

Pinning synchronization of Hyperchaotic network with time delay via one controller

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Abstract. In this paper, pinning synchronization of unilateral coupled Hyperchaotic network with time delay is investigated. According to Lyapunov stability theory, an appropriate controller and particular Lyapunov function are designed, then the pinning synchronization of a network is realized in which every node is a hyperchaotic Lorenz system. Numerical simulations are given to verify the effectiveness of the proposed method.

Keywords: Pinning synchronization; Time delay; Unilateral coupling

1. Introduction

Synchronization has been studied in many fields [1, 2] and many kinds of it are observed, such as, mutual synchronization [3], chaotic synchronization [4], complete synchronization [5], phase synchronization [6], generalized synchronization [7], etc.. Some approaches have been proposed to reach synchronization of chaotic systems [8-12]. At the same time, with the development of nonlinear dynamics, complex network attracted more and more attention of researchers, for example, the WWW, the Internet, social network and cited network. To know complex network better, many people start to study the dynamics of complex network [13-17]. As an important behavior of complex network, pinning synchronization received much attention in the past few years.

Based on above, pinning synchronization of unilateral coupled hyperchaotic network is to be investigated in this paper. Other parts of this paper are arranged as follows. Hyperchaotic network is presented in Section 2. Scheme to realize the pinning synchronization is introduced in Section 3. Section 4 gives some numerical simulations. Conclusion is shown in Section 5.

2. System description

In this paper, Lorenz system with time-delay is considered as follows:

$$\begin{aligned}\dot{x} &= a(y - x) + rw(t - \tau), \\ \dot{y} &= cx - y - xz, \\ \dot{z} &= xy - bz, \\ \dot{w} &= -yz - dw,\end{aligned}\tag{1}$$

where $\tau > 0$ is the time delay. When $\tau = 0$, system (1) is the hyperchaotic system [18]. If parameters are chosen as $a = 10$, $b = 8/3$, $c = 28$, $d = 1$, $\tau = 1$, system (1) has two positive Lyapunov exponents[19], $\lambda_1 = 0.6513$, $\lambda_2 = 0.1394$. It means that system (1) has hyperchaotic behavior. The hyperchaotic attractors of system (1) are depicted in Fig. 1 (3D overview).

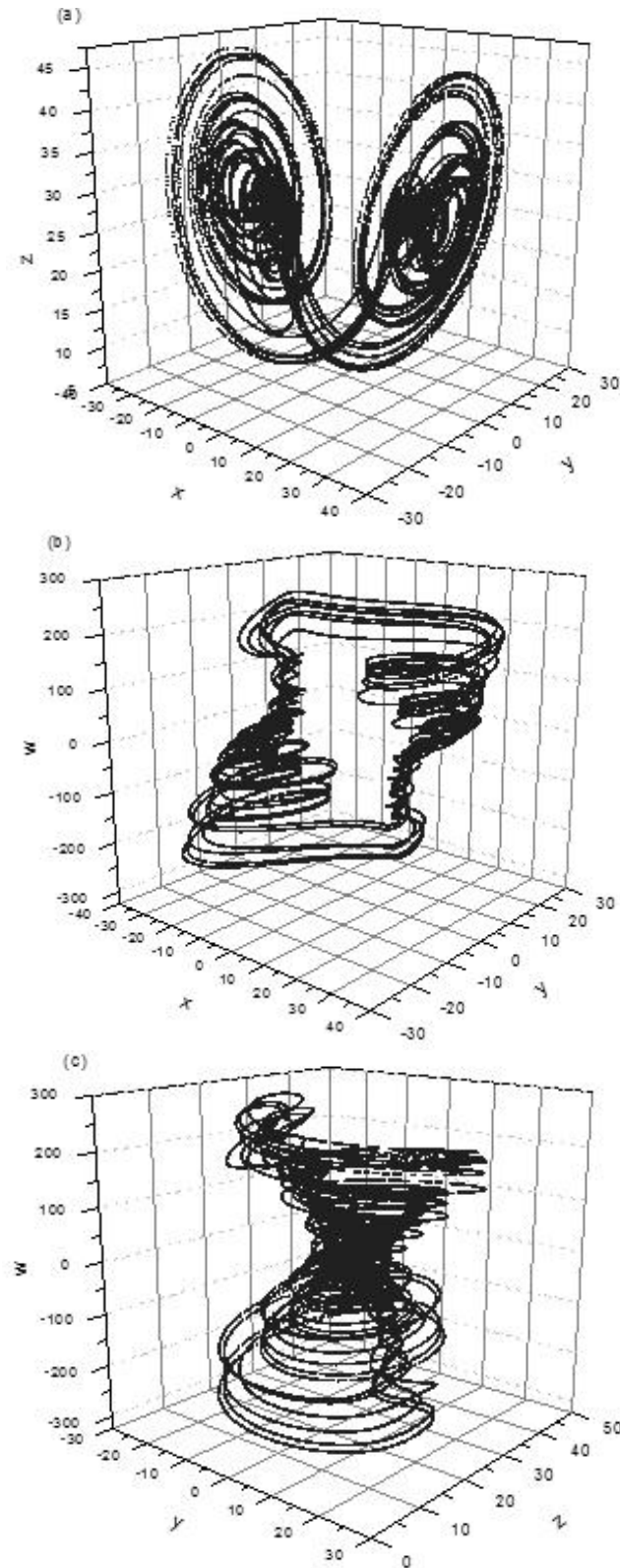


Fig. 1. 3D overview hyperchaotic attractor of system (1) . (a) (x, y, z) , (b) (x, y, w) , (c) (y, z, w) .

The unilateral coupled hyperchaotic system with time delay is expressed as follows.

$$\dot{x}_1 = a(y_1 - x_1) + rw_1(t - \tau),$$

$$\dot{y}_1 = cx_1 - y_1 - x_1z_1,$$