COOPERATIVE PARTIAL TRANSMIT SEQUENCE FOR PAPR REDUCTION IN SPACE FREQUENCY BLOCK CODE MIMO-OFDM SIGNAL

1 Bharti Rani, 2 Mrs Garima Saini
1 Scholar, M.E, NITTTR, Chandigarh
2 Assistant Prof. ECE, NITTTR, Chandigarh
Email id erbharti2@gmail.com

ABSTRACT

Orthogonal frequency division multiplexing (OFDM) is a popular method for high data rate wireless transmission. OFDM is combined with antenna to increase the diversity gain to enhance the system capacity on time-variant and frequency-selective channels, resulting in a multiple-input multiple-output (MIMO) configuration. To better handle fading channel, Space frequency block code (SFBC) MIMO-OFDM is preferred. In this paper space frequency block code (SFBC) is used for reducing PAPR using Co-operative partial transmit sequence (Co-PTS).

Index Terms: Space frequency block code (SFBC), Multiple-input multiple-output (MIMO), Orthogonal frequency division multiplexing (OFDM), peak-to-average power ratio (PAPR)

INTRODUCTION

With the constant demand of high spectral efficiency and high transmission speed for audio, video and internet applications, MIMO-OFDM has become the most promising technology combination for present and future wireless communications [1]. MIMO offers spatial diversity and therefore increase the capacity while OFDM allow systems to work in time varying or frequency selective environment. Recently, Multiple input multiple output (MIMO) Orthogonal frequency division multiplexing (OFDM) with space frequency block code (SFBC) has attracted increasing attention because it is robust to time selective fading channels [2]. However, SFBC MIMO-OFDM signal also inherit disadvantages from OFDM techniques e.g sensitivity to synchronization errors and high peak-to-average power ratio (PAPR). Therefore many PAPR reduction methods have been introduced.
Especially, the signal scrambling methods such as partial transmit sequence (PTS), selective mapping, ploy phase interleaving and inversion (PII), cross-antenna translation and partial shift sequence method [3,4,5,6,7]. All the PAPR reductions methods have some drawbacks such as increase in transmit power, high computational complexity, high bit error rate (BER), reduction in bit transmission rate of the system and high peak-to-average power ratio. In this paper, a co-operative partial transmit sequence (Co-PTS) is proposed for SFBC MIMO-OFDM signal [8]. In Co-PTS, alternate optimization and spatial sub block circular permutation are combined. The use of alternate optimization results improvement in performance for PAPR reduction.

**OFDM and PAPR**

In OFDM modulation, a block of \( N \) symbols \( X_n (n=0,1,2,\ldots,N-1) \) is transmitted in parallel, and each of them modulates a group of \( N \) subcarriers \( f_n (n=0,1,2,\ldots,N-1) \). The subcarriers are orthogonal to each other, and \( f_n = n\Delta f \), where \( \Delta f = 1/T \) and \( T \) is the symbol period. The resulting baseband OFDM signal \( x(t) \) can be written as:

\[
x(t) = \sum_{n=0}^{N-1} X_n e^{j2\pi n\Delta ft} \quad 0 \leq t < T_T
\]

In real implementation, the digital transmission signal may be generated by the Inverse Fast Fourier Transform (IFFT) in the transmitter and restored by Fast Fourier Transform (FFT) in the receiver. The PAPR of the OFDM signal can be defined as:

\[
PAPR(X) = 10 \log_{10} \frac{\max_{0 \leq n \leq N-1} |X_n|^2}{\mathbb{E} \{ |X_n|^2 \}}
\]

Where \( \mathbb{E} \{ \cdot \} \) denotes the expectation operation. Because independent phases of subcarriers may align with each other, OFDM signals often exhibit a high PAPR, and the PAPR increases proportionally with the number of subcarriers. The complementary cumulative distribution function (CCDF) is often used to characterize the probability that PAPR of an OFDM signal exceeds a given threshold (PAPR0), which can be expressed as

\[
CCDF = \Pr(\text{PAPR} > \text{PAPR}_0)
\]

**SFBC MIMO-OFDM System**

The SFBC MIMO-OFDM system that employs Alamouti scheme, although is an extension to more than two transmits antennas [7, 9]. A block diagram of such scheme is shown in Fig 1. A data symbol vector \( X = [X_0, X_j, \ldots, X_{N-1}] \) is encoded with space-frequency encoder into two vectors \( X_1 \) and \( X_2 \).
Fig 1. Block Diagram of SFBC MIMO-OFDM System

\[ X_1 = [X_0, -X_1^*, \ldots, X_{N-2}, -X_{N-1}^*] \]
\[ X_2 = [X_1, X_0^*, \ldots, X_{N-1}, -X_{N-2}^*] \] (4)

