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A hyperchaotic memristor system with exponential and discontinuous memductance function

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Abstract

Most of the memristor chaotic and hyperchaotic oscillators discussed in the literatures use the cubic flux controlled memristor model. The drawback of this model is that in spite of knowing the terminal voltage polarity, one cannot easily determine whether the memductance increase or decrease. Hence we propose new memristor hyperchaotic oscillators derived using exponential memductance and discontinuous memductance functions. Dynamical analysis of the proposed oscillators are conducted using equilibrium points, stability of equilibrium, Eigen values and Lyapunov exponents. Bifurcation plots are derived to understand the parameter dependence of the proposed oscillators. Multistability and coexisting attractors are exhibited by these memristor oscillators.

Keywords: memristor; hyperchaos; exponential memristor; discontinuous memristor;

1. Introduction

A memory system is the one which remembers past stimulus and in electromagnetic concept, it was proposed by Chua and Kang [1] as a class of device exhibiting similar behaviors. Portrait the relationship between flux and charge led to prologue a system with memory characteristics, remembering the charge, voltage or current that passed through it. Such a system is formulated and called “Memristor”. Many literatures discussed historical evolution of memristor and its characteristics also impact on advancement of analogue applications [2–12]. Various types of memristor models, such as ideal flux or charge-controlled memristors [16–21], generalized voltage-controlled memristors [22-24], and nonideal voltage-controlled memristors were studied in [2–4]. The intricate nonlinear characteristics of memristor naturally engenders chaotic behaviors in a system, which facilitate to articulate complex systems [13–15].

The Lyapunov exponent is a quantity that describes the rate of separation of infinitesimally close trajectories. A system should possess minimum one positive Lyapunov exponents to categorize as chaotic systems [30]. Hyperchaotic system is identified as a chaotic system with more than one positive Lyapunov exponent. Rössler framed the first hyperchaotic systems and studied its complex phenomena. A four-dimensional Lorenz-like hyperchaotic system investigated by introducing linear feedback in [31]. Rech et al modified Chua system with cubic polynomial and constructed a new hyperchaotic Chua system [32]. By adding Linear memory element in Qi system another hyperchaotic system is formulated [33]. Existence of Multiple attractors are an interesting topic, which are reported by many researchers [34, 35]. The various coexisting