International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 2, February - 2014

Performance Estimation of 2*1 MIMO-MC-CDMA Using Convolution Code in Different Modulation Technique by Zero-Forcing Detection

Mr. Atul Singh Kushwah
Asst. Professor
Indore Institute of Science and Technology-II Indore(M.P)

***Abstract* - In this paper we estimate the performance of 2*1 MIMO-MC-CDMA system using convolution code in MATLAB which highly optimizes 3G and 4G wireless communication system by reducing BER. MC-CDMA (Multi Carrier Code Division for Multiple Access) is a multi-user and multiple access system which is formed by the combination of OFDM and CDMA and convolution encoding scheme is used in encoder of CDMA as FEC (Forward Error Correction) code to reduce BER (Bit Error Rate). MC-CDMA system is a multi-carrier system in which single broadband frequency selective carrier is converted into parallel narrowband flat fading multiple sub-carriers to optimize the performance of system. Now this system further improved by combination of 2*1 MISO (Multiple Input Single Output) system which utilizes ZF (Zero Forcing) decoder at the receiver to reduce BER and also ½ rate convolutionally encoded Alamouti STBC (Space Time Block Code) block code as transmit diversity of MISO for multiple transmission of data through multiple transmit antenna. Main advantage of using MIMO-MC-CDMA using convolution code is to reduce the complexity of system and to reduce BER with increasing gain. In this we analyze system performance in different modulation schemes like, QPSK, 8-PSK, 8-QAM, 16-QAM, 32-QAM and 64-QAM in Rayleigh fading channel using MATLAB.**

Keywords: OFDM,CDMA,MIMO,MIMO-MC-CDMA and convolution code.

1. INTRODUCTION

Due to increased demand of high data rate and low probability of error in this paper we utilizes the technique of MIMO, CDMA and OFDM results enhanced technique for minimizing error rate. MC-CDMA is multicarrier and multiple access system which is a combination of OFDM and CDMA. CDMA is multiple access system and OFDM is multiple carrier system in frequency selective channel that is in OFDM, the frequency selective channel is converted into a group of N narrowband flat-fading channel or sub-carriers. The combination of both the technique results improved efficiency of the wireless communication system which results high data rate and low probability of error.

After that in this paper MIMO is combined with MC-CDMA to increase throughput. MIMO is multiple antenna system in which multiple receive diversity and multiple transmit diversity i.e half-rate convolutionally encoded Alamouti STBC code is used for synchronization of system to reduce ISI. To detect signal orthogonality ZF detection scheme is used. And finally combined MIMO-MC-CDMA [5] is formed by all above operations using MATLAB is then encoded using convolution code as FEC encoder. This MIMO-MC-CDMA using convolution code then analyzed in *QPSK, 8-PSK, 8-QAM, 16-QAM, 32-QAM and 64-QAM* modulation techniques in Rayleigh fading channels.

2. MULTI CARRIER CODE DIVISION MULTIPLE ACCESS (MC-CDMA)

MC-CDMA [2,6,4] is a combination of system of OFDM and CDMA system. This system allows the multiple users to access the wireless channel simultaneously by modulating and spreading their input data signals in frequency domain using PN spreading sequences. MC-CDMA combines the multipath fading of OFDM system with the multi-user access of CDMA system.

Mathematical Model

In present MC-CDMA system we assume that signal detection scheme will be implemented for two transmitting and one was receiving antennas. Each user use single transmitting antenna system. Assume H represent a channel matrix as hij for the channel gain between the ith transmit antenna and the jth receive antenna, j=1 and i=1 and 2. Each user data and the equivalent received signals are represented by $a=[a_1, a_2]T$ and $y=[y_1]$ T respectively, in which a_i and y_j denote the transmit signal from ith transmitting antenna and the received signal at the jth received antenna respectively. Assume n_j denote the white Gaussian noise of variance of σ_{n2}

at the jth receiving antenna and h_i denote the ith column vector of the channel matrix H. Now received signal y for system can be represented by

