ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

Position Control of Servo Motor Using Fuzzy Logic Controller

Nirmala Ashok Dange[1], Ashwini Pawar[2]

Student, Department of Electrical Engineering, G.H.Raisoni Institute of Engineering and Technology, Pune, Savitribai Phule Pune University, Pune, India[1]

Prof., Department of Electrical Engineering, G.H.Raisoni Institute of Engineering and Technology, Pune, Savitribai Phule Pune University, Pune, India[2]

ABSTRACT: By far most of the present day methods use the normal PID controllers due to their clear and fiery diagram, sensible expense, and feasibility for direct systems, however routine PID controllers are by and large not effective if the techniques included are higher demand and time delay structures. For this, Fuzzy Logic controllers were appeared. In case we solidify the two clever control structures, the issue will be resolved. The utilization of FLC's to servo systems produces comes about superior to anything conventional controllers. It is seen that, if there is a conformity in system parameters or weight unsettling impacts, the response of structure due to relating vital backup (PID) controller is essentially affected and PID controller needs retuning . Nevertheless, FLCs secure the needed response over broad assortment of system parameters and weight unsettling impacts. A FLC as a rule gives best results over those of customary controllers, to the extent the response time, settling time and particularly in quality. The objective of this paper is to dissect the time determination execution between routine controller and Fuzzy reason controller in position control course of action of a DC servomotor. This will fuse design and change of a controller for position control using Matlab/Simulink. The degree of this work is to apply two sorts of controller specifically PID and Fuzzy reason controller. The item part fuses programming continuous programming using Matlab/Simulink. Finally, the item will consolidate with hardware for position control of servo structure.

KEYWORDS:PID, fuzzy logic, position control system, servomotor.

I. INTRODUCTION

Servomotors are extensively used as a part of various modified structures, including drive for printers, recording gadgets, mechanical controllers, machine instruments, moving machines et cetera. Relative crucial subordinate (PID) controllers commonly control these motors. Such controllers will be adequately convincing if the speed and exactness essentials of control structures are not fundamental under moving circumstances of the systems. Also, the ordinary way to deal with overhaul the control movement is to tune the PID coefficients, yet this can't adjust to fluctuating control circumstances coming to fruition on account of weight unsettling impacts, system nonlinearities and change of plant parameters. The experience shows that FLC yields preferred results over those got by conventional control computations [3], [4]. Furthermore, FLC have, typical part of not requiring a low down numerical model and incite much faster and definite controllers for servo systems [5]. Fuzzy Logic Controllers rely on upon the Fuzzy set and Fuzzy reason speculation at first maintained by Lotfi A. Zadeh. Due to its heuristic nature, Fuzzy justification control is much nearer in soul to human derivation and normal lingo than standard method of reasoning systems. The FLC gives a figuring, which can change over the semantic control framework, in light of expert learning into a modified control system. In particular, the arrangement of FLC shows up to a great degree accommodating when the plants are too much personality boggling for examination by routine quantitative strategies or when the available wellsprings of information are deciphered subjectively, assessed or with insecurity. The usage of FLC in a general sense changes the best approach to manage control of drives. A standard controller changes the structure control parameters on the reason of a game plan of the differential numerical articulations, which delineates the model of drive system. In a Fuzzy controller, the progressions are made by a Fuzzy standard based expert structure, which is a reliable model of human behavior of the

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plant director [7], [8]. A FLC for the most part gives best results over those of conventional controllers, in regards to the response time, settling time and particularly in healthiness. The quality of FLC is admirable part in motor drive applications, where, the structure parameters are comprehensively changing in the midst of plant operation. Due to non-straight structure of the FLC, the essential framework issue lies in the determination of the consistent and completion rule set and the condition of enlistment limits. In any case, FLC's framework is made less requesting by warm and significance mechanical assemblies of the Fuzzy method of reasoning. In this paper, the possibility of Fuzzy justification has been used for position control, using dc servomotor. Consequent to the presentation of Fuzzy set theory by Zadeh and the essential advancement of a Fuzzy controller by Mamadani, Fuzzy control has gotten a wide affirmation, as a result of the closeness of deriving basis to human thinking and has found applications in various power plants and power systems. It gives an intense technique for changing over the expert sort control data into a modified control philosophy. Two reasons routinely set apart to seek after Fuzzy control are the aching to meld semantic control rules and the need to diagram a controller without adding to a definite system model. The principle Advantages of the Fuzzy control frameworks are as per the following.

II. IDESIGN OF CONTROLLER

In procedure control today, more than 95% of the control circles are of PID sort, most circles are really PI control. PID controllers are today found in all regions where control is utilized. The controllers come in a wide range of structures. There are standalone Systems in boxes for one or a couple circles, which are fabricated by the hundred thousand yearly. Fig. 1 demonstrates the piece chart of PID controller.