Which are fed to the IFFT Cyclic Prefix (CP) blocks and sent simultaneously from antennas TX1 and TX2, respectively. The demodulated signal at the receiver is then given by

\[ Y = \Lambda_1 X_1 + \Lambda_2 X_2 + Z \] (5)

After decoding the Y signal we get the signal \(^X\)

Proposed Co-PTS Schemes

In this paper, a cooperative partial transmit sequence (co-PTS) is proposed with SFBC MIMO-OFDM signal [8, 10]. In cooperative partial transmit sequence (Co-PTS) , alternate optimisation and spatial sub block circular permutation are combined, where the use of alternate optimisation results in reducing computational complexity and the use of spatial sub block circular permutation across all the transmitting antenna is able to increase the number of candidate sequences, which equivalently improves the performance for PAPR reduction.

Fig 2. Proposed Co-PTS with SFBC MIMO-OFDM

The proposed design is shown in Fig 2. Firstly the input sequence is modulated by QPSK modulation and converting into parallel form. The modulated signal X is coded into two vectors \(X_1(n)\) and \(X_2(n)\) by space frequency encoder block and a factor spatial sub-block circular permutation (SSCP) & alternate partial transmit sequence are introduced to achieve the modulate PAPR reduction performance.

Algorithm:-
Step1:- The modulated signal X, \(X(n) = [X_1, X_2, X_3, \ldots, X_{N-1}]\) the frequency domain sequence of OFDM system with N subcarriers
Step 2: The data symbol vector $X^v(n)$ is coded into two vectors $X_1(n)$ and $X_2(n)$ by space frequency encoder block as

$$X_1(n) = [X_0(n), -X_1^*(n), \ldots, X_{N-2}(n), -X_{N-1}^*(n)]$$

$$X_2(n) = [X_1(n), X_0^*(n), \ldots, X_{N-1}(n), -X_{N-2}^*(n)]$$

Step 3: To achieve the minimum PAPR, a factor for spatial sub-block circular permutation (SSCP) and alternate optimisation are used.

Step 4: All SSCP data block are transformed into time domain to get transmitted symbol or simply take IFFT of that sequence. Finally, the one signal with the minimum PAPR is selected for transmission.

**SIMULATIONS AND RESULTS**

The complementary cumulative distribution function (CCDF) of the PAPR of OFDM signals with 128 subcarriers, 4 & 8 sub block and phase weighting factors ($\pm j$) & ($\pm 1$) are used to evaluate the PAPR reduction performance of Co-PTS compared with original OFDM and SFBC MIMO-OFDM Signal. In the following results, $10^5$ random QPSK modulated OFDM signals are generated for simulation and the oversampling factor $L$ is four.

![Fig 3. PAPR performance of SFBC MIMO-OFDM signal in case 128 subcarriers, 4 sub block and phase weighting factor $\pm 1$](image1)

![Fig 4. PAPR performance of SFBC MIMO-OFDM signal in case 128 subcarriers, 8 sub block and phase weighting factor $\pm 1$](image2)
Fig 5. PAPR performance of SFBC MIMO-OFDM signal in case 128 subcarriers, 4 subblock and phase weighting factor ±j

Fig 6. PAPR performance of SFBC MIMO-OFDM signal in case 128 subcarriers, 8 subblock and phase weighting factor ±j

Table 1. Proposed PAPR values of 128 subcarrier for SFBC MIMO-OFDM with Co-PTS Technique

<table>
<thead>
<tr>
<th>S.no</th>
<th>Subcarrier</th>
<th>Subblock</th>
<th>Modulation</th>
<th>PAPR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>128</td>
<td>4</td>
<td>QPSK</td>
<td>4.7dB</td>
</tr>
<tr>
<td>2</td>
<td>128</td>
<td>8</td>
<td>QPSK</td>
<td>4.3dB</td>
</tr>
<tr>
<td>3</td>
<td>128</td>
<td>4</td>
<td>QPSK</td>
<td>5.8dB</td>
</tr>
<tr>
<td>4</td>
<td>128</td>
<td>8</td>
<td>QPSK</td>
<td>6.0dB</td>
</tr>
</tbody>
</table>
It is observed from table 2 that the PAPR ratio in reference literature [3,4,5,6,7] for MIMO-OFDM & SFBC MIMO-OFDM was found large as compared to the proposed table 1. With SFBC MIMO-OFDM by using Co-PTS technique. Hence, this proposed technique gives better result of PAPR approximately 4.7dB with 8 subblock compared to previous techniques.

**CONCLUSION**

The proposed Co-PTS technique with SFBC MIMO-OFDM signal makes use of alternate optimisation to reduce peak to average power ratio. At the same time, the number of candidate sequences is increased by employing spatial sub block circular permutation, which improves PAPR reduction performance equivalently.

**REFERENCES**


