International Journal of Research Studies in Science, Engineering and Technology
Volume 2, Issue 12, December 2015, PP 29-31
ISSN 2349-4751 (Print) & ISSN 2349-476X (Online)

Performance Enhancement of MIMO-MC-CDMA System by using Quasi-Orthogonal Space-Time Block Codes

P. Sreesudha, Dr. B.L. Malleswari

Assistant Professor, Department of ETM, GNITS, Hyderabad, India
sree.sudha38@gmail.com
Principal, SWEC, Hyderabad, India
blmalleswari@gmail.com

Abstract: *Modern wireless communication systems with high data rates and high spectral efficiency has dramatically increased. In modern wireless communication systems CDMA (Code Division Multiple Access) is a multiple access scheme and one of the channelization protocol which is ideally suited for mobile network. MIMO is a promising technique beyond 3G and 4G technologies. OFDM is a new paradigm in wireless communications. The combination of CDMA with OFDM system provides better performance comparing to existing techniques.*

Keywords: *CDMA, MIMO, MC-CDMA, Convolution Encoder.*

1. Introduction

Next generation wireless systems need to support high data rate services like multimedia services along with voice services. And the major problem in wireless systems is fading. OFDM is one of the promising technologies which combat the multi path fading problem. Since the high-speed data is transmitted over several lower-speed data streams with several carriers. CDMA is a form of SSMA (Spread Spectrum Multiple Access) and because of spreading characteristics CDMA provides security and multipath diversity. Thus the combination of CDMA and OFDM improves the performance.

In this paper the proposed system is implemented with spatial diversity. A diversity scheme is a method which improves the reliability of a message signal by two or more antennas at either transmit or receiver side with different characteristics. And if more numbers of antennas are used at the transmitter side then it is called transmit diversity [1]. And if more antennas are used at the receiver side then it is receive diversity. In this paper the system is implemented with transmit and receive diversity.

The paper is organized as follows: In Section II MIMO-MC-CDMA system model discussed. In Section III system has been designed with convolutional encoder and viterbi decoder. In Section

IV numerical results are given and In Section V conclusions given.

2. System Model

The Block Diagram of MIMO-MC-CDMA is shown in Fig 1. The data source is encoded with ½ rate convolution encoder then it is serial to parallel converted and spreads the data using a gold sequence.

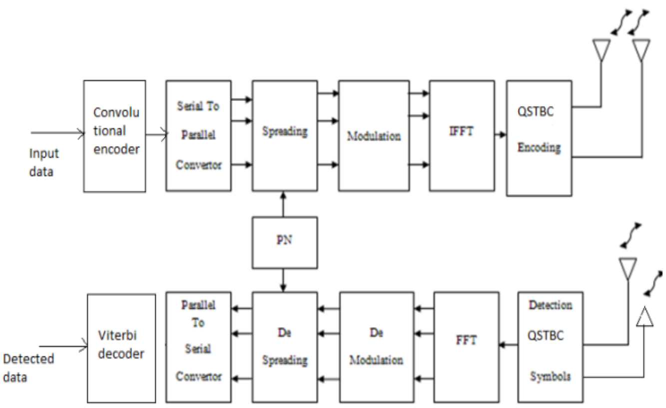

Fig1. *MIMO-MC-CDMA Block diagram*

The spread data is modulated using BPSK (Binary Phase Shift Keying) technique and given to IFFT block for generating orthogonal sub-carriers. Then the output from IFFT block is coded using Quasi-Orthogonal Space time block coding technique. And then the data is transmitted using transmitting antennas [7].

At the receiver side receiving antennas receives the symbols. The detected symbols are given to FFT process and its output is demodulated using BPSK scheme. The demodulated output is despread by using same gold sequence. And then the output is parallel to serial converted, then it is decoded with viterbi decoder.

3. MIMO-MC-CDMA SYSTEM WITH STC CODING

The MIMO-MC-CDMA system is implemented with rotated Quasi-Orthogonal Space-Time Block Codes along with convolutional encoder.

