International Journal of Innovative Computing, Information and Control
Volume **6**, Number **5**, May **2010**

ICIC International ©2010 ISSN 1349-4198
pp. 2055–2064

STATE FEEDBACK CONTROLLER DESIGN FOR A CLASS OF UNCERTAIN SYSTEMS WITH TIME-VARYING DELAYS AND CONTROLLER FAILURES

Limin Wang and Cheng Shao

Institute of Advanced Control Technology
Dalian University of Technology
Dalian, 116024, P. R. China
wlmzfxzqf@yahoo.cn; cshao@dlut.edu.cn

Received October 2008; revised March 2009

Abstract. *The design problem of state feedback controller for robustly exponential stabilization of a class of uncertain systems with time-varying delays and controller failures is investigated in this paper. A switched system model is constructed for describing the considered system. Then, based on switching strategy of average dwell time method, under the condition that the total activation time ratio between the stable subsystem and the unstable one is required to be lower bounded, criteria for the existence of such controllers which guarantee the resulting closed-loop systems exponentially stable are derived and formulated in terms of linear matrix inequalities. A parameterized characterization of the controllers is given in terms of the feasibility solutions to the LMIs. The effectiveness of the proposed robust control scheme is demonstrated by simulation examples.*
Keywords: Robustly exponential stabilization, Controller failures, Average dwell time, Switched systems, Linear matrix inequalities, Time-varying delay

1. **Introduction.** The controller failure problem has been a hot issue since it is often encountered in practical engineering systems, such as networked control systems, inverted-pendulum systems, and so on. Shimemura and Fujita [1] proposed a methodology for the design of state feedback control so that the closed-loop system remains stable even when some parts of the controllers fail. In [2], using two-channel decentralised controller configuration, criteria for the existence of reliable controllers that guarantee linear MIMO plants stable are obtained under the situation that one of the two controllers possibly fails. Due to the case of $u(t) = 0$, in [3], based on the average dwell time method, controller failure time analysis problem was studied, and exponential stability conditions were obtained by restricting the unavailability rate of the controller and the average time interval between controller failures. Subsequently, this result was extended to H_∞ gain case in [4] and the case of dynamical output feedback in [5], respectively. But the above-mentioned papers do not discuss the effect of delay.

In many practical systems, time-delay, as nonlinearities /uncertainties do, may give rise to instability or poor performance of a system [6-8]. In addition, there widely exists a class of feedback control systems composed of an uncontrolled system and a stable feedback controller, such as networked control systems, and so on. When the controller inevitably completely fails due to some known or unknown reasons, the system dynamics will be unstable. It is obviously important to establish some criteria under which the system is still exponentially stable subject to nonlinearities /uncertainties, controller failure and the tine varying-delay. To the best of our knowledge, little results on this topic have been available up to now. Although [9] considers the controller failure for a kind of