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AN ALTERNATE APPROACH TO THE ANALYSIS OF A T-S FUZZY MODEL

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Abstract. *An alternate approach to the analysis of a Takagi-Sugeno (T-S) fuzzy model is dealt with in this paper. The proposed approach is employed to search for eigenvalues of a T-S fuzzy model in any mixed weighting cases. This effective method is developed by a well-known Routh stability criterion as well as the root locus method to judge the stability of the nonlinear system approximated by a T-S fuzzy model, furthermore the root locus can be used to indicate the transient response of a T-S fuzzy model. The proposed method gets much more relaxed than that these reported previously. The efficiency and the power are demonstrated via several examples.*
Keywords: Stability, Transfer function, T-S model, Uncertain model

1. **Introduction.** The past two decades have witnessed a fast growth in the use of fuzzy control in a wide variety of commercial products and industrial systems. Among these applications, the problem of stability analysis is greatly important in the fuzzy control. In recent literature, Tanaka and Sugeno [1] have provided a sufficient condition for the asymptotic stability of a fuzzy system, the basis of it is that there must exist a common Lyapunov function for all the subsystems. This has been regarded as a rather significant result and some refining efforts have been made thereafter. However, there has not been an effective way yet to handle various attributes of a T-S fuzzy model. Kawamoto *et al.* [2] only considered a second-order system for stability. Tanaka [3] suggested the idea of using linear matrix inequality (LMI) for finding the common $\boldsymbol{P}$ matrix. Xia and Chai [4] proposed a stability condition that is based on *ad hoc* membership values. Zhao *et al.* [5] extended some past work to consider T-S fuzzy system with uncertainties. Wang *et al.* [6] utilized the concept of parallel distributed compensation (PDC) [7,8] to design fuzzy controllers to stabilize a fuzzy system.

The research on the stability analysis has gained extensive interest during the recent years. First, the relevant articles considered the problem of stability related to the switching system by assumption [9-13]. Joh*et al.* [14] suggested a systematic way of finding the common $\boldsymbol{P}$ matrix of N-simultaneous continuous-time linear systems under a pairwise commutativity assumption. Tanaka *et al.* [15] proposed a polynomial fuzzy model that is a more general representation of the well-known Takagi-Sugeno fuzzy model. Next, they derived stability conditions based on Lyapunov principles that contain quadratic forms as a special case. In a sense, the central issue lies in the search for a *common positive definite matrix* $\boldsymbol{P}$ *for multiple matrix equations.* The matrix $\boldsymbol{P}$ has provided a sufficient condition based on Lyapunov function for stability of T-S fuzzy systems [16-18]. But it is not necessary condition for stability of T-S fuzzy systems. The paper is to explore a little further into absolute stability of T-S fuzzy model.