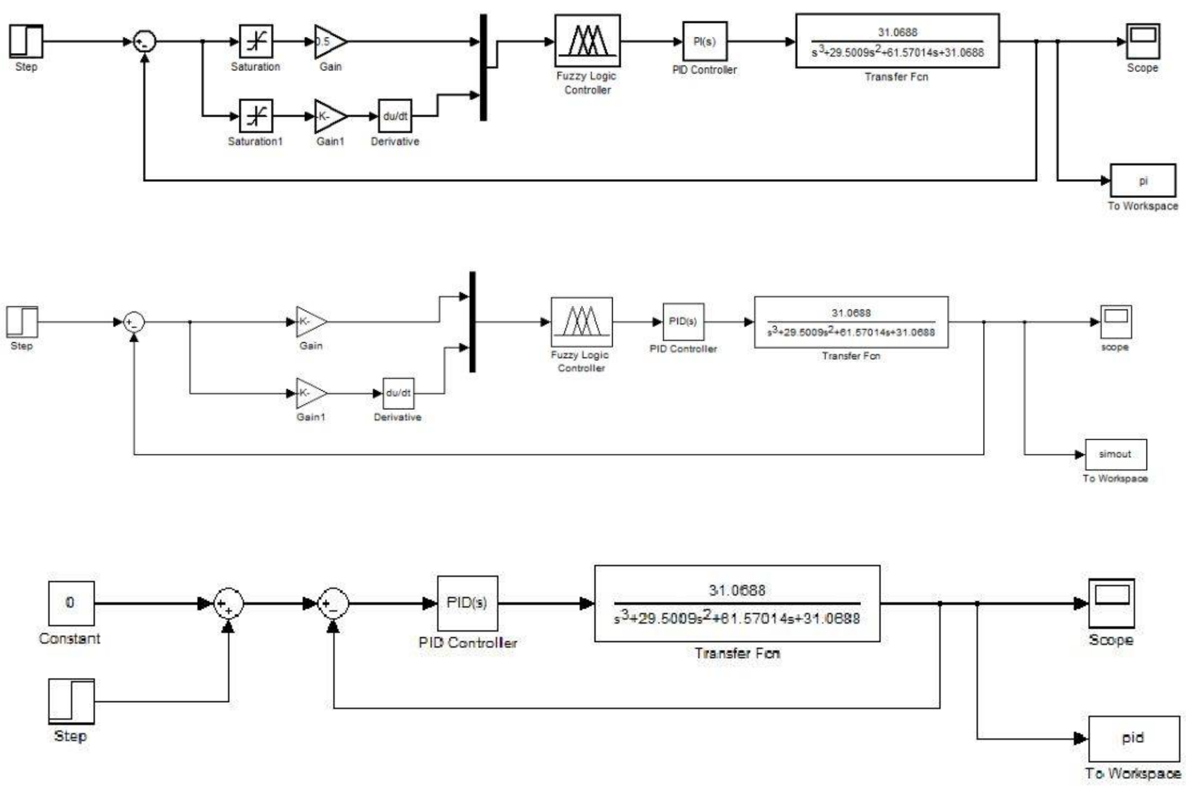

Figure 1: Block Diagram of Fuzzy, PI and PID Controller

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1. Ziegler-Nichols Method

Ziegler and Nichols had proposed a famous tuning parameter of PID controller in 1942. Steps involved in this method are as follows:

1. First, note whether the required proportional control gain is positive or negative. To do so increase the step the input under manual control and see that the resulting steady state value of the process output has also increased. If so, then the steady-state process gain is positive and the required Proportional control gain, K_P, has to be positive as well.

2. Turn the controller to P-only mode, i.e. turn both the Integral and Derivative modes off.

3. Turn the controller gain, K_P, up slowly (more positive if K_P was decided to be so in step 1, otherwise more negative if K_P was found to be negative in step (1) and observe the output response. When a value of K_P results in a sustained periodic oscillation in the output, mark this critical value of K_P as *Ku*, the ultimate gain. Also, measure the period of oscillation, Pu referred to as the ultimate period. Using the

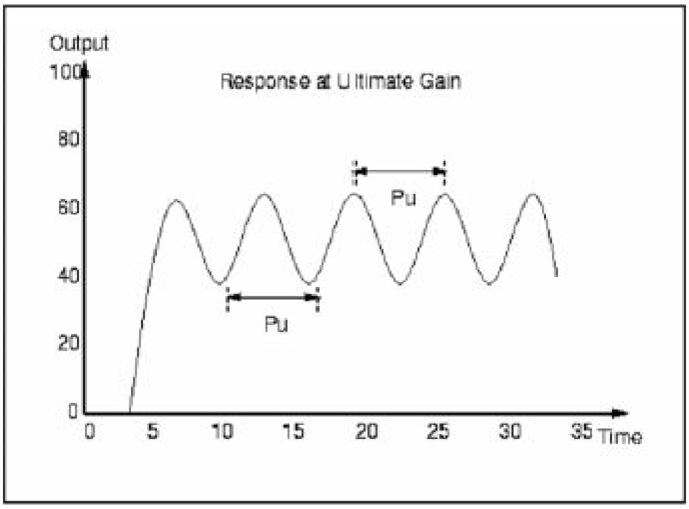

Figure 2: Response of Ultimate Gain

With some real processes the response to a step change or set point disturbance differs depending on the direction or size of the change. In this case it is irrelevant to look at the open-loop response to tune the controller. Instead the closed-loop response i.e. the behavior of the system with control has to be studied. The values of K_P, K_I and K_D are calculated from table 1.

