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A NEW HYBRID FUZZY PROPORTIONAL-DERIVATIVE PHASE-LOCKED-LOOP CONTROLLER FOR DC SERVOMOTOR SPEED CONTROL

Pitikhate Sooraksa[1] Chung-Wai Li[2] and Phuwanat Damrongporn[1]

[1]Department of Information Engineering
Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang
Chalongkrung Rd., Ladkrabang, Bangkok, 10520,Thailand

[2]Department of Electronic Engineering
City University of Hong Kong, Hong Kong SAR, P. R. China

Abstract. Some research work has been heading to the promising direction of enhancing conventional controllers with various powerful intelligent features. In this pursuit, the paper presents a new fuzzy-based phase-locked loop (FPLL) controller for DC servomotor speed control. Fuzzy logic provides fast response and enhances robustness of the system while PLL control gives excellent steady state system performance. Unlike the past literatures, this fuzzy-based controller employs a proportional-derivative (FPD) controller, which is constructed precisely based on rigorous mathematical analysis instead of using look-up tables, with stability guaranteed. Simulation and experimental results have signified the design objectives and been accomplished. The proposed new fuzzy-based PLL controller gives a better dynamic performance compared to a conventional PID controller.

Keywords. fuzzy control, PID control, phase-locked loop, motor control.

1 Introduction

Theory and applications of phase-locked loop (PLL) control for motors have been established elegantly for decades [1-12, 16, 18, 20-22]. A survey of the PLL can be found in [5]. Following the design criteria in [1-4] together with updated data sheets of motor and other PLL circuit components such as phase detector, loop filters, and motor drivers provided by manufacturers, an engineer can design a PLL control system easily. This PLL control scheme can be considered as *a conventional* technique.

The emergence of fuzzy logic gives rise to a new tool for engineering application. Reports on successful implementation of fuzzy controllers in control system applications [8, 9, 13, 14, 19, 24, 25] confirm it is a promising tool. Properties such as ability in handling non-linearity, coping with uncertain parameters, and controllability for complex dynamic systems make this new tool definitely useful. In addition, the design process for a fuzzy controller can be done in a short period of time and the implementation for a fuzzy control system is a rapid-prototype one. With this fact, fuzzy control scheme