International Journal of Innovative Computing, Information and Control
Volume **3**, Number **4**, August **2007**

ICIC International ©2007 ISSN 1349-4198
pp. 1009–1022

DISCRETE-TIME FUZZY CONTROLLER STUCK TO EXPERTS' VIEWS

Hugang Han

Department of Management Information System
Prefectural University of Hiroshima
1-1-71 Ujina-higashi, Minami-ku, Hiroshima 734-8558, Japan
hhan@pu-hiroshima.ac.jp

Received October 2006; revised February 2007

Abstract. *The primary idea of fuzzy control is to employ the knowledge of experts to control a plant instead of the algorithm derived from the mathematical model of the plant. In this paper, we propose a discrete-time adaptive fuzzy control system with a guarantee of system stability in which it persistently maintains the fuzzy rules in accordance with experts' rules.*

Keywords: Experts' fuzzy rules, System stability, Discrete-time control, Adaptive controller, Lyapunov function

1. **Introduction.** The application of fuzzy set theory to control systems has had innumerable successes in the industrial world. This shows that fuzzy control [1] is a very useful approach to develop a control system. However, some researchers, especially those who have got used to using the traditional control theory such as adaptive control to design a system under an entirely theoretical proof of its stabilities, are always concerned if the fuzzy control system designed will continue to work stably all the time till the proof is given, even if the designed fuzzy system has worked well as expected so far. This is an important reason why active research on adaptive fuzzy control systems, in which the guarantee of the stability of the control system is the first task to be solved, has been conducted. In the last decade or more, a large quantity of research on the adaptive fuzzy control system has achieved success in a sense (e.g. [2]-[6] and references therein). In order to develop a stable fuzzy control system, there are, in general, two ways:

(1) After using the so-called Takagi-Sugeno (T-S), also known as the Takagi-Sugeno-Kang (TSK) fuzzy models [7][8], to represent certain complex nonlinear systems, the control design is carried out based on the fuzzy models by the so-called parallel distributed compensation (PDC) scheme [9]. For each local lineal model, a linear feedback control is designed. The resulting overall controller is a fuzzy blending of the individual linear controllers. A sufficient condition for the system stability of the T-S fuzzy systems are obtained by solving a Linear Matrix Inequality (LMI) [9]-[11]. Actually, in this case this is nothing to do with experts' knowledge except for the T-S fuzzy models, which also is difficult to be described by experts' views.

(2) Another way is to adopt the Lyapunov synthesis approach, and considering the fuzzy rules involved in the approach as some approximators to deal with some unknown parts (functions) in the plant to be controlled. Furthermore, the traditional adaptive