
Optimization of CDMA based Wireless System

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Abstract

This paper presents an optimization problem of spreading codes (sequences) in asynchronous Direct Sequence Code Division Multiple Access (DS/CDMA) systems. Bit Error Rate (BER) is one of the performance measurements and it is related to the spreading sequences mathematically. Therefore, the performance of CDMA systems highly depends on the assignment of the unique spreading sequences to the users in which different types and subsets of sequences of a selected sequence type are designed. If the type and the subset of the sequences are not carefully designed, then the Multiple Access Interference (MAI) can be very high. Thus, the channel capacity can be reduced significantly. Hence, proper selection of the type of sequences and its sequence subset are necessary and important to achieve good performance of the system. In this paper, we will use Gold, Kasami and Multiple Spreading [1] sequences as the spreading sequences and apply the genetic algorithm to optimize the sequences such that the MAI is minimized. Although the Multiple Spreading has many advantages over the other PN code, its set of sequences still is not the best if no Genetic Algorithm is applied. Therefore it can be concluded the GA based Multiple Spreading is the best solution to produce PN codes for DS-CDMA system.

1 INTRODUCTION

Direct Sequence (DS) is a well known Spread Spectrum Technique in the current communication system, thus, we are interested in this work. In DS-CDMA, the data signal is multiplied by a Pseudo Random Noise Code (PN code). The codes used for spreading have low cross-correlation values and are unique to every user. This is the reason that a receiver, which has knowledge about the code of the intended transmitter, is capable of selecting the desired signal but other receiver only refer the signal as noise. Multiple Access (MA) is another important consideration in wireless communication system. It means that multiple, simultaneous users can be supported by the wireless system. In other words, a large number of users share a common pool of radio channels and any user can gain access to any channel (each user is not necessary assigned to the same channel). A multiple access method is a definition of how the radio spectrum is divided into channels and how channels are allocated to the many users of the system. In order to maximize the multiple access capacity, direct sequence code division multiple access (DS-CDMA) system which based on the SS technique is one of the best multiple access method.

However, its high multiple access capacity is limited by the problem of MAI (MA Interference). So, it will be the first problem to be overcome in order to optimize the performance of DS-CDMA system. This multiple-access interference problem exists as all users can use the same frequency band at any time and it can present a significant problem if the power level of the desired signal is significantly lower (due to distance) than the power level of the interfering user. However, this problem can be improved by generating the set of PN code sequences properly for multiple access.

The main objective of this work is to optimize the DS-CDMA based wireless system. All of the PN code generating techniques, have their own pros and cons. Walsh-Hadamard codes is orthogonal but as it uses only discrete carrier frequency, it does not have a single, narrow autocorrelation peak and also the spreading is not over the whole bandwidth. M-sequences, Gold-codes and Kasami-codes can spread over the whole bandwidth and Kasami-codes even have a large code set but all of them are non-orthogonal. So, the system using these codes is easier to suffer from the problem of MAI. Their disadvantages make them impossible to maximize the multiple access capacity and thus degrade the performance of DS-CDMA system. It seems that Multiple Spreading is the best method to generate PN codes as it can provide orthogonal codes within a cell while maintaining mutual randomness between users of different cells. Our work is aimed at finding an algorithm to generate a set of PN codes sequences which can suppress the MAI and so maximize the multiple access capacity of a DS-CDMA system in order to optimize the performance of a DS-CDMA based communication system. The performance of several PN codes generating algorithms will be compared, including Gold code, Kasami code and Multiple Spreading. Simulated Annealing and Genetic Algorithm will also be analyzed to find out the best algorithm to optimize the performance of a DS-CDMA system. The analysis has shown us that the GA based PN codes have better SNR and lower BER. When it is compared with another optimization algorithm - Simulated Annealing, the result shows that Genetic Algorithm is better.

References.

[1] Esmael H. Dinan and Bijan Jabbari "Spreading Codes for Direct Sequence CDMA and Wideband CDMA Cellular Networks", IEEE Communications Magazine, September 1998