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STABILIZATION OF T-S FUZZY SYSTEMS: AN SOS APPROACH

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Abstract. *This paper considers the quadratic stabilization problems and H_∞ control problems of T-S Fuzzy control systems. A new condition on quadratic stabilization problem, which is represented in terms of linear matrix inequalities (LMIs) and sum of squares (SOS), is obtained firstly. Based on the relaxed stabilization condition, the problem of H_∞ control designs through state feedback is studied. Theoretical analysis proves that the conditions obtained in this paper have less conservatism than some existing results on the underlying issues. Two illustrative examples are explored to sustain the findings in the paper.*

Keywords: T-S Fuzzy systems, Quadratic stabilization, H_∞ control, State feedback, Linear matrix inequality (LMI), Sum of squares (SOS)

1. **Introduction.** Takagi-Sugeno (T-S) fuzzy systems are nonlinear systems described by a set of "IF-THEN" rules. Stability issue of fuzzy control systems has been discussed in a large number of references, for instance to see [1-11] and references therein. A nice survey on this topic was presented recently by [12].

The purpose of this paper is to solve the quadratic stabilization problems and H_∞ control problems of T-S fuzzy systems with less conservatism. For T-S fuzzy systems, one of the approaches to stabilize the system through parallel distributed compensation (PDC) state feedback controller is to use a common Lyapunov function to design a fuzzy controller $u(t) = \sum_{i=1}^{r} \lambda_i(\xi(t))F_i x(t)$ such that the condition

$$\sum_{i=1}^{r} \lambda_i^2(\xi(t))Q_{ii} + \sum_{i<j} \lambda_i(\xi(t))\lambda_j(\xi(t))(Q_{ij} + Q_{ji})$$
$$= \begin{bmatrix} \lambda_1(\xi(t))I \\ \lambda_2(\xi(t))I \\ \vdots \\ \lambda_r(\xi(t))I \end{bmatrix}^T \begin{bmatrix} Q_{11} & Q_{12} & \cdots & Q_{1r} \\ Q_{21} & Q_{22} & \cdots & Q_{2r} \\ \vdots & \vdots & \ddots & \vdots \\ Q_{r1} & Q_{r2} & \cdots & Q_{rr} \end{bmatrix} \begin{bmatrix} \lambda_1(\xi(t))I \\ \lambda_2(\xi(t))I \\ \vdots \\ \lambda_r(\xi(t))I \end{bmatrix} < 0 \qquad (1)$$

holds for all state vectors $x(t) \in R^n$. The structure of the matrix $Q = (Q_{ij})$ is to be described in Proposition 2.1 below. Approaches presented in the references have made relaxations of the above condition. It is obvious that the validity of (1) does not imply