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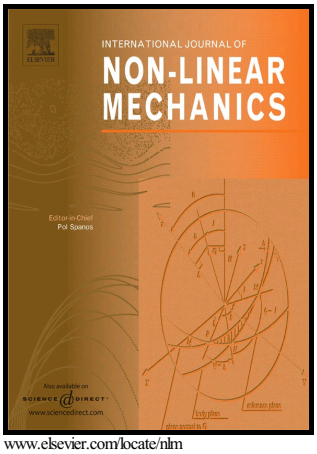

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Dynamics of delay induced composite multi-scroll attractor and its application in encryption

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Abstract

Time delay feedback has been shown to produce chaos from non-chaotic systems. In this paper, besides the single and double scroll chaotic attractors, a new composite multi-scroll attractor is found in stable systems with time delay feedback. From the viewpoint of the local stability analysis, conservation analysis, Lyapunov exponent spectrum and power spectrum, the composite multi-scroll attractor is shown to be a hyper-chaotic attractor. The phase trajectory in the new composite hyper-chaotic multi-scroll attractor diverges in multiple eigen-directions, which improves the security of secure communication and chaotic encryption. A paradigm using the multi-scroll attractor for encryption is proposed, demonstrating its potential applicability.

Keywords: time delay feedback, multi-scroll attractor, hyper-chaotic attractor

1. Introduction

As a dynamical phenomenon in the nonlinear systems, chaos widely exists in nature. The analysis and experimental observation of chaos contribute to deepen the understanding of nature. Since Edward Lorenz developed a simplified mathematical model for the atmospheric convection in 1963[1], numerous efforts have been devoted to understand chaos and the mechanism for generating chaos. Other differential systems, which may exhibit chaos, have been proposed and analyzed later. They include the Rössler system[2], Chua system[3][4], Lü system[5], Liu system[6], and so on. On one hand, the existence of chaos may not be desirable. Since the OGY seminal work on chaos control[7] was proposed, a lot of chaos control methods have been developed, e.g. delay feedback control[8], linear feedback controls[9], fuzzy control[10], adaptive control[11], impulsive control

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