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Performance Analysis of OCDMA System Using Gold Code

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Abstract

Code Division Multiple Access (CDMA), have been the main thrust behind a vast number of research activities. CDMA is technology for digital transmission of radio signal in telecommunication systems. In this technology, multiple users can transmit the data simultaneously in a channel using same frequency. Each user is assigned a distinguished code for transmission. There are different codes used for this purpose. The performance of any CDMA system is largely determined by the choice of the spreading codes which are used as a signature code for the users in such a system. However, depending upon the system requirement, the selection of spreading code has been the most important task on which a proper attention is required**.** Here, PN sequence and Gold sequence are generated using MATLAB Programming. Here, transmitted data is generated randomly using MATLAB function. During transmission, SNR (Signal to Noise Ratio) values of signal changes to calculate BER (Bit Error Rate) values to plot BER vs. SNR graph.

Keywords—AWGN, BER, BPSK, CDMA, Gold code, OCDMA, SNR.

INTRODUCTION

There has been a tremendous interest in applying Code Division Multiple Access (OCDMA) techniques to fiber optic communication systems. This technique is one of the multiple access schemes that are becoming popular because their advantages such as the flexibility in the allocation of channels, ability to operate asynchronously, enhanced privacy and increased capacity in burst networks (1). So here we use an optical domain because of their low loss and wide bandwidth. Optical fibers have a flat transfer function beyond 100 MHz and very low loss compared to other domain.

In order to make full use of available bandwidth in optical fiber, it is necessary to multiplex low rate data streams. There are three types of multiplexing techniques in optical domain.

- Wavelength division multiple access (WDMA)
- Time division multiple access (TDMA)
- Code division multiple access (CDMA)

As here we use CDMA, alternative to TDMA and WDMA networking schemes because it requires neither the time nor the frequency management systems. OCDMA can operate asynchronously, without centralized control, and it does not suffer from packet collisions. As a result, OCDMA systems have lower latencies than TDMA or WDMA. Furthermore, since time and frequency (or wavelength) slots do not need to be allocated to each individual user, significant performance gains can be achieved through multiplexing. Also, TDMA and WDMA systems are limited by hardware because of the slot allocation requirements. In contrast, OCDMA systems are only limited the tolerated bit error rate relationship to the number of users, affording the designer a much more flexible network design. (1)(2).

CDMA is a "spread spectrum" technology, allowing many users to occupy the same time and frequency allocations in a given band/space. As its name implies, CDMA (Code Division Multiple Access) assigns unique codes to each communication to differentiate it from others in the same spectrum. In this paper, a new type of orthogonal spreading code (gold code) has been generated by using pseudo-noise sequence as the basic sequence. The corresponding code generation algorithm has been developed in MATLAB 2011. The corresponding BER values of such a system have been plotted under different channel conditions.

GOLD CODE GENERATION

Gold code sequences are useful because a large number of codes can be generated with controlled cross correlation and with same length.

These codes can be created using a shift-register with feedback-taps. By using a single shift-register, maximum length sequences (M-sequences) can be obtained. Such sequences can be created by applying a single shift-register with a number of specially selected feedback-taps. If the shift-register size is n, then the length of the code is equal to 2n-1. The number of possible codes is dependent on the number of possible sets of feedback-taps that produce an M-sequence (3). Here we generate a new gold sequence by using two M-sequences. The actual operation can be performed by EX-OR or modulo-2 addition of two M-sequences of same length. As the length of sequences is same, they can maintain the same phase relationship. Every change in phase position between two M-sequences cause a new sequence to be generated (4). Gold code generator shown in Fig. I.

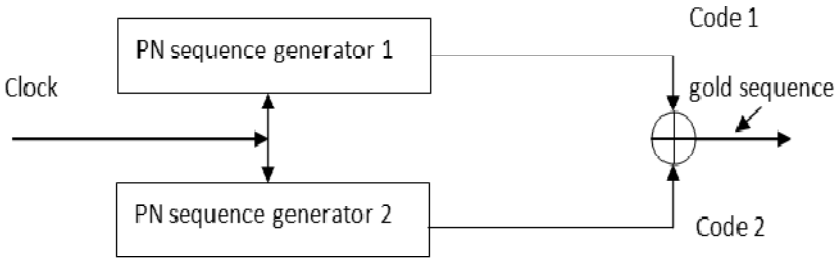

Fig. I: Gold code generator.

PERFORMANCE ANALYSIS OF THE GOLD CODE

The newly generated gold code can produce an enormous number of distinct code members of any particular length, as compared to Walsh code. This proposed code set of length (N+1) can offer as many as ($2N^2$+N) number of distinct members. So in a practical CDMA system, it can support a huge amount of user that would not be possible if Walsh code is used (5).

