPR
	4-QAM	11.8db
inal OFDM	16-QAM	11.23db
	AMS M=2	9.8db
4QAM	AMS M=4	8.8db
	AMS M=2	10.2db
16 QAM	AMS M=4	7.5db

3. AMS WITH SFBC SCHEME

Key idea of the proposed scheme is keeping the advantage of the SFBC structure to generate some AMSs via combining the signals at different transmit antennas. Specifically, when the proposed scheme is employed in SFBC MIMO OFDM systems with quadrature-amplitude modulation (QAM), For convenience and simplicity, the space–frequency block coding (SFBC) is employed in MIMO-OFDM systems in this project original data sequences at two antennas are partitioned into several pairs of sub blocks, and each pair of sub blocks multiplies by different factors to generate different pair of sub blocks.



64QAM	Without SFBC	10.25 db
	With SFBC	6.25db

ACE Scheme

The Active Constellation Extension (ACE) is an attractive technique because of good PAPR reduction performance and no restriction to the number of subcarriers [13]. It can be said that ACE method is a modified method of AMS. ACE method works better than ACE method. The main advantage of this scheme is that there is no need to send any side information to the receiver of the system, when, differential modulation is applied in all sub blocks. In this scheme, the coming input bits are divided into smaller disjoint sub blocks. Input from each partitioned sub block converted from frequency domain to time domain by using N-point inverse fast Fourier transform (IFFT). The time domain sequences are multiplied by rotating phase factors **Z= [Z1, Z2, Z3...Zm] ^T**, to minimize PAPR and then these sequences are then added to form the OFDM symbol for transmission.
The resulting time domain signal,

$$x'(z) = \sum_{m=1}^{M} z_m . x_m$$

Allowable phase factor,

$$z_m = e^{j\Phi_m}$$

Xm is the time domain sequence and Øm can take the value between (0, 2π). The main aim of this scheme is to design an optimal phase factor for each sub block set that minimizes the PAPR. Finally, the signal with the lowest PAPR is chosen for transmission.

4. ACE WITH SFBC SCHEME

ACE Based are increased with a total transmit power constraint over additive white Gaussian noise (AWGN) channel. Moreover, we derive the quantitative relations between PAPR reductions using SFBC (Space Frequency Block Coding). In order to eliminate the over head respective to side information concerning the sequence of pre-coders employed, we propose the use of pre-coded pilots.

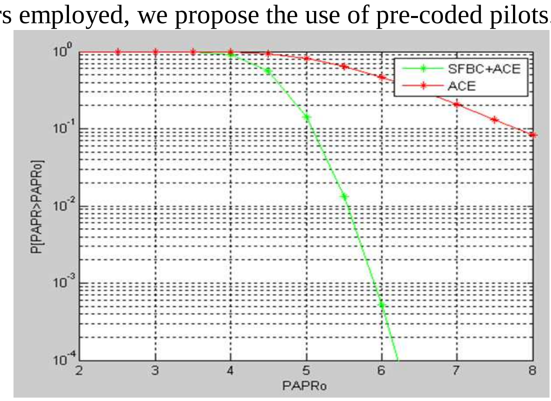


Fig: 6(a) PAPR Reduction on ACE with SFBC Using 256QAM

256 QAM	Without SFBC	above 8db
	With SFBC	6.25db
128QAM	Without SFBC	above 8db
	With SFBC	5.45db
64 QAM	Without SFBC	above 8db
	With SFBC	4.85db

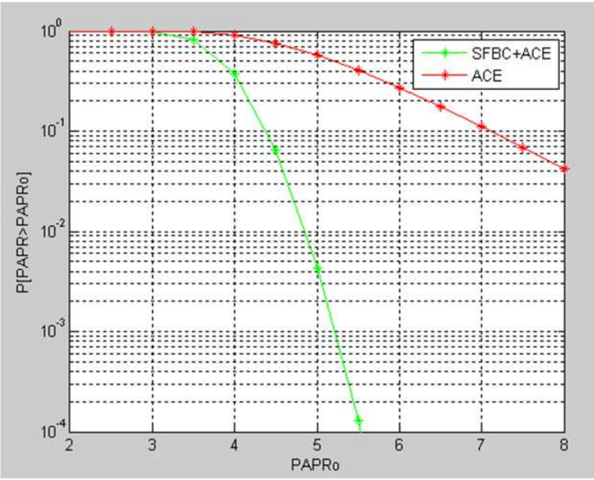


Fig: 6(b) PAPR Reduction on ACE with SFBC Using 128 QAM

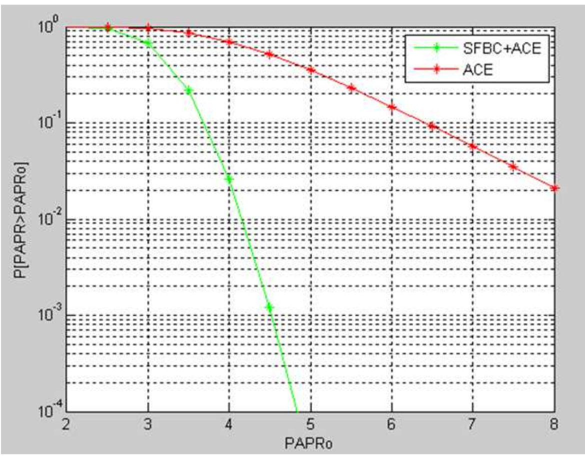


Fig: 6(c) PAPR Reduction on ACE with SFBC Using 64 QAM

5. CONCLUSION

In this paper, we investigated an efficient PAPR reduction technique dedicated to MIMO-OFDM systems using SFBC codebook. The main feature of our proposed method is that it induces an embedded signalling through the advanced pre-coders codebook that leads to a powerful recovery of the transmitted signal and guarantees a very low failure decision rate. To further improve the decision process, we proposed an additional embedded signal that consists of a set of rotated and un-rotated QAM constellations and when Used in the decision process (using a hard decision deduced from a Max-Log-MAP decoding), it significantly improves the MIMO-OFDM system performances in terms of CCDF of the PAPR, SIER and BER. This decision criterion ensures a good decision performance when the absolute LLR value is greater than a certain threshold. But when it is close to zero (for very low SNR values), the decision can be biased. To overcome this issue, conceiving a soft decision process would be an appropriate solution: this is a research aspect that we are currently investigating.

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