III. DESIGN OF FUZZY LOGIC CONTROLLER

The Fuzzy Logic Controller is intended to have two Fuzzy state Variables and one control variable for accomplishing position control of the DC Servo Motor. These two info variable are the blunder and change in mistake. It demonstrates the fundamental piece chart of Fuzzy rationale controller with data and yield variables. of a controlled framework is depicted by an arrangement of Fuzzy acquainted memory (FAM) decides that associate a Fuzzy information set to a Fuzzy yield set of the FLC. These principles are given by Mamdani consequently it is called as Mamdani's FIS.

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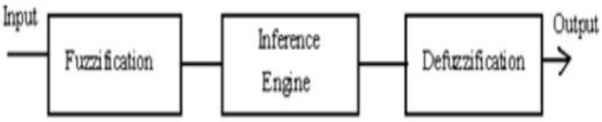

Figure 3: Block Diagram of Fuzzy Inference System

Crisp input information from the sensor is converted into fuzzy values for each input fuzzy set with the fuzzification block. The decision making logic determines how the fuzzy logic operations are performed and together with the knowledge base determines the outputs of each fuzzy IF-THEN rules. These two components are combined into the inference block. All the outputs are combined and converted to crispy values within the defuzzification block. Fuzzy rules can be described as a relational matrix R,*R=E x EC KP x Ki x Kd*

Firstly, "min" implication method is used to calculate the matrix *R*. Then the fuzzy reasoning results of outputsare gained by aggregation operation of fuzzy sets of inputs and matrix R, where "max-min" aggregation method isused. Because definite values of outputs are needed forapplication, the fuzzy results should be defuzzified. In this paper, the "centroid" method is used for defuzzification to gain the accurate values *kp, ki* and *kd*which are then sent to PID controller to control the system.

The error signal is the difference between the set point and output position of the motor. Following seven linguistic terms are used for the fuzzy sets i.e. negative big, negative medium, negative small, zero, positive small, positive medium, positive big which are denoted NB, NM, NS, ZE, PS, PM, PB respectively. The fuzzy sets are then defined by the triangular membership functions.