$y=Ha+n= h_1a_1+h_2a_2+n$ …… (1)

Where, $n=[n_1,n_2]^T$

As the interference signals from other transmitting antennas are reduced for detecting the desired signal from the target transmitting antenna, the detected desired signal from the transmitting antenna by inverting channel effect from a weight matrix W is

$\tilde{A}=[\tilde{a}_1\ \tilde{a}_2]=W_y$……… (2)

In Minimum mean square error (MMSE) scheme, the MMSE weight matrix is given by

$W_{MMSE}=(H^HH+\sigma_n^2I)^{-1}H^H$ … (3)

where $()^H$ denotes the Hermitian transpose. Now detected desired signal from the transmitting antenna is represented by

$\tilde{a}_{MMSE}=W_{MMSE}y$ ……. (4)

For Zero-Forcing (ZF) scheme, the ZF weight matrix is represented by

$W_{ZF}=(H^HH)^{-1}H^H$ ……. (5)

and the detected desired signal from the transmitting antenna using the following relation

$\tilde{a}_{ZF}=W_{ZF}y$ ……… (6)

It is intended to find the transmitted signal vector by Sphere Decoding (SD) scheme with minimum least ML metric. Suppose y_R and y_I represents the real and imaginary parts of the received signal y, i.e. $y_R= Re\{y\}$ and $y_I= Im\{y\}$. Corresponding to that the input signal x_i and the channel gain h_i from ith transmitting antenna to single receiving antenna can be showed by $a_{iR} = Re\{a_i\}$ and $a_{iI} = Im\{a_i\}$ and $h_{iR} = Re\{h_i\}$ and $h_{iI} = Im\{h_i\}$ respectively. We can say that,

$$\hat{H}=\begin{bmatrix} h1R\ h2R & -h1I - h2I \\ h1I\ h2I & h1R\ h2R \end{bmatrix}\ldots. \quad (7)$$

$$\hat{y}=[y_R\ \ jy_I]^T \quad \ldots\ldots\ldots \quad (8)$$

From (9) , the detected desired signal $\tilde{a}_{SP}$ with its real and imaginary components from the transmitting antenna can be represebted by[6]:

$$\tilde{a}_{SP}=[\tilde{a}_{1R}\ \tilde{a}_{2R}\ \tilde{a}_{1I}\ \tilde{a}_{2I}]^T{}_{=[}\ \hat{H}^T\ \hat{H}\ ]^{-1}*_{[}\ \hat{H}^T\ \hat{y}\ ]\ldots \quad (9)$$

3. MULTIPLE INPUT MULTIPLE OUTPUT (MIMO)

MIMO systems use multiple transmit antennas and multiple receive antennas at the receiver, so both transmit and receive diversity schemes are applied to reduce fading resulting from signal variations by wireless channel. It depends on the degree at which the multiple data replicas are faded independently; the system provides diversity gains which represents the difference in SNR at the output of the diversity combiner as compared to that of single branch diversity at certain probability level.

A MIMO system consisting of *N* transmit antenna elements equal to two, and of *M* receive antenna elements equal to one was modeled, accordingly diversity order of 2 can be achieved. For improving the performance combination of the multiple versions of the signals created by different diversity schemes is required. This paper applies maximal ratio combining (MRC) technique using Zero Forcing (ZF) decoder to combine M received signals to resonate on the mostly required desired transmitted signals. The sum of the received SNRs form M different paths is the effectively received SNR of the system with Alamouti STBC of 2*1 diversity. The receiver required to demodulate all M receive signals in case of ZF for a source with

independent signals in the received antennas.

4. MIMO-MC-CDMA COMMUNICATION SYSTEM MODEL USING CONVOLUTION CODE

Communication system model of MIMO-MC-CDMA using convolution is shown in fig.1.

