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GUARANTEED COST CONTROL FOR A CLASS OF NONLINEAR TIME-DELAY SYSTEMS BASED ON PARTITION OF UNITY

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Abstract. *This paper is concerned with the problem of guaranteed cost control for a class of nonlinear time-varying delay systems. The nonlinear system is firstly transformed into an equivalent retarded model with modeling error by using partition of unity. A guaranteed cost controller is then proposed in the presence of a modeling error based on the equivalent model. A sufficient condition for the existence of the guaranteed cost controller, which ensures asymptotic stability and a desirable lever of performance index for the nonlinear system, is analyzed using the Lyapunov-Krasovskii approach and then proposed in terms of linear matrix inequality (LMI). The optimal guaranteed cost controller can be obtained via solving a convex optimization problem when these linear matrix inequalities (LMIs) are feasible. The numerical example demonstrates the effectiveness of the approach proposed in this paper.*
Keywords: Partition of unity, Modeling error, Guaranteed cost control, Asymptotically stable, Time-delay systems

1. **Introduction.** It is well-known that time delay lies commonly in practical dynamic systems, such as chemical processes, long transmission lines in pneumatic systems, population dynamics and so on. The existence of time delay, especially time-varying delay, may usually cause instability and oscillations [1]. So the stability analysis and synthesis of such retarded systems are of great importance and have been given much consideration (see, e.g., [2]-[7] and the references therein).

In the past few decades, nonlinear time-delay systems have been widely discussed via fuzzy control approach. Some good results have been available (see, e.g., [6]-[9]). However, all these results are obtained by using the Takagi-Sugeno (T-S) fuzzy models, neglecting the modeling error between the nonlinear systems and the fuzzy models. It is well-known that fuzzy models are universal approximators. They are able to approximate complex dynamics systems within any specified accuracy. The higher the precision of the model, however, the larger the number of local models in the aggregation. While attempts to maintain a relatively small number (a core) of local models inevitably introduce modeling errors [10]. Note that the existence of modeling errors may be a potential source of instability for control designs which have been based on the assumption that the fuzzy model exactly matches the plant [11], especially in the case of systems with time-delay.

Guaranteed cost control was first introduced by Chang and Peng [12]. It ensures not only stability but also an upper bound on a given performance index for the system