The importance of quasi-orthogonal space time coding is it overcomes the limitations of space-time block codes. In space-time block codes code rate is one and full diversity order only for two transmitting antennas.

As the number of antennas increases the diversity order and code rate reduces. So that quasi-orthogonal space-time coding is preferred, though the QSTBC provides code rate and higher data rate but it does not provide perfect orthogonality. So that causes interference. In order to avoid that problem constellation rotation scheme is used in this.

The QSTBC matrix is shown below:

$$\begin{bmatrix} s_1 & s_2 & s_3 & s_4 \\ -s_2^* & s_1^* & -s_4^* & s_3^* \\ -s_3 & -s_4^* & s_1^* & s_2^* \\ s_4 & -s_3 & -s_2 & s_1 \end{bmatrix} \qquad (1)$$

In the above matrix, columns 1 and 4 are not orthogonal. Similarly 2 and 3 columns are not orthogonal. Rest all the combinations satisfy orthogonal property. The transmitter structure is similar to that of MC-CDMA with OSTBC case except for the QSTBC matrix structure and we are using 4 transmit antennas.

Even though the performance of MC-CDMA system with QSTBC enhances than with OSTBC, these codes do not achieve the full diversity since the difference matrix does not yield maximum rank.

So a new modulation scheme is considered by properly choosing the signal constellations.

4. NUMERICAL RESULTS

In this paper MIMO-MC-CDMA system with 4x1, 4x4 antennas and gold sequence is used for spreading. Result graphs are shown in Fig 2., Fig 3.

And the results show that the MIMO-MC-CDMA system with constellation rotation is giving better performance in 4x1 and 4x4 case, and the channel considered as Rayleigh fading channel. As the numbers of antennas are increasing then diversity increases so that gives better ber performance.

5. CONCLUSIONS

In a MC-CDMA system operating over a quasi-static flat Rayleigh channel, it is shown that using space time block codes by using transmit diversity improves the performance. Quasi orthogonal space time block codes with optimal rotation further improves the system performance comparing to STBC. That achieves full diversity. More ever the system is implemented with forward error correction scheme. And because of forward error scheme is used to further enhance the performance of the system.

We have implemented the MC-CDMA system with QSTBC with optimum constellation rotation with various number of receive antennas and showed the difference in performance between MIMO MC-CDMA system with rotated QSTBC and other techniques.

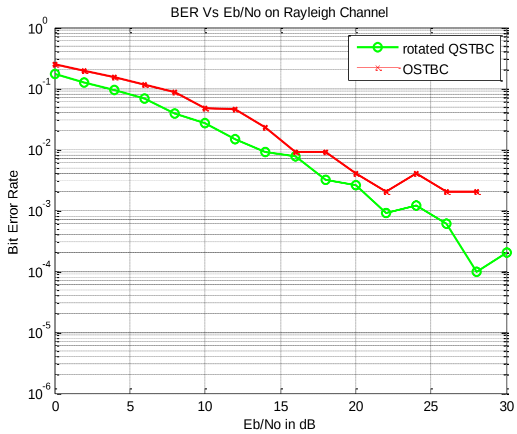

Fig2. *BER performance for OSTBC and rotated QSTBC for 4x1 antenna system*

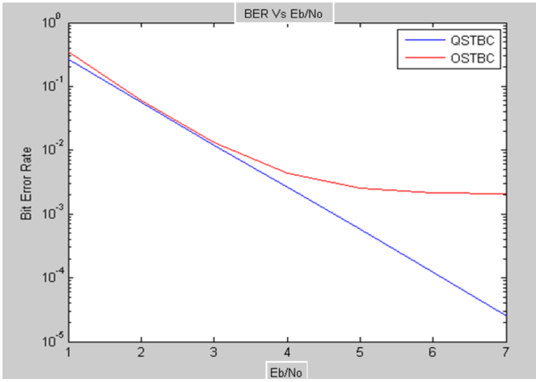

Fig3. *BER performance for OSTBC and rotated QSTBC for 4x4 antenna system*

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