In this communication system we are assuming transmitter sending random sequence to receiver so we are using random sequence generator using MATLAB. Now convolution encoding is done as FEC technique to reduce error probability. Now spreading of sequence is done using PN sequence generator. Now different modulation scheme is used like *QPSK, 8-PSK, 8-QAM, 16-QAM, 32-QAM and 64-QAM* this is shown by modulator block. Previously described system is MC-CDMA system which is already described in section 2 Multi-Carrier Code Division Multiple Access (MC-CDMA). Now MIMO encoder half- rate convolutionally encoded Alamouti's STBC block code is used which will be described in section 3 Multiple Input Multiple Output (MIMO). Combination of MIMO and MC-CDMA forms MIMO-MC-CDMA using convolution code as shown in fig.1. Now signal is then transmitted through Rayleigh Fading Channel [3]. Then receiver receive the signal in reverse fashion for the recovery of transmitted signal and BER calculation is done for estimating the system. In MIMO system two transmit antenna and one receive antenna is used.

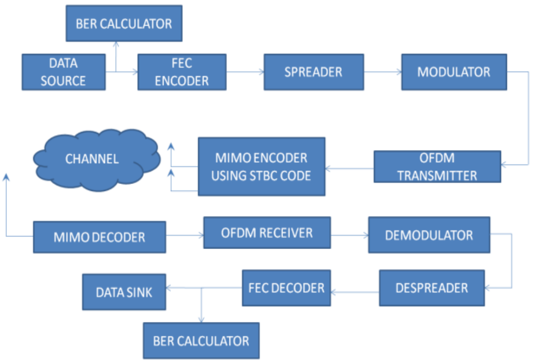

Fig.1. Communication System Model OF 2*1 MIMO-MC-CDMA using convolution code

4. SIMULATION RESULTS AND DISCUSSION:

Table 1 shows the simulated model parameters of MIMO-MC-CDMA [5-8] using convolution code in mentioned different modulation technique.

Performance estimation of MIMO-MC-CDMA using convolution code is shown in fig.1-7.

Fig. 8 depicts the comparative estimation of different modulation schemes in MIMO-MC-CDMA using convolution code.

Table 2 shows the performance estimation of all modulation schemes in terms of gain and BER.

From table.2 and Fig.8 we can say that QPSK shows high gain (17.86 dB) and very low BER with respect to other modulation schemes. This is possible by using convolution code as FEC encoding scheme in MIMO-MC-CDMA.

Table:1. Simulated model parameters.

No. of bits transmitted by user	1560
FEC Encoder	Convolution encoder
Channel Encoder	½ rate convolution encoder
Signal detection scheme	Zero forcing
Channel	Rayleigh Fading Channel
Signal to Noise Ratio	-10dB to 20 dB
CP Length	1280
OFDM Sub-carriers	6400
No. of transmitting and receiving antennas	2*1
Modulation Schemes	QPSK, 8-PSK, 8-QAM, 16-QAM, 32-QAM and 64 QAM

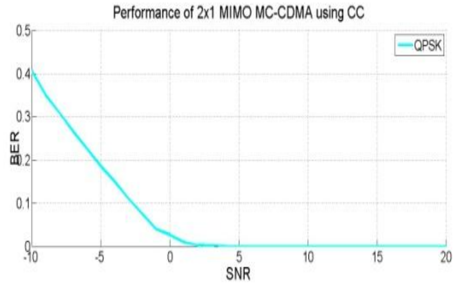

Fig.2. Performance estimation of MIMO-MC-CDMA using convolution code in QPSK modulation scheme.

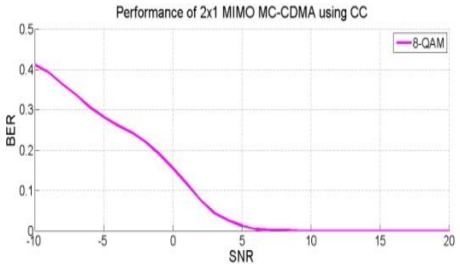

Fig.3. Performance estimation of MIMO-MC-CDMA using convolution code in 8-QAM modulation scheme.

