PERFORMANCE ANALYSIS OF MC-CDMA SYSTEM IN RAYLEIGH CHANNEL USING QPSK MODULATION

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Abstract

In this paper, the error performance of an MC-CDMA system is analysed with the help of Quadrature Phase shift Keying (QPSK) as the modulation technique mixed up with Additive White Gaussian Noise (AWGN) in the Rayleigh channel. CDMA suffers with the problem of selective frequency diversity during the downlink process. Orthogonal Frequency Division Multiple Access (OFDMA) techniques combine with the CDMA technique which arises to a Multi Carrier CDMA. As the number of users are increased the QPSK system performance better. This performance analysis is done with the calculation of the Bit Error Rate (BER) for the MC-CDMA system. The simulation is done using Matlab software.

Keywords: MC-CDMA, QPSK, Walsh code, AWGN, Rayleigh channel, BER

1. Introduction

Code Division Multiple Access (CDMA) is the very basic multiple access technique for high speed and very secure wireless communication. This is categorized into two based on the spreading methodology. One is the Direct Sequence (DS) CDMA technique and the other is the Frequency Hopping (FH) CDMA technique. Orthogonal Frequency Division Multiplexing (OFDM) also plays a major role is transmission at high data rates. Based on the number of carriers, they can be considered as Multi carrier Code Division Multiple Access (MC-CDMA) and it can be viewed as a combination of OFDMA and CDMA techniques [4] [9]. This overcomes the disadvantages of both the techniques and utilises the advantages of both which includes frequency diversity and frequency fading [3].

2. MC-CDMA System

This section explains about the model implementation of the MC-CDMA transmitter and receiver. MC-CDMA transmitter spreads the data in the frequency domain and a small part of the symbol is spreading code is transmitted through the subcarriers. The modulation technique implemented is QPSK modulation [5] [7]. The serial input data is converted into a parallel data stream and the code converter has generates a unique code for every different user. The generated parallel streams are spread using the spreading codes like PN sequence, Walsh codes, Hadamard codes and Gold codes [1] [2]. The symbols are then converted into time domain samples by applying Inverse Fast Fourier transform (IFFT). Cyclic prefix is introduced into block representation in order to compensate the Inter symbol Interference and Inter Carrier Interference. The frequency generator helps in IFFT conversion and the symbols are then multiplexed finally resulting in a serial stream. This signal is mixed up with Additive White Gaussian noise (AWGN) and is then transmitted into Rayleigh channel [8] [10]. The signal that is received from the wireless channel is again despread with the unique spreading code and again converted back into frequency domain. The symbols are passed into a Low Pass Filter (LPF) and are again multiplexed together. This receiver has all the received signals that are scattered into frequency signal. Model implementation of the MC-CDMA transmitter and receiver is shown in Fig 1 &2 respectively.

