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EFFECTIVE PAPR REDUCTION IN MIMO-OFDM USING COMBINED SFBC-PTS

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ABSTRACT

Orthogonal Frequency Division Multiplexing is a technique for achieving high data bit transmission but high Peak to Average Power Ratio at the transmitting end. The proposed algorithm combines the Space Frequency Block coding and Partial Transmit Sequence to reduce the PAPR to a minimum rate. Quadrature Amplitude modulation such as 256, 128, and 64 used to reduce PAPR. The proposed system supports multiple users as well as reduces the problem of PAPR at the maximum extent. Interleaving reduces the consumption of higher bandwidth and pre-coder avoids loss of data due to overlapping of signals. The proposed techniques proves higher spectrum efficiency, constant signal power for each of the users and better PAPR reduction are achieved by comparing with the existing systems such as SLM and PTS.

Keywords: orthogonal frequency division multiplexing (OFDM), space frequency block coding (SFBC), partial transmit sequence (PTS), quadrature amplitude modulation (QAM), selective mapping (SLM).

1. INTRODUCTION

Multi-Carrier Modulation is a data transmission technique which divides a high-bit rate data stream into several parallel low bit-rate data streams modulating several carriers. Orthogonal Frequency division Multiplexing (OFDM) is one such scheme for high speed wide band communication systems. The key to OFDM is maintaining orthogonality of the carriers. If the integral of the product of two signals is zero over a time period, then these two signals are said to be orthogonal to each other. It is well known for its less susceptibility to multipath fading and narrow band interference, high spectral efficiency and robustness [1]. It supports parallel data transmission and overcomes the problems faced by single carrier modulation. OFDM is one such scheme for high speed wide band communication systems The highest Peak-to-Average Power Ratio(PAPR) improvement showed at OFDM system with 256 subcarriers and Discrete Cosine Transform(DCT) & Selective Mapping(SLM) U=16 which is 7.7dB of improvement [2]. Here, the OFDM sequence is divided in to several (V) sub blocks as in Partial Transmit Sequence (PTS) and new phase sequence applied to PTS schemes. In this method separate clipping is done on each block [3]. In the case of the SLM technique, it was shown that this technique can achieve excellent PAPR reduction, it has a high signal processing complexity due to the use of multiple inverse fast Fourier transform (IFFT) operations per OFDM block [4, 5]. Similar to the SLM technique, the PTS technique [6] requires several IFFT operations per OFDM symbol and it can produce superior PAPR performance to the SLM technique. But it also has a higher complexity requirement and may require more side information (SI) bits. Both the SLM and PTS techniques have been of intense interest to many researchers who have proposed several modifications with the aim to reduce the complexity and improve the performance of these techniques [6]-[10].

Multiple-input multiple-output (MIMO) orthogonal frequency division multiplexing with space-frequency block coding (SFBC) [11] has attracted increasing attention because it is robust to time selective fading channels. SFBC is more robust in a fast fading environment among the two schemes. However, conventional SFBC changes the spectral components of the transmitted signal and destroy the low PAPR advantage of SCFDMA [12].

2. EXISTING SYSTEM

2.1 Signal scrambling techniques

In signal scrambling techniques, the OFDM signal is modified by introducing phase shits, adding peak reduction carriers or changing constellation points. The modification parameters are optimized to minimize PAPR. The different signal–Scrambling techniques are selective mapping (SLM), Partial transmit sequence (PTS), Tone injection (TI) and Tone rejection (TR) [13].

The existing techniques for reducing the high Peak-to-Average Power Ratio (PAPR) of OFDM systems are

- Selective Mapping Method
- Partial Transmit Sequence

2.1.1. Selective mapping method

The SLM technique is a simple and undistorted processing way to reduce the PAPR of OFDM signals. 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. Zadoff-Chu matrix Transform (ZCT) based SLM-OFDM systems also take advantage of frequency variations of the communication channel and can also offer substantial performance gain in fading multipath channels [4, 5, 14].

2.1.2. Partial transmits sequence

PTS is one of the PAPR reduction schemes to reduce the PAPR of the OFDM signal, but it is not more effective to reduce the PAPR in different sub-carrier. It is

ARPN Journal of Engineering and Applied Sciences

found by the analysis that PTS-CCET (Cyclic compression and expansion transform) and SLM-CCET can induce the PAPR performance in the case of constant Bit Error Rate (BER) [3, 14]. By applying this technique the number of IFFT is reduced to one half which results in lower complexity at the expense of slight PAPR degradation. The effects of the performance of the PAPR are also examined and it proves the effectiveness of the proposed method in reducing the out of band distortion [15].

3. PERFORMANCE ANALYSIS

3.1. Data loss

"Input and Output," one or more of full rows of pixels may be missing at the output of the receiver. In such cases, this would show the number of missing data and the total number of data transmitted, as well as the percentage of data loss, which is the quotient of the two.

