Dynamic Analysis of a New 4D Chaotic Financial System

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Abstract: Chaos is a very special subject in nonlinear science and mathematics. Chaotic phenomena were first discovered by Lorenz in 1963 and first given by Li Tianyan in 1975. During the period from 1970 to 1980, the chaos system developed rapidly. In the following decade, more and more scholars in the field of mathematics devoted themselves to the study of chaos theory, and began to try to control and utilize the chaotic financial system. The research done in this paper is not only the innovation in the field of theoretical research, but also the innovation in the field of application, which has great theoretical significance and application price. On the other hand, the superchaotic financial system is not only a very important economic model, but also a very important chaotic model. Since then the system has been discovered and research on the system has never stopped. Based on the control theory of nonlinear system, some new results of the system and its simplified system (chaotic financial system) control and synchronization are obtained.

1. Chaos

Chaos (Chaos), a unique form of motion for nonlinear dynamical systems, is widely found in the natural world, led by various sciences such as physics, chemistry, economics, biology, and technology, science and social sciences. Chaos is not actually "mixed ", that is, not pure" orderly ", but the unity of the two, with inherent regularity and universality, the content contains rich information resources and the potential of exploitable applications. for a given initial or initial state, chaotic systems all give a deterministic solution or process, that is, the long-term kinetic behavior of the system can be theoretically pre-determined. But for a nonlinear economic system, the above process may be normative behavior, or it may cause a huge change in the result or process because of the minimal disturbance to the initial value, that is, the dependence of the system on the initial value is very "sensitive ", which is commonly referred to as the butterfly effect.

In many research fields, nonlinear science has attracted more and more attention, and there are many scientific phenomena in this subject. In a word, chaotic system is a phenomenon that people pay more and more attention to. The research on it is also called chaotic system. Chaos is an advanced form of motion, which is mainly characterized by the extreme sensitivity of initial values. For example, the well-known far-oxygen effect refers to the subtle changes caused by the obvious after. after a series of chain reactions, this can be explained as the extreme sensitivity of small initial values, but this does not mean that the chaotic motion is either normal linear motion or irregular brownian motion. to be exact, the chaotic motion is caused by the dissolution and nonlinear transport of deterministic systems. In the process of decomposition, the chaotic system shows the decrease and stability of the phase volume, while in the process of nonlinear motion, chaos leads to the instability of the orbit, which gradually deviates from the local orbit, and chaos is a strange and complex moving side. The structure of chaotic motion has infinite particularity, and the two-dimensional chaotic system will inevitably produce an intersection point in the orbit, while the topology of the non-sensitive point is close to the two-dimensional autonomous system; the orbit

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can not be intersected. In general, the chaotic dimension of the autonomous system is three-dimensional.

Figure 1 Finance

2. Chaotic Calm of Four-Dimensional Superchaotic Financial System

Chaotic system stabilization: A suitable controller is designed. The chaotic system is asymptotically stable under the action of the controller. In other words, choosing a suitable controller makes the closed-loop chaotic system asymptotically stable. consider the following chaotic systems, where is the state variable of the system, is a nonlinear smooth vector function, and the origin is an equilibrium for the chaotic system. If the chaotic system is satisfied, it is called chaotic system to calm down.

For the chaotic motion system to achieve a calm state, there are many forms, from the practical operational simplicity point of view, the most suitable is linear feedback. However, this method is not perfect in terms of the difficulty of calculating the gain constants of linear feedback. At the beginning of the new century, Shanghai scholar Huang Debin found a new breakthrough, he used adaptive control method and linear feedback method to solve this long-standing problem, and later defined it as class linear feedback control. This method can be said to be a good way to calm the chaotic motion system, which integrates simplicity and generality. However, after careful deliberation, I still think that huang debin's linear feedback controller has some shortcomings. A necessary condition of Huang Debin's linear feedback controller method is that all chaotic systems must meet the requirements of the consistent Li spectrum. Recent literature studies have concluded that the adaptive control method of the class linear feedback controller can be used even if it does not satisfy the consistent lich condition. Second, the number of feedback gain constant is too large, if the dimension of chaotic system is relatively large, it is difficult to find a way to make chaotic motion system to achieve calm, third, Huang Debin's linear feedback controller method ignores the controllable characteristics of chaotic system. The controller obtained by using Huang Debin's method redundantly contains all the states of the chaotic system, which is not easy to become a reality in practice. Although Huang Debin made a simplified explanation of his linear feedback controller, the author found that his idea was a problem. In this paper, we re-improve huang debin's linear feedback controller, correct the lack of strong application conditions, too many feedback gain constants, ignore the controllable characteristics of chaotic system, and get a new linear feedback controller, which contains only one feedback increase. In particular, for hyperchaotic financial systems and chaotic financial systems, the designed controller is a single input controller.

