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ROBUST FUZZY CONTROL VIA OBSERVER FEEDBACK FOR PASSIVE STOCHASTIC FUZZY SYSTEMS WITH TIME-DELAY AND MULTIPLICATIVE NOISE

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Abstract. *This paper focuses on the observer-based passive fuzzy controller design problem for uncertain Takagi-Sugeno (T-S) fuzzy models with time-delay and multiplicative noise. For stability analysis and synthesis, the sufficient conditions are derived via Lyapunov-krasovskii function and Itô's formula in terms of Linear Matrix Inequalities (LMIs). In addition, the passivity theory is employed to discuss external disturbance effect on a system for achieving attenuation performance. Based on the concept of Parallel Distributed Compensation (PDC), the proposed observer-based fuzzy controller is developed. Through the proposed design method, the robust asymptotical stability and passivity of closed-loop system can be driven by the designed observer-based fuzzy controllers. Finally, a control simulation of the nonlinear synchronous generator system is presented to demonstrate the effectiveness and an application of the proposed design method.*
Keywords: Stochastic Takagi-Sugeno fuzzy models, Passivity property, Observer feedback, Robust asymptotical stability, Time-delay systems

1. **Introduction.** Recently, the stability and stabilization problems of stochastic dynamic systems have attracted much attention via stochastic differential equation [1] which is described by Itô's form or Langevin's form. Based on stochastic differential equation, many control approaches [2-4] have been proposed to extend the issues from deterministic systems to stochastic systems. Further, the T-S fuzzy model approach [5-10] has been also applied to represent the nonlinear stochastic system. Several stability criteria [11-20] have been developed for T-S fuzzy model with multiplicative noise. Specifically, the fuzzy controller design for nonlinear stochastic system was investigated in [11-14], filtering problems were addressed in [15-18], sliding model control was studied in [19], observer-based controller design method was developed in [20].

On the other hand, the time delay is a common and wicked phenomenon in many industrial and engineering dynamic systems. It may cause the inaccuracy of signal transmission, instability and poor performance of systems. Also, the parameter uncertainty appears in most systems that leads us to obtain incorrect mathematic model during modeling process. Considering both of time-delay effect and parameter uncertainties, the stability analysis and synthesis of stochastic system becomes more complex and challenging than that in deterministic systems. Additionally, the external disturbance is also considered in this paper for discussing the attenuation performance. From [21-23], one can find that the passivity theory was provided to discuss the effect of external disturbance on systems. With different settings of power supply function [23], several types of attenuation performance are concluded in passivity theory. In general, the strictly input passivity