3.2. Bit error rate

Demodulated data is compared to the original baseband data to find the total number of errors. Ratio of the total number of errors by total number of demodulated symbols, the bit-error-rate (BER) is found.

3.3. Phase error

During the OFDM demodulation, before being translated into symbol values, the received phase matrix is achieved for calculating the average phase error, which is defined by the difference between the received phase and the translated phase for the corresponding symbol before transmission.

3.4. Peak to average power ratio

In general, the PAPR of OFDM signal *a(t)* is defined as the ratio of the period between the maximum instantaneous power and its average power during an OFDM symbol.
PAPR is defined as:

$$PAPR = 10\log_{10}\frac{Ppeak}{Pav} \quad (1)$$

P_{peak} and P_{av} are computed as

$$P_{peak} = \max|a(t)|^2 = N|A|^2 \quad (2)$$

$$Pav = \frac{1}{T}\int_0^T |a(t)|^2\,dt = A^2 \quad (3)$$

PAPR is expressed as:

$$PAPR\ [dB] = 10\log_{10} N \quad (4)$$

High PAPR has been recognized as one of the major practical problem involving in OFDM modulation. High PAPR results from the nature of the modulation itself where multiple subcarriers or sinusoids are added together to form the signal to be transmitted [16].

4. PROPOSED SYSTEM

4.1 SFBC based PTS process in MIMO-OFDM

The existing system uses either SFBC or PTS, but the proposed system includes the combination of both SFBC and PTS as shown in Figure-1.

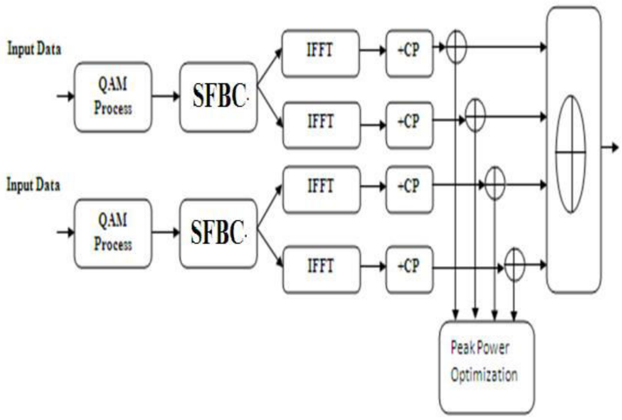

Figure-1. Block diagram of SFBC and PTS.

4.1.1 Transmitter section

The transmitter section consists of low density parity encoder (LDPC), Inter leaver or filters, symbol mapped, space frequency block coding (SFBC) and IFFT is the combination of LDPC encoder. Inter leaver and symbol mapped performs the Bit Interleaved Coded Modulation (BICM). Encoder, which the binary input values such as 0 and 1 are added to the matrix. So that even if any losses occurred during the transmission of signals, it will affect only the added binary values, that the error can be reduced. Next, filter can be used to reduce the noise of the signal; the output of the LDPC encoder is given to the filter.

4.1.2 Space frequency block coding (SFBC)

If Space time coding (STC) is joined to multi-carrier modulation, such as OFDM, SFBC can be performed. Space time coding is one of the main methods in order to exploit the capacity of MIMO channels. The block diagram of SFBC can be shown in Figure-2

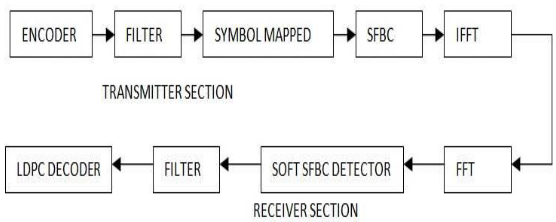

Figure-2. Block diagram of SFBC MIMO-OFDM system.

Since STC techniques use both time and spatial domains for coding data symbols, diversity and spatial

ARPN Journal of Engineering and Applied Sciences

multiplexing can be combined for achieving robustness at the receiver with a higher data rate transmission. SFBC are the frequency domain version of STBC in which data is encoded in frequency domain rather in time domain [17]. An N-point IFFT is used to converting the signal to a time domain signal. The output of IFFT is converted to serial and a cyclic prefix is then added. Since perfect channel state information at receiver has been assumed, training symbols have not been added for synchronization and channel estimation

4.1.3 Receiver section

The receiver section consists of FFT, Soft SFBC, Filter or Inter leaver, LDPC Decoder, Slicer. Next FFT is used to convert back from time domain signal into frequency domain signal through the FFT process.

