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Research Paper

PAPR REDUCTION IN MIMO OFDM SYSTEM USING SLM AND PTS SCHEMES

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OFDM consist of large number of independent subcarriers, as a result of which the amplitude of such a signal can have high peak values. In this paper, we introduce a modified SLM technique to reduce PAPR. The simulation results show PAPR can be reduced by applying the proposed scheme. The complexity is also reduced in proposed scheme. The PAPR of original OFDM is near about 10.4 dB. By using SLM technique with original OFDM PAPR is reduced nearly about 0.5 dB. And by using the modified SLM technique PAPR is reduced nearly about 0.8 dB in comparison to original OFDM.

Keywords: OFDM, MIMO, PAPR, Companding transform

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. Poly-phase Interleaving and Inversion (PII).

MIMO-OFDM SYSTEM

MIMO uses multiple transceivers at both the transmitter and receiver to operate. Because MIMO allows more bits/sec/hertz to be transmitted in a given bandwidth, it improves spectral efficiency and allows operators to simultaneously support more users with high

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data-rate requirements. Increased spectral efficiency, higher data rates and the ability to increase data throughput without additional bandwidth or transmit power, makes MIMO especially attractive for use in wireless communication.

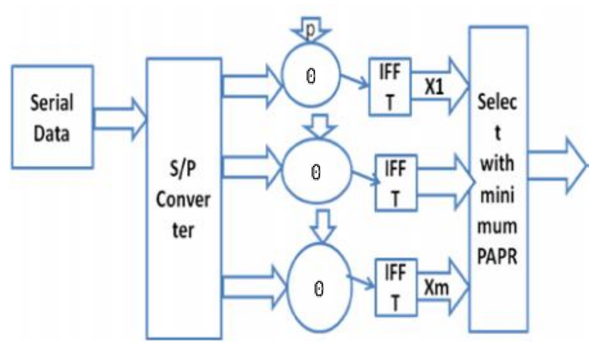
Systems. In MIMO terminology, the "Input" and "Output" are referenced to the wireless channel, which includes the antennas. Performance gains are achieved as multiple transmitters simultaneously input their signal into the wireless channel and then combinations of these signals simultaneously output from the wireless channel into multiple receivers. For downlink communication, a single Base Station (BS) would contain multiple transmitters connected to multiple antennas and a single Mobile Station (MS) would contain multiple antennas connected to multiple receivers. Each subcarrier carries one bit of information (N bits total) by its presence or absence in the output spectrum. The frequency of each subcarrier is selected to form an orthogonal signal set, and these frequencies are known at the receiver. Note that the output is updated at a periodic interval T that forms the symbol period as well as the time boundary for orthogonality. Figure 4 shows the resultant frequency spectrum. In the frequency domain, the resulting sin function side lobes produce overlapping spectra. The individual peaks of sub bands all line up with the zero crossings of the other sub bands. This overlap of spectral energy does not interfere with the system's ability to recover the original signal. The receiver multiplies (i.e., correlates) the incoming signal by the known set of sinusoids to produce the original set of bits sent. The digital implementation of an OFDM system will enhance these simple principles and permit more complex modulation.

Selective Mapping Method

The SLM technique is a simple and undistorted processing way to reduce the PAPR of OFDM signals (You *et al.*, 2003). The basic principle of SLM is to generate different versions of the same OFDM symbol and transmit the one with the lowest value of PAPR. To create these different versions of the same OFDM symbol, we consider *U* codes of length *M* and these codes are such that the initial constellation remains unchanged. If Cm [m = 0, 1, 2, 3, …, M-1] *K* is a point of 2^2k-QAM constellation, the randomly generated codes dm(m, u) = [0, 1, 2, ..., M-1] x [1, 2, 3, ..., U]. In order to retrieve the original data, the receiver requires a perfect knowledge of the used code. Therefore log2U bits are needed to be transmitted as side information to recover them perfectly, leading to reduction of the useful data rate.

