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AN APPROACH FOR STABILITY ANALYSIS OF T-S FUZZY SYSTEMS VIA PIECEWISE QUADRATIC STABILITY

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Abstract. *This paper presents a new approach for the stability analysis of Takagi-Sugeno (T-S) fuzzy systems. An idea is investigated to use piecewise quadratic Lyapunov function with low amount of computations. This class of Lyapunov function candidates is much richer than the common quadratic Lyapunov function. By exploiting the piecewise continuous Lyapunov function, we derive stability conditions that can be verified via convex optimization over linear matrix inequalities (LMIs) or bilinear matrix inequalities (BMIs). This idea will be used to derive some sufficient stability conditions for output feedback controller, parallel distributed compensation (PDC) and dynamic parallel distributed compensation (DPDC). Independence of this method of finding only one positive definite matrix that makes this method highly applicable, has less computation. Also, independence of these fuzzy sets to be normalized and their shapes make this method more useful. A numerical example which is given illustrates the effectiveness of the proposed method.*

Keywords: T-S fuzzy systems, Piecewise quadratic Lyapunov, Stability analysis, Linear inequality matrix (LMIs)

1. **Introduction.** Recent fuzzy control was developed and extensively applied in the previous decades and relevant methods were developed and applied with more or less success depending on the specific problems [1-4]. One of the foremost challenges in system theory brought from forth to present-day technological, environmental and societal process is to overcome the increasing size and complexity of the relevant mathematical models. Stability analysis is one theses mathematical tool which plays very important roles in the synthesis systems.

Since each nonlinear system can be represented by a fuzzy plant model [5], therefore, a fuzzy plant model can play an important model base for a nonlinear system. However, without carrying out an in-depth analysis, the design of the controller may come with no guarantee of system stability, so the stability analysis of T-S fuzzy systems has attracted considerable interest in the fuzzy system literatures [6-8]. Most of these results require the existence of a common quadratic Lyapunov function. Tanaka and Sugeno proposed a design and stability method for fuzzy systems via Lyapunov direct method [9]. It is required that for all local linear models, a common positive-definite matrix P must be found to satisfy the Lyapunov equation. In many cases, it is difficult to find a common positive matrix P when the number of rules for fuzzy systems is large and conditions for existence of such functions are restrictive and difficult to establish. In most of researches and literatures, proposed method are based on matrix inequalities (linear matrix inequality (LMIs) and bilinear matrix inequality (BMIs)) [10-12]. Robust stability and reasonable performance are also important observations which have been worked [13,14]. One of other important