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PAPR Reduction in MIMO OFDM Using SLM Scheme

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Abstract— Multiple-Input multiple-output (MIMO) orthogonal frequency division multiplexing 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 sum of separated data blocks are created from an OFDM data block using a set of phase sequence. It chooses lowest PAPR and select sequences for transmission. As an outcome, the adaptive selected mapping increases the power efficiency and reduces the impulse interference.

Index terms-MIMO,OFDM, ASLM, PAPR, BER.

I. Introduction

High data rate wireless access is demanded by many applications. The growing development of the telecommunication world increases the need for spectral resources, especially which are more rare and expensive, so the use of the multiplexing techniques in particular the modulations multi-carrier is thus a very useful mean to better optimize these resources. Several techniques permitting a better use the spectral band of the channel exist. Traditionally, more bandwidth is required for higher data-rate transmission. Such as wireless local area networks, wireless metropolitan area networks, digital audio broadcasting, and digital video broadcasting which are popular for transmission over frequency-selective channels. This paper reduce the PAPR Reduction for efficient transmission.[5]

MIMO is an acronym that stands for Multiple Input Multiple Output. It is an smart antenna technology. It has attracted attention in wireless communications, because it offers significant increases in data throughput and link range without additional bandwidth or increased transmit power. It achieves this goal by spreading the same total transmit power over the antennas to achieve an array gain that improves the spectral efficiency (more bits per second per hertz of bandwidth) and/or to achieve a diversity gain that improves the link reliability to reduced fading.

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MIMO technology takes advantage of a natural radio-wave phenomenon called multipath. With multipath, transmitted information bounces off walls, ceilings, and other objects, reaching the receiving antenna multiple times via different angles and at slightly different times. They have dual capability of combining the SIMO and MISO technologies. They can also increase capacity by using Spatial Multiplexing (SM). The MIMO method has some clear advantages over Single-input Single-output (SISO) methods. The fading is greatly eliminated by spatial diversity, low power is required compared to other techniques in MIMO. Multiple-Input/Multiple-Output (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. MIMO can be sub-divided into three main categories : 1.Precoding 2.Spatial multiplexing 3.Diversity coding

Precoding is multi-stream beam-forming, in the narrowest definition. In more general terms, it is considered to be all spatial processing that occurs at the transmitter. In (single-stream) beam-forming, the same signal is emitted from each of the transmit antennas with appropriate phase and gain weighting such that the signal power is maximized at the receiver input. The benefits of beam-forming are to increase the received signal gain, by making signals emitted from different antennas add up constructively, and to reduce the multipath fading effect. In line-of-sight propagation beamforming results in a well defined directional pattern. However, conventional beams are not a good analogy in cellular networks, which are mainly characterized by multipath propagation.When the receiver has multiple antennas, the transmit beam-forming cannot simultaneously maximize the signal level at all of the receive antennas, and precoding with multiple streams is often beneficial.Precoding requires knowledge of channel state information (CSI) at the transmitter and the receiverSpatial multiplexing requires MIMO antenna configuration.

In spatial multiplexing, a high rate signal is split into multiple lower rate streams and each stream is transmitted from a different transmit antenna in the same frequency channel. If these signals arrive at the receiver antenna array with sufficiently different spatial signatures and the receiver has accurate CSI, it can separate these streams into (almost) parallel channels. Spatial multiplexing is a very powerful technique for increasing channel capacity at higher signal-to-noise ratios (SNR). The maximum number of spatial streams is limited by the lesser of the number of antennas at the transmitter or receiver. Spatial multiplexing can be used without CSI at the transmitter, but can be combined with precoding if CSI is available.

Spatial multiplexing can also be used for simultaneous transmission to multiple receivers, known as space-division multiple access or multi-user MIMO, in which case CSI is required at the transmitter [9].The scheduling of receivers with different spatial signatures allows good separability.

Diversity Coding techniques are used when there is no channel knowledge at the transmitter. In diversity methods, a single stream (unlike multiple streams in spatial multiplexing) is transmitted, but the signal is coded using techniques called space-time coding. The signal is emitted from each of the transmit antennas with full or near orthogonal coding. Diversity coding exploits the independent fading in the multiple antenna links to enhance signal diversity. Because there is no channel knowledge, there is no beamforming or array gain from diversity coding. Diversity coding can be combined with spatial multiplexing when some channel knowledge is available at the transmitter.

