# DC Motor Speed control using Fuzzy PID

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***Abstract* – This paper has been written in order to get a motor whose speed is controlled by fuzzy PID. The proportional and integral and derivative gains of the PID controller are mainly fixed according to fuzzy logic. A good dynamic behavoiur of Dc motor , a perfect speed with a very less rise as well as settling time , minimum steady state error and overshoot .**

***Keywords* – Speed control, DC motor fuzzy PID, Fuzzy logic**

## I. INTRODUCTION

In development of an high performance DC motor which have daily uses as well as industrial uses such as in lifts, rolling mills etc. DC drives which of their high flexibility, simple to ease , excellent reliabilities and moderate cost have made its use in industries.
PID stands for proportional integral derivative and is also one of the device used to control process variables like speed, temperature etc.
Fuzzy logic is a simple method for simulation and can be used for increasing the speed of DC motor. For design of fuzzy system, a high accuracy is not required .and a perfect mathematical model is also not required.
The main problems in uze of PID in speed control are effects of non linearity in DC motor. Non linear such as saturation as well as fiction could decrease the performance of the conventional controls.
In this study, we have use a fuzzy logic method and suggest self tuning PID controller in order to control and make a DC motor which has minimum overshoot .

## II. MODELLING AND SIMULATION

Modelling of a DC motor can be done by many methods. In this model, we have used separately excited DC motors equivalent model The relation is as follows:

$$V_{a=}E_b + I_a R_a + L_a\left(\frac{dI_a}{dt}\right)$$

$$E_b = K\phi\omega$$

$$T_m = J_m\frac{d\omega}{dt} + B_m + T_L$$

If motor's friction is insignificant, then it may be ignored and in equation (3), it will be equal to:

$$T_m = J_m\frac{d\omega}{dt} + T_L$$

According to the above, the model speed will be equal to:

$$W(S) = (K\phi I_a - T_L)/J_m S$$

shows the models of the DC motor designed using equation (5).
Considering the separately excited DC motor model,

The separately excited DC motor will be converted as below:

$$K\phi = K_m$$

$$\frac{w(s)}{V_a(s)} = \left(\frac{1}{K_m}\right)\left((1 + ST_{em})(1 + ST_a)\right)$$

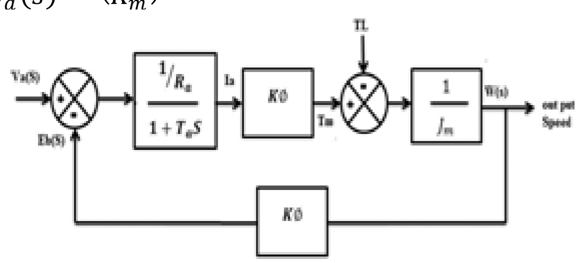


Fig.1 DC-Motor modelling

## III. FUZZY LOGIC CONTROLLER

Fuzzy logic systems are usually based on knowledge or based on rule systems. The main is the rule known as If-Then rules. If-Then statements those in which some or more words are being characterized by the continuous membership functions and where If is the condition and then is the conclusion of the function.

## IV. FUZZIFICATION

The membership function that are associated to the control variables have been rectangular in shape. The universe of the discourse that is of all the input and the output variables have been established. Each of the following discourse have been divided into following seven fuzzy sets. The seven sets are as follows.NL, NM, NS, ZE, PS, PM, PL .

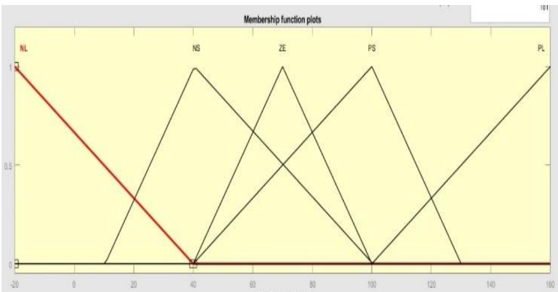


Fig.2 Fuzzification

## V. INFERENCE ENGINE

The knowledge based involved the defining of the rules that are represented by IF-THEN statements which gives the relation between input and output variables in the terms of membership functions. In this variables are processed by following inference engine that execute the following 25 rules. The rules are maked on the knowledge of behaviour system and the experience of controller. In this , max product method is used.

