Speed Control of DC Motor Using PID & Fuzzy Logic Controller

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Abstract- *DC motor speed is controlled using PID controller and fuzzy logic controller . PID controller requires a mathematical model of the system while fuzzy logic controller base on experience via rule-based knowledge. Design of fuzzy logic controller requires many design decisions, for example rule base and fuzzification. The FLC has two inputs, one of these inputs is the speed error and the second is the change in the speed error. The center of gravity method is used for the defuzzificztion. Fuzzy logic controller uses mamdani system which employs fuzzy sets in consequent part. PID controller chooses its parameters base on trial and error method. PID and FLC are investigated with the help of MATLAB / SIMULINK package program simulation. It is founded that FLC is more difficult in design comparing with PID controller, but it has an advance to be more suitable to satisfy non-linear characteristics of DC motor. The results shows that the fuzzy logic has minimum transient and steady state parameters , which shows that FLC is more efficiency and effectiveness than PID controller.*

Keywords- Pid Controller, Fuzzy Controller, Dcmotor, Simulink, Dc Motor

I. INTRODUCTION

Direct current (DC) motor is a current (DC) motor is a fairly simple electric motor that uses electricity and magnetic field to produce torque. DC motors consist of one set of coils, called armature winding, inside another set of coils or a set of permanent magnets, called the stator. Applying a voltage to the coils produces a torque in the armature, resulting in motion. DC motor has been widely used in industrial applications due to its simple structure, low initial cost, high accuracy control system, high control performance, high reliability and provide excellent control of speed for acceleration and deceleration. There are several applications required a high start-up torque. The D.C. motor, by its very nature, has a high torque versus. Falling speed characteristic and this enables it to deal with high starting torques. DC motors is very important in industrial as well as other purpose applications such as still rolling mills, electric trains, electric vehicles, electric cranes and robotic manipulators require speed controllers to perform their tasks. There are several method used to control in DC motor such as Proportional Integral Derivative (PID) controller, fuzzy logic controller (FLC). The simulation development of the PID controller with the mathematical model of DC motor is done using Ziegler-Nichols method and trial and error method. The PID parameter is tested with MATLAB/SIMULINK program. (FLC) the fuzzy logic controller is designed according to fuzzy rules so that the systems are fundamentally robust. The FLC has two inputs. One is the motor speed error between the reference and actual speed and the second is change in speed error (speed error derivative).For comparison purpose, PID and Fuzzy controllers have been tested using MATLAB/SIMULINK program for speed under load and no load conditions. The result shows that the Fuzzy controller is the best controller than PID controller. In addition fuzzy logic controller Demonstrates good performance, faster design and work well for high-order and nonlinear and shows the efficiency over the PID controller.

Related Work:-The PID controller and fuzzy controller for separately excited DC motor speed controller have been designed using MATLAB software. When applied PID controller and fuzzy controller , the system performance has been improved. It concluded that when compared fuzzy controller with the conventional PID controller, fuzzy controller has better performance in both transient and steady state response, it also has better dynamic response curve, shorter response time, small steady state error (SSE) and high precision compare to the conventional PID controller.PID Controller for Speed Control of DC Motor. The affecting parameters on speed control of DC motor have also been discussed. This review article is also presenting the current status of tuning of PID controller for speed control of DC motor using soft computing techniques.

fuzzy controller with transition Petri layer has been presented. The system was used as speed controller for shunt DC motor. Computation cost of the system with and without TPL has been analyzed, showing superiority of the system with TPL. Also quality of reference speed by the controlled motor has been analyzed, showing improvement offered by incorporation type fuzzy sets in the system

Methodology

1. PID Controller :-

proportional–integral–derivative controller (PID controller) is widely used in industrial control systems. It is a generic control loop feedback mechanism and used as feedback controller. PID working principle is that it calculates an error value from the processed measured value and the desired reference point. The work of controller is to minimize the error by changing in the inputs of the system. If the system is not clearly known then applying PID controller provide the best results if it is tuned properly by keeping parameters of the system according to the nature of system.

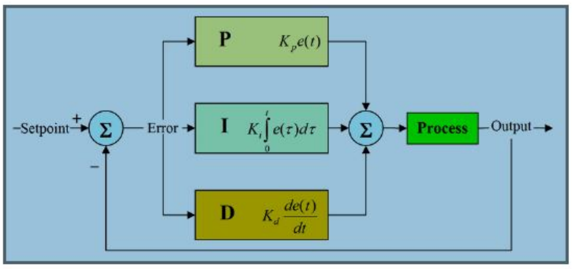


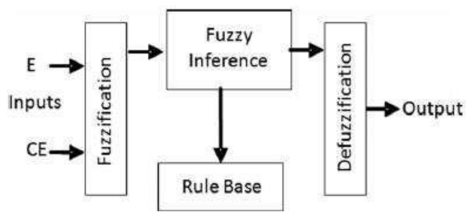
Figure 1.

as the controller output, the final form of the PID algorithm is:

$$u(t) = \mathrm{MV}(t) = K_p e(t) + K_i \int_0^t e(\tau)\, d\tau + K_d \frac{d}{dt} e(t)$$

II. Fuzzy Logic Controller

Fuzzy systems are knowledge based or rule based systems. The heart of a fuzzy system is a knowledge base consisting of the so- called If-Then rules. A fuzzy If-Then statement in which some words are characterized by continuous membership functions. After defining the fuzzy sets and assigning their membership functions, rules must be written to describe the action to be taken for each combination of control variables. These rules will relate the input variables to the output variable using If-Then statements which allow decisions to be made.



