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COMPARISON OF HYBRID FUZZY-PID AND PID CONTROLLER FOR SPEED CONTROL OF DC MOTOR

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Abstract

In the control of DC motors in production, especially in industry, there are many systems with high requirements for operation because it greatly determines the quality of products made and the system's productivity. In fact, there have been many studies on classical controllers and fuzzy controllers. Each controller has its advantages and disadvantages. This paper will study the hybrid fuzzy controller, which is a controller that combines the advantages of the two classical and fuzzy controllers mentioned above. Specifically, the article will focus on the problem of evaluating the effectiveness of the hybrid fuzzy controller in speed control for DC motors with external disturbance.

Keywords: DC motors, PID, Fuzzy controller, Hybrid Fuzzy-PID.

1.INTRODUCTION

The classic controllers applied to motor control have been studied a lot and have achieved many positive results. However, in modern control, fuzzy controller or hybrid fuzzy controller provides a new controller to improve the quality of classical controller, as well as control unknown or difficult to identify objects. Many fuzzy logic control schemes used in industrial practice today are based on some simplified fuzzy reasoning methods [1], which are simple but at the expense of losing robustness, missing fuzzy characteristics, and having inconsistent inference[2]. A novel non-Gaussian stochastic control framework for the problem of disturbance estimation and rejection by combining fuzzy identification technology with disturbance observer design [3]. The undesirable characteristics of the fuzzy PI controller are caused by integrating operation of the controller, even though the integrator itself is introduced to to overcome steady state error in response [4]. A systematic procedure for constructing a multi-input multi-output fuzzy controller that guarantees identical performance to an existing stabilizing linear controller [5]. A computation of fuzzy model is applied of fuzzy controllers in a noisy environment which shows in [6]. This paper focus on the problems of evaluating the effectiveness using the hybrid fuzzy controller in speed control for DC motors with disturbance affects on the system

2. CONTROL DESIGN

On the basis of the theory of fuzzy control, the classical control has two common structures of the hybrid fuzzy controller: FLC is connected in parallel with classical PID and FLC is responsible for a fuzzy lock. Below is a proposal of a hybrid fuzzy control structure for the problem of motor speed stability, based on the distribution of the working area between the fuzzy controller and the classic PID controller through the switching switch as shown in Figure 1.

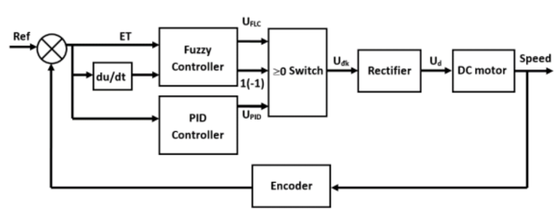

Figure 1. *The hybrid fuzzy PID system architecture for motor speed control using a switching*

In controlling the speed of the DC motor, we use a two-loop control structure as shown, the system is capable of stabilizing the motor speed. Specifically, there are two feedback loops, the inner loop is the current loop and the outer loop is the speed loop. The design calculation

of the regulator for the current loop and the speed loop according to the typical system method is adopted.
With the characteristics and properties of the current loop circuit, we design a current loop circuit according to a I typical system, then the current loop circuit is given that shown in Figure 2. Then we can consider that the current loop control is the PI controller.

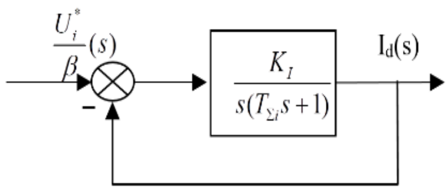

Figure 2. *The synthetic current loop circuit structure according to a I typical*

Similar to the characteristics and properties of the speed loop circuit, we design a speed loop circuit according to a II typical system, then the speed loop circuit as shown in Figure 3 which we can consider that the speed loop control is the PI controller.

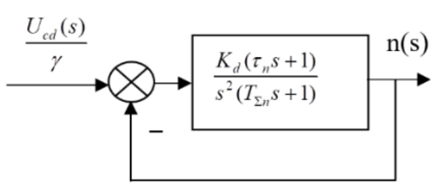

Figure 3. *The synthetic speed loop circuit structure according to a II typical*

3. SIMULATION RESULTS

Base on the theoretical basis, combining the control structure diagram for the DC motor proposed in Figure 1. The simulation structure for the stable speed control system of a DC motor using hybrid fuzzy PID algorithm in Matlab Simulink software as shown in Figure 4.