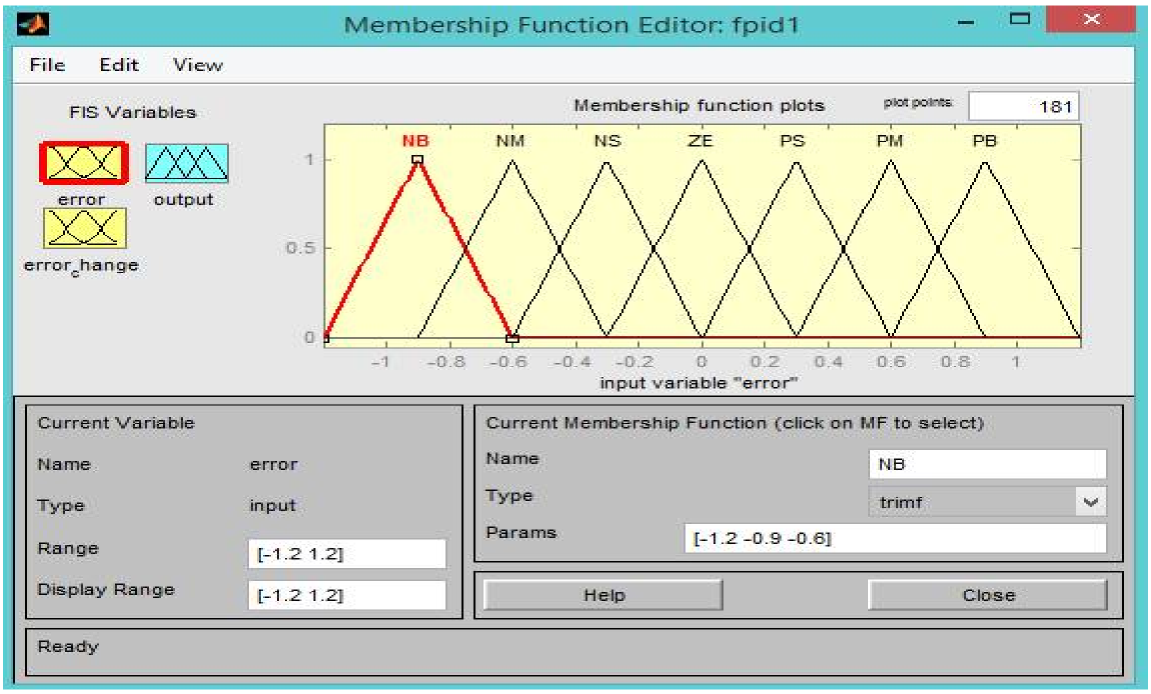

Figure 3: *Membership function of Error*

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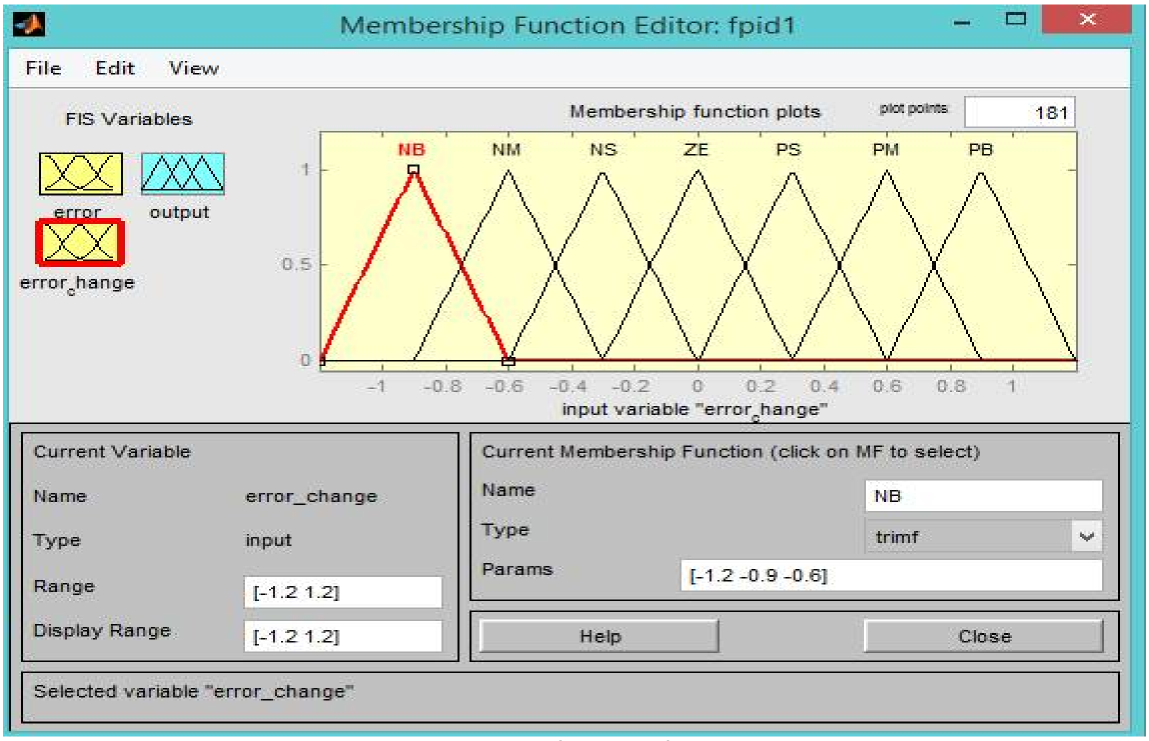