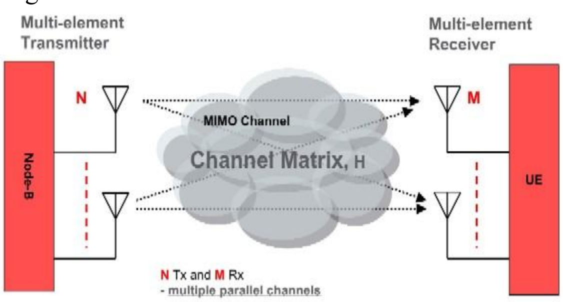

Fig 1: Block Diagram Of MIMO

Section I ,II,III deals with concepts of MIMO,OFDM and PAPR respectively.Section IV deals with Criteria for selection of PAPR reduction.Section V deals with Performance of PAPR reduced signals. Section VI deals with Problem description of PAPR reduction.Section VII deals with Principle of selected mapping.Section VIII deals with Adaptive SLM algorithm.Section IX deals with Merits of SLM.Section X deals with Simulation result .Section XI deals with Conclusion and in section XII deals with References.

II. Orthogonal Frequency Division Multiplexing SLM

Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier modulation technique that divides the available spectrum into subcarriers, with each subcarrier containing a low rate data stream. Orthogonal frequency-division multiplexing (OFDM) is a method of digital modulation in which a signal is split into several narrow band channels at different frequencies. The technology was first introduced in the 1960s and 1970s during research into minimizing interference among channels near each other in frequency.OFDM has offers high data rate transmission with high spectral efficiency, immunity to multipath fading, and simple implementation using fast Fourier transform (FFT).OFDM is readily implemented by present day processors in many high speed networks. However, one of the major drawbacks of OFDM systems is the high peak-to-average power ratio (PAPR) which can result in poor power efficiency, degradation in bit-error-rate (BER) performance, and spectral spreading where there are more than one antenna at either end of the radio link which is termed as MIMO - Multiple Input Multiple Output. MIMO can be used to provide improvements in both channel robustness as well as channel throughput.[4]

III. Peak To Average Power Ratio

The peak-to-average power ratio (PAPR) is a related measure that is defined as the peak amplitude squared (giving the peak power) divided by the RMS value squared (giving the average power).An OFDM signal consists of a number of independently modulated Sub-Carriers, which can give a large peak-to-average power (PAPR)when added up coherently. When N signals are added with the same phase, they produce a peak power that is N times the average power. The peak power is 16 times the average value. The peak power is defined as the power of a sine wave with amplitude equal to the maximum envelope value.

Hence, an unmodulated carrier has a PAPR of 0 dB. An alternative measure of the envelope variation of a signal is the Crest factor, which is defined as the maximum signal value divided by the RMS signal value. For un modulated carrier, the Crest factor is 3 dB. This 3 dB difference between the PAP ratio and Crest factor also holds for other signals, provided that the center frequency is large in comparison with the signal bandwidth.

A large PAPR brings disadvantages like an increased complexity of the analog-to-digital (A/D) and digital-to-analog (D/A) converters and a reduced efficiency of the RF power amplifier. To reduce the PAPR ratio, several techniques have been proposed, which basically can be divided in three categories. First, there are signal distortion techniques. which reduce the peak amplitudes simply by nonlinearly distorting the OFDM signal at or around the peaks. Examples of distortion techniques are clipping, peak windowing, and peak cancellation. Second, there are coding techniques that use a special FEC code set that excludes OFDM symbols with a large PAPR the third technique scrambles each OFDM symbol with different Scrambling sequences and selecting the sequence that gives the smallest PAPR.The PAPR is the relation between the maximum power of a sample in a given OFDM transmit symbol divided by the average power of that OFDM symbol. PAPR occurs in a multi- carrier system where the different sub- carriers are out of phase with each other. At each instant they are different with respect to each other at different phase values. when all the points achieve the maximum value simultaneously, that will cause the output envelope to suddenly shoot up which causes a 'peak' in the output envelope

IV. Criteria For Selection Of PAPR Reduction

As in everyday life, we must pay some costs for PAPR reduction. There are many factors that should be considered before a specific PAPR reduction technique is chosen. These factors include PAPR reduction capability, power increase in transmit signal, BER increase at the receiver, loss in data rate, computational complexity increase, and so on. Next, we briefly discuss each factor.

