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ROBUST STABILIZATION CONDITIONS AND OBSERVER-BASED CONTROLLERS FOR FUZZY SYSTEMS WITH INPUT DELAY

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Abstract. *In this paper, robust state feedback and observer-based fuzzy controllers are developed for uncertain T-S fuzzy systems with input delay. By using a generalized Lyapunov function and introducing a parameterized model transformation with free weighting matrices, the less conservative robust stabilization conditions are given for both state measured and state unmeasured cases, which are formulated in terms of linear matrix inequalities (LMIs). It is proved that the proposed fuzzy control approach can guarantee the stability of the closed-loop system. A simulation example is given to illustrate the effectiveness of the proposed approaches.*
Keywords: Fuzzy control, T-S fuzzy systems, Input delay, Parametric uncertainties, Fuzzy state observer, Stability conditions

1. **Introduction.** During past years, Takagi-Sugeno (T-S) fuzzy model [1] has attracted lots of attention, since it has been to be 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, the control design is worked out by taking full advantage of the strength of modern linear control theory. Moreover, it has been proved that a linear T-S fuzzy model is a universal approximator of any smooth nonlinear system on a compact set. The stability and controller design issues on T-S fuzzy systems have been discussed in the extensive literature, e.g., [2-5].

On the other hand, it is well known that time delay is frequently encountered in various complex nonlinear systems, such as chemical systems, mechanical systems, and communication networks. It has been well recognized that the presence of time delay may result in instability, chaotic mode, and poor performance of control systems. Therefore, more recently, increasing attention has been drawn to the study of stability analysis and controller design for T-S fuzzy systems with time delays [6-16]. Among them, the problems of stabilization and control have been studied based on delay-independent method in [6-8]. Some delay-dependent fuzzy controller design approaches have been developed by [9-13]. The stabilization and synthesis of T-S fuzzy time-delay descriptor systems have been considered in [14], while the robust stabilization approaches for fuzzy systems with interval time delay can be found in [15,16], the above results are further extended by [17-19] to the fuzzy systems with input saturation, and sensor actuator failures, respectively. More recently, by using a generalized Lyapunov function and introducing a parameterized model transformation with free weighting matrices, the new robust stability conditions