International Journal of Innovative
Computing, Information and Control
Volume **5**, Number **10(B)**, October **2009**

ICIC International ©2009 ISSN 1349-4198
pp. **3593–3602**

ON A GENETIC ALGORITHM BASED SCHEDULED FUZZY PID CONTROLLER

Leehter Yao and Chin-chin Lin

Department of Electrical Engineering
National Taipei University of Technology
1, Sec. 3, Chung-Hsiao E. Rd., Taipei, 10608, Taiwan
ltyao@ntut.edu.tw

Received July 2008; revised December 2008

Abstract. *An adaptive fuzzy PID controller with gain scheduling is proposed in this paper. The structure of the proposed gain scheduled fuzzy PID (GS_FPID) controller consists of both fuzzy PI-like controller and fuzzy PD-like controller. Both of fuzzy PI-like and PD-like controllers are weighted through adaptive gain scheduling, which are also determined by fuzzy logic inference. A modified genetic algorithm called accumulated genetic algorithm is designed to learn the parameters of fuzzy inference system. In order to learn the number of fuzzy rules required for the TSK model, the fuzzy rules are learned in an accumulated way. In other words, the parameters learned in the previous rules are accumulated and updated along with the parameters in the current rule. It will be shown that the proposed GS_FPID controllers learned by the accumulated GA perform well for not only the regular linear systems but also the higher order and time-delayed systems.*
Keywords: Gain scheduling, Fuzzy PID controller, Adaptive control, Genetic algorithm

1. **Introduction.** PID controllers have been widely used in the industry due to the facts that they have simple structures and they assure acceptable performance for the majority of industrial processes. Because of their simple structures, PID controllers are easy to design, operate and maintain. Consequently, PID controllers earn their popularity among practitioners in the industry. Beginning with Ziegler and Nichols's works [1], various parameter tuning methods for conventional PID controllers have been proposed [2]. Ever since fuzzy theories are proposed in [3], fuzzy logic has gradually adopted as one of major approaches for controller design. One of the prominent and efficient ways is applying fuzzy logic to the design of PID controllers. The well-known pioneered and successful example in early stage was the design of a fuzzy PI controller and its practical engineering applications [4-5]. There have been numerous articles investigating different schemes of applying fuzzy logic to the design of PID controllers, which are generally termed as fuzzy PID controllers. Fuzzy PID controllers can be further classified into two types: the gain scheduling type and the direct action type [6,7].

For the gain scheduling type of fuzzy PID controllers, the PID gains are tuned based on a fuzzy inference system rather than the conventional Ziegler and Nichols's approach. In [8-9], three PID gains K_p, K_i and K_d were respectively calculated through fuzzy logic based on error and error rate. In [10], the PID gains were still calculated based on Ziegler and Nichols's formula, yet the formula was parameterized by a single parameter. A fuzzy inference system was then designed to calculate this single parameter. In order to preserve good load disturbance attenuation, [11] calculated the set-point weight by a fuzzy inference system but calculate three PID gains by conventional Ziegler and Nichols's approach. In [12], the PID gains for a self-tuning PID controller are designed based on generalized