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Low Complexity Slm Based Paper Reduction for Multiuser Stbc Mc-Cdma System

Seepana Sirisha#1 & Tejaswi Madugula #2

#1Asst. Prof, M.Tech Department of ECE, Viswanadha Institute of Technology and Management, Visakhapatnam AP.

#2 Student, M.Tech Department of ECE, Viswanadha Institute of Technology and Management, Visakhapatnam AP.

ABSTRACT

Space Time Block Code Multi Carrier Code Division Multiple Access (STBC MC-CDMA) is an attractive technique for 4G wireless communication systems in the present generation. However ,MC-CDMA – OFDM suffers from high PAPR(peak-to-average power ratio).STBC is a special form of Multiple Input Multiple Output (MIMO). It is employed for 2 transmit antennas (Nt) and 1receiver antenna(Nr) by Alamouti under flat fading conditions. Hence, STBC is integrated with multicarrier techniques such as OFDM (Orthogonal Frequency Division Multiplexing) and MC-CDMA (Multi Carrier Code Division Multiple Access). This technique converts frequency selective channel to several flat fading channels by using OFDM AND MC-CDMA technique and thereby eliminating ISI(Inter Symbol Interfacing) and equalization for the system is obtained. Like other Multicarrier techniques STBC MC-CDMA also suffers from high Peak-to-average power ratio(PAPR). To eliminate this high PAPR ,many techniques have been proposed ,among which SLM (Selective Mapping) technique is considered to be the best PAPR reduction technique.

This project focuses mainly on SLM(Selective Mapping) technique to STBC MC-CDMA and a low complexity system is designed where equalization is carried out in time domain. As the number of users increases BER performance degrades.In this technique we first generate a number of alternate OFDM signals from the original data block . These are then transmitted to the OFDM signal having minimum PAPR(peak-to-average power ratio).SLM(Selective Mapping)system use the sample powers of sub blocks to generate cost functions for selecting samples to estimate the peak power of each candidate signal, thus reducing the computational complexity of the system. The data rate and complexity at the transmitter side is one of the best advantage for this technique when compared to the other techniques for PAPR(peak-to-average power ratio) reduction.

Keywords: MIMO; MC-CDMA; STBC; SLM

1.Introduction:

In a single carrier system, single fade causes the whole data stream to undergo distortion i.e frequency selective fading. The Single carrier systems also suffer from heavy Inter Symbol Interference (ISI). In telecommunication ISI is a form of distortion of signal in which one symbol interferes with the subsequent symbols. Thus it is an unwanted phenomena as the previous symbols have similar effect as noise thus making the communication less reliable. ISI occurs when the signal bandwidth is less than the coherence bandwidth or when the delay spread is greater than the symbol duration. To combat the problem of ISI multicarrier techniques have been proposed for high rata data transmission. Multicarrier techniques divide the whole bandwidth into large no of narrow band orthogonal subcarriers [1, 2]. Thus the signal bandwidth becomes very less compared to the coherence bandwidth ensuring no

ISI in time domain and flat fading in frequency domain. Multicarrier systems such as Orthogonal Frequency Division Multiplexing (OFDM) and Multi Carrier Code Division Multiple Access (MC-CDMA) are considered to be the best technologies for 4G wireless communication systems.

2.Space Time Block Code (STBC)

STBC is a special form of MIMO(Multiple Input Multiple Output). It is originally employed for 2 transmit antennas and 1 receiving antenna by Alamouti [5, 6]. Later it was designed for any no of antennas. It achieves a diversity order of 2 without Channel State Information (CSI) at the transmitter and without bandwidth expansion.

3. PAPR reduction techniques :

There are so many PAPR reduction techniques exist. Some of the important PAPR reduction techniques include

- Clipping and filtering
- Coding
- Interleaving
- Tone injection
- Tone reservation
- Active constellation extension
- Selected mapping (SLM) and
- Partial transmit sequence (PTS)

4. SELCTIVE MAPPING(SLM)

Like all multi-carrier techniques , MC-CDMA also suffers from high PAPR problem. To overcome this problem many techniques have been proposed out of which Selective Mapping (SLM) is considered to b the best for the PAPR reduction.

