Performance Of MC-CDMA Using Modulation Techniques For Rayleigh And Gaussian Channels

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Abstract

Multi-carrier code division multiple access is modulation method for high speed data communication. It removes the problem of inter symbol interference. *MC*-CDMA systems combined with multiple antennas are a promising technique, beyond 3G and 4G wireless communications. MC-CDMA provides spatial diversity, which mitigates the fading. The usage of MC-CDMA can significantly improve the performance of wireless communication system. In this paper, review of the working of transmitter and receiver model of MC-CDMA system, performance of BER versus bit energy to noise ratio of MC_CDMA using various modulations for Rayleigh and Gaussian channel is given.

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

I. Introduction

Wireless communications is an emerging field, which has seen enormous growth in the last several years. The spectacular growth of video, voice and data communication over the Internet, and the equally rapid pervasion of mobile telephony, justifies great expectations for mobile multimedia. Due to this growth of multimedia communication, the users demanded high data rate communication systems in wireless environment where the spectral resource is scarce. To fulfill the requirements new technologies like Code Division Multiple Access and Orthogonal Frequency Division Multiplexing (OFDM) are few promising systems for the 4G communication standards. MC-CDMA is modulation method for high speed data communication [2].

MC-CDMA

MC-CDMA is a modulation method that uses multi-carrier transmission of DS-CDMA type signals [8]. MC-CDMA is based on the combination of Orthogonal Frequency Division Multiplexing (OFDM), a multicarrier modulation, and Code Division Multiple Access (CDMA), a spread spectrum technique .Orthogonal Frequency Division Multiplexing (OFDM) is a special case of multicarrier modulation, where a single data stream is transmitted over a number of lower rate subcarriers. By using a large number of sub-carriers, a high immunity against multipath dispersion can be provided since the useful symbol duration Ts on each sub-stream will be much larger than the channel time dispersion. Hence the effects of ISI will be minimized [3].

Need for MC_CDMA

MC-CDMA takes advantage of both OFDM and CDMA and makes an efficient transmission system by spreading the input data symbols with spreading codes in frequency domain. It uses a number of narrowband orthogonal subcarriers with symbol duration longer than the delay spread. This makes it unlikely for all the subcarriers to be affected by the same deep fades of the channel at the same time thereby improving performance [3].

The paper is organized as follows: In section II,MC_CDMA system model are discussed, in section III, BER performance based on different modulation techniques are discussed, In Section IV, The role of walshcodes for MC_CDMA systems have been discussed and the paper is concluded in Section V.

II.THE SYSTEM MODEL

MCCDMA Transmitter Model

MC-CDMA transmitter is similar to OFDM transmitter with small difference. In OFDM many different symbols are transmitted by subcarriers but in MC-CDMA same symbol is transmitted by different subcarriers. The explanation of the above concept is clearly shown in figure1.The input data rate symbols are converted to parallel streams. Then each parallel stream is spread using spreading codes like Walsh, Hadamard etc [2].

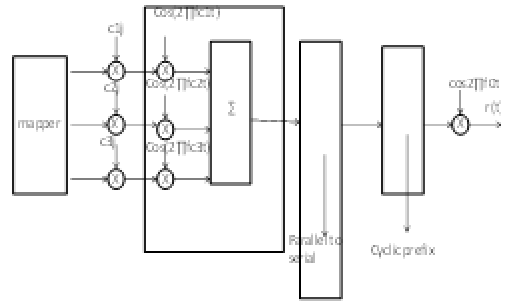

Figure1. MC-CDMA Transmitter

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 different code of the user in the frequency domain. The input data stream is multiplied by the spreading code. The users are separated by different codes. All data corresponding to the total number of sub carriers are modulated in baseband by an inverse Fast Fourier transform (IFFT) and converted back into serial data. Then, a cyclic prefix is inserted between the symbols which is a repeat of the end of the symbols at beginning, to combat the inter-symbol interference (ISI) and the inter-carrier interference (ICI) caused by multipath fading. And hence the cyclic prefix length is chosen such that it is greater than the delay spread of the channel. In MC-CDMA transmission, it is essential to have frequency non selective fading over each sub carrier. Therefore, if the original symbol rate is high enough to become subject to frequency selective fading, the input data have to be serial to parallel (SIP) converted into parallel data sequences and each SIP output is multiplied with the spreading code of length GMC.
In order to improve the performance of the system, an appropriate approach for channel estimation is, to use dedicated pilot symbols that are periodically inserted in the transmission frame also known as block-type pilot channel estimation. The pilot

tones can also be inserted into each symbol with a given frequency spacing; this is known as comb-type pilot channel estimation. The frequency response of the channel at frequencies where pilot tones are not located can be interpolated using various interpolation techniques such as linear, spline, FFT or low pass filtering [2].

MCCDMA Receiver model

The MCCDMA receiver configuration for the j^{th} user is shown in Figure 2. The received signal is first down converted. Then, the cyclic prefix is removed and the remaining samples are serial to parallel converted to obtain the m-subcarriers components (corresponding to the ajp 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.[2].

