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A Survey on MIMO OFDM PAPR Decreasing Methodologies

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ABSTRACT
Lots of research being carried out now a days to outperform in terms of QoS and reliable in the area of modern wireless communication system in the same regard we are investigating various methodologies of detection in MIMO-OFDM System. Here we are studying MMSE and modified forms of MMSE detection algorithms, Sphere decoding methodologies and the combination of these two in MIMO OFDM system with digital modulation methodologies like BPSK, QPSK and QAM etc [1]. The advantages of hybrid detection technique are the better PAPR performance of the system for lower signal to noise ratio values as well as the reliability against interference and noises.

Keyword
OFDM, MIMO, PAPR, Precoding.

1. INTRODUCTION
Various multicarrier modulation schemes have invented in order to meet these demands, some distinguished among them being Code Division Multiple Access (CDMA) and Orthogonal Frequency Division Multiplexing (OFDM). OFDM is a frequency–division multiplexing (FDM) technique utilized as a digital multicarrier modulation scheme. A large number of intimately spaced orthogonal subcarriers is used to hold data. The data is separated into several equivalent streams of channels, one for each subcarrier.

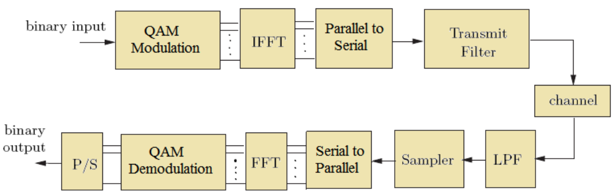
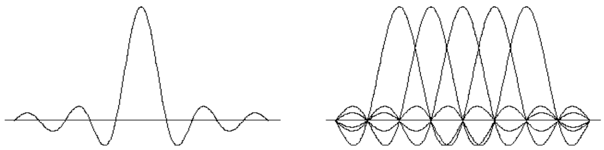


Fig.1.2. OFDM transceiver architecture

Each subcarrier is modulated with a guessable modulation scheme (such as QPSK) at a low symbol rate, maintaining whole datarates alike to the guessable single carrier modulation schemes in the same bandwidth. As it is ineffective to transfer a Improved rate data stream through a channel, the signal is split to give a number of signals over that frequency range. All of these signals are independently modulated and transmitted over the communication channel [1] [2]. On receiver end, these signals are input to a demultiplexer where it is demodulated and recombined to obtain the original signal.

OFDM is a particular form of multi-carrier modulation which is mainly right for transmission over a dispersive channel. Here the unlike carriers are orthogonal to each other, i.e., they are completely independent of one another. This is achieved by introduction of the carrier accurately at the nulls in the modulation spectrum of each other [1] [2].



(a) (b)

Fig.1. (a) Spectrum of an OFDM sub-channel, (b) OFDM Spectrum

Orthogonal frequency-division multiplexing (OFDM) is a very popular technique for digital transmission over frequency selective channels. Due to the transmitter side signal processing a rather improved peak-to-average-power-ratio (PAPR) occurs, which leads to non-linear distortion of the power amplifier and in turn to out-of-band radiation.

Pros:
- Due to improvement in symbol period, there is a drop in delay spread. Adding of guard band almost removes the ICI and ISI in the system[1].
- Translation of the channel into several closely spaced orthogonal subcarriers renders it resistant to frequency selective fading[1] [2].
- As it is obvious from the spectral model of an OFDM system, orthogonally insertion the subcarriers guide to improved spectral efficiency.
- Can be powerfully implemented using IFFT.

Cons:
- This system is improved susceptible to Doppler shifts which influence the carrier frequency offsets, ensuing in ICI.
- Occurrence of a large number of subcarriers with changing amplitude results in a Improved Peak to Average Power Ratio (PAPR) of the system, which in turn hampers the effectiveness amplifier.

2. SYSTEM PAPRAMETERS
2.1 Peak to Average Power Ratio (PAPR):
In the presence of big number of separately modulated subcarriers in an OFDM system the peak power of the system can be very improved as compared to the average power of the whole system. This ratio of the PAP value is named as Peak-to-Average Power Ratio. Coherent addition of N signals of identical phase produces a peak which is N times the average signal [3]. The major cons of a Improved PAPR are-

1. Improved complexity in the A/D Converters and D/A Converters.

2. Decrease in efficiency of Radio Frequency amplifiers.

2.2 Cumulative Distribution Function (CDF):

It is one of the most often used parameters, which is used to compute the efficiency of any PAPR technique. Normally, the Complementary CDF (CCDF) is used in its place of CDF, which helps us to calculate the probability that the PAPR of a definite data block exceeds the given threshold.

