SOC 기술을 이용한 새로운 Multi-Code CDMA system의 설계

공형윤, 우일승
울산대학교 전자공학과
Tel: +82-052-259-2194, Fax: +82-052-259-1685

Design of New Multi-Code CDMA System by Using SOC Technique

Hyung-Yun Kong, Il-Seung Woo
Dept. of Electronics, University of Ulsan
Tel: +82-052-259-2194, FAX: +82-052-259-1685
E-mail: hkong@uou.ulsan.ac.kr, wis123@hanmail.net

Abstract

In this paper, we discuss reducing the number of orthogonal code in Multi-Code CDMA (MC-CDMA) system. MC-CDMA system is highlighted for multi-media communication services, but conventional MC-CDMA(CMC-CDMA) systems are needed many more orthogonal codes compared to traditional direct sequence CDMA(DS-CDMA) systems. In this paper, we propose the system which can reduce the number of orthogonal codes using sub-orthogonal code(SOC) technique. We certificate that the performance of the proposed system shows the almost same result under gaussian noise environment as compared to CMC-CDMA system through Monte-Carlo computer simulation method.

I. Introduction

Demand has recently been increasing for multi-media wireless communication with integrated voice, data, and video. To achieve such multi-media services, it is necessary to use high bit rate transmission with several Mbps. One way to achieve high data rate is to use parallel transmission, in which the transmitted high-speed serial data is converted to slow parallel data in several channels [1]. Multi-code Direct Sequence Code Division Multiple Access (MC-DS/CDMA) is one method of parallel transmission technique [2]. MC-CDMA system is an effective technique to achieve high data rates and possible support for multi-media wireless communications. MC-CDMA system is achievable high data rate, but it has some problems. First, the transmitting signals of the orthogonal MC-CDMA system, however, has a large amplitude fluctuation. In contrast, the amplitude levels which are constructed as successive "zero" often appears [3]-[4]. Second, MC-CDMA system, typically many more orthogonal sequences are needed as compared to traditional DS-CDMA systems [4]. In this paper, we propose the solution of the second problem by using SOC method.

II. Conventional MC-CDMA System

In this part, we refer to the system configuration of CMC-CDMA system briefly. CMC-CDMA system uses the parallel transmission, in which the transmitted high-speed serial data is converted to slow parallel data in several channels by orthogonal codes. So, the orthogonality is an important factor in implementing efficient signal multiplexing. The parameters of CDMA that are subject to orthogonality are codes, modulation and frequency. We select walsh codes, which is consisting of M× M sequence and generated by Walsh-Hadamard matrix. Walsh-Hadamard matrix form is shown in formula (1).

$$H_k=\begin{bmatrix} H_{k-1} & H_{k-1} \\ H_{k-1} & \overline{H_{k-1}} \end{bmatrix} \quad (1)$$

Walsh codes are satisfied perfect regularity orthogonal condition and linearity, this represented in formula (2) and (3).

$$\frac{1}{T}\int_0^{T_w} w_j(t)\cdot w_k(t)\,dt=\begin{cases} 1, & j=k \\ 0, & j\neq k \end{cases} \quad (2)$$

$$(j,k=0,1,\ldots,M-1)$$

$$W_j(t)\cdot W_k(t)=W_l(t) \quad (3)$$

$$(j,\ k,\ l\in 0,1,\ldots,M-1)$$

The transmitter of CMC-CDMA system is shown in Fig.1, and transmitted signal can be expressed as shown in formula (4). [3, 5, 6].

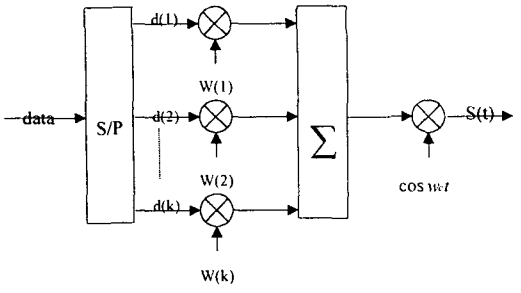

Fig.1 The transmitter of CMC-CDMA system

The transmitted signal is shown in formula(4).

$$s(t)=\sum_{j=1}^{k} d_j\cdot w(j)\cdot \cos w_c t,\quad d_j,\ w(j)=\pm 1 \quad (4)$$

III. Proposed Multi-Code CDMA System

1. The structure of PMC-CDMA system

In this section, we show the way of reducing the number of orthogonal code, which is used in PMC-CDMA, by using SOC technique. PMC-CDMA system can be designed by adding SOC to CMC-CDMA system. SOC means that the code length is shorter than orthogonal code, that is, if orthogonal code is consist of M×M sequence, then SOC is consisted of M/2×M/2 or M/4×M/4 sequence, etc. For instance, if we select one code among the 8×8 orthogonal codes, such as (0, 1, 0, 1, 0, 1, 0, 1) or so on, then M/2M/2 can be represented by following as; sub-w(1)=(0, 0, 0, 0), sub-w(2)=(0, 1, 0, 1), sub-w(3)=(0, 0, 1, 1), and sub-w(4)=(0, 1, 1, 0). The period of orthogonal code and sub-orthogonal code is same, and we can get the following reliability (function (5)) in M/2 case and that is one method of our proposal.