A. Papr Reduction Capability

Clearly, this is the most important factor in choosing a PAPR reduction technique. Careful attention must be paid to the fact that some techniques result in other harmful effects. For example, the amplitude clipping technique clearly removes the time domain signal peaks, but results in in-band distortion and out-of-band radiation.

B. Power Increase In Transmit Signal

Some techniques require a power increase in the transmit signal after using PAPR reduction techniques.The transmit signal power should be equal to or less than previously used PAPR reduction technique, then transmit signal should be normalized back to the original power level, resulting in BER performance degradation for these techniques.

C. Ber Increase At The Receiver

This is also an important factor and closely related to the power increase in the transmit signal. Some techniques may have an increase in BER at the receiver if the trasmit signal power is fixed or equivalently may require larger transmit signal power to maintain the Bit error rate(BER) after applying the PAPR reduction technique. In some techniques such as Selected mapping(SLM),Partial transmit sequences(PTS), and interleaving, the entire data block may be lost if the side information is received in error. This may also increase the BER at the receiver.

D.Loss In Data Rate

Some techniques require the data rate to be reduced.The block coding technique requires one out of four information symbols to be dedicated for controlling PAPR. In SLM, PTS, and interleaving, the data rate is reduced due to the side information which is used to inform the receiver of what has been done in the transmitter. In these techniques the side information may be received in error unless some form of protection such as channel coding is employed. When channel coding is used, the loss in data rate due to side information is increased further.

E. Computational Complexity

Computational complexity is another important consideration in choosing a PAPR reduction technique. Techniques such as PTS find a solution for the PAPR reduced signal by using many iterations. The PAPR reduction capability of the interleaving technique is better for a larger number of interleavers. Generally, more complex techniques have better PAPR reduction capability.[12]

F. Other Considerations

Many of the PAPR reduction techniques do not consider the effect the components in the transmitter such as the transmit filter, digital-to-analog (D/A) converter, and transmit power amplifier. In practice, PAPR reduction techniques can be used only after careful performance and cost analysis for realistic Environments.

TABLE 1: COMPARISON OF VARIOUS TECHNIQUES

Reduction Technique	Parameters			Operational Required at transmitter (TX)/Receiver(RX)
	Decrease Distortion	Power raise	Defeat data rate	
Clipping and Filtering	NO	NO	NO	TX:Clipping RX:None
Selective Mapping(SLM)	Yes	NO	Yes	TX:M Times IDFT Operations RX:Side information Extraction,Inverse SLM
Block Coding	Yes	NO	Yes	TX:Coding or Table Searching RX: Decoding or Table Searching
Partial Transmit Sequence (PTS)	Yes	NO	Yes	TX:N Times IDFT Operations RX:Side Information extraction,Inverse PTS
Interleaving	Yes	NO	Yes	TX:D Times IDFT Operation,D-1 times Interleaving RX: Side information Extraction , De-Interleaving
Tone Reservation (TR)	Yes	Yes	Yes	TX: IDFT Operation. RX: Side information Extraction
Tone Injection (TI)	Yes	Yes	NO	TX: IDFT Operation. RX: Side information Extraction

V. PERFORMANCE OF THE PAPR-REDUCED SIGNALS

Performance of the PAPR reduced signals Tone Reservation(TR) consists on reducing the PAPR by reserving a few tones (PRT) within the transmitted bandwidth and assign them the appropriate values.

