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Performance Analysis of Optical Code Division Multiple Access System

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ABSTRACT

In optical code division multiple access system, many users share the same transmission medium by assigning a unique pseudo random optical code (OC) to each user. In this paper, we analyze OCDMA system using MATLAB simulation. We analyze the system in terms of BER in cases of fading, Gaussian noise and jammer noise by varying numerous parameters of the system. As the number of active users increases, the BER increases.

Keywords: OCDMA, OC, MAI, BER, SNR.

1. INTRODUCTION

Multiple accesses which uses the spread spectrum technology for transmission has become very popular in cellular radio networks. Optical code division multiple access (OCDMA) is a technique in which user uses a specific unique code rather a specific wavelength or a time slot. OCDMA uses the spread spectrum technique of code division multiple access (CDMA) combined with the optical link for transmission of data. OCDMA provides the large communication bandwidth along with the capability of secure data transmission. The key advantage of OCDMA is the multiple access technique which allows many users to share the same optical link simultaneously. This is done by giving each user a specific code which can be decoded only by the required user. OCDMA has many unique features that make it favorable data transmissions. Its characteristics make it suitable to increase the capacity and number of users in burst networks. OCDMA can accommodate a large no. of channels on a single carrier frequency. It can utilize the bandwidth effectively through coding system. OCDMA systems provide high degree of scalability and security. It provides high noise tolerance.

OPTICAL CODE DIVISION MULTIPLE ACCESS (OCDMA)

OCDMA had the potential to generate some of the previously unused bandwidth of the optical fiber and to carry over to the optical domain the benefits of CDMA in radio frequency systems. The early attempts of implementing of OCDMA were not so successful. At that time technology available was not so advanced. In the last 20 years the OCDMA field has matured substantially. The Optical CDMA systems suffer from the problem of Multiple Access Interference (MAI) .As the number of users increase the bit error rate (BER) degrades because the effect of MAI increases. So, there is a limitation in number of users, as the number of users increase Signal-to-noise ratio (SNR) decrease and probability of error increase. There is a limitation of speed also in optical CDMA systems-since very short pulses are to be required within each bit time, here for it limits the bit rate for a finite pulse width transmitter. There is also a problem of high optical splitting at encoder/decoder. OCDMA is one of the main technologies of Third Generation Cellular System. The main advantage of the OCDMA is that a user can transmit data in different data rates simultaneously and user can transfer different types of data also. Instead of using TDMA the OCDMA provides higher data transmission rate and provide the services to multiple users without any data loss. Orthogonal frequency will use the concept of modulation technique to transfer large amount of data using radio waves in a wireless network. As we know the radio signals can be divided into the smaller sub signals that enable the OCDMA to transfer the data in multiple data rate slots. It provides the simultaneous data transmission without any user interference.

2. OBJECTIVES AND RESEARCH METHODOLOGY

Following objectives have been decided for this Research work.

- To find out a MAI analysis of the OCDMA network.
- To determine optimum system parameters in the design of an OCDMA system.
- Find out the BER versus received optical power for various numbers of users with the help of m-sequences.

When working with OCDMA spectrum, first of all we would generate the signal. For this we would need to specify Channel Length, number of sub-carriers. Then we would distribute the whole signal among these sub-carriers for parallel

transmission. The next step is to define the interference to be included in the form of noise, Channel noise etc. In our work we are randomly generating the Spectrum using rand () command of MATLAB. OCDMA blocks are divided into J identical sub blocks such that:

