

## ADVANCED CONTROL OF THE WANG-CHEN CHAOTIC SYSTEM VIA BACKSTEPPING DYNAMIC SURFACE METHOD

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**Abstract.** This study explores the dynamics and control of the three-dimensional Wang-Chen chaotic system via backstepping dynamic surface method, a significant model in the study of chaotic phenomena. A detailed analysis of its dynamical properties, including chaotic attractors and Lyapunov exponents, is performed to elucidate the system's inherent complexity. To regulate the chaotic behaviour effectively, a dynamic surface control (DSC) method based on backstepping approach is proposed. The control strategy is designed to stabilize the system while addressing computational challenges associated with traditional backstepping methods. The performance of the proposed approach is rigorously validated through numerical simulations conducted in MATLAB, demonstrating its robustness and effectiveness in managing the complex dynamics of the Wang-Chen chaotic system.

**Keywords.** Wang-Chen chaotic system, Chaotic attractors, Lyapunov exponents, Backstepping control, Dynamic surface control, Nonlinear systems.

**AMS (MOS) subject classification:** 34C28, 37G35, 93B51, 93C10, 93C80.

## 1 Introduction

Chaotic systems, known for their extreme sensitivity to initial conditions and complex, unpredictable dynamics, are prevalent across various natural and engineered domains [1, 2]. These systems exhibit intricate behaviours observable in natural processes [3, 4], physical systems [5], secure communication [6], engineering applications [7, 8] and chaos synchronization [9, 10, 11, 12]. As a result, their analysis and control are a critical area of research. Effectively managing chaotic systems is essential for preventing instability and achieving desired behaviours.

Over the years, numerous control methods have been developed and studied in the literature [13, 14], including optimal control [15], adaptive control [16, 17, 18], integral sliding mode control [19, 20], fuzzy control [21, 22], event-triggered control [23, 24], backstepping control [25, 26], and dynamic surface