Figure 4: *Membership function of Changing Error*

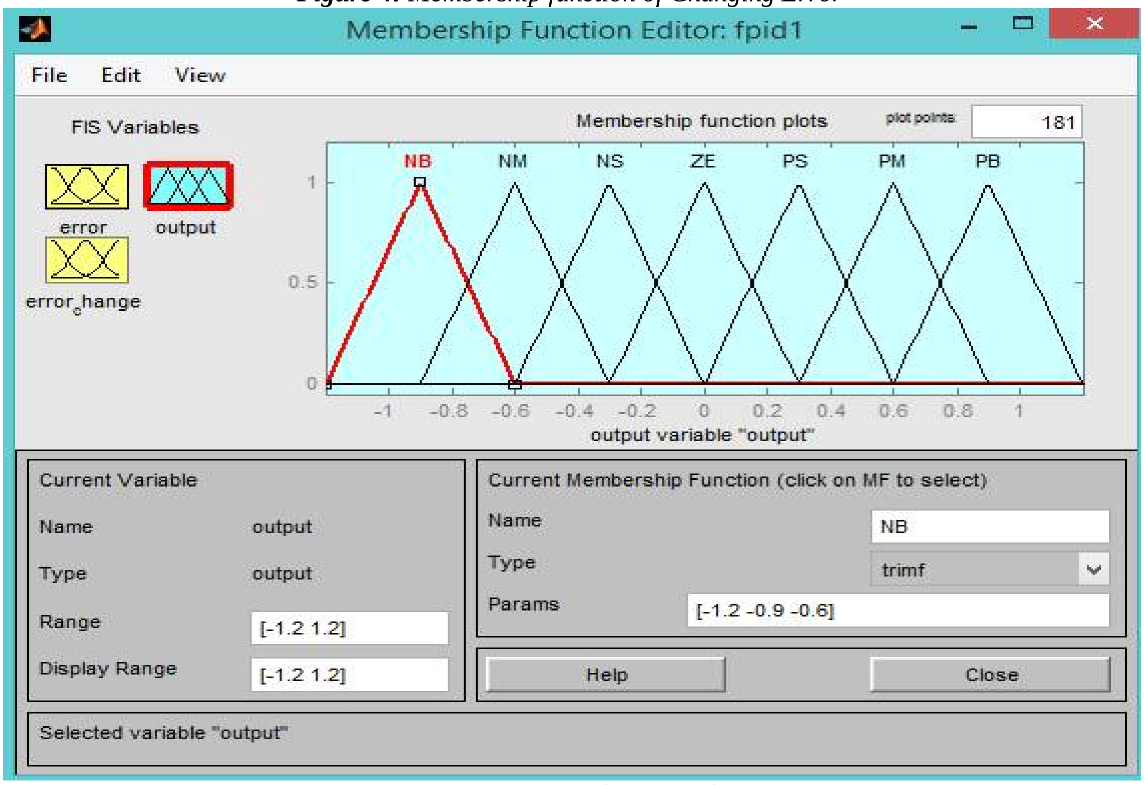

Figure 5: *Membership function of Output*

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IV. PROJECT DESIGN

The idea of this project is to develop a Fuzzy Logic Controller (FLC) and conventional PID controller by using MATLAB/Simulink. The target of the project is control the position of the DC motor. The result for both simulations is elaborate and discuss in Chapter 4 and 5 in Result section.

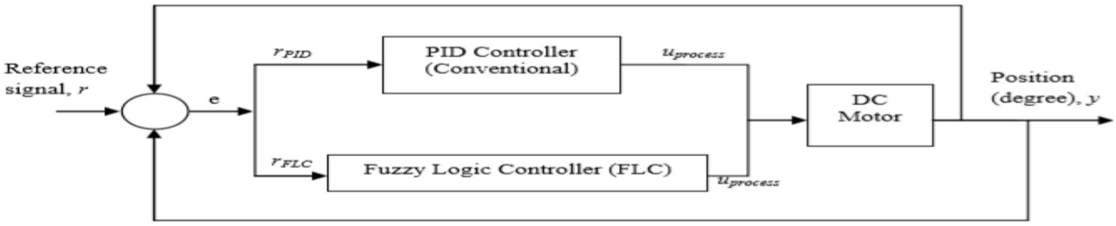

Figure 6 Block diagram of position control of DC motor

Main controller of this project is to perform Fuzzy Logic Controller while PID controller is use to compare the performance of the controller. The FLC will provide modified control action to the existing PID control system.

V. FLOW CHART

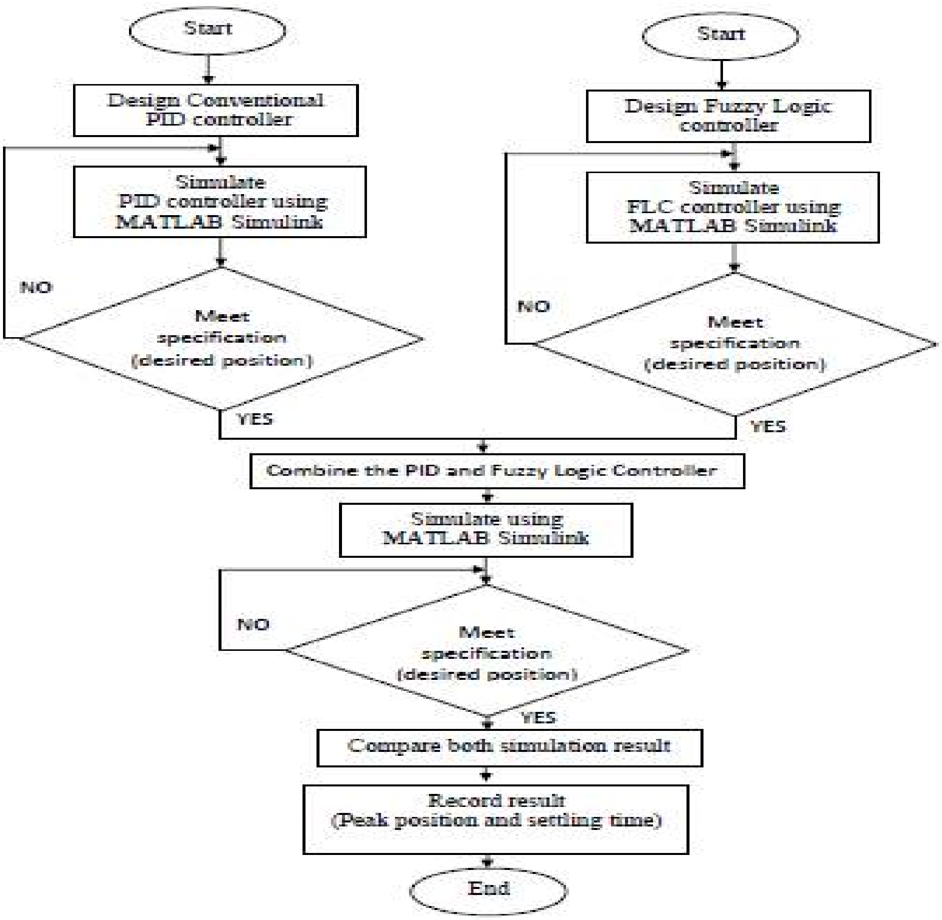

Figure.7 Flow chart of overall methodology

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ISSN (Online): 2278 – 8875

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VI. OVERVIEW OF SERVO SYSTEM

The review of servo system where set point is given through personal computer. The computer program (FIS) output is given to DAC which converts digital to analog signal. This analog signal is given to driver circuit of servo amplifier. From driver circuit output is given to servo amplifier which amplifies current to the motor. A potentiometer is connected to the shaft of the motor and a voltage of 5V is given to it, which is distributed over 360°. Thus the motor shaft position is converted in voltage signal and given back to PC through ADC as feedback signal.

