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GEOMETRIC APPROACH OF BURSTING IN A HYPERCHAOTIC SYSTEM

Behruz Raesi1 and Khadijeh Horr2
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:

\[
\begin{align*}
\dot{x} &= y - x + 15yz - rv \\
\dot{y} &= -cx - 5y - xz \\
\dot{z} &= xy - (8/3)z \\
\dot{v} &= -26y + 13yz,
\end{align*}
\]

(1.1)