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Chaos synchronization using the Fourier series expansion with application to secure communications

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Abstract: In this paper, a new method for secure communication based on chaos synchronization is proposed. It is consisted of a state feedback controller and a robust control term using the Fourier series expansion for compensation of uncertainties. In comparison with other uncertainty estimators such as neural networks and fuzzy systems, Fourier series are more efficient, since they have fewer tuning. Thus, their tuning process is simpler. Similar to the parameters of fuzzy systems, Fourier series coefficients are estimated online using the adaptation rule obtained from stability analysis. The case study is the Duffing–Holmes oscillator. Also, observer-based secure communication using the Fourier series expansion has been proposed. Simulation results and comparisons, reveal the superiority of the proposed approach.

Keywords: Secure communication, Chaos synchronization, Fourier series, Stability analysis, state observer.

1. Introduction

Due to the widespread applications of chaos in various sciences such as secure communications [1], nonlinear circuits [2], chemical reactions [3], power electronics [4] and laser [5], researches on the characteristics of this phenomenon and its control have been increased considerably. Nowadays, chaotic behavior has widespread applications in electrical engineering. Nanoscale memristor is being recommended as a suitable option to become the important element of novel ultra-high density low-power non-volatile memories. As a result, many researchers have focused on chaos in memristor-based circuits [6]. Fractional-order chaotic systems and their synchronization techniques are also being studied extensively [7]. Chaos has also been applied in the field of image encryption frequently [8]. In real-time implementations, finding two identical oscillators is almost impossible, since we are faced with different sources of uncertainties such as parametric uncertainty and external disturbances which can degrade the communication system performance and increase the