Feedback control of chaos in a hyperchaotic finance system

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Abstract

Based on the mathematical model of a nonlinear finance chaotic system, the complicated dynamical behavior of the model is further investigated. Firstly, the complicated dynamical behaviors of the system are analyzed. Moreover, the feedback control of the nonlinear finance chaotic system is presented. We settle the nonlinear finance chaotic system to equilibrium point with only one controller.

Keywords: Hyper chaotic finance system, chaos control, feedback control

1. INTRODUCTION

Chaos has not a general definition in literature but there are some properties of chaotic systems. The chaotic system is very sensitivity to initial conditions. In order that any nonlinear system is able to behave chaotic, the system must be at least three dimensional for autonomous system and two dimensional for non-autonomous system in the continuous system (N. Noroozi, 2008)

Since the control of chaotic systems is firstly proposed by Ott, Grebogi and Yorke (E. Ott, 1990), chaos control has become one of the much interesting research subject. Over the last decades, many methods and techniques have been developed such as OGY method (E. Ott, 1990), passive control (S. Emiroğlu, 2010) and feedback control (A.E. Matouk, 2008).

Juan Ding (J. Ding et al., 2009) have reported a dynamic model of 4D chaotic finance system, composed of three first-order differential equations with state feedback. The state equations of 4D chaotic finance system are written below Eq 1.

$$\begin{aligned} \dot{x} &= -a(x+y)+w \\ \dot{y} &= -y-axz \\ \dot{z} &= b+axy \\ \dot{w} &= -cxz-dw \end{aligned} \tag{1}$$

where a; b are the parameters of the system (1), and c is constant(where c=0.2), and d is the control parameter.

Using Matlab model of system in Figure 1, when parameters a = 3; b = 15; c = 0:2 and d= 0.12, phase portraits of system are obtained as shown in Figure 2.

