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CONTROLLING A CHAOTIC SYSTEM TO HYPERCHAOTIC

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Abstract. This paper proposes a new four-dimensional continuous autonomous hyperchaotic system, which is constructed based on the Lü system by introducing a nonlinear state feedback controller. Some dynamical properties, including equlibria, stability, Lyapunov exponents spectrum and bifurcation, of this hyperchaotic system are investigated in detail. Moreover, a novel analog circuit is also designed for verification of various attractors.

Keywords. Hyperchaos; feedback control; bifurcation; circuit realization

1 Introduction

Over the last two decades, hyperchaos has been intensively studied in many engineering-oriented applied fields, such as nonlinear circuits [1, 2], secure communications [3], lasers [4], neural networks [5], control [6] , synchronization [7], and so on.

Hyperchaotic system is usually defined as a chaotic system with at least two positive exponents, implying that its dynamics are expended in several different directions simultaneously. It means that hyperchaotic systems have more complex dynamical behaviors which can be used to improve the security of a chaotic communication system. Therefore, the theoretical design and circuit realization of various hyperchaotic signals have recently become the focal research topics [2, 8-10].

Historically, hyperchaos was firstly reported by Rössler [11]. However, the hyperchaos was firstly discovered in electronic circuits by Matsumoto and his colleagues [12]. Over the last two decades, there are various hyperchaotic systems discovered in high-dimensional systems. Typical examples are hyperchaotic Rössler system [11], 4D hyperchaotic Chua's circuit [13], hyperchaotic modified Chua's circuit [9]. Very recently, hyperchaos was found numerically and experimentally by adding a simple state feedback controller [10, 14, 15] or a sinusoidal parameter perturbation controller [16] in the gen-