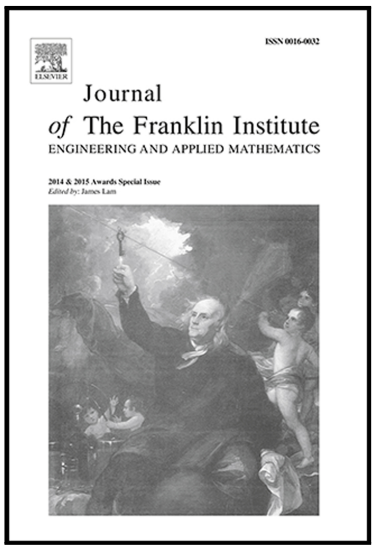

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R. Sakthivel, R. Sakthivel, V. Nithya, P. Selvaraj, O.M. Kwon

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Fuzzy sliding mode control design of Markovian jump systems with time-varying delay

R. Sakthivel[1,2,*], R. Sakthivel[3], V. Nithya[1], P. Selvaraj[3] and O.M. Kwon[4,*]

[1]Department of Mathematics, Bharathiar University, Coimbatore 641046, India

[2]Department of Mathematics, Sungkyunkwan University, Suwon 440-746, South Korea

[3]Department of Mathematics, Anna University Regional Campus, Coimbatore - 641046, India

[4]School of Electrical Engineering, Chungbuk National University, 1 Chungdae-ro, Cheongju 28644, Republic of Korea.

Abstract

This paper studies the robust stochastic stabilization problem for a class of fuzzy Markovian jump systems with time-varying delay and external disturbances via sliding mode control scheme. Based on the equivalent-input-disturbance (EID) approach, an online disturbance estimator is implemented to reject the unknown disturbance effect on the considered system. Specifically, to obtain exact EID estimation Luenberg fuzzy state observer and a low-pass filter incorporated to the closed-loop system. Moreover, novel fuzzy EID-based sliding mode control law is constructed to ensure the stability of the closed-loop system with satisfactory disturbance rejection performance. By employing Lyapunov stability theory and some integral inequalities, a new set of delay-dependent robust stability conditions is derived in terms of linear matrix inequalities (LMIs). The resulting LMI is used to find the gains of the state-feedback controller and the state observer a for the resulting closed-loop system. At last, numerical simulations based on the single-link arm robot model are provided to illustrate the proposed design technique.

Keywords: Markovian jump systems; Fuzzy systems; Sliding mode control; Disturbance estimator.

I. Introduction

Markovian jump systems (MJSs), as a special kind of hybrid systems, consist of a finite number of subsystems and a random switching rule that indicates the active subsystem at each instant of time. Specifically, switching among the subsystems is governed by a Markov chain. In practice, MJSs are more appropriate to model systems which are subject to abrupt changes in their structure and parameters, such as power systems, robot systems and financial systems. Based on this framework, a lot of attention has been attracted to the research of MJSs due to the fact that MJSs are considerably proper to express real-world systems subject to random abrupt changes or sudden environmental changes in their structures. Thus, many research works about MJSs with mode transition applied by a Markov process have been studied [1]–[10]. On the other hand, many of the real-world systems can be described by nonlinear systems which have the serious difficulties in control system and analysis. In recent years, Takagi-Sugeno (T-S) fuzzy model-based approach has been proven to be a powerful tool for modeling nonlinear systems. Moreover, fuzzy-model-based control approach offers a systematic way to tackle nonlinear systems. Therefore, in recent years, a great number of stability analysis and control synthesis results for the class of T-S fuzzy systems in both continuous-time and discrete-time contexts have been extensively discussed in the literature [11]–[14]. In addition, time delays are inevitable in many industrial and practical systems [15]. Therefore, many delay-dependent stability conditions are developed for T-S fuzzy systems with time-delay, for more details about the subject, one can refer [16] and the references therein.

*Corresponding authors: Emails: krsakthivel@yahoo.com (R. Sakthivel) madwind@chungbuk.ac.k (O.M. Kwon)