The soft SFBC detector is a diversity combiner which is used at the receiver for detection. It takes the output from the de-multiplexers at the output of FFT block and performs space frequency block decoding. This output acts as the input to the filter, in order to reduce the noise of the signal. Finally the low density parity check decoder is given to reduce the error.

The complex baseband OFDM signal for N subcarriers represented as:

$$X(T) = 1/\sqrt{N}\sum_{n=0}^{N-1} x_n \; e^{j2\pi\Delta f\tau},)0 \le t \le NT \qquad (5)$$

NT is the duration of an OFDM data block. Output data of the lowest PAPR is selected to transmit. PAPR reduction effect will be better as the copy block number U is increased. PTS method effectively reduces PAPR without any signal distortion. But it has higher system complexity and computational burden. This complexity can less by reducing the number of IFFT block and the side information is not present in SFBC system. Average power is maintained with fewer causes of spectrum side lobes. The proposed system of SFBC provides less BER with higher SNR.

4. STIMULATED RESULTS

Figure-3a, b, and c, shows the stimulated result of Selective mapping for different subcarrier values, which is used to reduce the PAPR. The SLM algorithm is used to plot the graph between CCDF and PAPR (db) with different subcarriers namely K=64, 128, 256. Comparison is made for N= 2 and 4 for all subcarriers and plotted. The PAPR reduction is better for K=64 and N=6 and results are tabulated in Table-1. As the number of user increases the PAPR also increases and the overall efficiency is higher.

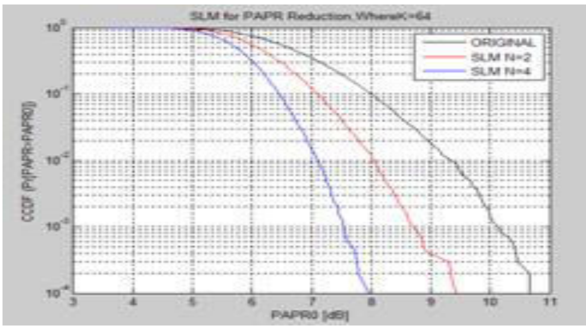

Figure-3(a). SLM FOR K=256.

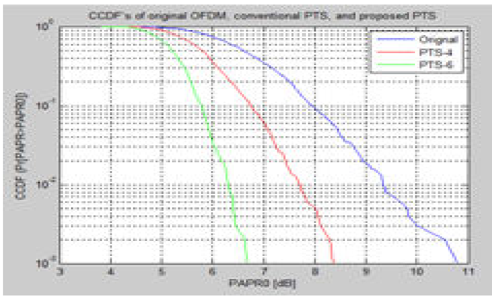

Figure-3(b). SLM FOR K=128.

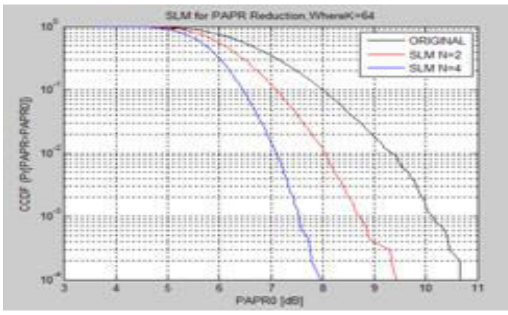

Figure-3(c). SLM FOR K=64.

Table-1. SLM output Comparison.

	K=256	K=128	K=64
Original PAPR	**11.85dB**	**11.53dB**	**11.22dB**
SLM N=4	9.75dB	9.52dB	9.32dB
SLM N=6	9.12dB	8.21dB	8.01dB

The PAPR reduction using Partial Transmit Sequence technique is simulated and shown in Figure 4a, b, and c, for various numbers of subcarriers (K). For different users such as V=4, 6 plot is made between CCDF and PAPR and tabulated in Table-2. The graph indicates, the original PAPR given in the range of 10dB and using PTS technique efficiently reduced the PAPR according to the sub carrier K. Number of user increases, reduction is better

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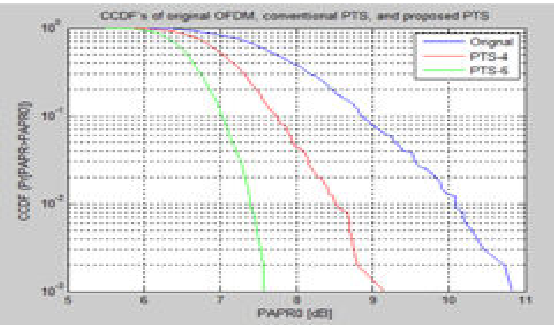

Figure-4(a). PTS FOR K=256.

