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Dual quadratic compound multiswitching anti-synchronization of Lorenz, Rössler, Lü and Chen chaotic systems

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Abstract. This paper offers a unique synchronization strategy for synchronizing eight chaotic systems. The new approach is referred to as dual quadratic compound anti synchronization. We additionally employed signal multi-switching to augment the complexity of the suggested technique. In communication theory, the transmission and security of the resulting signal are more effective because of the numerous combinations of chaotic systems and multiswitching that provide such complicated dynamic behavior. To demonstrate the acquired results, Lorenz, Rössler, Lü, and Chen chaotic system are used. Using the Lyapunov stability principle, sufficient conditions are attained and appropriate controllers are built to achieve the required synchronization between eight chaotic systems. To validate the findings from theory, numerical simulations, and graphics are presented using MATLAB.

1 Introduction

Over the last few decades, extensive research has delved into the realm of chaos synchronization, leading to the proposal of numerous synchronization schemes and algorithms. Pioneering work in this field was undertaken by Pecora and Carroll in 1990 [1], where they introduced a method for achieving synchronization in chaotic systems through linear feedback. Subsequent to their groundbreaking contribution, a plethora of synchronization strategies and algorithms have emerged, encompassing diverse approaches such as active control, sliding mode control, adaptive control, back-stepping method, and various other techniques [2–5].

Building upon the foundations laid by Pecora and Carroll, researchers have introduced a multitude of methods for synchronizing both identical and non-identical chaotic systems. These approaches include complete synchronization, anti-synchronization, hybrid synchronization, lag synchronization, phase and anti-phase synchronization, function projective synchronization, hybrid projective synchronization, and hybrid function projective synchronization [6–13].

The applications of chaos theory span across diverse domains, influencing fields such as ecology, biology, physics, chemistry, cryptography, economics, engineering, astronomy, and beyond [14–20]. Over the preceding 3 decades, the allure of chaos theory has drawn the interest of researchers hailing from a multitude of disciplines, owing to its significant impact and relevance in various scientific and practical contexts.

Given the unconventional and intricate nature of the dual synchronization scheme, it has captivated the interest of researchers. In contrast to previous scenarios involving a single drive-response system, the dual synchronization approach entails two drive systems and two response systems. The inception of the concept of dual synchronization dates back to 2000, credited to Liu and Davids [21]. Researchers have investigated a variety of schemes with multiple drive-response systems, including combination synchronization, compound synchronization, combination-combination synchronization, dual combination-combination synchronization, compound combination synchronization, double compound synchronization, double compound combination synchronization, anti-difference quadratic compound synchronization, triple compound synchronization, triple compound combination synchronization, etc. [22–31].

Introducing additional intricacy to synchronization schemes, Ucar et al. innovatively introduced the concept of multi-switching of signals [32]. This approach involves the synchronization of various states of the

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