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OBSERVER BASED FAULT-TOLERANT CONTROL FOR FUZZY SYSTEMS WITH SENSOR AND ACTUATOR FAILURES

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Abstract. *This paper proposed an observer based fault-tolerant control approach for the fuzzy T-S systems with sensors and actuators faults. By establishing the actuator fault and sensor fault models, an observer based fuzzy output feedback fault tolerant controller is developed and new stabilization conditions of the fuzzy fault tolerant control systems are given, which are formulated in terms of linear matrix inequalities (LMIs). The LMIs can be efficiently solved using the convex optimization techniques. It is shown that the proposed fuzzy fault-tolerant control approach can guarantee the stability of the closed-loop system in the event of the actuator and sensor failures. Numerical simulation example is given to illustrate the effectiveness of the proposed design method.*
Keywords: T-S fuzzy systems, Observer, Fault-tolerant control, LMIs

1. **Introduction.** During past years, Takagi-Sugeno (T-S) fuzzy model [1] has attracted lots of attention, since it has been proved to be a very good representation for a certain class of nonlinear dynamic systems. The common practice is as follows. First, this fuzzy model is described by a family of fuzzy IF-Then rules which represent local linear input-output relations of the systems. The overall fuzzy model of the system is achieved by smoothly blending these local linear models together through the membership functions. Then, based on this fuzzy model, control design is worked out by taking full advantage of the strength of modern linear control theory. Moreover, it has been shown that a linear T-S fuzzy model is a universal approximator of any smooth nonlinear system on a compact set [2]. The stability issue of the fuzzy control systems has been discussed extensively in literature, e.g., [2-4]. In recent years, several so-called relaxed stabilization conditions were reported ([6-8]) to release the conservatism of the conditions proposed in [3-4]. Using the relaxed stabilization conditions, both state feedback controllers and output feedback controllers for stabilizing T-S fuzzy systems can be easily obtained, see for example, [6-8]. Recently, motivated from the work of fuzzy based T-S model nonlinear control [2-8], the issues of reliability and fault controllers for T-S fuzzy control systems have been considered in [9-11], where the T-S fuzzy model was employed to study the reliable or LQ fault-tolerant problems for a continuous-time or discrete-time fuzzy systems. However, the proposed methods in [10-12] are confined to the actuator failures and didn't consider the fuzzy systems with sensor failures or state unmeasured. More recently, [12] has proposed a fault tolerant controller for uncertain time-delay fuzzy systems with actuator failures. Although the proposed method in [12] can deal with the fuzzy systems with time delay and unmeasured state, it is still confined to the case of the actuator failures without considering the case of sensor failures. As we know, in practice, many control systems are subjected to faults which can be caused by actuators, sensors or systems faults. Therefore,