Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **14 (2007)** 603-610

ANALYSIS OF A NEW CHAOTIC SYSTEM WITH THREE QUADRATIC NONLINEARITIES

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Abstract. This paper reports the transformation of the chaotic Chen attractor to another non equivalent chaotic attractor by adding a cross-product nonlinear term to the first equation of the Chen system. Basic properties of the new system are analyzed by means of Lyapunov exponent spectrum and bifurcation diagram. This analysis show that this system has complex dynamics with some interesting characteristics in which there are several periodic regions, but each of them has quite different periodic orbits..
Keywords. New quadratic system, New chaotic attractors, Three nonlinearities, Modified Chen system.
AMS (MOS) subject classification: 37N10.

1 Introduction

The finding of quadratic chaotic attractors is quite a very interesting field in the study of dynamical systems, since many technological applications such as communication, encryption, information storage, uses these chaotic attractors [6]. In addition to the well known quadratic systems [1-2-3-4-5-7-8-9], a new continuous-time three-dimensional autonomous system is presented in this paper:

$$\begin{cases} \dot{x} = a(y-x) + yz \\ \dot{y} = (c-a)\,x + cy - xz \\ \mathring{z} = xy - bz \end{cases} \tag{1}$$

where we add a cross-product nonlinear term to the first equation of the Chen system [4], where the parameters a, b, c are assumed to be positive along this study. Note that the system (1) is symmetric under the coordinate transform $(x, y, z) \longrightarrow (-x, -y, z)$, this transformation persist for all values of the system parameters. Therefore for system (1), the divergence of the flow is given by $\nabla V = \frac{\partial \dot{x}}{\partial x} + \frac{\partial \dot{y}}{\partial y} + \frac{\partial \dot{z}}{\partial z} = -(a - c + b)$, then the system (1) is dissipative when $a - c + b > 0$, and it converges to a set of measure zero exponentially.

The fixed point of system (1) has the form $\left(x = \frac{-ay}{-a+\frac{1}{b}y^2}, y, z = \frac{ay^2}{ab-y^2}\right)$, when $y \neq \pm\sqrt{ab}$, where y is the solution of the equation: