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Analysis and Adaptive Control Synchronization of a Novel 3-D Chaotic System

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Abstract: In this paper, a new 3D chaotic system is introduced. Basic dynamical characteristics and properties of this new chaotic system are studied, namely the equilibrium points and their stability, the Lyapunov exponent, Lyapunov exponent spectrum and the Kaplan-Yorke dimension. Also, we derive new control results via the adaptive control method based on Lyapunov stability theory and the adaptive control theory of this new chaotic system with unknown parameters. The results are validated by numerical simulation using Matlab.

Keywords: *chaotic system; strange attractor; Lyapunov exponent; Lyapunov stability theory; adaptive control; synchronization.*

Mathematics Subject Classification (2010): 37B55, 34C28, 34D08, 37B25, 37D45, 93C40, 93D05.

1 Introduction

In mathematics and physics, chaos theory deals with the behavior of certain nonlinear dynamical systems that under certain conditions exhibit a phenomenon known as chaos, which is characterised by a sensitivity to initial conditions [1]. Chaos as an important nonlinear phenomenon has been studied in mathematics, engineering and many other disciplines. Since Lorenz discovered a three-dimensional autonomous chaotic system [2], many other systems have been introduced and analysed, we mention the Chen, Rössler and Lü systems [3,4,5]. After that hyperchaotic systems were constructed using many different methods. The synchronization of two chaotic systems was introduced in the work of Pecora and Carroll [6], then many different methodologies have been developed for synchronization of chaotic systems such as the OGY method [7], active contol method [8], sliding mode control [9], backstepping control [10], function projective method [11], adaptive control [12-14], etc.

In this work, a new chaotic system is introduced and we derive new control results via the adaptive control method based on Lyapunov stability theory and the adaptive control theory for this new chaotic system with unknown parameters. The results are validated by numerical simulation using Matlab.

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