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Original article

Stochastic chaos synchronization using Unscented Kalman–Bucy Filter and sliding mode control

Mahdi Heydari, Hassan Salarieh *, Mehdi Behzad

Center of Excellence in Design, Robotics, and Automation (CEDRA), Department of Mechanical Engineering, Sharif University of Technology, P.B. 11555-9567, Azadi Ave., Tehran, Iran

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Abstract

This paper presents an algorithm for synchronizing two different chaotic systems by using a combination of Unscented Kalman–Bucy Filter (UKBF) and sliding mode controller. It is assumed that the drive chaotic system is perturbed by white noise and shows stochastic chaotic behavior. In addition the output of the system does not contain the whole state variables of the system, and it is also affected by some independent white noise. By combining the UKBF and the sliding mode control, a synchronizing control law is proposed. Simulation results show the ability of the proposed method in synchronizing chaotic systems in presence of noise.

Keywords: Chaos synchronization; Unscented Kalman–Bucy Filter; Sliding mode; White noise

1. Introduction

Chaos synchronization between two identical or different chaotic systems is an attracting field of study in nonlinear dynamics and chaos [5,8,9]. Pecora and Carrol introduced the idea of synchronization between two identical chaotic systems [9,10,31]. Various methods for chaos synchronization have been presented and applied theoretically and experimentally to many chaotic systems [12,21,22]. A basic configuration for chaos synchronization is the drive-response pattern, where the response chaotic system must track the drive chaotic trajectory. In [4,15,23,24,28,32] synchronization of hyper-chaotic systems were investigated and a generalized method for chaos synchronization was proposed [4,28]. Active linear and nonlinear control methods have been used for chaos synchronization between two identical or non-identical systems [5,11,14,15,27,29,38,42,45,52]. Parametric adaptive control has been greatly used in chaos synchronization [38,45]. Besides, many techniques are investigated based on combination of observer and control systems [6,34,40] and applied for both chaos control and chaos synchronization. In [6] the Extended Kalman–Bucy Filter (EKBF) is used as an observer to estimate the states of the drive system. In [19] the problem of chaos synchronization is investigated using adaptive observer design and Lyapunov stability theory. Also some robust nonlinear methods such as variable structure [25,53], H_∞ [1,42] and impulsive [41] robust controllers are used for chaos synchronization. Recently synchronization between two stochastic chaotic systems, i.e. two chaotic systems

* Corresponding author. Tel.: +98 21 6616 5586; fax: +98 21 6600 0021.
E-mail address: salarieh@sharif.edu (H. Salarieh).

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