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DELAY-DEPENDENT FUZZY CONTROL DESIGNS FOR A CLASS OF NONLINEAR SYSTEMS

Hugang Han

Department of Management Information System
Prefectural University of Hiroshima
1-1-71 Ujina, Minami-ku, Hiroshima-city, Hiroshima 734-8558, Japan
hhan@pu-hiroshima.ac.jp

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Abstract. *This paper deals with the problems of stability analysis and control designs for a class of delay-dependent nonlinear systems with input constraint when using T-S fuzzy model in consideration of the uncertainties in the system. As a result, it arrives at two kinds of feedback controllers in terms of linear matrix inequalities (LMIs), in which the latter tries to use less information about the delay. In order to make the LMIs less conservative, two other controllers from the above controllers are provided, trying to make the so-called ellipsoids, in the insides of which the closed-loop system stability is guaranteed, as large as possible.*
Keywords: Uncertainties, LMIs, Input constraint, Adaptive law, Conservatism

1. **Introduction.** One of the essential elements in control problem is the model of the dynamical system to be controlled. In many cases a mathematical model of the system is unavailable or incomplete, or the equations that we believe are adequate to represent the behavior of the system are too complicated for the design purpose. This is the most likely reason why the application of fuzzy set theory to control problem has been the focus of numerous studies. The reason is that the fuzzy set theory provides an alternative to the traditional modeling and design of control systems, where knowledge of the dynamic model of the system in the traditional sense is uncertain and time-varying. In recent years, there have been significant advances in the study of the stability analysis and controller synthesis for the so-called Takagi-Sugeno (T-S) fuzzy systems [1], which have been used to represent certain complex nonlinear systems. The overall model of the system is obtained by the fuzzy blending of these local models. The control design is carried out based on the fuzzy model by the so-called parallel distributed compensation (PDC) scheme [2]. For each local linear model, a linear feedback control is designed. The resulting overall controller is again a fuzzy blending of the individual linear controllers. Originally, Tanaka and his colleagues have provided certain conditions that are sufficient for the stability of the T-S fuzzy systems in the sense of Lyapunove [2]. The feedback control gain in each PDC control rule is obtained by solving certain linear matrix inequalities (LMIs).

It is well known that there exist many complex nonlinear systems with time delay in practice such as communication networks. It is thus natural to have the T-S fuzzy model with time delay. Recently, considerable attention has been paid to the T-S fuzzy model with time delay [3, 4, 5, 6, 7, 8, 9]. However, most of the works only took into account time delay with system state due to its straightforward extension from the regular T-S fuzzy model in the aforementioned LMI approach, and few results considered the time delay directly in system inputs. In [8, 9], some approaches were proposed with consideration