In our case, we have considered the most commonly used channel: the AWGN (Additive White Gaussian Noise) channel where the noise gets spread over the whole spectrum of frequencies. BER has been measured by comparing the transmitted signal with the received signal and computing the error count over the total number of bits. For any given modulation, the BER is normally expressed in terms of SNR. Here we use a BPSK (Bit Phase Shift Keying) modulation technique (6).

The Gold code has been used as a spreading code in a SIMULINK based multi-user downlink CDMA system model and the resulting BER values have been plotted for different values of channel SNR.

RESULT ANALYSIS

Bit error rate (BER) of a communication system is defined as the ratio of number of error bits and total number of bits transmitted during a specific period. It is the likelihood that a single error bit will occur within received bits, independent of rate of transmission. There are many ways of reducing BER. Here, we focus on spreading code & modulation techniques. In our case, we have considered the most commonly used channel: AWGN channel where the noise gets spread over the whole spectrum of frequencies. BER has been measured by comparing the transmitted signal with the received signal and computing the error count over the total number of bits. For any given modulation, the BER is normally expressed in terms of SNR.

Here first we generate a gold code sequence using two PN-sequences as shown in Fig. II. This sequence is then modulated by BPSK modulation technique as shown in Fig. III.

To plot BER vs. SNR graph in AWGN channel, a predefine function we have used in MATLAB programming. Here, AWGN function is used to define an AWGN

channel. Then gradually the values of SNR increases in AWGN channel and calculate the BER value. Using these values the graph was plotted as shown in Fig. IV.

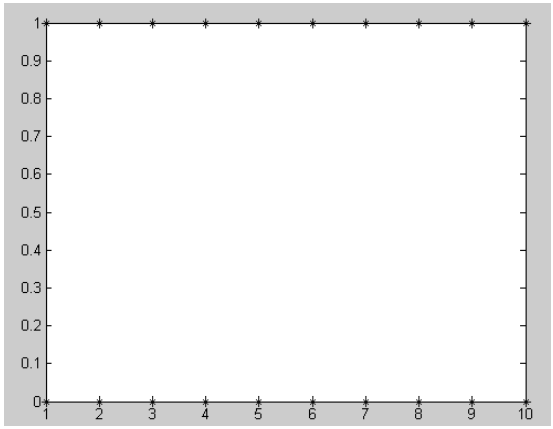

Fig. II: Output of gold sequence generation using matlab.

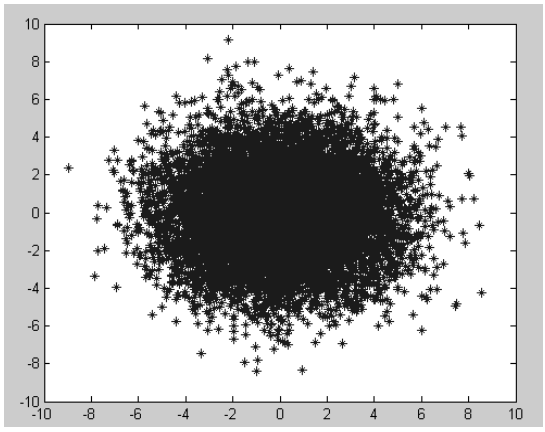

Fig III: BPSK modulation of Gold sequence.

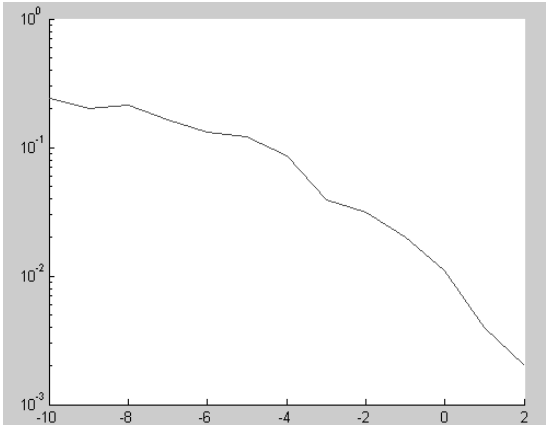

Fig. IV: BER performance in a downlink CDMA system in an AWGN channel.

CONCLUSION

As we know the selection of the spreading code in a CDMA system has been going to be very difficult task for the code designers. If someone tries to increase the number of codes in order to support a high capacity CDMA system, this will have the undesirable effect of higher cross correlation value between the code members. So, this code is such that it can serve both the purpose of capacity and efficiency of spread spectrum system simultaneously. The BER performance of the proposed code looks very much assenting irrespective of the channel and user conditions.

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