Block diagram of a fuzzy inference system.

Figure 2.

Fuzzification

The first step in designing a fuzzy controller is to decide which state variables represent the system dynamic performance must be taken as the input signal to the controller. Fuzzy logic uses linguistic variables instead of numerical variables. The process of converting a numerical variable (real number or crisp variables) into a linguistic variable (fuzzy number) is called fuzzification.

Rule Base

A decision making logic which is, simulating a human decision process, inters fuzzy control action from the knowledge of the control rules and linguistic variable definitions [9]. The rules are in the “If Then” format and formally the If side is called the conditions and the Then side is called the conclusion. The computer is able to execute the rules and compute a control signal depending on the measured inputs error (e) “difference between the output speed and the set point” and error variation as inputs to the fuzzy controller and control function as the output which it will be the armature voltage.

Inference engine

Inference engine is defined as the Software code which processes the rules, cases, objects or other type of knowledge and expertise based on the facts of a given situation. When there is a problem to be solved that involves logic rather than fencing skills, we take a series of inference steps that may include deduction, association, recognition, and decision making.

Defuzzification

The reverse of Fuzzification is called Defuzzification. The use of Fuzzy Logic Controller (FLC) produces required output in a linguistic variable (fuzzy number). According to real world requirements, the linguistic variables have to be transformed to crisp output. There are many defuzzification methods but the most common method is center of gravity.

Result and discussion

To achieve the desired goal of this study which is the speed control of DC motor, DC motor system was converted into its equivalent mathematical model and applied control system to it through the MATLAB program.the comparison of system responses using PID, FLC and also the numerical comparison.

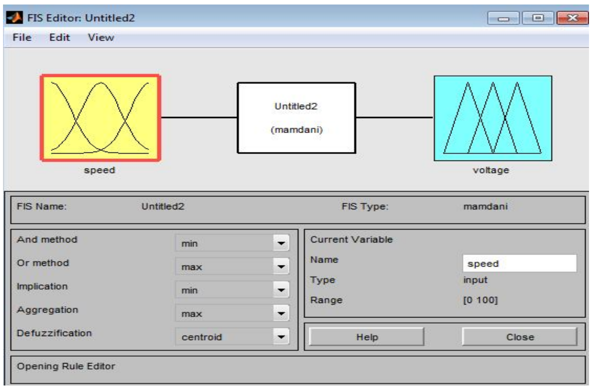


Figure 3.Fuzzy logic tools in MATLAB

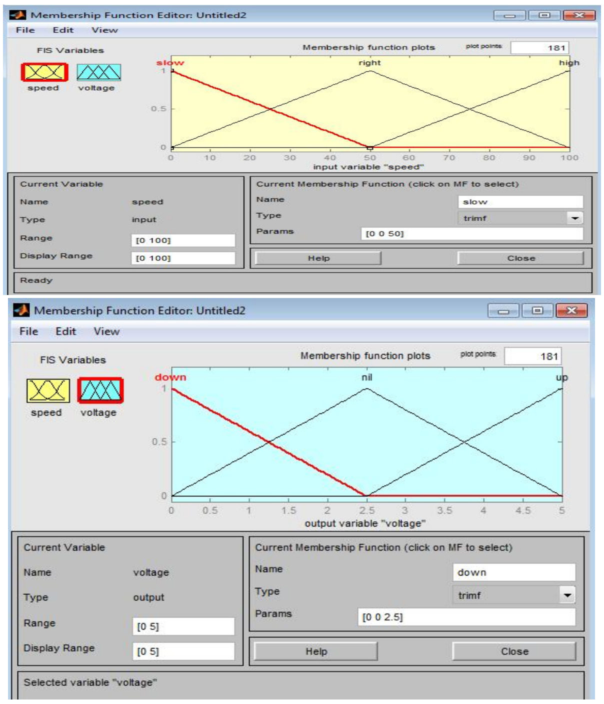


Figure 4. Mumber Function Defination

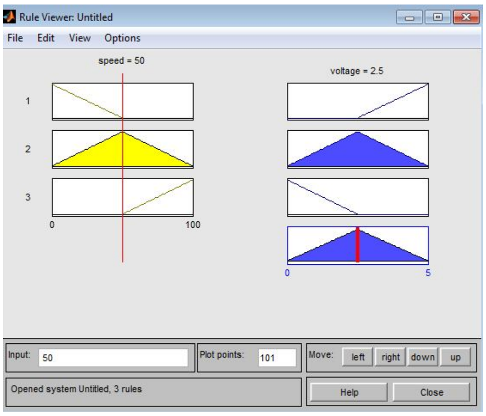


Figure 5. Fuzzy Rule Base for control of dc motor

III. CONCLUSION

The PID controller and fuzzy controller for separately excited DC motor speed controller have been designed using MATLAB software. When applied PID controller and fuzzy controller , the system performance has been improved. It concluded that when compared fuzzy controller with the conventional PID controller, fuzzy controller has better performance in both transient and steady state response, it also has better dynamic response curve, shorter response time,small steady state error (SSE) and high precision compare to the conventional PID controller.

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