Performance Analysis Of Mimo Mc-Cdma Using Walsh Code with BPSK, QPSK and MSK Modulation on AWGN and Rayleigh Channel

Manjinder Singh
Assistant professor
ECE,Department
SUSEC Tangori,Mohali

Dr. Ranjit Kaur
Associate Professor
ECE,Department
Punjabi University,Patiala

Abstract— Multi-carrier code division multiple access (MC-CDMA) is modulation method for high speed data communication. The usage of MIMO MC-CDMA can significantly improve the performance of wireless communication system. This paper presents the analysis of Multi Input Multi Output Multi-Carrier CDMA system performance for BPSK, QPSK, MSK modulation over AWGN channel and Rayleigh channel. This represents the performance analysis of MIMO MC-CDMA system when it has users 2, 4, 16, 32 and 64 users and 1T-1R,2T-2R,4T-4R,NT-NR on AWGN and Rayleigh channel. The SNR between 0dB and 20dB the BER value showed an effect of AWGN and Rayleigh fading channel on the MIMO Multi-Carrier-CDMA system. It also compare MIMO Multi-Carrier-CDMA BER vs. SNR over BPSK,QPSK and MSK modulation techniques show that minimum BER obtained using NT-NR with MSK modulation technique for both AWGN and Rayleigh channel.

Keywords—MC-CDMA,QPSK and MSK modulation, Rayleigh channel, AWGN, Walsh code and BER Performance.

I. Introduction

Wireless communications is field, which has growing in last years. The major development of data and video communication for Internet, and the same rapid pervasion of the mobile communication and great expectations for mobile communication system [1]. Due to growth of mobile multimedia the number of users needed very high data rate for communication systems in wireless environment where the spectral resource is used. To filling the basic requirements are small promising systems for the 4G system [2]. Multi-Carrier-CDMA system is technique for very high data rate communication .The recent technique like (CDMA)Code Division Multiple Access and Orthogonal Frequency Division Multiplexing (OFDM).

MC-CDMA

MC-CDMA is a modulation method that uses multi-carrier transmission of Direct Sequence CDMA signals. Multi-Carrier-CDMA system is adding of Orthogonal Frequency Division Multiplexing (OFDM) and Code Division Multiple Access. OFDM is a technique of multi-carrier modulation. In OFDM a data stream is code Division Multiple Access and spread spectrum technique is mostly used [8]. The Orthogonal Frequency Division transmit over a number of lower rate sub-carriers. The large number of sub-carriers removing of multipath dispersion can provide the best symbol duration. So that the effects of ISI will be reduced [3].

Multiple Input Multiple Output (MIMO)

MIMO system is a scheme based on multiple transmitting and multiple receiving antennas which can achieve very high data rates in rich multipath scattering environments without increasing the transmission bandwidth or the total transmitted power of the system. Multi Input Multi Output is technique for very high data rates through spatial multiplexing and increase the spectral efficiency of the system in rich scattering environments by providing spatial diversity [10].

II. THE SYSTEM MODEL

MC-CDMA Transmitter Model

MC-CDMA transmitter is similar to OFDM transmitter. But in case of OFDM separate symbols are transmitted on sub-carriers. In case of MC-CDMA equal symbol is transmitted on different sub-carriers [2]. The explanation of concept is in figure 1.
In this figure, the main difference between MC-CDMA & OFDM is that the MC-CDMA scheme transmits the same symbol in parallel through several subcarriers whereas the OFDM scheme transmits Walsh code is used as a spread different number of Walsh code are obtained from the Hadamard matrix which is a square matrix where each row in the matrix is orthogonal to all other rows. Every column in matrix is orthogonal to each column. The Hadamard matrix is generate with zero matrix and applying the Hadamard transform. Each column and row in the Hadamard matrix corresponds to a Walsh code sequence of length n. Orthogonality between codes in the Hadamard matrix is defined such that the cross-correlation associated over zero offset between pair of sequences, is zero. The Hadamard transform is defined as:

\[
H_n = [0]
\]

\[
H_{2n} = \begin{bmatrix} H_n & H_n \\ H_n & -H_n \end{bmatrix}
\]

\[
H_2 = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}
\]

**IV. Modulation Technique:**

**MSK Modulation**

Minimum Shift Keying (MSK) is a form of a type of continuous-phase frequency shift keying. It is used in various applications. MSK is also called continuous phase modulation (CPM). The continuous phase modulation minimizes BW consumption by eliminating phase discontinuity. The Minimum Shift Key modulated signal is defined as:

\[
S(t) = d(t) \cos(\pi t/2T) \cos(2\pi ft) + d(t) \sin(\pi t/2T) \sin 2\pi ft.
\]

**V. SYSTEM CHANNEL**

**AWGN Channel**

The simplest channel environment is the Additive-White-Gaussian-Noise (AWGN) channel. The Additive white noise comes from the thermal heat noise on each receiving antenna. The signal transmit from transmitting antenna to the nth receive antenna experiences propagation losses on channel. Additive white Gaussian noise is used to transmit signal while signals travel from the channel and simulate background noise of channel.