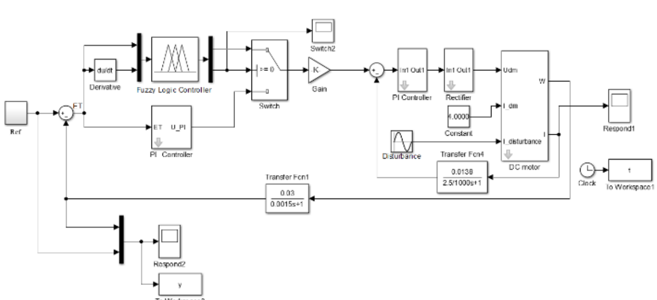

Figure 4. *Structural diagram of simulation of hybrid fuzzy-PID controller system for DC motor on Matlab Simulink*

Hybrid fuzzy simulation structure in the Figure 4 shows the hybrid fuzzy PID controller in speed loop, which is the combination of fuzzy controller and classical PI controller for speed stable loop. In which the hybrid fuzzy PID controller, through the switch decides that if the error and the difference derivative error are large, the fuzzy controller will work, if the error and the difference derivative error are small then the PI controller will work. Thus, we can realize the flexibility of the hybrid fuzzy PID controller during the operation of the system. In the Figure 5. which illustrates the operating principle switche between the fuzzy controller and the PI controller in the proposed hybrid fuzzy PID controller structure.

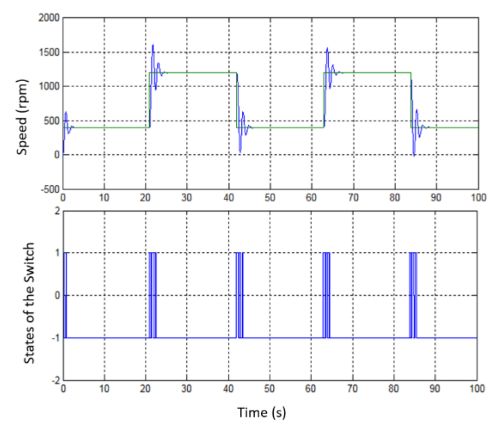

Figure 5. *Illustrating the operating principle of a switching in the hybrid fuzzy PID controller*

To demonstrate the correct of hybrid fuzzy PID controller structure for the speed stability control problem with the effect external disturbance. We do explain more clearly the effectiveness of the hybrid fuzzy PID controller in controlling DC motors by comparing simulation results between classical PID controllers. Especially to effectively highlight the hybrid fuzzy PID controller in the presence of external disturbance. We give the parameters of external disturbance acting on the motor shaft with the sine input setting.

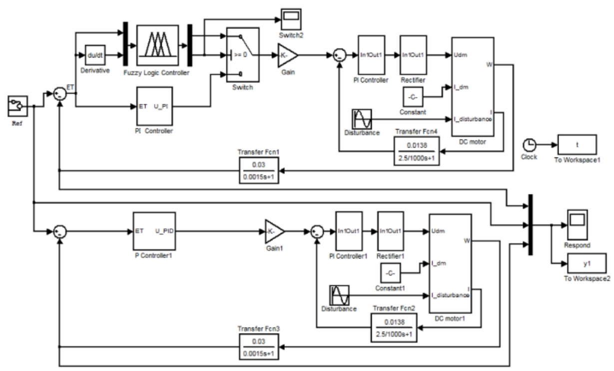

Figure 6. *Simulation of P-controller and hybrid fuzzy PID controller for DC motor*

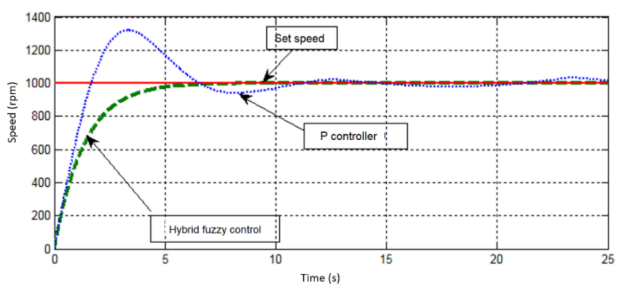

Figure 7. *Comparison of the response between the P controller and the hybrid fuzzy PID controller of the speed loop without external disturbance.*

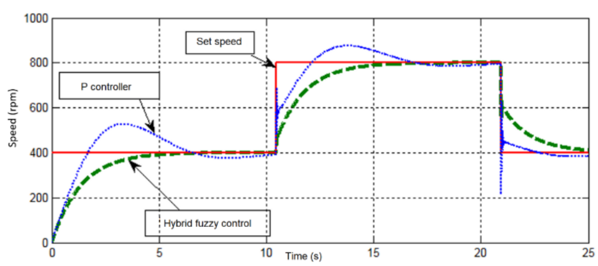

Figure 8. *Comparison of the response between the P controller and the hybrid fuzzy PID controller of the speed loop with external disturbance*

The response of system denotes the quality of the proposed hybrid fuzzy-PID controller given the better response than the PID controller which shown in the Figures 7 and 8 as well.

4. CONCLUSIONS

This paper focuses on presenting a control structure for a DC motor, which uses a hybrid fuzzy PID controller to control the speed of DC motor and demonstrate the stability of the system. Besides, through Matlab Simulink software, the simulation control algorithms to control motor speed, with effects of external disturbances on the system. The paper which evaluating the effectiveness of the hybrid fuzzy controller when the system is affected by external disturbances in the control of a DC motor. It shows that when the DC motor is affected by external disturbances, the response of the hybrid fuzzy PID controller proposed for the speed loop circuit has superior control quality compared to the PID controller as well.

5.ACKNOWLEDGEMENT

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