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Dynamical analysis and FPGA implementation of a large range chaotic system with coexisting attractors

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Based on the generalized 3-D Lü chaotic system, this paper presents a new 3-D autonomous continuous chaotic system with a large range parameter $b \in [7,500]$. The system has coexisting chaotic attractors depending on the distances from unstable equilibrium points to a given initial point. The topological horseshoes and entropy are obtained by the aid of the topological horseshoes theory and numerical computations. The results show that the new system is chaotic. Moreover, the system's chaotic characteristics are verified by Multisim simulation and FPGA implementation.

Keywords: chaotic system, coexisting attractors, FPGA implementation, topological horseshoes

1 Introduction

The research and application of chaos theory have been given great attention in many fields since the first chaotic attractor was discovered by Lorenz in the early 1960s [1]. Up to now, various chaotic systems have been proposed, such as Chen System [2], Lü system [3], Liu system [4], Qi system [5], Bao system [6], Pehlivan system [7], Jafari system [8], Sampath system [9], et al. The exploration of new chaotic systems will certainly lead to promote people's understanding on chaotic phenomena so as to further enrich chaos theory and improve its application in secure communication [10], circuit control [11], bioengineering [12], et al.

In general, a 3-D autonomous continuous system can be described by $\dot{\mathbf{y}} = \mathbf{B}\mathbf{y} +$