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On Chaotification and Stabilization of Zeraoulia-Sprott Map

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Abstract: This paper explores the stabilization of chaotic dynamics in the Zeraoulia-Sprott (Z-S) map using both feedback and non-feedback control strategies. By leveraging the stability theorem for discrete systems and the principle that lower energy correlates with greater stability, we systematically investigate the transition from chaos to periodic behavior. The study compares the effectiveness of feedback-based stabilization techniques with a minimum energy approach, analyzing their impact across different periodic orbits and dimensions. Numerical simulations validate the proposed methods, demonstrating their feasibility and efficiency in controlling chaos within the Z-S system. These findings contribute to a broader understanding of chaos suppression in discrete nonlinear systems and offer practical insights into their control applications.

Keywords: *discrete dynamical systems; Zeraoulia-Sprott map; chaos control; chaotification; stabilization; feedback control; minimum energy control.*

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1 Introduction

Nonlinear dynamical systems are essential in many scientific and engineering fields, where discrete-time models can exhibit chaotic behavior, with applications in secure communication, cryptography, neural networks, and control theory. The Zeraoulia–Sprott (Z-S) map, a simple yet complex 2D rational mapping, shows diverse dynamics—periodic, quasi-periodic, and chaotic—making it a valuable model for studying stability and control [1].

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