International Journal of Innovative Computing, Information and Control
Volume **6**, Number **6**, June **2010**
 ISSN 1349-4198
pp. **2621–2636**

ROBUST SELF-TUNING FUZZY TRACKER DESIGN OF TIME-VARYING NONLINEAR SYSTEMS VIA CONDITIONAL-LMI APPROACH

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Received December 2008; revised June 2009

Abstract. *This study presents a search strategy to identify nonlinear dynamic systems as time-varying fuzzy models by using modeling performance indexes. We introduce the fuzzy Lyapunov function to design robust fuzzy trackers of unknown nonlinear systems with an H_∞ performance index based on modeling error. In addition, we propose an off-line compound search strategy of robust gains called the conditional linear matrix inequality (CLMI) approach which is composed of the proposed improved random optimal algorithms (IROA) and the standard linear matrix inequality (LMI) method. Moreover, on-line self-tuning gains are optimized by the cost function of IROA. Finally, examples of previous technical research are given to illustrate the utility of the proposed design method.*
Keywords: Conditional-LMI, Time-varying fuzzy model, On-line self-tuning gains, Improved random optimal algorithms (IROA), Modeling error

1. **Introduction.** The motivation of this study as well as its contribution in the application of real systems are addressed by comparing two examples that deal with similar problems [17]. There are four difficulties that we encounter in this research, including how to reduce the time-varying effect of control systems, how to solve a non-standard LMI problem, how to optimize the robust fuzzy controller, and how to identify an unknown time-varying control system with a smaller number of fuzzy rules.

The novel robust fuzzy controller, which can tune the control gains on-line and the proposed architecture, utilized an off-line CLMI-based fuzzy sub-controller and an on-line switching IROA-based fuzzy sub-controller. All in all, the fuzzy controller uses only 2 rules. The design of the automatic tuning of the control gains is based on the novel performance index. The stability of the proposed tracking control design can be proven by using the multiple Lyapunov method [17]. The two examples show good control performance and robustness in the face of strong modeling error, time-varying effect and nonlinear disturbances.

In Takagi-Sugeno (T-S) fuzzy control, in order to minimize the complexity of the controller, it is always desirable that the number of rules in a working controller is as small as possible. However, based on the PDC control scheme, the number of T-S fuzzy control rules and model rules are the same [17]. Hence, if we reduce the number of T-S fuzzy model rules to as few as possible, then the simple fuzzy controller structure enables