

Hyperchaotic Spread Spectrum Sequences Selection and Its Application in DS-CDMA System¹

Shuying Li^{*}, Huan Lian^{**}, Yaqin Zhao^{***}, and Zhilu Wu^{****}

Harbin Institute of Technology, Harbin, China

**e-mail: hitlishuying@gmail.com*

***e-mail: lianhuan_hit@163.com*

****e-mail: yaqinzhaohit@hit.edu.cn*

*****e-mail: wuzhilu@hit.edu.cn*

Received in final form November 25, 2014

Abstract—In this paper we propose a new algorithm for hyperchaotic spread spectrum sequences selection. Firstly, binary hyperchaotic spread spectrum sequences are generated by a 6-order cellular neural network (CNN). Secondly, we analyze the properties of the sequences according to the P-values and correlation function. Finally, a new algorithm proposed for hyperchaotic spread spectrum sequences selection is based on the properties of hyperchaotic sequences. In order to prove the effectiveness of the proposed selection algorithm, some of the selected hyperchaotic sequences are applied in direct sequence code division multiple access (DS-CDMA) system. Simulation results show that the selected hyperchaotic sequences have better performance than *m*-sequences and have similar performance with Gold sequences. Compared with *m*-sequences or Gold sequences, hyperchaotic spread spectrum sequences are better suitable for secure communication systems.

DOI: 10.3103/S0735272715090022

1. INTRODUCTION

Hyperchaos was firstly proposed by Rossler and defined as a system with two or more positive Lyapunov exponents [1]. Due to its sensitivity to initial value and good randomness property, hyperchaos has been widely used, in particular, in such field as communication and image processing. Compared with common chaos with only one positive Lyapunov exponent, hyperchaos has more complex dynamic behaviors which makes it more attractive for communication systems [2]. Therefore, more and more scholars pay attention to hyperchaos.

In a direct sequence code division multiple access (DS-CDMA) system, different users are recognized by different spread spectrum sequences. Therefore, the correlation properties of these sequences will impact the fading of multipath and multiple access interference, which affects the performance of the DS-CDMA system [3]. In [4], the authors analyzed the characteristics and performance of different spread spectrum sequences in DS-CDMA system. Traditional spread spectrum sequences, such as *m*-sequences and Gold sequences have the following disadvantages: low complexity, bad security and insufficient quantity [5]. Therefore, more and more people are trying to find new spread spectrum sequences to replace the traditional ones. In [6], a new kind of spread spectrum sequences based on Gray and Inverse Gray sequences was proposed. In [7], the authors presented a generic method to construct multiple sets of orthogonal codes for application in direct sequence spread spectrum system. In recent years, hyperchaos theories have been developing rapidly. Hyperchaos shows a good potential for its application in DS-CDMA systems. Hyperchaotic sequences have the advantage of sufficient quantity, and they are more complex than *m*-sequences and Gold sequences, which offers the possibility for application in DS-CDMA systems [8].

Cellular neural network (CNN) was first proposed by Chua and Yang in 1988 [9, 10]. And it is a nonlinear system that can generate chaotic or hyperchaotic phenomenon when particular conditions are satisfied. Hyperchaos in CNN was discovered by P. Arena in a 4-order CNN [11]. In paper [12] the authors

¹ This work was partially supported by the National Natural Science Foundation of China under Grant No. 61102085, and Natural Scientific Research Innovation Foundation in Harbin Institute of Technology under Project No. HIT.NSRIF 201151.