$$8T_w=4T_{sw} \quad (5)$$

where, T_w, T_{sw}: chip duration of orthogonal and sub-orthogonal code

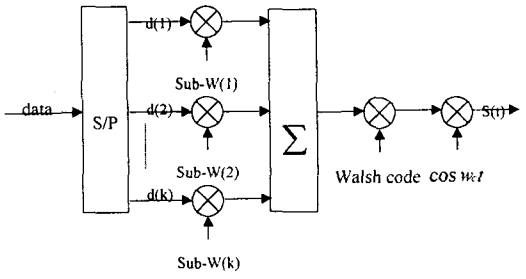

Fig.2 The transmitter of PMC-CDMA system

The structure of PMC-CDMA system is represented

in Fig.3. In Fig.3, we can express the transmitted signal as following;

$$s(t) = \sum_{j=1}^{k} d_j \cdot sub - w(j) \cdot w(i) \cdot \cos w_c(t) \quad (6)$$

$$d_j,\ sub - w(j),\ w(i) = \pm 1$$

where w(i) is i-th orthogonal code

In system suggested here, we propose all users using the same SOCs. Although the same SOCs apply to all users, this system has no problem of detecting the original data in receiver system because the orthogonality is kept up by main orthogonal code, therefore this system can reduce the number of orthogonal code in CMC-CDMA system.

2. Attention Points between Orthogonal Code and Sub-Orthogonal Code

Proposed system has a problem that does not allow the same form between orthogonal code and SOC. For instance, if the orthogonal code is (00110011) and SOC is (0101), which has the same shape when comparing to orthogonal code, then we can not detect the transmitted data at the receiver system and can not use that kind of orthogonal code which has the same form with SOC in time domain. To apply SOC technique to CMC-CDMA system for reducing the number of orthogonal code, we should avoid the same form as stated above when comparing to orthogonal code. So, if the number of orthogonal code is M and the number of SOC is k, then we can use only (M-k) orthogonal codes, which has different shape as compared to SOCs shape, because SOC is always consisted of part of orthogonal codes. In this paper, we propose all users using the same SOC as mentioned before, otherwise the number our useful orthogonal codes are decreased.

V. Simulation Results

We show that the performances of the PMC-CDMA system produce the almost same result under gaussian noise environment as compared to CMC-CDMA system through Monte-Carlo computer simulation. And we also state the conclusion in this section. Fig.4 marks the comparison of BER between two systems, CMC & PMC-CDMA system, in case of 1-user under gaussian noise and represents that the performance of two systems is almost same without regard to the number of SOC which applies to CMC-CDMA system, where M is 64 case. In Fig.5-Fig.7, we plot the performance of PMC-CDMA system in case of 4-users that apply to all users according to different number of SOC, M/2, M/4, M/8.

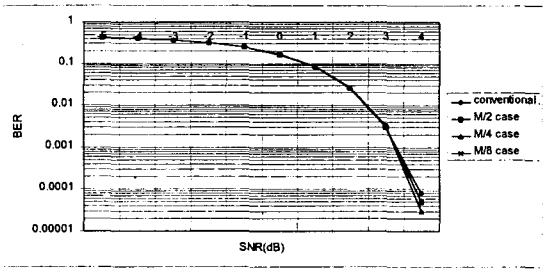

Fig.3 Comparison of the performance between CMC-CDMA and PMC-CDMA system

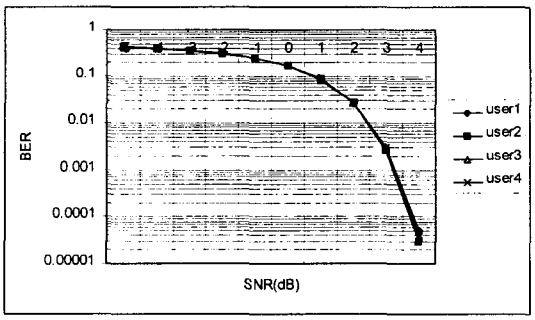

Fig.4 The performance of PMC-CDMA system with M/2 orthogoanl code

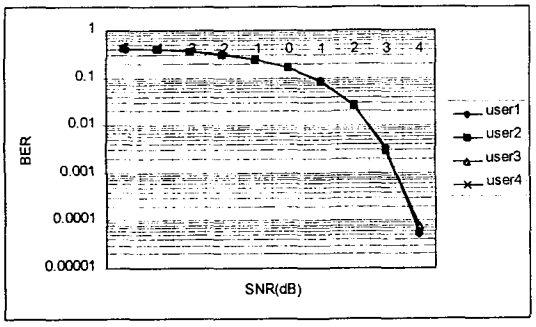

Fig.5 The performance of PMC-CDMA system with M/4 orthogonal code

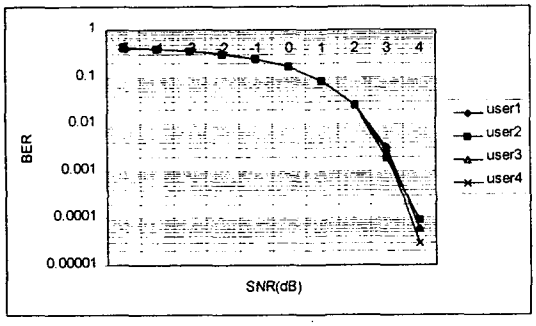

Fig.6 The performance of PMC-CDMA system with M/8 orthogonal code

VI. Conclusions

In this paper, we propose a new system, called PMC-CDMA system, which can prevent increasing the number of orthogonal code in MC-CDMA system by adopting SOC technique. CMC-CDMA system requires many more orthogonal codes when comparing to DS/CDMA system, but proposed system can increase data rate without increasing the number of orthogonal code. Recently, wireless communication system requires high-speed data transmission for multi-media services. PMC-CDMA system is one way to achieve higher data rate for multi-media service. Thus, this system is very useful which system can support the multi-media communication system and many other wireless communication systems.

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