TR Advantages: 1. No distortion is introduced to the data bearing tones.2. No side information is required.3.Increase in average energy per bit which might reduce the BER performance improvement.In SLM from the original data block,candidate data block are generated and the one with lowest PAPR is transmitted.At the receiver reverse operation is performed to recover the original data block.It is crucial that side information is received without errors.Finally,the side information has to be heavily protected.[3]

VI. PROBLEM DESCRIPTION

1. Applicable only for small number of antenna (i.e) the antenna size will be increased which means the complexity

also increases which reduce the performance and increase the bit error rate.

2. SLM is also a non-distortion PAPR reduction scheme suffer from the problem of side information. The PAPR reduction capability of SLM based OFDM system mainly depends on the number of alternative sequences and the generation of phase sequence are used to produce the alternative sequences.

3. Different types of modulation technique are used for transmission.Some modulation technique are QAM,QPSK and BPSK.The QPSK,QAM are best modulation scheme to transmit the signal ,but we can transmit only the small amount of data rate , the data rate can be reduced if we send large data rates .[2][13]

VII. Principle Of Selected Mapping

The probability of PAPR larger than a threshold assuming that M OFDM symbols carry the same information and that they are statistically independent of each other. In this case, the probability of PAPR greater than threshold value is equals to the product of each independent candidate probability.

In selected mapping method, first M statistically independent sequences which represent the same information are generated, and next, the resulting M statistically independent data blocks are then forwarded into IFFT operation simultaneously. Finally, at the receiving end, OFDM symbols x1,x2,x3… in discrete time-domain are acquired, and then the PAPR of these M vectors are calculated separately. Eventually, the sequences xd with the smallest PAPR will be selected for final serial transmission.[8].

VIII. Adaptive SLM Algorithm (ASLM)

OFDM as a multi-carrier modulation technique particularly suited for high-speed wireless transmission. Our study is mainly focused on evaluating of various PAPR reduction performances in OFDM system. However, there are still many technical problems to be resolved although its excellent characteristics manifested in almost all aspects of wireless communications.

The main idea of the proposed scheme is adaptively change the phase and to select among the Inverse discrete fourier transform(IDFT), Inverse discrete cosine transform (IDCT) and Inverse discrete sine transform(IDST)techniques to get the lowest PAPR Where we use adaptive algorithm with maximum number of phase sequence which equals 16 phases, below we shall describe the main steps of the proposed scheme. Like SLM technique, the input data structure is multiplied by random phase series. Unlike the conventional SLM scheme, the proposed scheme selects among IDFT, IDCT and IDST to get the lowest PAPR. Moreover, the multiplied phases are changed adaptively if the PAPR is higher than pre-determined value.

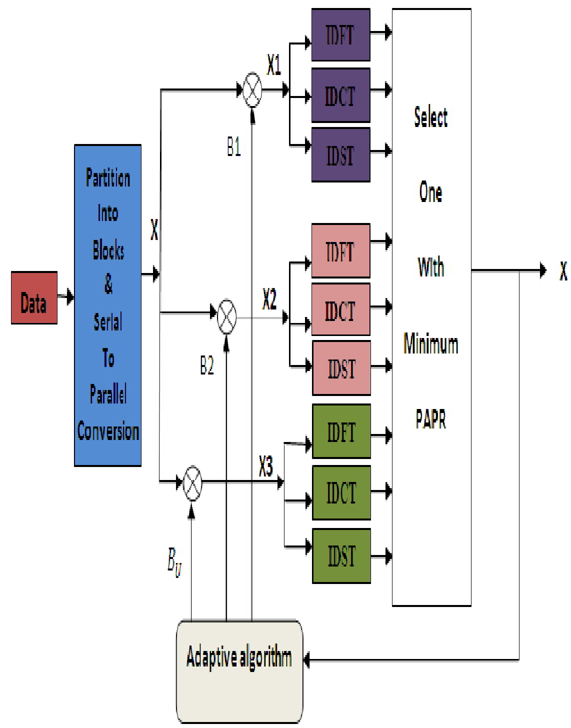

Fig 2 : Block Diagram Of Proposed Scheme

Finally, the transmitter send the data block, which have minimum PAPR. The proposed scheme is described as follows: First we design the target PAPR value (threshold PAPR). Second, partition the data into blocks (X) and generates four phases and each data block is multiplied by a phase sequence (B1, B2, B3, B4). Third, calculate the IDFT, IDCT and IDST for every block (X1, X2, X3, X4). Fourth, measure PAPR for each block, select the lowest PAPR and compare it with threshold PAPR . If the PAPR is lower than or equal than threshold PAPR, then the transmitter send the data block which have minimum PAPR. Otherwise, change the phase sequences (B1, B2, B3, B4) and again do the previous steps for each data block. The maximum number of phase sequences is 16 phases.Modulations like Quadrature phase shift keying and Quadrature modulation are compared based on bit error rate and signal to noise ratio.