In basic idea of this technique is to first generate a number of alternate OFDM signals from the original data block . These are then transmit the OFDM signal having minimum PAPR .The data rate and complexity at the transmitter side is one of the best advantage for this technique when compared to the other techniques for PAPR reduction. Selective Mapping (SLM)technique name itself indicated that one sequence is selected out of number of sequences. This is an effective and distortion less technique used for PAPR reduction. According to discrete time OFDM transmission we should make a data block considering N number of symbols from the constellation plot. Here N is the number of subcarriers to be used for transmission. Then data block U number of independent candidate vectors are generated with multiplication of independent phase vectors.

In the transmitting section of STBC MC-CDMA system in which the users data are digitally modulated and spreaded using Walsh-Hadamard orthogonal codes having Spreading factor (SF) which is same for all users mathematically. Then all this spreaded information bits are summed up to provide the CDMA signals as denoted by X . The CDMA signal is divided into two streams for encoding in STBC format for transmitting antennas is explained in previous chapter 3 Now the SLM technique is applied.

In this SLM technique N number of sub carriers are used. The data block U number of independent candidate vectors are generated with multiplication of independent phase vectors. Let us now consider X as the data block with X(k) as the mapped sub symbols(i.e symbols from constellation). Here k=(0,1,2,……. N-1). Let the u^{th} phase vector be denoted as $B^{(u)}$ where u=(0,1,…..U). The u^{th} candidate vector that is generated by the multiplication of data block with phase vector is denoted by $X^{(u)}$.

The equation to get the k^{th} element of u^{th} candidate vector is:

$$X^{(u)}(k) = X(k)B^{(u)}k$$

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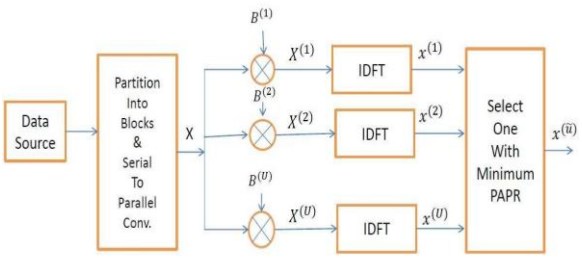
By then doing the IFFT operation for the each candidate vector we will obtain U number of alternative OFDM signals , so the symbol of alternative OFDM signals can be mathematically represented as:

$$x_n = IFFT\{X\} = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X\kappa \, e^{\frac{j2\pi ki}{N}}$$

So out of U number of alternative OFDM signals the signal having minimum PAPR is showed.

Let that selected OFDM signal be $X^{(u)}(k)$. This Selective Mapping (SLM) technique is showed below for low complexity:



Block diagram of Selective Mapping(SLM)

So this technique generates alternative OFDM symbols the independent phase vectors .from the above equation the kth value of uth phase vector is denoted as $B^{(u)}$(k) and can be found by

$$B^{(u)}(k) = e^{j\emptyset(u)}(k)$$

Where $\emptyset(k)$ Is the random phase value. So from the equation we get $X^{(u)}(k)$ be a phase rotated version of X(k). From this it is clear that the two vectors$B^{(m)}$ and $B^{(l)}$are dependent if any joint cumulant between them is non zero.

