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Passive and impulsive synchronization of a new four-dimensional chaotic system

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ABSTRACT

This paper studies the synchronization problem for a new chaotic four-dimensional system presented by Qi et al. Two different methods, the passive control method and the impulsive control method, are used to control the synchronization of the four-dimensional chaotic system. Numerical simulations show the effectiveness of the two different methods.

1. Introduction

In 1963, Lorenz found the first chaotic attractor in a simple three-dimensional autonomous system [1]. Later, an even simpler three-dimensional chaotic system, which has only one cross-product term, was constructed by Rössler [2]. In 1999, Chen and Ueta presented another well-known three-dimensional chaotic system [3], referred to as the Chen system, that has been proved to be dual and topologically nonequivalent to the Lorenz system. Thereafter, the Lü system [4], a critical system between the Lorenz and Chen systems, was constructed in 2002, followed by the Lorenz system family [5] as a connection of Lorenz, Chen and Lü systems; already, many researchers have studied chaos theory [6].

During the last few decades, dynamic chaos theory has been deeply studied and applied extensively in many fields, such as secure communications, optical systems, biology and so forth [7].

Recently, Qi et al. [8] constructed a new 4D autonomous chaotic system, which has cubic cross-product nonlinearity in each equation. This system can generate complex dynamics within wide parameter ranges, including chaos, Hopf bifurcation, period-doubling bifurcation, periodic orbits, sinks and sources, and so on [9].

The problem of chaos synchronization is directly related to the observer problem in control theory. In general, the designed controller with the state variable of the master will make the trajectories of the state variables of the slave system track the trajectories of the state variables of the driver system [10].

So far, many different techniques and methods have been proposed for achieving chaos synchronization, such as the OGY method [11], the linear feedback method [12], the adaptive synchronization method [13], the backstepping nonlinear control method [14], the sliding mode control method [15], active control [10] and the projective synchronization method [16].

In the present paper, the passive control and impulsive control methods are applied to synchronize two new identical chaotic four-dimensional systems presented by Qi et al. Numerical simulations show the effectiveness of the two different methods.

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