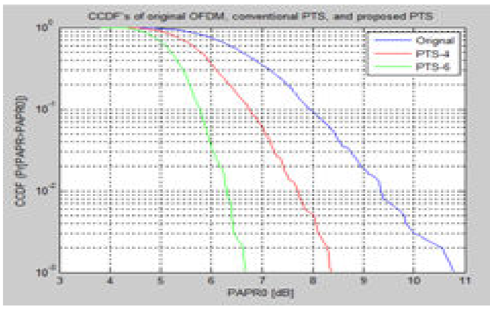

Figure-4(b). PTS FOR K=128.

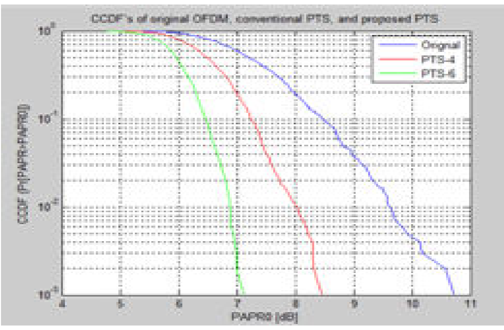

Figure-4(c). PTS FOR K=64.

Table-2. PTS output comparison.

	K=256	K=128	K=64
Original PAPR	10.95dB	10.75dB	10.25dB
SLM N=4	9.12dB	8.42dB	8.12dB
SLM N=6	7.56dB	7.21dB	6.65dB

The stimulated result for the proposed system is shown in Figure (5 a, b, c), that determines to combine both the SFBC-PTS algorithm to reduces the PAPR in the system. The SLM and PTS technique alone determines the high ratio of PAPR which gives the less performance in the system. So to overcome this drawbacks, combined SFBC-PTS algorithm can be applied to give simulated results in the range of 4.95db, 5.28db and6.25db of PAPR with various subcarriers as K=64,128 and 256 as given in the Table [3].

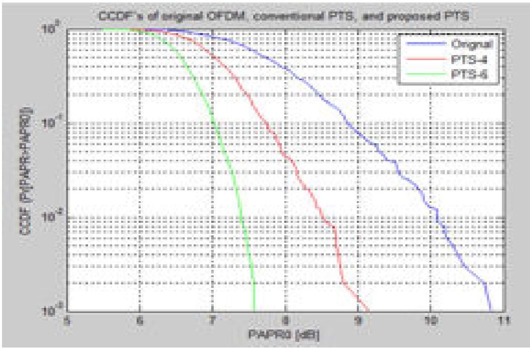

Figure-5(a). Combined SFBC-PTS K=256.

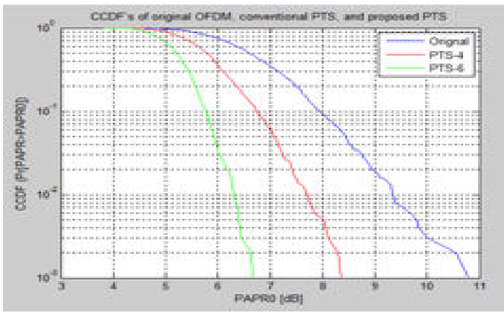

Figure-5(b). Combined SFBC-PTS K=128.

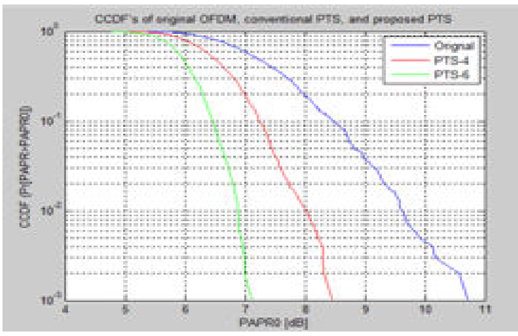

Figure-5(c). Combined SFBC-PTS for K= 64.

Table-3. SFBC with PTS comparison.

	K=256	K=128	K=64
Without SFBC using PTS	above 8dB	above 8dB	above 8dB
With SFBC using PTS	6.25dB	5.28dB	4.95dB
	K=256	K=128	K=64

5. CONCLUSIONS

Wireless Communication is emerging technology in the present times and OFDM systems are in use because of its advantages such as providing High Spectral Efficiency, Increased Bandwidth Power and its robustness against multipath Interference. But the OFDM System suffers from the drawback of high values of PAPR. It is observed that Amplitude Clipping and filtering results in Data Loss.

This paper supports multiple users as well as reduces the problem of PAPR at the maximum, by combining space frequency block coding (SFBC) and partial transmit sequence (PTS). It uses interleaving technique to reduce the consumption of higher bandwidth and uses pre-coding technique to avoid loss of data due to overlapping of signals. So large number of users can be served within a single base station, where higher spectrum efficiency and constant signal power for each of the users can be achieved. The PAPR reduction in each technique is noticed, and identified that the proposed system produces a minimum PAPR which yields higher efficiency.

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