

DELAY-DEPENDENT ROBUST STABILITY OF UNCERTAIN T-S FUZZY SYSTEMS WITH TIME-VARYING DELAY

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ABSTRACT. *The robust stability problem of continuous-time Takagi-Sugeno (T-S) fuzzy systems with Time-varying delay is addressed. A less conservative delay-dependent robust stability condition is presented in term of LMIs (linear matrix inequalities) by using a new fuzzy Lyapunov-Krasovskii functional. Neither any model transformation nor any bounding technique for bounding cross terms is needed during the derivation of the stability condition. Differently from previous Lyapunov-Krasovskii functional, not only the membership function information but also the information of time-varying-delay state $x(t - \tau(t))$, delay-upper-bounded state $x(t - h)$, current state $x(t)$ and the derivative of the state $\dot{x}(t)$ are used to construct the fuzzy Lyapunov-Krasovskii functional. Finally, two examples are given to illustrate the effectiveness of the results.*

Keywords: T-S Fuzzy system, Delay-dependent, Stability, Fuzzy Lyapunov-Krasovskii functional

1. Introduction. Fuzzy control has developed increasingly over the few years [1,3,9,10,12,18,25,27]. In particular, the T-S fuzzy model as one of the commonly used modeling methods for complex nonlinear systems has been extensively studied. A lot of results for T-S fuzzy systems, uncertain T-S fuzzy systems and T-S fuzzy systems with time-delay were proposed [4,11,19,20,22].

In general, the results for T-S fuzzy systems with time-delay can be classified into two types: *delay-independent* criteria [2,5,23] which are derived mainly from Lyapunov-Razumikhin functional and *delay-dependent* criteria [6-8,13,15,16,21,24,26,28] which are derived mainly from Lyapunov-Krasovskii functional. The delay-dependent criteria are less conservative than the delay-independent criteria and have received considerable attention from many authors.

For the delay-dependent criteria, there are two main methods to reduce the conservatism. (I): one is to make a change in the structure of Lyapunov-Krasovskii functional. It is known that different structure of Lyapunov-Krasovskii functional can lead to different criterion. The more information about the systems is included in Lyapunov-Krasovskii functional, the less conservative results can be obtained. E.g. in [7,13], a delay-dependent robust stability criterion was given in terms of linear matrix inequalities (LMIs) by using the Lyapunov-Krasovskii functional, due to the time delay information included in the Lyapunov-Krasovskii functional, the result is less conservative than delay-independent criteria. In particular, because there exists the information of delay derivative in the result [13], the result in [13] is less conservative than the one in [7]. While, it should