By implementing the CL Theorem for a multicarrier signal with a large number of subcarriers, the real and imaginary part of the time domain signals have a average of zero and a variance of 0.5 and follow a Gaussian distribution. So Rayleigh distribution is followed for the amplitude of the multicarrier signal, where as a central chi-square(CCS) distribution with two degrees of freedom is followed for the power distribution of the system [3].

3. PREVIOUS WORK

In 2012 Arunjeeva, L. Arunmozhi, S. presented their work "A novel complexity PAPR decreasing scheme for MIMO-OFDM systems" IEEE Conference in which they have used a number of PAPR decreasing methodologies have been proposed for MIMO-OFDM system, however, most of them involve very Improved computational complexity and are not applicable to MIMO-OFDM systems with space frequency block coding. A novel complexity PAPR decreasing scheme for SFBCMIMO-OFDM systems is proposed.

In 2011 Wei Xuefeng presented their work "A new algorithm for decreasing of peak-to-average power ratio in MIMO-OFDM system" IEEE Conference in which they have used the copy theory based mixed on the traditional SLM scheme, this work proposes a new kind of OFDM MIMO system reduces the SLM PAPR algorithm and shows the corresponding policy results. According to the simulation results, we can see this improved technique not only keeps the former probability scheme's advantages, but also further reduces the probability of Improved PAPR value.

In 2011 Wang, L., Liu, J. presented their work "Cooperative PTS for PAPR decreasing in MIMO-OFDM". It leads to prohibitively large computational complexity. A cooperative PTS (co-PTS) is proposed. In co-PTS, alternate optimization and spatial sub-block circular permutation are employed. Simulation results show that co-PTS can reduce computational complexity dramatically and achieve better PAPR decreasing performance compared to ordinary PTS.

In 2010 Umeda, S. Suyama, S. Suzuki, H. Fukawa, K. presented their work "PAPR Decreasing Method for Block Diagonalization in Multiuser MIMO-OFDM Systems" IEEE Conference This work proposes BD transmission selected mapping (BD-SLM) that can reduce PAPR while maintaining the BD effect. BD-SLM performs the phase shift to modulation signals of all users before the linear precoding. From several phase sequences, it selects a phase sequence that minimizes the peak of the time-domain signals at all transmit antennas. Computer simulations demonstrate that BD-SLM can drastically reduce PAPR in 16 × 4 MIMO-OFDM with four users, and that it can alleviate the performance degradation even when the power amplifier causes nonlinear distortion[3] [4].

In 2009 Biao Yan , Hui Zhang , Yinxia Yang , Qian Hu , Mengdong Qiu presented their work "An improved algorithm for peak-to-average power ratio decreasing in MIMO-OFDM systems". In which they have used Sub-block Successive Transform (SST) algorithm is an effective method to decrease the PAPR of the MIMO-OFDM signals, and can fully utilize the degrees of freedom in space domain to overcome the shortage of Successive Suboptimal Cross-Antenna Rotation and Inversion (SS-CARI) algorithm. However, the degrees of freedom in frequency domain are not considered in SST algorithm. For this problem, an improved SST (ISST) algorithm is proposed, in which, not only Sub-blocks are permuted in the same way as SST algorithm in space domain, but also sub-blocks on the same antenna are successively rotated in frequency domain. So it can fully use the degrees of freedom in both space domain and frequency domain. Simulation results indicate that the effect of PAPR decreasing of presented method is obviously better than that of SST algorithm[3] [6].

TABLE 1. Challenges to reduce PAPR in OFDM systems

Year	Author	Title	Approach	Result
2009	Biao Yan , Hui Zhang , Yinxia Yang , Qian Hu , Mengdong Qiu	An improved algorithm for peak-to-average power ratio decreasing in MIMO-OFDM systems	Sub-block Successive Transform (SST) algorithm	Reduce the PAPR of the MIMO-OFDM signals
2010	Umeda, S. Suyama, S. Suzuki, H. Fukawa, K.	PAPR Decreasing Method for Block Diagonalization in Multiuser MIMO-OFDM Systems	BD transmission selected mapping (BD-SLM)	Reduce PAPR in 16 × 4 MIMO-OFDM with four users
2011	Wang, L., Liu, J.	Cooperative PTS for PAPR decreasing in MIMO-OFDM	Cooperative PTS (co-PTS) Method	Achieve better PAPR decreasing performance
2011	Wei Xuefeng	A new algorithm for decreasing of peak-to-average power ratio in MIMO-OFDM system	Copy theory based mixed on the traditional SLM scheme	Reduces the probability of Improved PAPR value
2012	Arunjeeva, L. Arunmozhi, S.	A novel complexity PAPR decreasing scheme for MIMO-OFDM systems	SFBCMIMO-OFDM systems Used	Reduce PAPR in MIMO-OFDM

