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GEOMETRIC APPROACH OF BURSTING IN A HYPERCHAOTIC SYSTEM

Behruz Raesi[1] and Khadijeh Horr[2]

[1] e-mail: raesi@shahed.ac.ir,
Department of Mathematics, Basic Sciences School, Shahed University, Tehran, Iran.
[2] e-mail: kh.horr@shahed.ac.ir,
Department of Mathematics, Basic Sciences School, Shahed University, Tehran, Iran.

Abstract

A hyperchaotic system is presented in this paper. The fast subsystem used here, is analyzed by local stability and bifurcation. The basic dynamic properties of the system are investigated by using either theoretical analysis or numerical method. It exhibits extremely rich dynamical behaviors, 2-tori (quasi-periodic bursting), limit cycles (periodic), chaotic and hyperchaotic attractors. We survey paper [1], and in this article, we have developed and correct it.

Keywords: hyperchaotic system, Lyapunov exponent, quasi-periodic bursting, bifurcation.

1 Introduction

The term bursting refers to the dynamic activity in which some variables undergo alternation between an active phase of rapid, spike-like oscillations and a silent phase of near steady state resting behavior. This activity is observed in various electrically excitable biological system such as nerve cells, secretory cells, and muscle bers [2]. Historically, Rinzel [3] firstly made some theoretical slow-fast analysis on bursting oscillations, Most of the mathematical models for bursting oscillations are based on the observation that the systems contain variables of significantly different time scales, so they are described by slow-fast systems. Based on various bifurcation structures occurring in the transitions between steady states and oscillatory states, a comprehensive classification scheme of codimension-1 planar bursters was suggested in [4]. Mathematical models for bursting oscillations often involve a rich structure of dynamic behaviors. Besides periodic bursting solutions, the systems display other types of periodic solutions as well as more exciting behaviors including chaotic dynamics. In this paper, we studied a four-dimensional autonomous system, which has extremely rich dynamics, including 3-torus (triple torus), 2-torus (quasi-periodic), limit cycles (periodic), chaotic and hyperchaotic attractors. Historically, hyperchaos was first reported by Rossler in 1979 [5]. The system can be described by the following differential equations:

$$\begin{cases} \dot{x} = y - x + 15yz - rv \\ \dot{y} = -cx - 5y - xz \\ \dot{z} = xy - (8/3)z \\ \dot{v} = -26y + 13yz, \end{cases} \tag{1.1}$$