In selection mapping method, firstly M statistically independent sequences which represent the same information are generated, and next, the resulting M statistically independent data blocks Sm = [Sm,o; Sm,1; Sm,2; …; Sm.n-1], for m = 1, 2, ..., M are then forwarded into IFFT operation simultaneously Xm = [x1, x2, x3, …, xn] T in discrete time-domain are acquired and then the PAPR of these M vectors are calculated separately. Eventually, the sequences

Figure 1: SLM Scheme for PAPR Reduction in OFDM Systems



xd with the smallest PAPR is selected for final serial transmission.

Partial Transmit Sequence (PTS)

Partial Transmit Sequence (PTS) algorithm is a technique for improving the statistics of a multicarrier signal. The basic idea of partial transmits sequences algorithm is to divide the original OFDM sequence into several sub-sequences and for each sub-sequences multiplied by different weights until an optimum value is chosen.

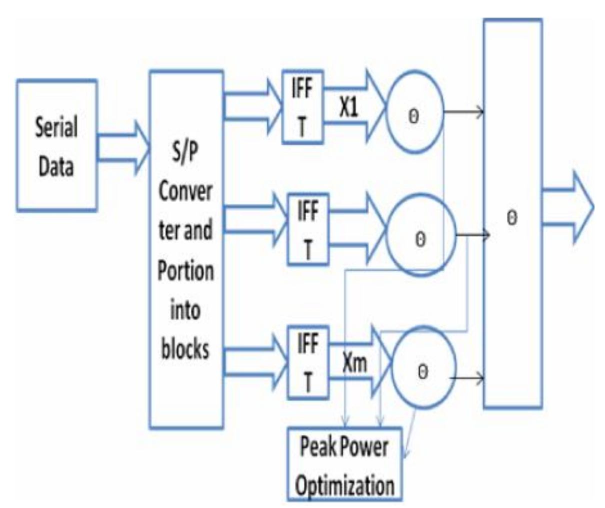
From the left side of diagram, the data information in frequency domain X is separated into V non-overlapping sub-blocks and each sub block vectors has the same size N. So for each and every sub-block it contains N/V nonzero elements and set the rest part to zero. Assume that these sub-blocks have the same size and no gap between each other. The sub-block vector is given by

X = Σv = 1 to V bvXv ...(1)

In this method, input data block X is partitioned in M disjoint sub blocks. Xm = [Xm,0; Xm,1; Xm,2; ...; Xm, N-1] T; m = 0, 1, 2, ..., M-1; such that "m-1 to M Xm=X and sub blocks are combined to minimize PAPR in time domain. Here S times Over sampled time domain signal of Xm (m=0, 1, 2....m-1); is obtained by taking the IDFT length of NS on Xm concatenated with (S-1) N Zeros.

Complex Factor bm = ΣΣ¢jϕm (m = 0, 1, 2, ..., M-1) are introduced to combine PTS. The set of Phase factors is denoted as vector b = [b0, b1, ..., bM-1] T.

Figure 2: Block Diagram of Partial Transmit Sequence Technique



RESULT ANALYSIS

For 256-QAM, when the original signal is compared with the PTS scheme, 10.82 dB and 0.03 dB PAPR reduction with V = 2 and V = 4, whereas when the original signal is compared with the SLM scheme, 1.25 dB and 2.15 dB PAPR reduction with M = 2 and M = 4.

For 128-QAM, when the original signal is compared with the PTS scheme, 10.25 dB and 1.28 dB PAPR reduction with M = 2 and M = 4, whereas when the original signal is compared with the SLM scheme, 1.65 dB and 2.895 dB PAPR reduction with M = 2 and M = 4.

