URN etd-0407109-183719-1578
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Statistics This thesis had been viewed 51 times. Download 60 times.
Department
Year 2007
Semester 1
Degree Master
Type of Document Master's Thesis
Language English
Title Setpoint Gain Scheduling Using Fuzzy Logic And Its Application To A Linear Stage
Date of Defense 0000-00-00
Page Count 76

Keyword
setpoint gain scheduling
fuzzy logic
positioning
settling time
optimal gain

Abstract
PID controllers have been employed in servo systems for decades. It is well known that an underdamped system has a faster response but accompanied by undesired overshoot, while an overdamped system has no oscillation at all but its response is too slow. In the past, the system engineers had to make a compromise in between with the conventional PID controllers. It is desired that a system would act like an underdamped one to have a faster response in the beginning, while it' d act like an overdamped one to have almost no oscillation.
We propose a setpoint gain scheduling scheme for PID controllers using fuzzy logic to take the advantages of fast response and oscillation suppression. Two set points are used in scheduling PID gains. The PID controller will have fixed high proportional and integral gains for quick response before reaching the first set point, so the system is underdamped. Also, the system is overdamped to yield no oscillation with a different set of PID parameters after passing the second set point. And the gains vary linearly between the first and second setpoints.
Our objective is to make the positioning system reach the target position and settle down as soon as possible. In optimizing the parameters, we use Powell's method, a non-gradient based method, to provide conjugate direction search for faster convergence. An optimal step size along each search direction will be found using the golden section method to achieved better performance.
The experimental setup consists of an ADLink motion control card PCI 8366 installed in a desktop PC, a Mitsubishi amplifier, an AC servo motor, and a Hiwin ballscrew linear stage. LabView software is used to program the suggested methods.
The setup is used to demonstrate the effectiveness of our proposed setpoint gain scheduling scheme. The results show that the optimized setpoint gain scheduled Fuzzy-PID controller has much better performance in positioning than the optimized conventional PID controller.
Advisory Committee Tung-Yung Huang - advisor

Files etd-0407109-183719-1578-001.pdf
etd-0407109-183719-1578-002.pdf

indicate access worldwide

Date of Submission 2008-01-25