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A Review on Comparison of PI DC Motor Speed Controller and PI Fuzzy DC Motor Speed Controller

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Abstract: In recent years, brushless dc (BLDC) machines have gained widespread use in electric drives. These machines are ideal for use in clean, explosive environments such as aeronautics, robotics, electric vehicles, food and chemical industries and dynamic actuation. Using these machines in high-performance drives requires advance and robust control methods. Conventional control techniques require accurate mathematical models describing the dynamics of the system under study. These techniques result in tracking error when the load varies fast and overshoot during transients. In lieu of provisions for robust control design, they also lack consistent performance when changes occur in the system. If advance control strategies are used instead, the system will perform more accurately or robustly. It is therefore, desired to develop a controller that has the ability to adjust its own parameters and even structure online, according to the environment in which it works to yield satisfactory control performance. An interesting alternative that could be investigated is the use of fuzzy logic control (FLC) methods. In the last decade, FLC has attracted considerable attention as a tool for a novel control approach because of the variety of advantages that it offers over the classical control techniques. Unlike other conventional control schemes, FLC is a model-free controller. It does not require an exact mathematical model of the controlled system and therefore, is less sensitive to system parameter changes. In addition, rapidity and robustness are the most profound and interesting properties in comparison to the traditional control methods.

Keywords: PI, Fuzzy logic, Hybrid Controller, BLDC Motor, Speed Control.

Literature Survey:

Pritha Agrawal et al. (2013) proposed a comparative study of speed control of Brushless DC (BLDC) motor drive with Proportional-Integral (PI) and Fuzzy Logic (FL) based speed controllers is evaluated. To develop and improve variable speed drive technology many efforts have been made in recent years which attempts to attain the desired speed of the motor. Unfortunately, traditional speed controllers such as proportional plus integral (PI) type controllers perform very well but only under small set of conditions. Even though they are widely used in industry due to their simple control structure and ease of implementation, these controllers do not operate properly when the system has a high degree of load disturbances, parametric variations and nonlinearity as in case of BLDC motor. In recent years, the application of fuzzy logic controller (FLC) for high dynamic performance of motor drives has become an important tool. These controllers are inherently robust to load disturbances and can be easily implemented. The modeling and simulation of both the speedcontrollers have been carried out in MATLAB/SIMULINK. Speed and torque response, obtained under PI and Fuzzy logic based speed controller, are compared for various operating conditions. The simulation results show that the FL based speed control of BLDC motor gives a better speed response and provides suitable output.

Dhanya K Panickel and Ms. Remya Mol (2013) This paper aims at the design and simulation of hybrid PI-fuzzy control system for the speed control of a brushless dc motor. The performance of the fuzzy logic controller (FLC) is better under transient conditions, while that of the proportional plus integral (PI) controller is superior near the steady-state condition. The combined advantages of these two controllers can be obtained with hybrid PI -fuzzy speed controller. Both the design of the fuzzy controller and its integration with the proportional-integral (PI) controller is to be done. The principle of the proposed control system is to use a PI controller, which performs satisfactorily in most cases, while keeping in the background, a fuzzy controller, which is ready to take over the PI controller when severe perturbations occur. By combining the two controllers, one can get the quick response of the PI controller while eliminating the overshoot possibly associated with it.

Victor Dutta et al. (2014) This paper presents a proportional-integral (PI) Fuzzy rule based controller using Matlab for speed control of a dc motor. Also an analysis and performance evaluation of the proposed controller design has been carried out and presented in this paper. The fuzzy logic controller is designed using Fuzzy logic toolbox in Matlab, A mathematical model based on fundamental equations governing the operation of a dc motor has been obtained and used to design the motor model in Matlab Simulink. The simulation results of the PI-Fuzzy controller show control potentialities.

Shashi Bhushan Kumar et al. (2013) proposed the design of intelligent control systems has become an area of intense research interest. A promising direction in the design of intelligent systems involves the use of Fuzzy logic controller to discover the abilities of intelligent control systems in utilizing experience via rule-based knowledge. The most commonly used controller in the industry field is the proportional plus- integral-plus- derivative (PID). PID controller requires a mathematical model of the system while Fuzzy logic controller (FLC) provides an alternative to PID controller, especially when data are not available or partly available for the system. For comparison purpose, three controllers PI, PID and FLC have been designed and implemented in the MATLAB/Simulink model to examine the performance of DC motor with different loads. The results show that the FLC give better response compared to PI &PID controller.