From set point and feedback signal error is calculated the difference between the errors of two conjugative iterations gives change in error and this error and change in error is given as input to FIS which gives the output signal to achieve desired position.

TABLE 2SYSTEM PARAMETERS

Potentiometer sensitivity (Kp)	5.093 V/rad
Signal amplifier gain (Ka)	1
Back EMF constant (K)	$15x10^{-3}$ V/rad/s
Armature Resistance (R)	2
Armature Inductance (L_r)	1mH
Motor Torque Constant (K)	$15x10^{-3}$ N-m/A
r	
Combined moment of inertia motor	$42.6x10^{-6}$ Kg-m^2
shaft & load referred to the	
motor shaft side (Jm)	
Viscous damping coefficient of the	$47.3x10^{-6}$
motor referred to the motor	Nm/rad/s
shaft side *(Dm)*	

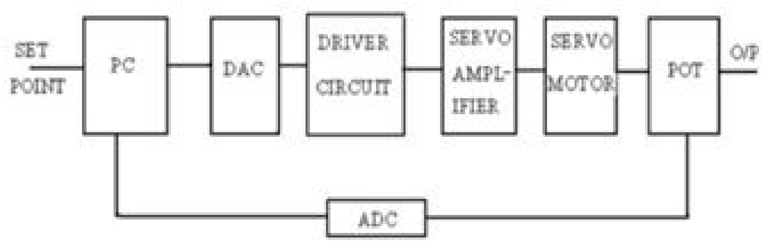

Figure 8: Block Diagram of Servo System

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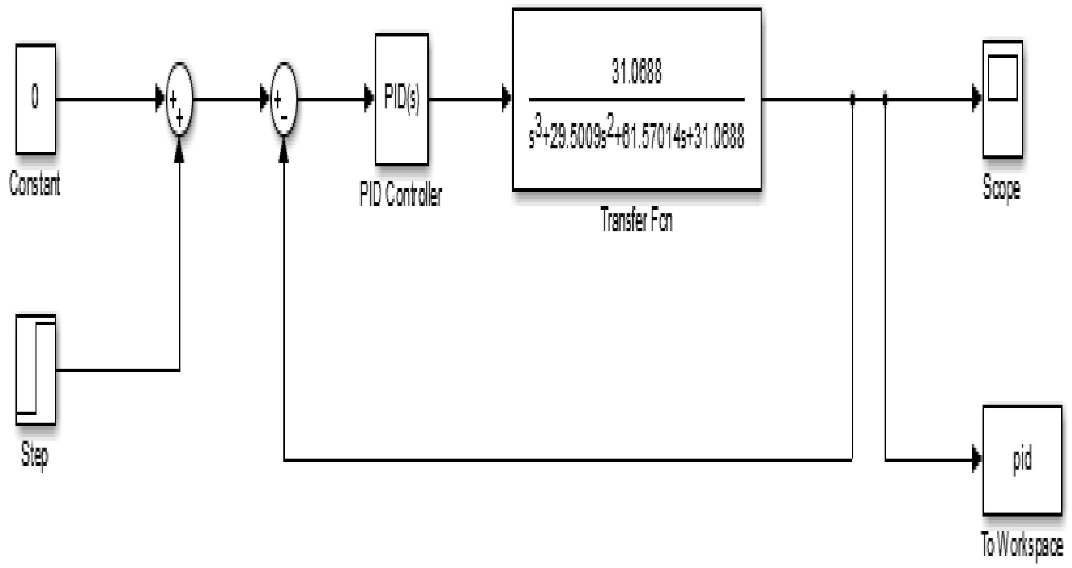
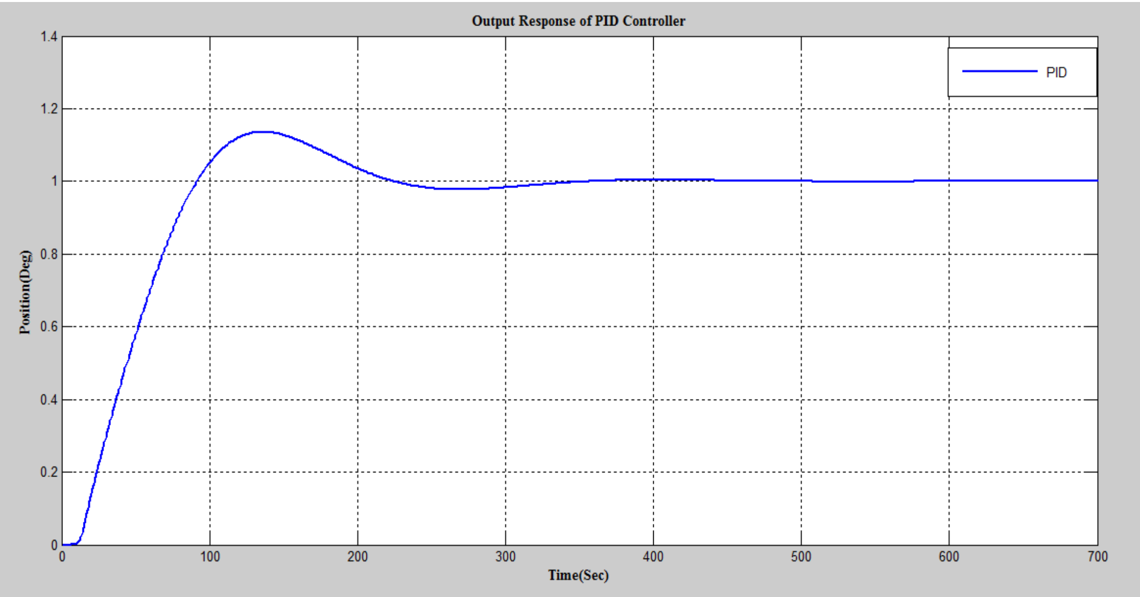
VII. SIMULATION RESULTS

