International Journal of Innovative Computing, Information and Control
Volume **6**, Number **11**, November **2010**

ICIC International ©2010 ISSN 1349-4198
pp. 4843–4856

FAULT ACCOMMODATION FOR NEAR SPACE VEHICLE ATTITUDE DYNAMICS VIA T-S FUZZY MODELS

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Received May 2009; revised September 2009

Abstract. *Based on both adaptive and sliding mode control techniques, this paper proposes an integrated approach to fault detection, estimation and fault-tolerant control for near space vehicle (NSV) attitude dynamics during re-entry phase. Firstly, the Takagi and Sugeno (T-S) fuzzy model is employed to approximate complex nonlinear NSV dynamics with actuator faults. Then, an adaptive fault diagnostic observer is proposed for detecting and estimating the actuator faults. Using the on-line obtained fault information, the fault tolerant control scheme based on the sliding mode technique is developed to compensate for the effects of actuator fault by stabilizing the closed-loop control system. Finally, simulation results are given to show the effectiveness and potential of the proposed techniques when different actuator fault scenarios are tested.*
Keywords: Adaptive diagnostic observer, Near space vehicle (NSV), Fault-tolerant control, Sliding mode technique

1. **Introduction.** More and more advanced technological systems rely on sophisticated control systems to increase their safety and good dynamic performance. For safety-critical systems such as aircraft, and space vehicle, conventional feedback control may results in unsatisfactory performance or even instability in the event of system faults. To improve system's reliability and safety, fault detection and isolation (FDI) and fault-tolerant control (FTC) for dynamic systems have become an attractive topic and have received considerable attention in the past two decades. Fruitful results can be found in several excellent books [1,2], and the references therein.

In general, FDI is the first step in fault accommodation to monitor the system and to determine the location of faults. The FDI problem for linear and nonlinear systems has been studied widely by researchers, where the most frequently used approaches based on analytical models include diagnostic observers, parity space, parameter estimation, frequency domain approach and so on [3-5]. The FTC needs to take an appropriate control action when there are large parameter variations due to the occurred system faults. The FTC approaches can be classified into two groups: passive FTC and active FTC. The passive FTC system uses a fixed controller and does not consider whether the fault has occurred or not. Once a fault has occurred, the passive FTC system can tolerate it by maintaining stability and some dynamic performance, see [6-8]. In an active