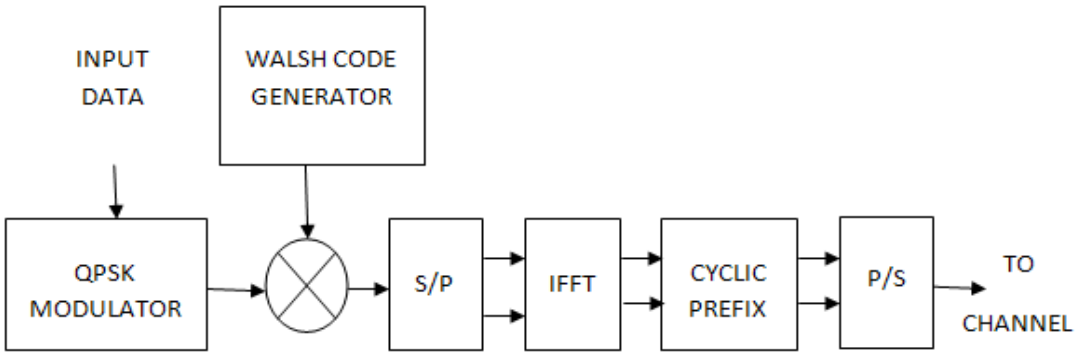

Fig. 1. Model implementation of an MC-CDMA transmitter

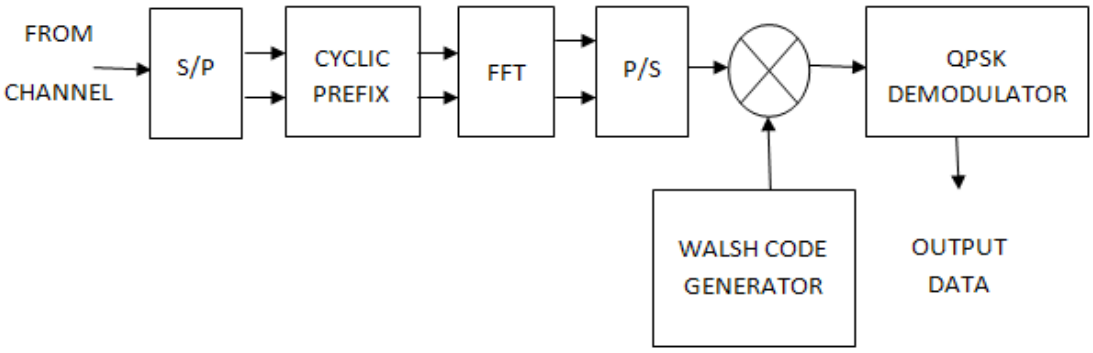

Fig. 2. Model implementation of an MC-CDMA receiver

3. Simulation Results

The MC-CDMA model is simulated using MATLAB software. The number of users considered in this implementation is two and the sub-carriers involved are four. The number of bits used is 10000 and Walsh code is used in spreading the sequence and the sequence is transformed using Inverse Fast Fourier transform (IFFT). Cyclic prefix is appended for each of the user. Quadrature Phase Shift Keying (QPSK) modulation technique is used in the model simulation. Both the users are added together and passed into the channel for transmission. The signal that is transmitted is passed to the Rayleigh channel in the presence of Additive White Gaussian Noise (AWGN). The number of tapings considered in the Rayleigh channel is four. Cyclic Prefix is removed at the receiver side and the sequence is transformed using Fast Fourier Transform (FFT). Equalization is done at the receiver and the Bit Error Rate is calculated for both the users. Comparison between the theoretical values and the simulated BER values are shown in Fig.3.

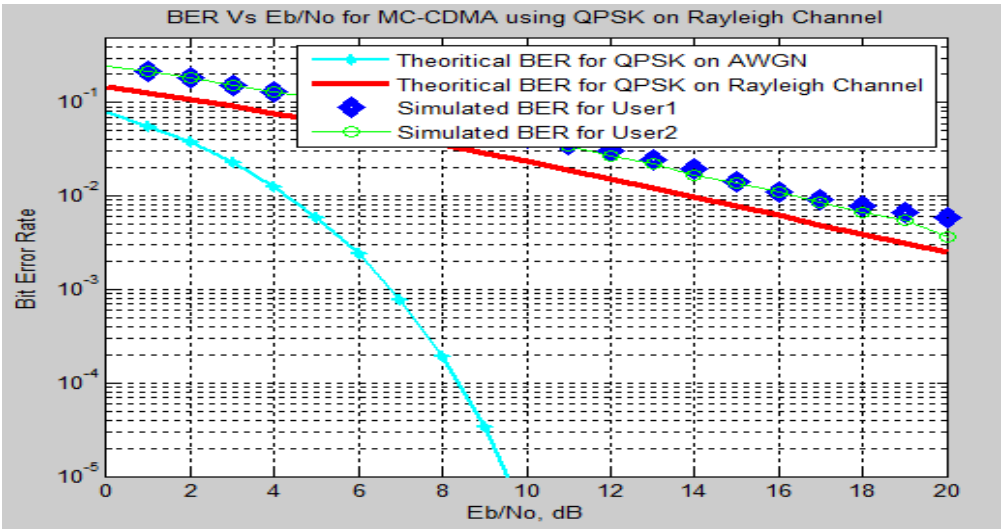

Fig. 3. BER Vs E_b/N_o on Rayleigh Channel

4. Conclusions

From the simulated results, we analyze the BER performance of an MC-CDMA system modulated by QPSK modulation technique. The number of users is two and the data subcarriers are considered to be four. Bit Error Rate is the ratio of between the number of error bits to the total number of bits that are transferred at a particular interval [6]. The expression for the calculation of the BER is given by ½ efrc($\sqrt{E_b/N_o}$). Results are simulated using MATLAB software and the results shows that as the value of E_b/N_o increases the value of the bit error rate decreases. The number of user and the number of subcarriers can also be increased and the performance of this MC-CDMA system can be analyzed.

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