1. Simple PID Controller





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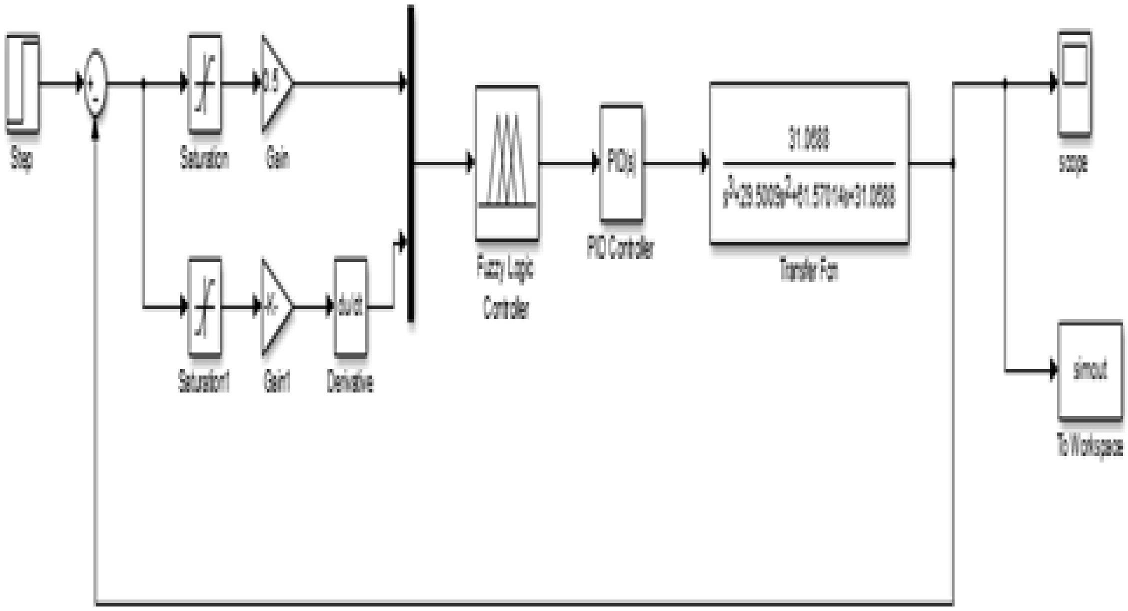
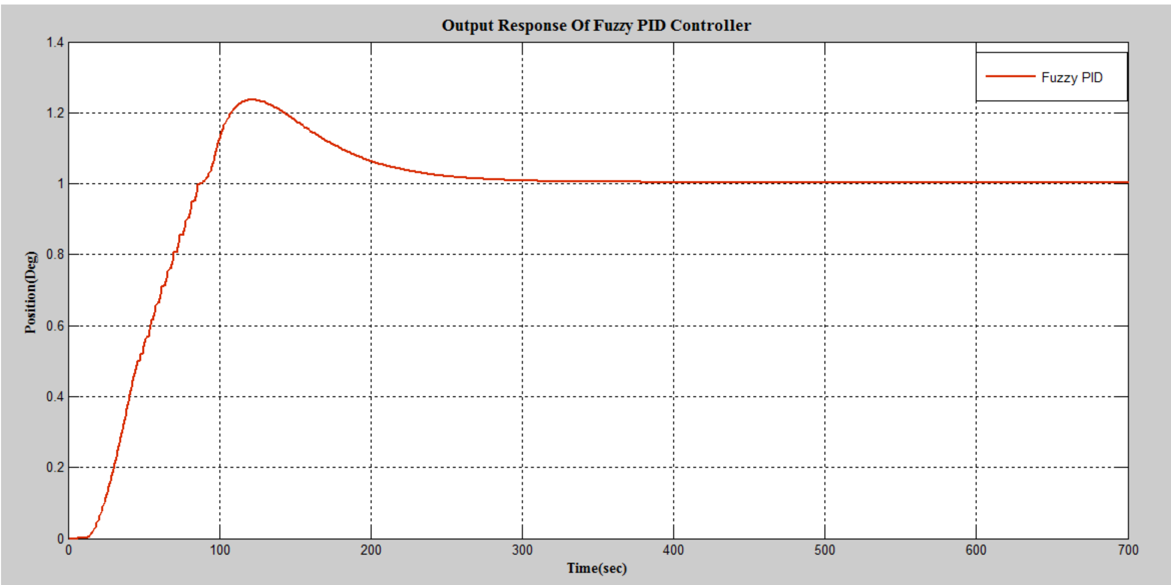
2. Simulation of Fuzzy PID





