Line Integral Fuzzy Lyapunov Function based Control Design of Takagi-Sugeno Fuzzy Systems Using Mean Value Theorem

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ABSTRACT

This article addresses the problem of state feedback stabilisation for continuous-time model nonlinear which is described by a decoupled multi-model flou with differential mean value theorem The main contributions of the proposed technique is we use a novel descriptor well-known line-integral Lyapunov fuzzy candidate (LILF) to obtain minimal conservative conditions for state feedback controller.

Keywords: Takagi-Sugeno fuzzy systems, Integral Lyapunov fuzzy function, Stabilization

1 Introduction

Takagi-Sugeno (T–S) fuzzy systems [1] offer a convenient method for studying nonlinear models and several typical theoretical foundations and applications. These systems can approximate a large class of nonlinear systems. The majority of works consider using a quadratic Lyapunov function (QLF). Each of those constraints is expressed by linear matrix inequalities (LMIs). Conservatism in the design of T-S fuzzy control systems can arise from several sources, including:(1) Construction of the T-S fuzzy model. (2) Elimination of MFs. (3) Integration of MFs information and finally, the choice of Lyapunov function can also affect the level of conservatism [2]. Non-quadratic Lyapunov functions (NQLF) are a new type of Lyapunov function developed for T–S fuzzy models, namely the line-integral function candidate. The proposed function approach mentioned in the statement is likely a modification or extension of the conventional QLF. The line-integral Lyapunov function with mean value theorem-based approach is a novel technique for the stability analysis and stabilization of T-S fuzzy models [3]. The main contribution of this abstract is the development of a new approach to designing controller of fuzzy model with differentiel on the mean value theorem that guarantees global asymptotic stability through the use of convex programming methods and offers less conservative.

2 Methodology

We develop several control algorithms based on the controller for systems non-linear described by fuzzy multi-models via the use of quadratic and non-quadratic Lyapunov functions such as; MVT (mean value theorem) controller via a QLF. and LILF.

3 Results and Discussion

Let us consider the non-linear model we can give as follows:

$$\begin{cases} \dot{x}_1(t) = x_1(x_1 - 5) + 4x_2 \\ \dot{x}_2(t) = 0.2x_1(bx_1 - x_2) + ax_1x_2 - {x_2}^2 \end{cases}$$

The feasible areas of the LMI's using SeDuMi solver can be represented in the Figure 1.

Figure 1 represents the comparison of the Stability areas of the LMI's condition between the non-quadratic form and the classique quadratic lyapunov fuzzy function. The stable area of Theorem 3 is covered by the feasible region obtained with it demonstrating that LMIs regions in non-quadratic form are less conservatism than those in conventional quadratic lyapunov approach.

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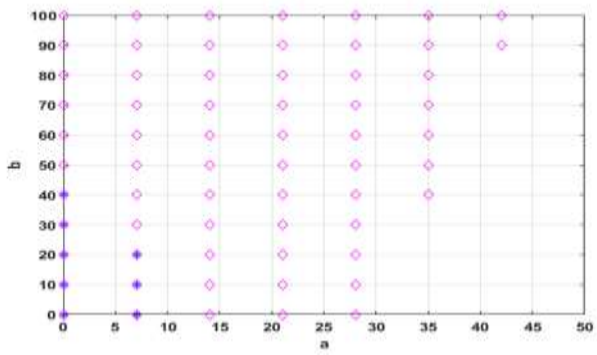

Figure 1: *Feasibility areas of NQLF* form *and the conventional QLF via SeDuMi solver*

The controller gains:

$$K = [0.4126 \quad 0.9528]$$

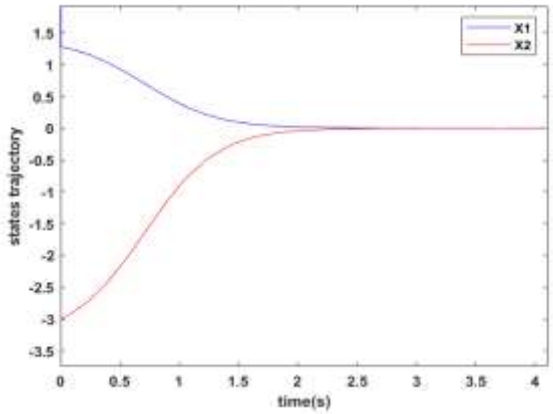

Figure 2: *States evolution*

Figure 2 shows the simulation results of state trajectory of T–S system with state feedback control law under initial Conditions are $x_0(t)$= [0 -3]. This state presents that the proposed control law demonstrate the stability of system.

4 Conclusion

In this abstract, a new non-linear controller for Takagi-Sugeno fuzzy descriptor systems based mean value method technique is suggested. The results of the comparison represent that the derived stability problem for the LILF are more extensive feasibility areas.

How to Cite

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