

AN INTEGRATED FAULT-TOLERANT CONTROL FOR NONLINEAR SYSTEMS WITH MULTI-FAULT

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ABSTRACT. *This paper presents the integrated fault-tolerant control scheme for nonlinear system with multi-fault. After the unknown faults are estimated online by using the fuzzy credit assignment CMAC (FCACMAC), the effective control law reconfiguration strategy based on the sliding mode control technique is used to compensate for the effect of multi-fault. For multiple faults scenarios and three-tank system, the proposed fault-tolerant controller adjust its control signal by adding a corrective sliding mode control signal to guarantee the system stability, and numerical simulations demonstrate the effectiveness of the proposed sliding mode fault-tolerant controller.*

Keywords: Fault diagnosis, Fault-tolerant control, Fuzzy credit assignment CMAC, Sliding mode control, Nonlinear system

1. Introduction. In modern engineering, the system stability becomes a critical issue after those dramatic dynamic changes. Extensive research activities have focused on developing Fault-Tolerant Control (FTC) to maintain the system stability and to avoid the losses under various fault scenarios for decades. Literature [1-3] has provided excellent overviews of recent research work on FTC.

Alternative adaptive fault-tolerant control methods for some special industry systems can be found in recent literatures [4-9]. For the flight control [10,11,25], the design of control law reconfiguration was presented by using multi-layer neural network and fuzzy model. Recently Zhang et al. studied adaptive fault-tolerant control of nonlinear uncertain systems further [3,7,12,13], Mao Z. H. et al. [24] presented the fault-tolerant control for a class of networked control systems, and sliding mode variable structure control for uncertain stochastic systems was studied in literature [23].

From literatures above, the design and analysis of FTC algorithms have received significant attention. However, most research works in these literatures are about the fault-tolerant control for single fault, for multi-fault condition, the general controller reconfiguration is still lacking, especially the integrated fault-tolerant control of fault diagnosis and control law reconfiguration online for multi-fault nonlinear system has not been reported now.

This paper focuses on the multi-fault nonlinear system, the integration of fault diagnosis and control law reconfiguration online is presented. The nonlinear system faults are diagnosed by the fuzzy credit assignment-based CMAC (FCACMAC) neural network by authors [14,22], compared with MLP fault estimator in [18], the fault identification of FCACMAC has the advantages of local generalization and rapid learning convergence. The fault-tolerant controller is realized by the discrete-time sliding mode control technique (DSMC) [15-17]. In this paper the function of DSMC different from function in literature