Figure 2 Finance

3. Chaotic Synchronization of Four-Dimensional Chaotic Financial System

Chaotic synchronization is defined as two different initial values of the same chaotic motion system under the action of the controller to achieve the same pace, we call the chaotic motion system up to the track. An overview of chaotic system synchronization is given below. consider a chaotic system, where the state variable of the system is a smooth nonlinear vector function. Let the chaotic system be the main system, then the corresponding slave chaotic system. which is the control to be designed. Then the error chaotic system is: if satisfied, the main chaotic system and the slave chaotic system reach the same. Chaotic system synchronization means that the main chaotic system and the motion state from the chaotic system can reach one. In fact, the main chaotic system and the synchronization from the chaotic system are the towns of the error system of these two systems. Therefore, the study of chaotic system synchronization problem is actually the study of the main chaotic system and from the chaotic system error system stabilization problem. In recent studies, there are more and more researches on chaotic synchronization problem. The relevant literature and theories on this problem also have some skills of chaos control and methods of chaos control.

OGY control method
Adaptive control method
Delay Feedback Control
Pulse control method proportional to system variables
Variable Feedback Control
Driving response synchronization method
Fuzzy Control Method

These representative methods have been successfully applied in many fields. Specifically, at the beginning of the new century in the fields of secure communication, laser physics, signal processing, chemical reaction, biomedicine and so on, shanghai scholar huang debin found a new breakthrough. This method can be said to be a good way to calm the chaotic motion system, which integrates simplicity and generality. However, after careful deliberation, I still think that huang debin's linear feedback controller has some shortcomings. A necessary condition of Huang Debin's linear feedback controller method is that all chaotic systems must meet the requirements of the consistent Li spectrum. Recent literature studies have concluded that the adaptive control method of the class linear feedback controller can be used even if it does not satisfy the consistent lich condition. Second, the number of feedback gain constant is too large, if the dimension of chaotic system is relatively large, it is difficult to find a way to make chaotic motion system to achieve calm, third, Huang Debin's linear feedback controller method ignores the controllable characteristics of chaotic system. The controller obtained by using Huang Debin's method redundantly contains all the states of the chaotic system, which is not easy to become a reality in practice. Although Huang Debin made a simplified explanation of his linear feedback controller, the author found that his ideas were actually problematic.

Figure 3 Finance

4. Chaotic Counter-Synchronization of Four-Dimensional Superchaotic Financial System

The definition of chaotic inverse synchronization refers to the consistent state of two identical chaotic systems with different initial values in the closed-loop chaotic system under the action of the controller.

Compared with the study of chaotic system synchronization problem, the complexity of anti-synchronization problem of chaotic system is more prominent. The main reason is that the origin of the chaotic system is obviously the equilibrium point of the error system of the principal chaotic system and the slave chaotic system in the study of the chaotic system. However, in the study of the anti-synchronization problem of chaotic system, only some chaotic systems with special properties such as the odd function chaotic system can satisfy the equilibrium of the error system of the principal chaotic system and the slave chaotic system. In this sense, the complexity of the study of the anti-synchronization problem of chaotic systems is more prominent than that of the study of the synchronization problem of chaotic systems, that is, when this situation is encountered, some variables of chaotic systems sometimes can not achieve anti-synchronization, and sometimes we need to input feedback to achieve the desired results. It is worth noting that the research on anti-synchronization of chaotic system is becoming more and more popular at the present stage. Although the research on anti-synchronization of chaotic system is very promising and valuable, the research on anti-synchronization of chaotic system has made great achievements. However, the research on anti-synchronization of chaotic system is now in its primary level for a certain period of time.

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References

[1] Chen, Jie., He, Chun., Yang, Xiao. Financial market stability study based on quantile regression technique. Finance, no. 04, pp. 59-68, 2013.

[2] Dong, Jun., Pan, Yun. chaotic dynamics behavior of agents. Information and Control, vol. 28, no. 1, pp. 5-7, 1999.

[3] Yu, Xiao. Rossler system dynamics behavior study and chaos suppression. Industrial Instrumentation and Automation Devices, no. 4, pp. 6-8, 30, 2013.

[4] Qin. A study of the dynamic behavior of a class of 3D chaotic systems. Journal of Northeast Normal University (Natural Science Edition), vol. 47, no. 1, pp. 48-52, 2015.

[5] Zhang, Fuchen., Chen, Rui., Chen, Xiusu., Li, Ruyi., Zeng, Siao. he Yi. study on the dynamic behavior of two types of lorenz-type chaotic models. Journal of Chongqing Industrial and Commercial University (Natural Science Edition), vol. 35, no. 2, pp. 14-17, 2018.