**Rayleigh Channel**

**III. WALSH CODE**

**MC-CDMA Receiver model**

The MC-CDMA receiver block for the nth user is show in Figure 2. The received data signal is down converted. The cyclic prefix is removed and the remaining samples are serial to parallel converted to obtain the m-subcarriers components (corresponding to the app. data), where m = 1, 2, ... , GMC. The m-subcarriers are first demodulated by a fast Fourier transform and then multiplied by the gain qi to combine the received signal energy scattered in the frequency domain.

**Figure 2. MCCDMA Receiver**
The Rayleigh fading is primarily caused by multipath reception of signals. Rayleigh fading is a model for the effect of a propagation environment on a radio signal[7]. The Rayleigh distribution is frequently used to model multipath fading with no direct line-of-sight (LOS) path. In this case the channel fading amplitude $\alpha$ is distributed according to

$$p_\alpha(\alpha) = \frac{2\alpha}{\Omega} \exp\left(-\frac{\alpha^2}{\Omega}\right), \quad \alpha \geq 0$$

VI.SYSTEM MODEL & SIMULATION

RESULTS

The system model of MIMO Multi-User MC-CDMA with MSK using Walsh code.

The MIMO MC-CDMA is simulated and analysis using Matlab Software. The MIMO MC-CDMA was simulated on an Rayleigh multipath fading and Additive White Gaussian Noise (AWGN) channel for show the effect of both channel on BER performance of MIMO MC-CDMA with respect to SNR(signal to noise ratio) [12].

A.BER Performance of MIMO Multi-User MC-CDMA for MSK on Rayleigh and AWGN Channel

The Effect of Rayleigh & AWGN channel on MIMO Multi-user MC-CDMA system having two and four users which are sending $10^4$ bits on the channel. The users data were spread using 4-bit Walsh code and modulated by Minimum Shift Keying modulation. The simulation shows that in figure 5. This figure show BER vs signal to noise ratio values for 2 user and 4 user. Bit error rate for 4 users is less than 2 users. But the BER of MIMO MC-CDMA using the MSK modulation is more decrease for 2 users and 4 users than BPSK,QPSK modulation.

Figure 4: The system model of MIMO Multi-User MC-CDMA with MSK using Walsh code.

Figure 5: MIMO MC-CDMA on Rayleigh & AWGN for 2, 4 users

MC-CDMA Performance effected on Rayleigh & AWGN channel which have 4 users and 16 users, every user has $10^4$ bits on channel. The users data were spread using 16-bit Walsh code and modulated using Minimum Shift Keying modulation. The simulation result shows that in figure 6. The Result show that the bit error rate is inversely vary with the number of users, therefore increasing the number of users less BER. Bit error rate for 16 users is less than 4 users, so that if we increase the number of users the effect of BER is less on the performance of MIMO MC-CDMA system.

Figure 6: MIMO MC-CDMA on Rayleigh & AWGN for 4, 16 users

But the BER of Multi-user MC-CDMA using the MSK modulation is decrease for 4 users and 16 users than BER of Multi-user MC-CDMA using BPSK,QPSK modulation.
MC-CDMA Performance effected on Rayleigh & AWGN channel which have 4 users, 16 users, 32 users, 64 users each user has $10^4$ bits on the channel. The data were spread using 32 bit, 64-bit Walsh code and modulated using Minimum Shift Keying modulation. The simulation result indicates that the bit error rate is inversely vary with the number of users. In figure 7 BER of 32 user is higher than 64 users but less than 16 and 4 users.

This result show that as the number of user increase bit error rate also decrease. But the BER of Multi-users MC-CDMA using the MSK modulation is less for 32 users and 64 users than Multi-users MC-CDMA using BPSK, QPSK modulation.

B.BER Performance of MIMO MC-CDMA System Using MSK on Rayleigh and AWGN Channel

when Rayleigh fading is added to AWGN the channel and simulation result show the behavior of fading on the BER of MIMO MC-CDMA system. MIMO MC-CDMA Performance effected on AWGN and Rayleigh channel which have 1 Transmitter and 1 Receiver modulated using Minimum Shift Keying modulation. For 1T -1R the simulation result shows that bit error rate is higher and starts to decrease from SNR -2dB to 10dB.In figure 8 simulation result shows that bit error rate using 1T-1R higher. But the BER using the MSK modulation are more decrease with 1T-1R as compare to BPSK,QPSK modulation on Rayleigh &AWGN channel.

MIMO MC-CDMA Performance effected on AWGN and Rayleigh channel which have 2T-2R and modulated using Minimum Shift Keying modulation. It is clear that the BER is higher at the minimum SNR and then starts to decrease.

