Nonlinear Dynamics and Systems Theory, **25** (2) (2025) 206–216

Electronic Circuit and Complete Synchronization via Active Backstepping Control for a New Chaotic 3-D Jerk System

A. R. Mamat [1*], M. A. Mohamed [1], S. Vaidyanathan [1,2], A. Sambas [1,3], L. Patria [4] and R. Ramesh [5]

[1] *Faculty of Informatics and Computing, University Sultan Zainal Abidin, Besut Campus 22200, Terengganu, Malaysia.*

[2] *Centre for Control Systems, Vel Tech University, Avadi, Chennai 600062, Tamil Nadu, India.*

[3] *Department of Mechanical Engineering, Universitas Muhammadiyah Tasikmalaya, Tasikmalaya 46196, Indonesia.*

[4] *Department of Information System, Faculty of Science and Technology, Universitas Terbuka, Banten 15437, Indonesia*

[5] *Department of Computer Science and Engineering, KKR and KSR Institute of Technology and Sciences, Vinjanampadu, Vatticherukuru Mandal, Guntur-522017, India.*

Received: July 12, 2024; Revised: April 2, 2025

Abstract: This paper presents the modeling, electronic circuit implementation, and complete synchronization of a new chaotic 3-D jerk system with two quadratic nonlinearities. The proposed jerk system, characterized by the third derivative of its output being a function of lower-order derivatives, exhibits chaotic behavior under specific parameter conditions. The system's dynamics are analyzed, revealing the presence of chaotic attractors through numerical simulations and Lyapunov exponents. An electronic circuit realizing the jerk system is designed using operational amplifiers, resistors, and capacitors, demonstrating chaos through Multisim and MATLAB simulations. Additionally, a backstepping control technique is employed to achieve complete synchronization between the master and slave jerk systems, with potential applications in secure communications and cryptosystems. Theoretical proofs and simulation results validate the effectiveness of the proposed synchronization method.

Keywords: *chaos theory; chaotic systems; dynamical systems; jerk systems; bifurcation; synchronization; backstepping control.*

Mathematics Subject Classification (2020): 34H10, 65P40, 34D06, 34D08, 94C30, 94C60.

* Corresponding author: arm@unisza.edu.my