Ahmed M. Ahmed et al. (2015) proposed brushless DC (BLDC) motors are one of the most interesting motors, not only because of their efficiency, and torque characteristics, but also because they have the advantages of being a direct current (DC) supplied, but eliminating the disadvantages of using Brushes. BLDC motors have a very wide range of speed, so speed control is a very important issue for it. There are a lot of parameters which need to be in focus while talking about a speed controller performance like starting current, starting torque, rise time, etc. There are two main methods for controlling the speed, PID Controllers, and Fuzzy PI controllers. Both are different in complexity and performance. In this paper, the PI and Fuzzy PI speed controllers for the BLDC motors will be proposed. A simulation study is conducted to evaluate the efficiency of the proposed speed controllers. Further, a comparative study is performed to validate the system effectiveness.

G.T.P.Naidu et al. (2015) proposed PMDC motors are widely used in instrumentation applications, particularly in robotics and computer peripherals. The speed of PMDC motor can be controlled by many controllers. In this paper PID, pole placement and Fuzzy controller are used .The advantages and disadvantages of each controller for different conditions under no load, load and disturbance conditions using software MATLAB are being discussed. Pole placement controller can be employed to obtain speed control of PMDC motor. An addition of integrator reduced the noise disturbances in pole placement controller and this makes it a good choice for industrial applications. An intelligent controller is introduced with a DC chopper to make the PMDC motor speed control smooth and almost no steady state error is observed. To prove the robustness of the proposed Fuzzy PI controller, three different controllers are compared and concluded from the results that Fuzzy controller performs to PID controller in terms of steady state error and smooth step response.

Sudhanshu Mitra et al. (2015) proposed in this paper a comparative study on the performance analysis of BLDC Motor is presented. The mathematical model of the BLDC motor is developed and it is used to examine the performance of the controllers. Initially a PI controller is developed for the speed control of the given BLDC motor. Then a fuzzy logic based controller is developed. Through extensive simulations it is observed that the performance of fuzzy logic controller is slightly better than PI controller.

Mohamed BOUTOUBA et al. (2017) This paper present a speed control of DC motor system powered by a photovoltaic source via Luo DC-DC. Luo converters are new generation of DC-DC converters on power electronics which presents better performances and high accuracy. As known, the produced voltage in a photovoltaic system is not stable, controller's techniques are required to guaranties a continuous voltage in the DC motor and thereafter the desired rotation speed. A PI-Fuzzy controller technique is proposed to control periodically the transferred voltage to the DC motor. The mean goal of the proposed system is the use of new DC-DC converter as intermediate controlled by Fuzzy logic strategy in order to reach better pursuit with low ripples of the DC motor speed. Multiples simulations are done to improve the functionality and the good behaviour of the proposed system.

Dr. Ali N. Hamoodi et al. (2018) in this paper , A comparison is made between PI- controller and fuzzy logic controller (FLC) in order to controlled the self –excited motor. Matlab simulation package is used to simulate Dc motor and sketched the speed response curve for each type of controller. Final results clearified that the FLC improve Speed response of dc motor rather than PI controller.

Conclusion: The aim of this study is to compare the two controllers namely, Fuzzy PI and Genetic PI controller for the speed controller of a separately excited motor. The control system includes a hysteresis current controller as well as speed controller. The results of application of genetic PI controller are compared to those obtained by the fuzzy PI controller under variable reference speed, variable load and variable parameter conditions and are summarized in Table 1 below.The paper compares the performance of fuzzy PI controller with that of genetic PI controller and it is shown that the genetic PI controller provides slightly better results in terms of the settling time and steady-state error. As a result, tuning the controller gains using genetic based algorithms will provide better dynamic response for the speed control of dc motor drives.

Table 1: Comparison of PI and Fuzzy PI DC motor controller

Specifications / *Controllers*	Transient performance	Steady-state performance	Complexity	Computational time
Fuzzy PI	*Good*	*Good*	*Moderate*	*Medium*
Genetic PI	*Better*	*Better*	*Complicated*	*Long*

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