Chapter 8
Conclusions and Recommendations for Further Research of Large-Scale Fuzzy Interconnected Control Systems

ABSTRACT

In this chapter, our purpose hereafter is to shed more light on some prevailing aspects and potential remarks in the fuzzy control of large-scale fuzzy interconnected systems from fuzzy modeling and analysis aspects, control aspects, application aspects, and future research.

8.1 FUZZY MODELING AND ANALYSIS ASPECTS

A predominant characteristic of large-scale nonlinear interconnected systems is the interconnections with different interacting subsystems. How to process the interconnections is one of the most difficult problems, especially when nonlinear dynamics appears in the interconnections.

8.1.1 Explosive Fuzzy Rules

A large-scale system consists of several subsystems with interconnections connected to the other subsystems. Thus, it is quite natural to seek nonlinear dynamics on the interconnections, when considering large-scale nonlinear

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interconnected systems. In general, the nonlinear interconnection $\overline{A}_{ij}$ includes the fuzzy index term $l$ of the $i$-th subsystem and the fuzzy index term $s$ of the $j$-th subsystem, when using fuzzy-model-based presentation. It must be emphasized that this condition will lead to a large number of fuzzy rules, when the number of subsystems increases. It is also noted that a large increase of the number of fuzzy rules will generally cause a large increase in the number of LMI-based results if using the traditional control methods. Consequently, it is worth studying a new way to reduce the number of LMI for the proposed solutions to large-scale fuzzy interconnected systems.

In this book, we have proposed some bounding inequalities approaches to eliminate the fuzzy index term $s$ of the $j$-th subsystem (Chapter 2). Based on the techniques, we proposed some design results on the decentralized control for large-scale fuzzy interconnected systems. It is noted that using bounding inequalities induces design conservatism to some extent. The developed results lead a tradeoff between the number of LMI and the design conservatism.

### 8.1.2 Asynchronous Premise Variables

The concept of parallel distributed compensation (PDC) is widely proposed in the sense that the fuzzy system and the fuzzy controller share the same premise membership functions. Although the PDC design concept can relax the results on stabilization conditions when compared with the proposed linear controller. However, when considering these cases that the premise variables of the fuzzy controller undergo sampled-data measurement (Chapter 4), and/or event-triggered control (Chapter 5), and/or network-induced delay (Chapter 4), the asynchronous variables are more realistic. It is noted that when the asynchronous knowledge on the premise membership functions of the fuzzy controllers and the fuzzy systems is unavailable, it generally leads to a linear controller instead of a fuzzy one. In Chapters 4 and 5, we assumed the asynchronous bounding and designed the fuzzy controller. It is also noted an asynchronous increase on the premise membership functions of the fuzzy controllers and the fuzzy systems will induce more conservative on stabilization conditions. The developed results lead a tradeoff between the asynchronous condition and the design conservatism.
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