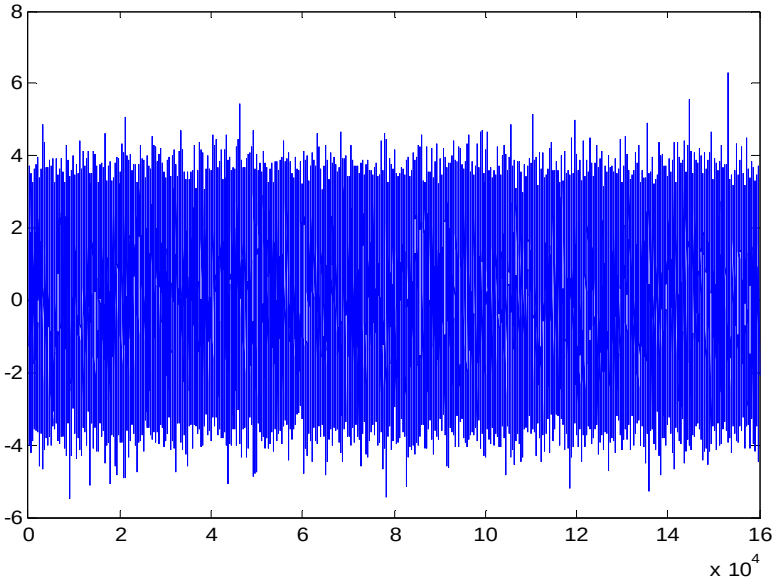
M = N / J
Where N = no. of carriers
J = no. of sub-blocks
M = size of each sub-block
In this work, we would include two factors: Noise and randomness. We would include different intensity of noise in different sub-carriers and would show the change in error rate as the signal passes through the channels. Another factor included for variation is randomness. By adding randomness we can depict the variation occurring in the signal that can lead to distortion also. And in this case channel sensing becomes desirable. For showing randomness factor we are using rand function. In this function after modulation signal from different subcarriers is verified against calculated BER (Bit Error Rate). In this way signal from each sub-carrier is verified noise and the result shows parallel output for all the sub-carriers (gradually). Here, firstly describe the number of active users for our scheme. Use 16active users per channel. For transmission signals from different sub-carriers are converted into digital form before transmission and are send in the combination of 0's and 1's (bits) simultaneously. In digital form, these are represented as I-Waveform and Q-Waveform where I-waveform represents odd bits and Q-waveform represent even bits. I/Q waveforms show any change in magnitude or phase of the signal being send. These are more prevalent in Radio Frequency communication system and mainly where signal modulation is involved because of its efficient way of signal modulation while transmitting the signal. Here converting carrier sine waves into me I /Q waveforms because signal modulator that manipulates amplitude and phase is much expensive and less flexible in sine waveforms as compared to circuit used for I/Q waveforms. In between transmission and receiving of the signal, channel sensing would be done. For this purpose we have generated an array of clock timer for sensing purpose. At receiver side, signal is received as combination of even and odd waveforms collectively and parallel. Next step is to filter the signal using low pass filter and Kalman filtering method to improve the signal further. The signal is then analyzed sensing time and throughput.

3. SIMULATION TOOL

MAT LAB is used as simulation tool.

4. SIMULATION RESULTS

Parameters used for analysis are:
Number of blocks generated=100, wavelength=10,000nm, normalized sampling frequency=5-20MHz, random function=Rand (Matlab), number of input samples=100, carrier spacing=5KHz, bandwidth=20nm, number of active users=16.
The generated signal is shown by the following graph:



We analyze the performance of OCDMA in case of fading, Gaussian noise and jammer noise. The following graphs show the results:

IN CASE OF FADING

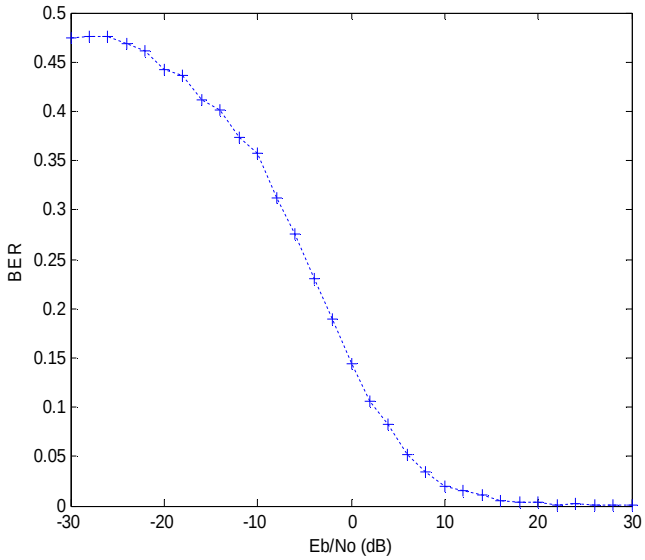


Fig.1 (EB/No. vs. BER) Represent the Difference between Normalized SNR to Bit Error Rate in Small Scale

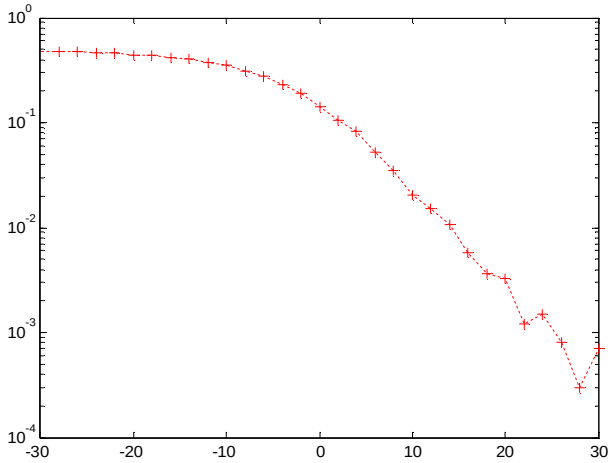


Fig.2 (EB/No. vs. BER) Represent the difference between Normalized SNR to Bit Error Rate in Large Scale