ASLM proposal can significantly improve the PAPR distribution of System,that is ,significantly reduce presenting probability of large peak power Signal.The increasing number of OFDM signal frames M raise the complexity dramatically but with benefit of the small improvement of the PAPR reduction Performance .ASLM algorithm adapted to any length of FFT frame which means it can be used for different OFDM systems with different number of carriers.It is particularly suitable for OFDM systems with large number of sub-carriers with (more than128).ASLM can significantly improve the performance of OFDM system by reducing the PAPR but at the same time price is also very clear that is the complexity of the implementation.

IX. MERITS OF ASLM

The Adaptive Selected mapping Algorithm reduced the Peak-to-Average Power Ratio (PAPR) of the Orthogonal Frequency Division Multiplexing (OFDM) systems by 5.8 dB at Complimentary Cumulative Distribution Function (CCDF) of 10^-1.2 .

X. SIMULATION RESULTS

The below graph shows the comparison of BER rate and signal to noise ratio in existing system where existing system value dipped at 6.8 dB and proposed value graph dipped at 6.3 dB.

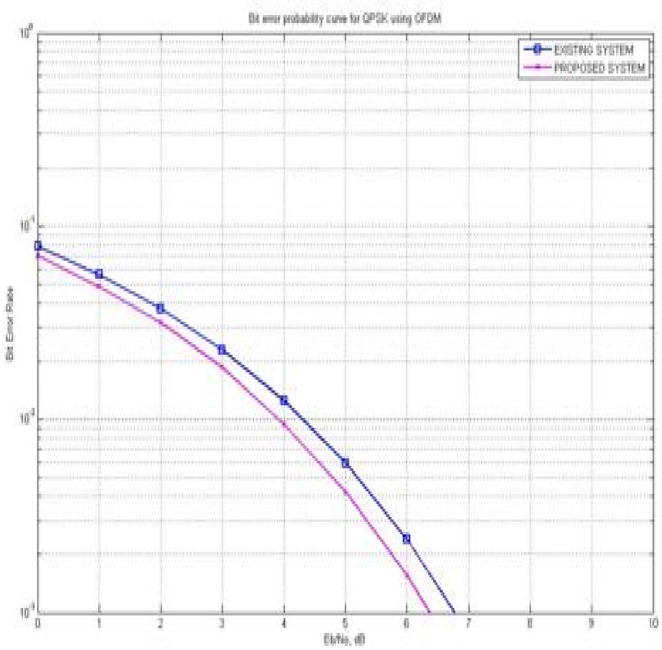

Fig 3: Comparison Of Proposed And Existing System

XI. CONCLUSION AND FUTURE ENHANCEMENT

In this paper PAPR reduction scheme have proposed which depends on SLM adaptive phase.The proposed scheme adaptively selects among IDFT, IDCT and IDST based OFDM and adaptively change phase to get the lowest PAPR. This technique achieved PAPR reduction up to 5.8 dB in case of 8 sub-carriers and 16 sub-carriers at clipping probability of 10^{-2} compared to conventional SLM technique. The reduced complexity adaptive symbol selection (multiple signal representation) method for OFDM PAPR reduction has been evaluated. Its performance, advantages and drawbacks have been discussed. The improvement of power amplifier efficiency due to the PAPR reduction has been analyzed using computer simulations. The adaptive selected mapping technique are used to reduce the PAPR which can be combined with other modulation scheme to reduce complexity and the peak power and give better signal to noise ratio and reduce the bit error rate.The main advantage of the proposed combination is to reduce PAPR which improves power efficiency and improvement in BER performance is achieved over conventional technique.

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