UNIVERSITI TEKNOLOGI MARA

A NEW STRUCTURE DESIGN FOR BALL AND BEAM SYSTEM USING FUZZY PID CONTROLLER WITH REFERENCE MODEL

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Ball and beam position control system is one of the most popular laboratory equipment used to study about nonlinear dynamics and open-loop unstable control system. The unstable behaviour such as time taken for ball to stable on the beam can be observed where the ball will move continuously on a beam when the beam is tilted. Many controllers had been designed to achieve stability and transient response for this mechanism including PID controller. Lately, incorporation of fuzzy in the system to facilitate PID tuning has been found to basically simplify the design problem where fuzzy will update the PID parameters based on current value of error and the rate of error. However, from the findings reported by previous researches on the self-tuning fuzzy PID applications, some of the controlled output was configured to fulfill any desired control performance such as settling time and rise time. Having determined the desired performance is important in any controller design as it will ensure that the controlled output is performing as desired. Hence, this research proposed a new structure with some modification on the ordinary self-tuning fuzzy PID structure where added the model reference in self-tuning fuzzy PID structure and the input of fuzzy will be configured to follow the design specifications set by the output response of a model reference. The model reference used was a first-order model where the specifications can be adjusted by varying the pole location. Hypothetically, the pole location of a first-order system will influenced the time constant, rise time and settling time of the model output and hence, the ball and beam output response. In this research, the pole of a reference model was varied between -0.1 to -1.0 and its effect on the ball and beam output response was observed and evaluated based on the result of step response, set point tracking and load disturbance test. The performance of the proposed controller was compared to the ordinary self-tuning Fuzzy PID and Fuzzy PI plus PD controller. All the simulation process was run in MATLAB/Simulink R2015a software. The results of this research show that the proposed design can improve the performance of fuzzy PID and Fuzzy PI plus PD by producing an output that is guided by the desired control specifications where the settling time can be varied from 4 to 40 seconds.

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