IN CASE OF GAUSSIAN NOISE

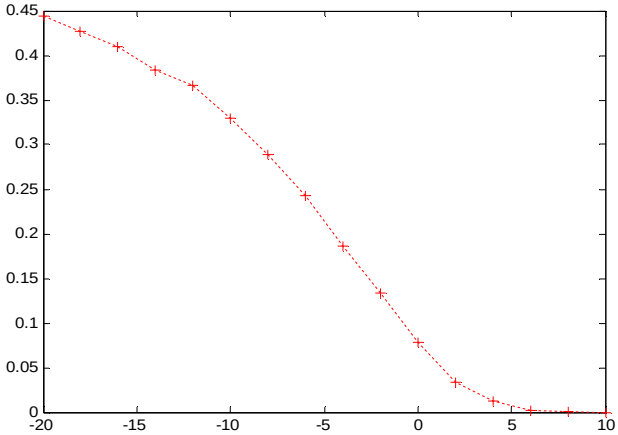


Fig.3 (EB/No. vs. BER) Represent the Difference between Normalized SNR to Bit Error Rate in Small Scale

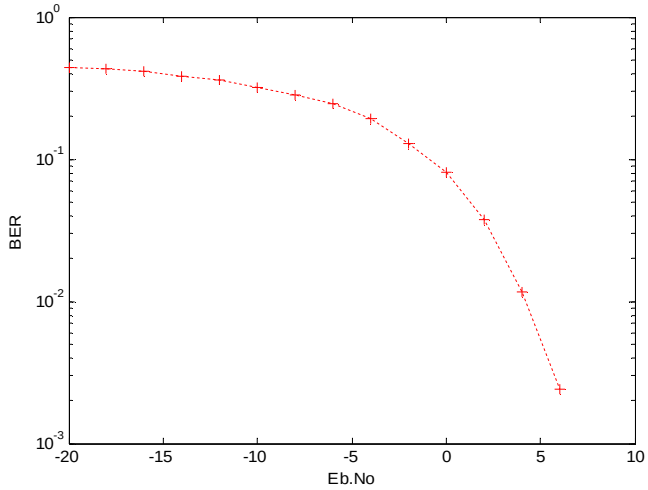


Fig. 4 (EB/No. vs. BER) Represent the Difference between Normalized SNR to Bit Error Rate in Larger Scale**.**

IN CASE OF JAMMER NOISE

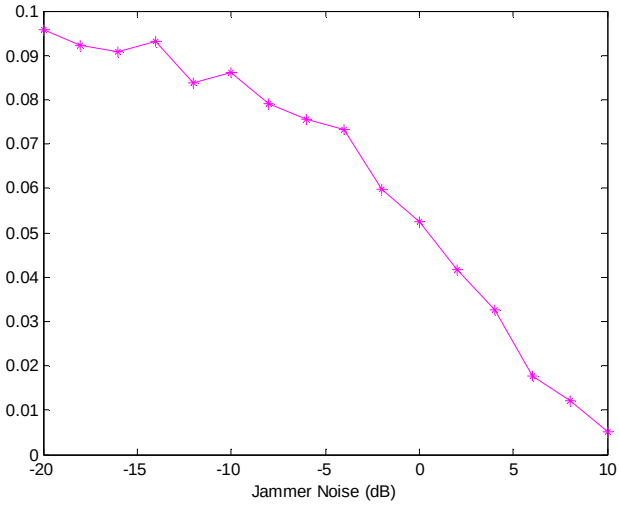


Fig. 5 (EB/No. vs. BER) Represent the Difference between Normalized SNR to Bit Error Rate in Small Scale

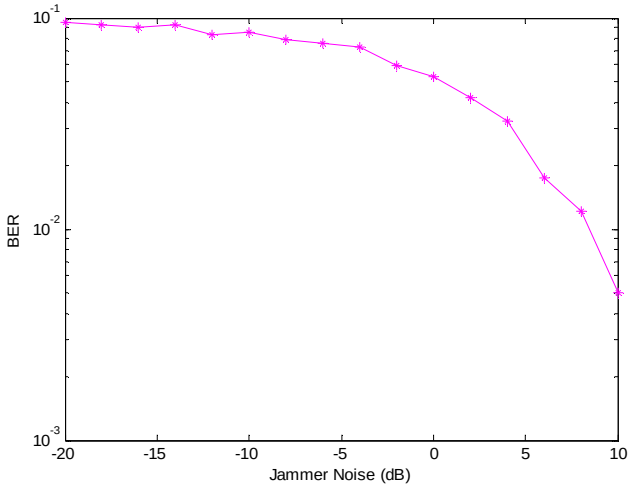


Fig. 6 (EB/No. vs. BER) Represent the Difference between Normalized SNR to Bit Error Rate in Large Scale

5. CONCLUSION

The proposed work is the improvement of OCDMA with the concept of orthogonal approach. This approach is presented here to improve the network reliability in case of Noisy and the fading Channel. The system presented here, provide an enhanced throughput mechanism to provide the efficient communication over the network. We observe that a high power of optical transmission is required in order to maintain a BER number of users The proposed work considered the jammer noise and Gaussian white noise with MAI. We also observe the behaviour of the OCDMA system by analysis the x, y scatter diagram of OCDMA system. We observe that when the fiber length is decreased, the index of noise effect of the optical fiber increased. In addition BER performance degrades due to the noise effect in the OCDMA system.

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