Figure 3: PAPR Reduction Using 256 Subcarriers in MIMO OFDM Systems

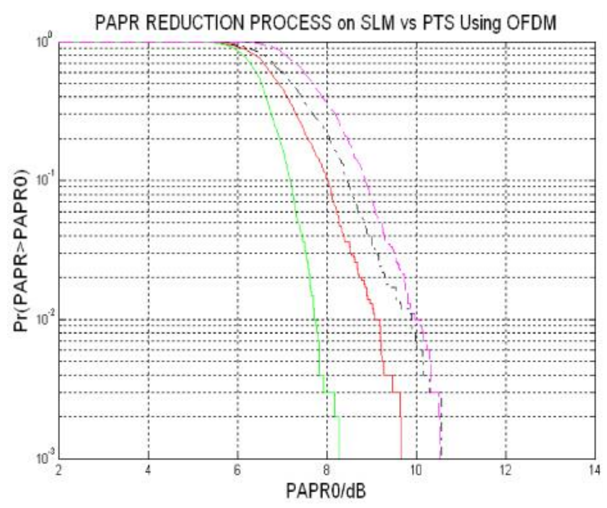


Figure 4: PAPR Reduction Using 128 Subcarriers in MIMO OFDM Systems

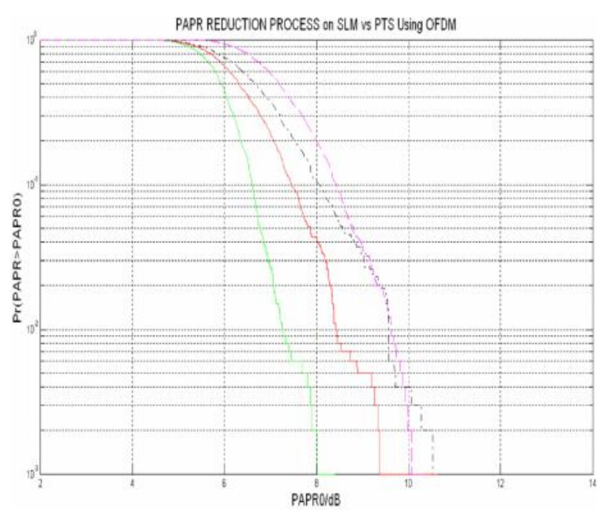


Figure 5: PAPR Reduction Using 64 Subcarriers in MIMO OFDM Systems

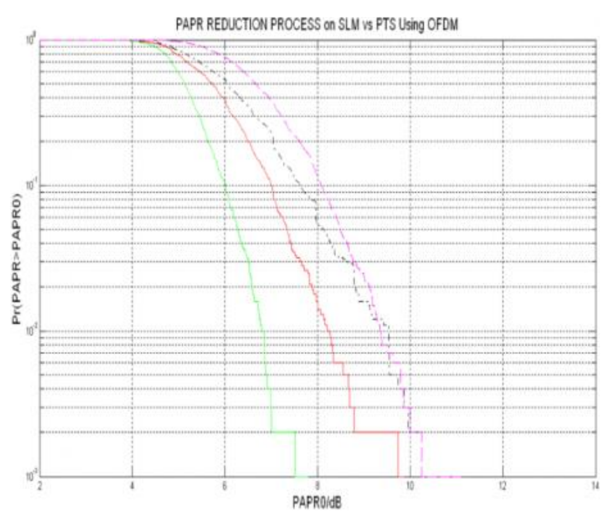


Table 1: Tabulation form for Comparison Between PTS and SLM

		K = 256	K = 128	K = 64
PPTS	VV = 2	10.52dB	10.25dB	10.15dB
	VV = 4	10.49dB	10.38dB	10.25dB
SSLM	MM = 2	9.5dB	9.25dB	9.15dB
	MM = 4	8.35dB	8dB	7.5dB

For 64-QAM, when the original signal is compared with the PTS scheme, 10.15 dB and 1.842 dB PAPR reduction with M = 2 and M = 4, whereas when the original signal is compared with the SLM scheme, 1.85 dB and 3.125 dB PAPR reduction with M = 2 and M = 4.

CONCLUSION

Orthogonal Frequency Division Multiplexing (OFDM) is a very attractive technique for wireless communications due to its spectrum efficiency and channel robustness. 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 the present work, two different PAPR reduction techniques, i.e., SLM and PTS have been implemented on the MIMO OFDM system and the PAPR reduction parameter has been analyzed. The SLM has been used to make MIMO OFDM system. The results show that SLM scheme is more effective than the PTS scheme to reduce PAPR in MIMO OFDM systems with QAM modulation.

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