In figure 9 shows the plot of BER using 2T-2R for -2db to 10db of SNR .The Result indicate that BER with 2T-2R are lower as compared to 1T-1R. BER using the MSK modulation are decrease for 2T-2R than BPSK, QPSK modulation.

BER Performance of MIMO MC-CDMA system has 4T-4R and NT-NR on Rayleigh fading and AWGN channel using MSK modulation.The BER simulation plot is shown in Figure 10.The result show that BER are inversely vary with the number of transmitter and receiver.More the number of transmitter and receiver lower the BER of MIMO MC-CDMA using the MSK modulation.BER of MC-CDMA for NT-NR is lower than 4T-4R,2T-2R,1T-1R.
Figure 10: MIMO MC-CDMA on Rayleigh & AWGN for 1T-1R,2T-2R,4T-4R,NT-NR

But the BER of MIMO MC-CDMA using the MSK modulation are more decrease for NT-NR,4T-4R than BPSK,QPSK modulation.

C. Comparison Results of MIMO MC-CDMA With BPSK,QPSK and MSK Modulation on Rayleigh & AWGN Channel

The MIMO MC-CDMA is simulated using Matlab. The system was simulated over an Additive White Gaussian Noise (AWGN) channel and Rayleigh multipath fading channel models to show the effect of them on the bit error rate relating to signal to noise ratio.

Effect of Rayleigh & AWGN channel on MIMO MC-CDMA system having 2 user,4 users,16 users,32 users and 64 users sending 10^4 bits and using 1T-1R,2T-2R,4T-4R,NT-NR on the channel. The data were spread using Walsh code and modulated by Minimum Shift Keying,QPSK and BPSK Modulation.

Comparison graphs show that BER Of MIMO MC-CDMA using Walsh code with MSK Modulation technique is reduced as compare to BER Of MIMO MC-CDMA With QPSK and BPSK Modulation on Rayleigh & AWGN channel. The result show that MSK Modulation is very much better than QPSK and BPSK modulation in BER Performance of MIMO MC-CDMA on Rayleigh & AWGN channel.

**Table 2:** Multi-User MC-CDMA with MSK,QPSK,BPSK (Bit Error Rate VS SNR)

<table>
<thead>
<tr>
<th>M TYPE</th>
<th>USER 2</th>
<th>USER 4</th>
<th>USER 16</th>
<th>USER 32</th>
<th>USER 64</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPSK</td>
<td>.92</td>
<td>.105</td>
<td>.85</td>
<td>.88</td>
<td>.88</td>
</tr>
<tr>
<td>QPSK</td>
<td>.44</td>
<td>.103</td>
<td>.84</td>
<td>.86</td>
<td>.87</td>
</tr>
<tr>
<td>MSK</td>
<td>.11</td>
<td>.101</td>
<td>.80</td>
<td>.82</td>
<td>.81</td>
</tr>
</tbody>
</table>

Comparison Table 2 show that Bit Error Rate of Multi-user MC-CDMA for 2 users, 4 users, 16 users, 32 users and 64 users using the MSK modulation is found to be quite efficient than using QPSK,BPSK modulation technique.

**Table 3:** MIMO MC-CDMA with MSK,QPSK,BPSK (Bit Error Rate VS SNR)

<table>
<thead>
<tr>
<th>M TYPE</th>
<th>1T-1R</th>
<th>2T-2R</th>
<th>4T-4R</th>
<th>NT-NR</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPSK</td>
<td>.15</td>
<td>.43</td>
<td>.45</td>
<td>.35</td>
</tr>
<tr>
<td>QPSK</td>
<td>.13</td>
<td>.23</td>
<td>.31</td>
<td>.25</td>
</tr>
<tr>
<td>MSK</td>
<td>.11</td>
<td>.18</td>
<td>.23</td>
<td>.18</td>
</tr>
</tbody>
</table>

Comparison Table 3 show that BER Of MIMO MC-CDMA using Walsh code for 1T-1R,2T-2R,4T-4R,NT-NR with MSK Modulation technique is reduced as compare to BER Of MC-CDMA With QPSK and BPSK Modulation on AWGN and Rayleigh channel. So that MSK Modulation is much better than QPSK and BPSK modulation in BER Performance of MIMO MC-CDMA on AWGN and Rayleigh Fading channel.

VII CONCLUSION

This paper has presented and showed that BER vs SNR Performance of MIMO MC-CDMA using walse code with MSK modulation on AWGN and Rayleigh Fading channel. The BER vs SNR of Multi-user MC-CDMA with MSK modulation on Rayleigh & AWGN channel show that BER is inversely vary with number of users, more number of users lower BER. But BER of MIMO MC-CDMA for 2, 4, 16, 32, 64 users is decrease with MSK modulation as compare QPSK, BPSK modulation. The BER vs SNR of MIMO MC-CDMA for 1T-1R,2T-2R,4T-4R,NT-
NR decrease with MSK modulation as compare QPSK and BPSK modulation on AWGN and Rayleigh channel.

VIII REFERENCES