The condition of mutual independence between $B^{(m)} and \, B^{(l)}$is given by

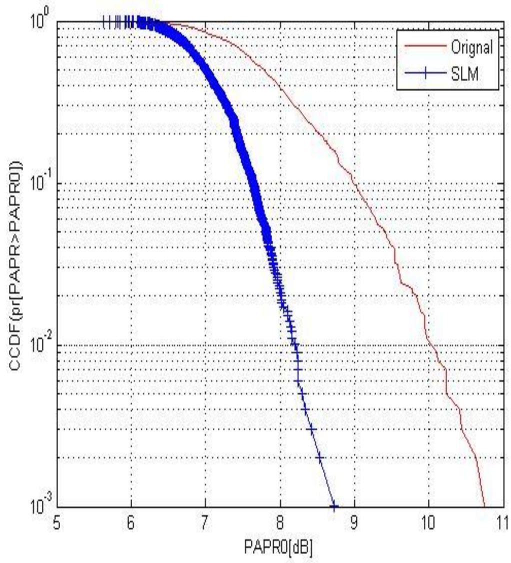
$$E^{-e^{j\emptyset}}=0$$

For satisfying the above condition $\emptyset$ should be uniformly distributed in $[0,2\pi]$ according to this $\emptyset$ the variance of the PAPR reduction performance is shown.

The information bits are transmitted from the data source .the transmitted data is now partitioned into blocks individual sub blocks and to this serial to parallel conversion is done. Now these blocks are individually summed with the $B^{(u)}$ and then generates $X^{(u)}$signals .

These are then passed to the IFFT. The output of these is now transmitted to the Select one with minimum PAPR which generates output for the Selective Mapping technique.

5. Experimental Results



CCDF plot for the Selective Mapping scheme

6. Advantages of SLM

- Distortion less technique: SLM doesn't distort the signal while processing. Hence BER performance is unaffected.
- Flexible system design: The system is compatible.

- PAPR reduction capability: It is proved that the PAPR is considered to be the best reduction technique
- Low computational complexity: The system has very low complexity and hence SLM is the best technique.

7.Conclusion

MC-CDMA has been the promising technology for 4G wireless communication system. Since it is a combination of both OFDM and CDMA, it explores the advantages of both the schemes. MIMO integrated with multicarrier techniques can boost the data rate and the reliability of the link. Also by using multi antenna elements MIMO can achieve diversity which in turn will improve BER performance thus improving the reliability at the receiver. So STBC MC-CDMA is a suitable candidate in this regard which can achieve speed, range and reliability simultaneously.

But the problem with multicarrier technique is PAPR which is also the major drawback for STBC MC-CDMA and restricts its application. High PAPR causes intermodulation products, increases the cost of the transmitter, and increases the complexity of the ADC and PTS techniques. So PAPR must be reduced at any cost. To reduce PAPR many methods have been proposed. Most of the methods proposed are application specific such as they are only applicable to binary signaling or particular no of subcarriers. But SLM is a flexible technique which isapplicable for any modulation scheme or any no of subcarriers. In this project, SLM is applied to STBC MC-CDMA for PAPR reduction. Since STBC employs 2 transmitting antennas, SLM must be applied to both the antennas in both intervals. But implementation of SLM is restricted to 1st symbol time interval only. The optimum phase factors obtained in the 1st symbol interval is directly applied to the 2nd symbol time interval with some simple mathematical calculation. Hence the cumbersome task of applying SLM to 2nd symbol time interval for both the antennas is eliminated. So the complexity is reduced by 50%. Also a low complexity system is designed for the above scheme where the receiver is assumed to have knowledge of side information bits transmitted from the transmitter side after obtaining the optimum phased factor. These bits are used for rotation back of the subcarriers at the receiver side to retrieve the transmitted bits. The STBC encoding and decoding scheme are operated in time domain. The proposed STBC MC-CDMA with SLM technique is compared with SISO MC-CDMA with SLM technique in terms of CCDF and BER performance. CCDF plots show that SISO MC-CDMA with SLM scheme performs marginally better than STBC MC-CDMA with SLM scheme at a huge BER degradation. CCDF and BER plots for multiple users have also been plotted and it can be concluded that as the no of users increase the CCDF performance improves and BER performance degrades.

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Guide Profile:

Seepana Sirisha working as Asst. Prof, M.Tech Department of ECE, Viswanadha Institute of Technology and Management, Visakhapatnam AP.

Students Profile:

Tejaswi Madugula
Received B.Tech degree from Chaitanya Engineering College,Visakhapatnam.
Pursuing MTech Degree in DECE ,Department of ECE, Viswanadha Institute of Technology and Management , Visakhapatnam AP.