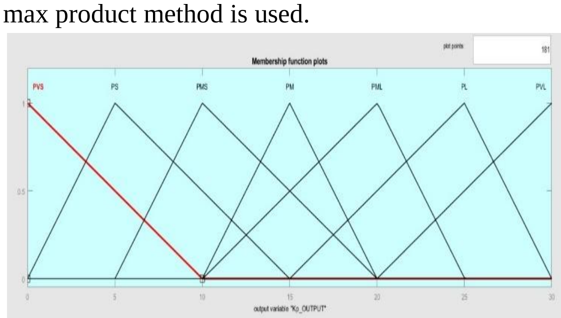


Fig. 3 Rule base parameters for Kp

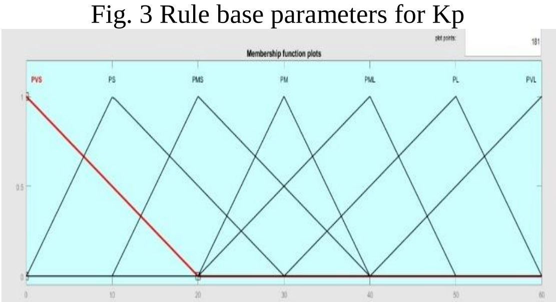


Fig.4 Rule base parameters for Ki

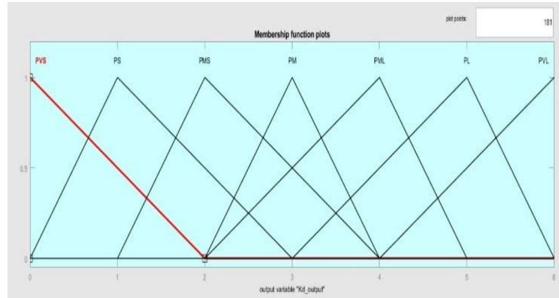


Fig. 5 Rule base parameters for Kd

## VI. RULE BASE

The decision making logic or in short simulate a human decision process, inters the given fuzzy action from the behaviour of the rules of the control and the variables. The rules are basically in IF-ELSE format where the IF is known as conditions and THEN is known as conclusion. The computer will be able to execute the rules and form a signal based on the input error as well as change in error.

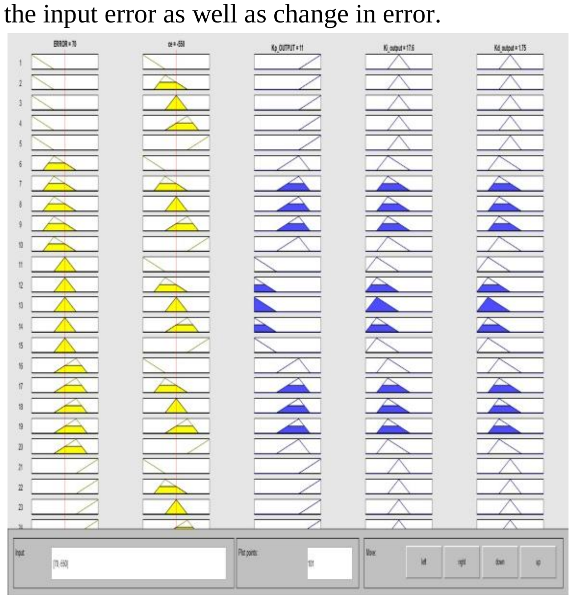

Fig. 6 Rule base

## VII. DEFUZZIFICATION

The reversal of the fuzzification process is called as defuzzification. The utilization of the FLC forms an output in a semantic variable.

In order to explore fuzzy membership functions ,designers chooses many different shapes based upon their use. Some of the shapes are trapezoidal, triangular, gaussian etc.

Execution of the FLC requires four keys:

- The number of fuzzy sets that contain variables.
- Graphing the measurements on the sets which it supports.
- The control protocol that tells the behaviour of the controller.
- Shape or design of function.

Adjusting fuzzy membership functions and its rules

The performance of the FLC, the rules and the membership functions are adjusted accordingly. The membership functions are being adjusted by making area of it near the ZE region narrower. On opposite side, making area far from ZE region gives fast response.

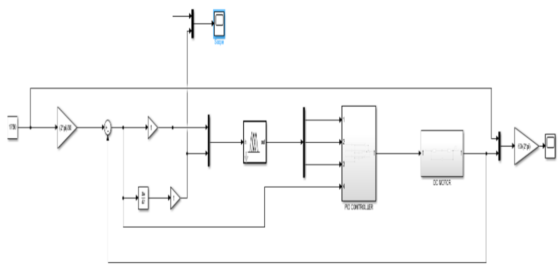

Fig. 7 Fuzzy PID Model

Fig. 8 Fuzzy PID graph

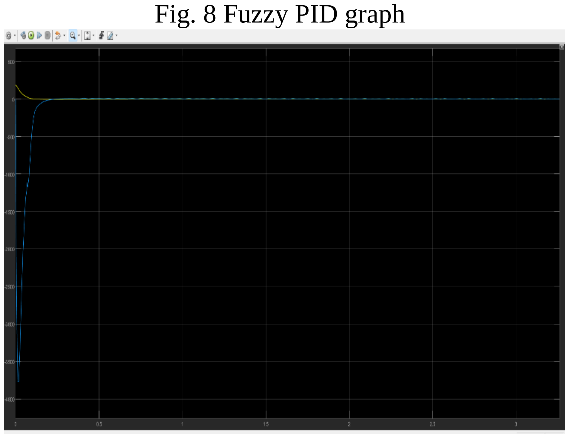

Fig. 9 Fuzzy tuned PID

## VIII. CONCLUSION

The outcome of the project is that we have studied and know how DC motor works and how its speed is controlled that is how to increase the speed of the motor. We have also come to know and understand the basics of DC. This project ensures design method of two inputs as well as three outputs of self tuning fuzzy PID controller and have used MATLAB in order to design fuzzy controller. The fuzzy controller has adjusted the proportional, integral and derivative gains respective to speed error as well as change in speed error. The self tuning FLC has good dynamic response curve, short response time and small overshoot, small steady state error.

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