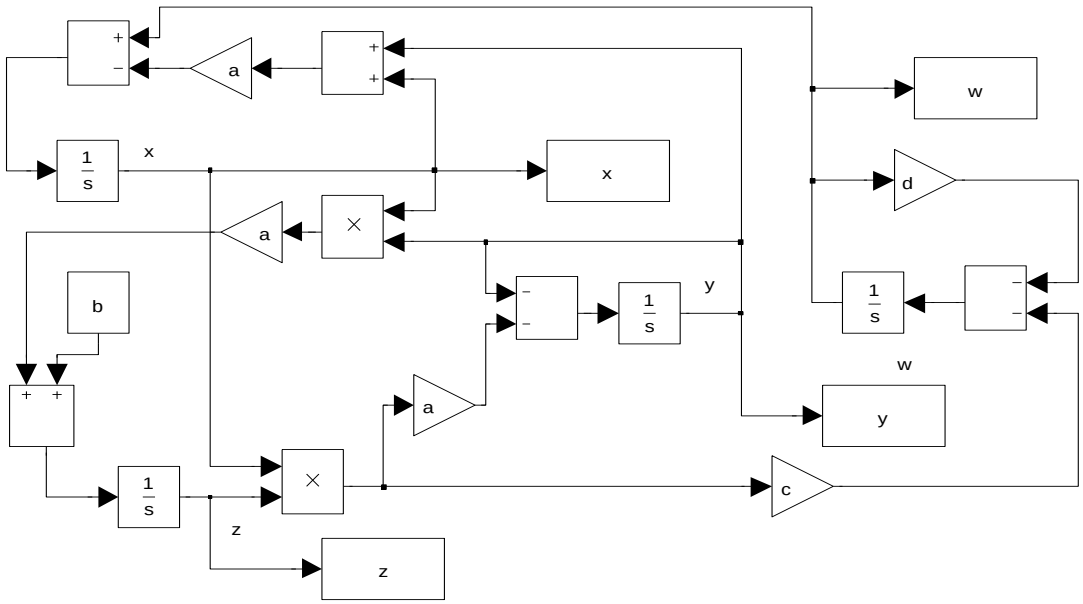

Figure 19. Matlab-Simulink model of hyper chaotic system

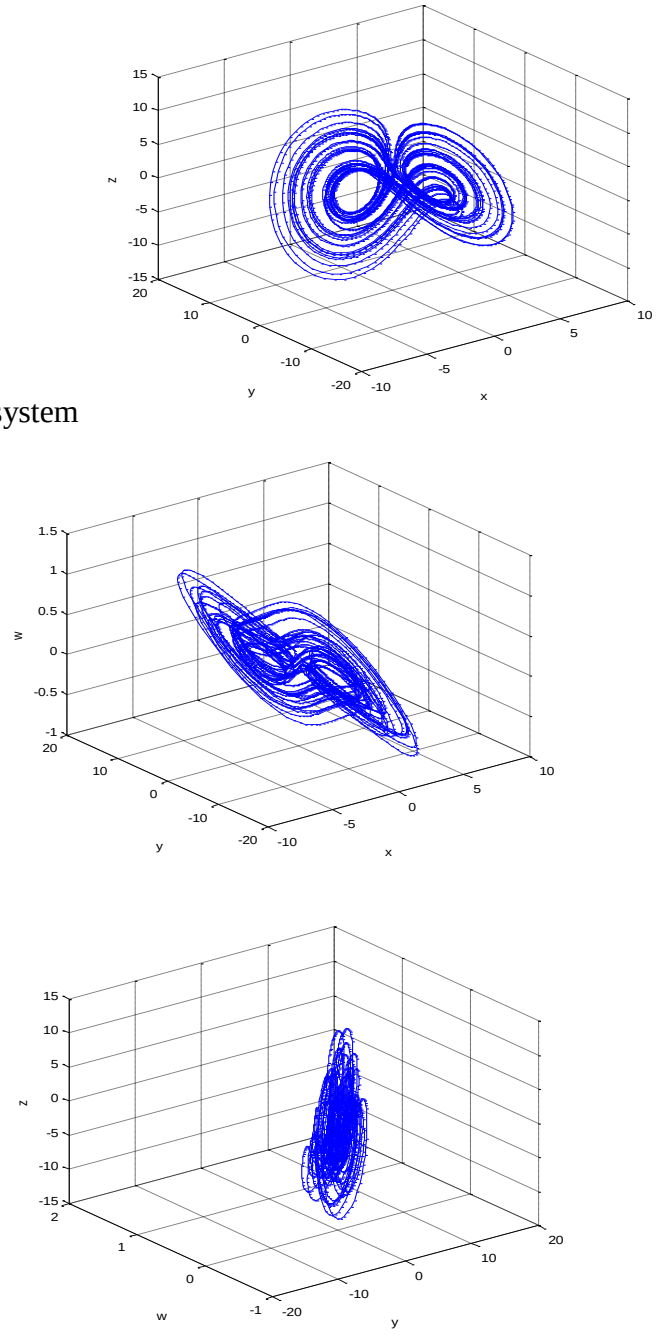

Figure 2 Phase portraits of system

2. FEEDBACK CONTROL OF HYPER CHAOTIC FINANCE SYSTEM

In this section, the control of chaotic system (2) is achieved using feedback control theory. The controlled model given by

$$\begin{aligned}\dot{x} &= -a(x+y) + w - u_1 \\ \dot{y} &= -y - axz - u_2 \\ \dot{z} &= b + axy - u_3 \\ \dot{w} &= -cxz - dw - u_4\end{aligned} \tag{2}$$

where u1, u2 and u3 are external control inputs and are proposed as follows

u1 = k1x, u2 = k2y, u3 = k3z and u4 = k4z

where k1, k2, k3 and k4 are all positive feedback gains. Our aim is to drive the system's trajectory to any of the equilibrium points of the system.

When feedback controllers are activated at t=25 s, time trajectories of finance chaotic system are shown in Figure 3.

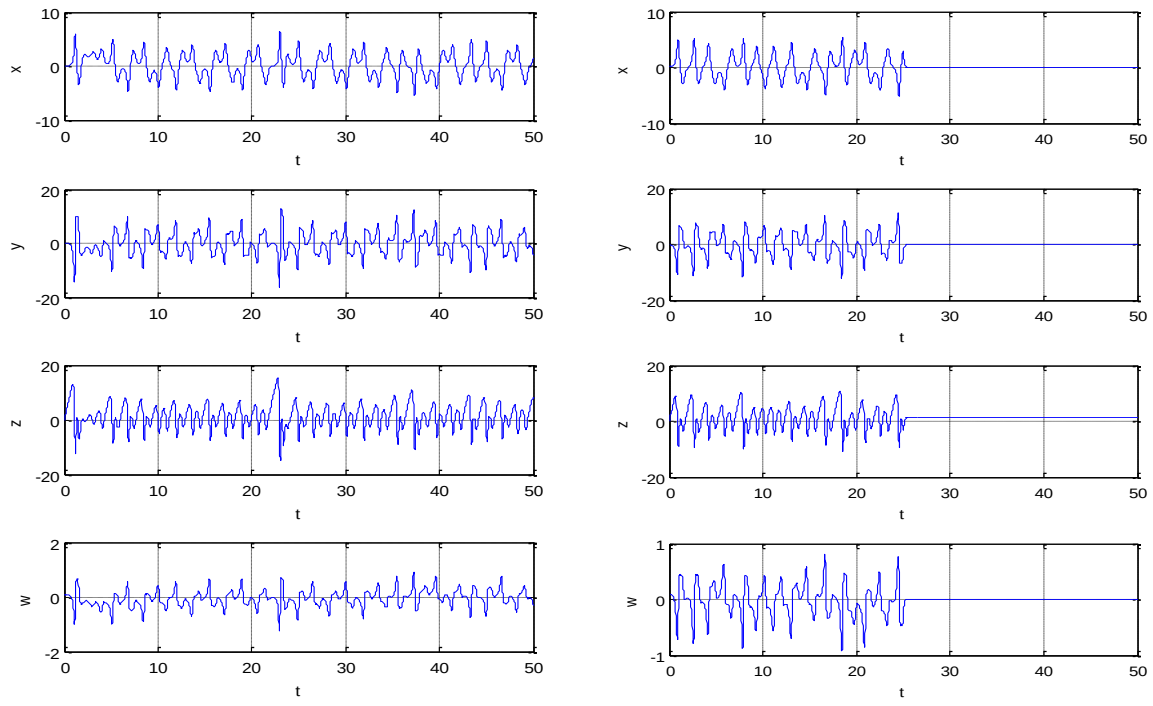

Figure 3 Time series of uncontrolled and controlled chaotic finance system

3. CONCLUSION

This work addresses controlling chaos of finance chaotic system by using feedback control. Based on the feedback theory, feedback controllers are proposed to realize the global asymptotical stability of the controlled system. Numerical simulations show the effectiveness of the proposed control method.

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