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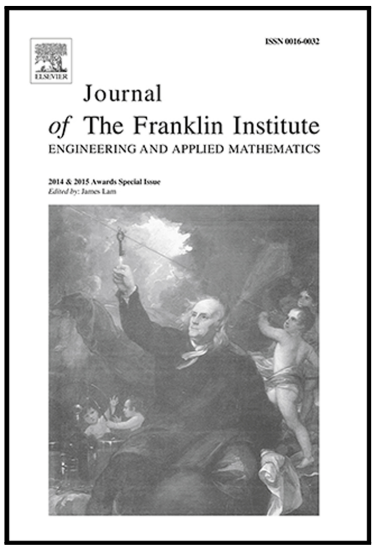

Chaotification of a class of linear switching systems based on a Shilnikov criterion

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Chaotification of a class of linear switching systems based on a Shilnikov criterion

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Abstract

This paper proposes an approach for constructing and generating chaos from a class of three-dimensional linear switching systems via a heteroclinic loop based on the Shilnikov criterion. First, the existence of a switching rule for the system is derived by utilizing the Shilnikov heteroclinic criterion. Then a general design philosophy and its procedure of switching rule are provided to ensure that the proposed approach is applicable to engineering. Two numerical examples are presented to validate the main principle and the implementability of the scheme. Theoretical analysis and numerical simulation are used to demonstrate the feasibility and effectiveness of developed techniques.

Keywords: Chaotification, Linear switching, Shilnikov criterion, Heteroclinic orbit.

1. Introduction

Switching dynamical systems consist of a finite family of subsystems and are controlled by a switching rule. These systems are characterized as "$1+1 \neq 2$" [1] for their variety of dynamic behaviors raised by different switching rules. Considerable interest in research on switching systems has emerged during the last two decades. Many nature or man-made systems with a switching nature are modeled by switching systems [2, 3]. Furthermore, since switching control is easy to implement in real systems, many engineers are interested in its analysis and application in numerous control systems [3–5].

Chaos and chaos-like dynamics have been researched for more than 40 years since the first chaotic attractor was discovered by Lorenz. With the development of research on chaos, there has more attention on effectively generating chaos, especially in specific fields such as mechanical engineering, biomedicine, flow dynamics, power systems, and data encryption [2, 6–11]. Indeed, chaos is important for achieving certain performance level.

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