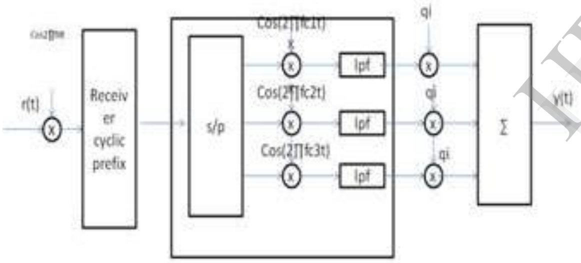

Figure 2.*MCCDMA Receiver*

III. BER PERFORMANCE

Pragya Pallavi, et al., [1] has proposed Multi-carrier code division multiple access (MC-CDMA) is an attractive choice for high speed wireless communication as it mitigates the problem of inter symbol interference (ISI). In this Transmitter and Receiver of MC-CDMA system is modeled. In this discussion about performance of bit error rate (BER) versus bit energy to noise ratio (Eb/No) of Multi Carrier Code Division Multiple Access (MC-CDMA) systemsusing various detection techniques i.e. Maximal Ratio Combining (MRC) and Equal Gain Combining (EGC) over Rayleigh channel using BPSK modulation and Additive White Gaussian Noise channel so that BER decreases.

A. Sharmila et al. [2], has proposed MC-CDMA as a combination of CDMA and OFDM, resulting in better frequency diversity and higher data rates. In this MIMO systems use multiple antennas at both transmitter and receiver. MIMO MC-CDMA signals received willnever be corrupted because copies of same signals are transmitted over all sub-carriers. Therefore better BER performance for MC-CDMA communication system is achieved using variable number of bits with BPSK modulation on Rayleigh channel and Additive White Gaussian Noise.

Poonam Singh, et al. [3], has proposed MC-CDMA based on the combination of Orthogonal Frequency Division Multiplexing (OFDM), a multi carrier modulation, and Code Division Multiple Access (CDMA). In this Transmitter and channel, Receiver model fading channel model of MC-CDMA system is modeled. Based on frequency domain equalize BER performance of multi carrier spread spectrum systems in a multipath Rayleigh fading, AWGN channel. Here BER decreases as number of users increase.

IV. WALSH CODE

M.F. Ghanim, et al. [4], has proposed Multi-carrier code division multiple access (MCCDMA) systems receive a great deal of attention due to their great potential in achieving high data rates in wireless communication. In this Transmitter, Receiver model, various channel and spreading code of MC-CDMA system is modeled based on Walsh coding performance MC-CDMA system at different number of user 4, 16, 32 and 64. When the data is sent and received over AWGN channel and Rayleigh channel. BER is better and vary directly proportional to number of users.

Madhvi Jangalwa, et al., [5] has proposed Multi-Carrier Code Division Multiple Access (MC-CDMA) is one suitable choice for next generation wireless communication system. MC-CDMA is the combination of CDMA and OFDM schemes. In this Transmitter and channel Receiver model, various types of spreading code of MC-CDMA system are modeled based on Walsh-Hadamard (W-H) code for spreading, which reduces the multiple access interference (MAI). BER performance of MC CDMA system for differentlength of spreading code over Rayleigh fading channel is investigated.

Volipour et al., has proposed [6] space-time block codes for Multi-carrier code-division-multiple-access (MC-CDMA) systems. Now a day's there is huge demand for wide band wireless networks especially for wireless sensor and ad-hoc networks. MC-CDMA combines the advantages of CDMA in a multiple user environment byusing multiple carrier modulation over frequency selectivefading channels. The principle here is the modulated signal is spread in the frequency domain by using a spreading sequence and then it is transmitted over orthogonal subcarriers. So modulation over orthogonal sub-carriers provides for robust and convenient demodulation of spread symbols.

Jia Shen et al., [10] have proposed multi user antenna detector for MIMO CDMA systems based on space time turbo codes in [10]. In this the receiver is designed to detect the multi user interference and also multi antenna interference. The linear minimum mean-squared error (MMSE) and an MMSE based Turbo Parallel Interference Cancellation (PIC) detector both are used to cancel the interference between multiple users.

V. CONCLUSIONS

This paper has presented that performance of MC-CDMA system for Rayleigh and Gaussian channel. BER with EGC and MRC in Rayleigh Channel with BPSK modulation decreases, the bit energy to noise ratio, Eb / No increases. BER for MC-CDMA system using variable number of bits with BPSK modulation on Rayleigh channel and Additive White Gaussian Noise decreases, the bit energy to noise ratio, Eb / N0 increases. Comparison is made between with and without channel coding. BER performance with channel coding is better than the without channel coding. Coding rate also affects the BER performance.

The effect of AWGN channel on MC-CDMA system using Walsh code with BPSK modulation is that the bit error rate is directly proportional with the number of users, when, Rayleigh fading was added to the channel. The bit error rate increased with fading in addition to the number of users. Comparing the performance among the BPSK, QPSK and 16-QAM modulation techniques, it is shown that BPSK and QPSK can provide performance improvement over 16-QAM.

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