Improved PAPR has been guessable as one of the major practical difficulty involving OFDM modulation. Improved PAPR results from the nature of the modulation itself where multiple subcarriers are added jointly to form the signal to be transmitted. When N sinusoids add, the peak magnitude would have a value of N, where the standard might be quite low due to the negative interference between the sinusoids. Improved PAPR signals are usually unnecessary for it usually strains the analog circuitry. Improved PAPR signals would require a large range of dynamic linearity from the analog circuits which usually results in exclusive devices and improved power utilization with lower efficiency (for e.g. power amplifier has to operate with larger back-off to maintain linearity). In OFDM system, some input sequences would result in improved PAPR than others. For example, an input sequence that requires all such carriers to transmit their maximum amplitudes would positively result in a improved output PAPR. Thus by preventive the possible input sequences to a negligible sub set, it should be possible to achieve output signals with a assured low output PAPR. The PAPR of the transmit signal x(t) is the ratio of the maximum instantaneous power and the average power.

By Definition,

Where E {.} denotes expectation operator.

If a signal is a sum of N signals each of maximum amplitude equal to 1 Volt, then it is conceivable that we could get maximum amplitude of N Volts, that is, all N signals add at a moment at these maximum points. For an OFDM signal, that has 126 carriers each with normalized power of 1W, then the maximum PAPR can be as large as 10 log10 126 or 21 db. This is at the instant when all 126 carriers combine at their maximum point unlikely but possible [2]. The RMS PAPR will be around half of the number as 10-12 db. The large amplitude variation causes in-band noise and improvements the Error Rate which the signal has to go through amplification nonlinearities.

The criteria of the PAPR decreasing are to find the approach that it can reduce PAPR mainly and at the same time it can keep the good concert in terms of the following factors as probable. The following criteria should be considered in using the methodologies:

- The Improvement capacity of PAPR decreasing is main factor to be considered in selecting the PAPR decreasing technique with as few injurious side effects such as in-band deformation and out-of- band radiation.
- Low average power: even though it also can reduce PAPR through average power of the original signals improvement, it requires a larger linear operation PAPR Decreasing Methodologies

Several methods have been recommended to decrease PAPR over the years [7] [8] [9] [10] [11]. PAPR decreasing methodologies differ according to the necessity of the system and are reliant on various factors such as PAPR Spectral efficiency, decreasing capacity, improvement in signal transmit power, failure in data rate, difficulty of calculation and improvement in the Error Rate at the receiver end are various factors which are taken into report before adopting a PAPR decreasing technique of the system. Several methodologies have been recommended for PAPR decreasing, with different levels of success and complexity. Several methodologies show for the decreasing of this PAPR [12]. These methodologies are divided into two groups signal scrambling methodologies and signal distortion methodologies which are given below:

3.1 Signal Scrambling Methodologies

Block Coding Methodologies, Block Coding method with Error Correction, Selected Mapping (SLM), Partial Transmit Sequence (PTS), Interleaving Technique, Tone Reservation (TR) and Tone Injection (TI).

3.2 Signal Distortion Methodologies

Peak Windowing, Envelope Scaling, Peak Decreasing Carrier and Clipping and Filtering.

4. CONCLUSIONS

Multicarrier systems are proving better in transmission than single carrier systems. OFDM is a digital multi-carrier modulation method where a great number of closely spaced orthogonal sub- carriers are used to carry data. One of the major drawbacks of in OFDM systems is that the complex transmit signal can display a very Improved PAPR when the input sequences are improved associated. In this work, we described numerous important aspect related to the PAPR & its overall effect on the OFDM system & give names several methodologies adopted by the system according to the necessity[3] [4]. These methodologies can be used to decrease the PAPR at the cost of loss in data rate, signal transmit power improvement, BER performance degradation, computational difficulty improvement.

5. ACKNOWLEDGMENTS

This paper is not a original work by its nature. The text has been drawn from the available published literature on the subject. The authors would like to thank the anonymous reviewers whose comments improved the quality of the paper.

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