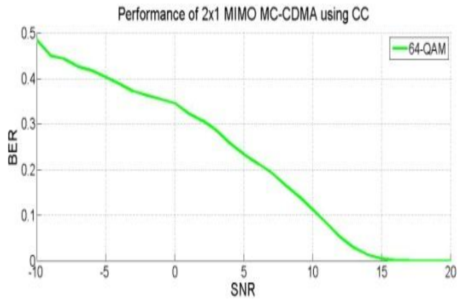

Fig.4. Performance estimation of MIMO-MC-CDMA using convolution code in 64-QAM modulation scheme.

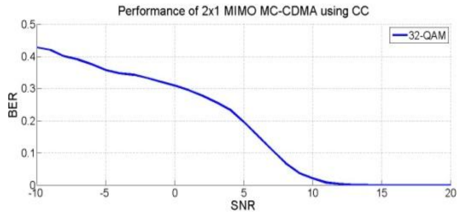

Fig.5. Performance estimation of MIMO-MC-CDMA using convolution code in 32-QAM modulation

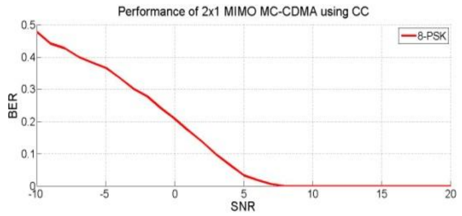

Fig.6. Performance estimation of MIMO-MC-CDMA using convolution code in 8-PSK modulation

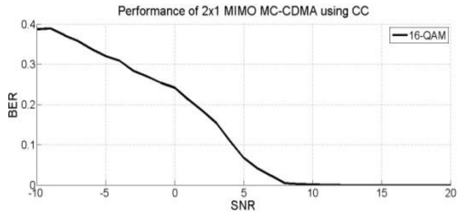

Fig.7. Performance estimation of MIMO-MC-CDMA using convolution code in 16-QAM modulation

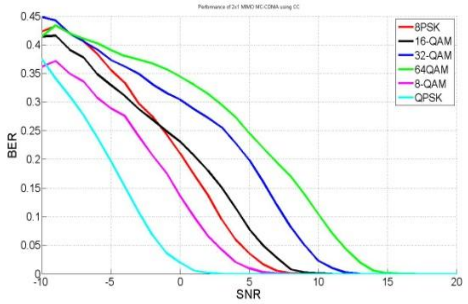

Fig.8. Performance estimation of MIMO-MC-CDMA using convolution code in 8-QAM, 16-QAM, 32-QAM, 64-QAM, 8-PSK and QPSK modulation scheme.

Table: 2. Performance estimation at 1dB SNR with respect to 64-QAM modulation technique as shown in fig.8:

Modulation	**BER at -1dB**	**Gain w.r.t 64-QAM**
QPSK	**0.005385**	**17.86 dB**
8-QAM	**0.09949**	**5.2 dB**
8-PSK	**0.1731**	**2.798 dB**
16-QAM	**0.2063**	**2.03 dB**
32-QAM	**0.2872**	**0.599 dB**
64-QAM	**0.3297**	**0 dB**

5. CONCLUSION

Fig.8 shows the comparative estimation of MIMO-MC-CDMA using convolution code in QPSK, 8-PSK, 8-QAM, 16-QAM, 32-QAM and 64 QAM modulation schemes. Table 2 shows the comparative estimation of different modulation schemes which shows that as modulation scheme order is lower results increase in BER. This paper aims to reduce bit error rate which is found in QPSK modulation scheme with gain of 17.86 dB with respect to 64-QAM which represents that the gain of QPSK is higher as compared to other modulation technique with very low probability of error because errors were removed at 2dB in QPSK.

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