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

ICIC International ©2010 ISSN 1349-4198
pp. **2637–2644**

ROBUST ACTIVE FAULT-TOLERANT CONTROL FOR A CLASS OF UNCERTAIN NONLINEAR SYSTEMS WITH ACTUATOR FAULTS

Lingya Meng[1,2] and Bin Jiang[1]

[1]College of Automation Engineering
Nanjing University of Aeronautics and Astronautics
Nanjing 210016, P. R. China
binjiang@nuaa.edu.cn

[2]College of Information and Control Engineering
China University of Petroleum
Dongying 257061, P. R. China
lymdream@126.com

Received January 2009; revised August 2009

Abstract. *For a class of uncertain nonlinear systems with actuator faults, robust active fault-tolerant control is investigated based on the adaptive observer, feedback linearization, and backstepping design theory. Time-varying faults and bounded uncertainty are simultaneously considered in the paper. An adaptive observer is firstly constructed to estimate the faults and then a backstepping-based active fault-tolerant controller is designed to compensate for the faults. The main theoretical contributions of this work are a new fault updating law which relaxes the assumption conditions of the fault diagnosis observer and a new recursive control law for tracking the time-varying reference input signal. The asymptotical stability of the closed-loop fault-tolerant control system is proved by Lyapunov theorem. The numerical simulation results demonstrate the application and effectiveness of the proposed scheme.*

Keywords: Fault-tolerant control, Nonlinear, Robust, Fault estimation, Adaptive observer, Backstepping

1. **Introduction.** In many control systems, faults may occur at any uncertain time and in any locations such as sensors, actuators, or the plant. No matter where faults come from, they will lead to performance deterioration or even instability of the systems. Since actuators affect the system behaviors directly, faults in the actuators can cause more serious damaging results [8]. So developing the reliability of the control systems with actuator faults is very significant in the control engineering.

Active fault-tolerant control (FTC) is an effective way to increase the reliability of the control systems. In the past several decades, there have been several approaches on it such as multiple-model [1,20], adaptive control [4,12] and adaptive observer-based design [6,16,17] et al. Among the various methods, the adaptive observer-based technique is the one that has been developed most extensively. However, there are still some practical problems not to be solved, for example, the assumption conditions of the fault diagnosis observer are very difficult to be satisfied, which greatly limits the approach to be used in the control engineering.

The objective of the paper is to design an active fault-tolerant controller to maintain the stability, robustness and tracking performance of the faulty system. The main contributions of the paper are as follows: Firstly, time-varying faults and bounded uncertainty are simultaneously considered in the paper, which is more practical in the control engineering. Secondly, a new fault updating law is presented, which can effectively relax