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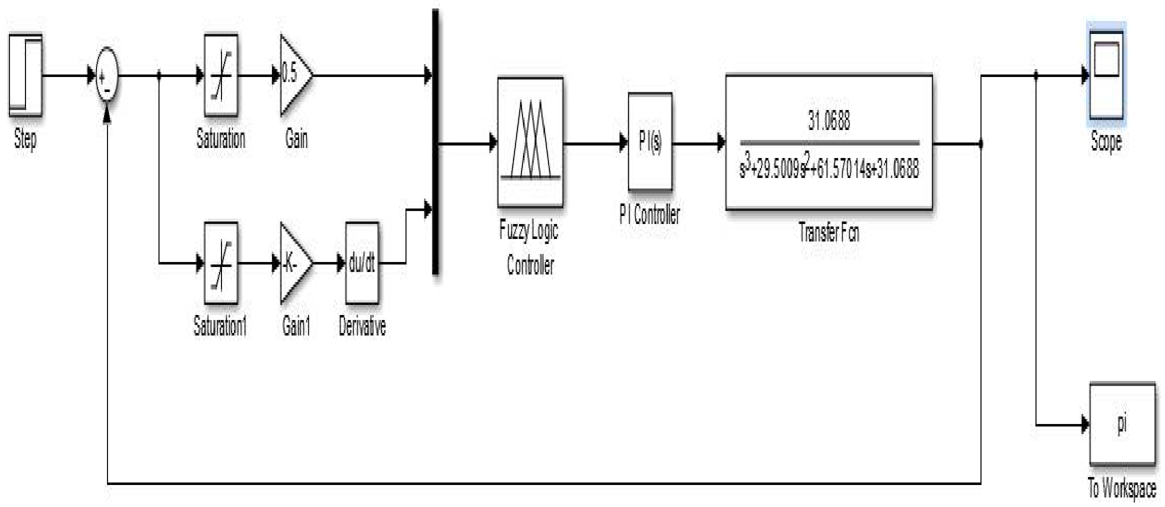
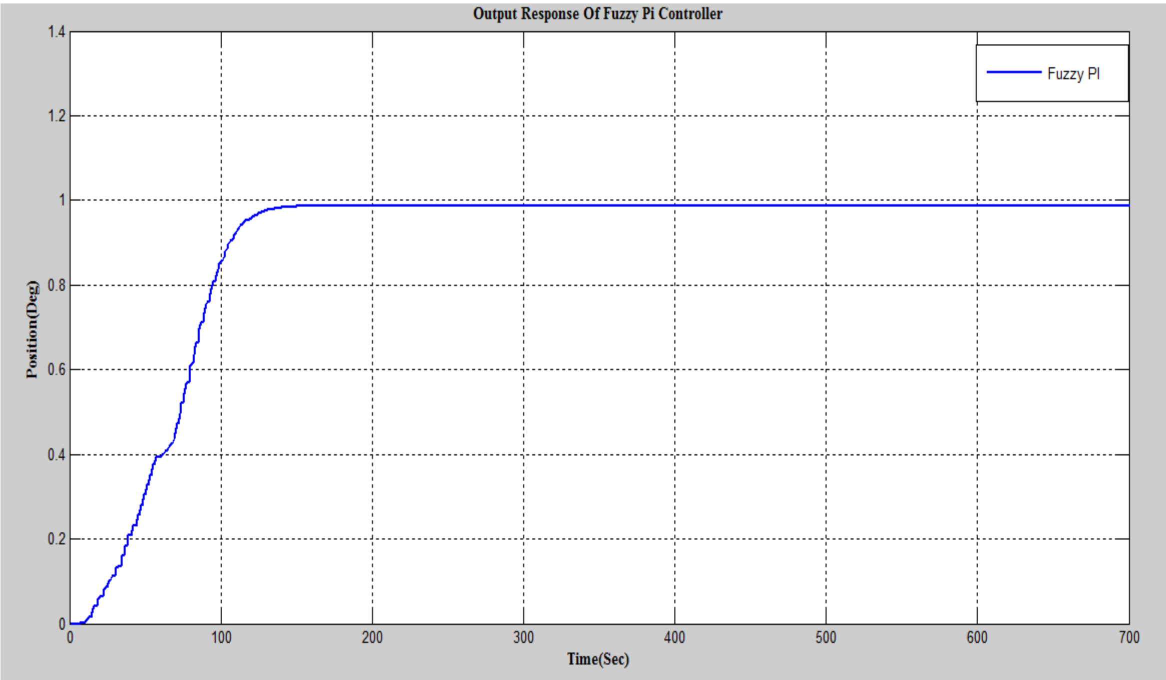
3. Simulation of fuzzy-PI





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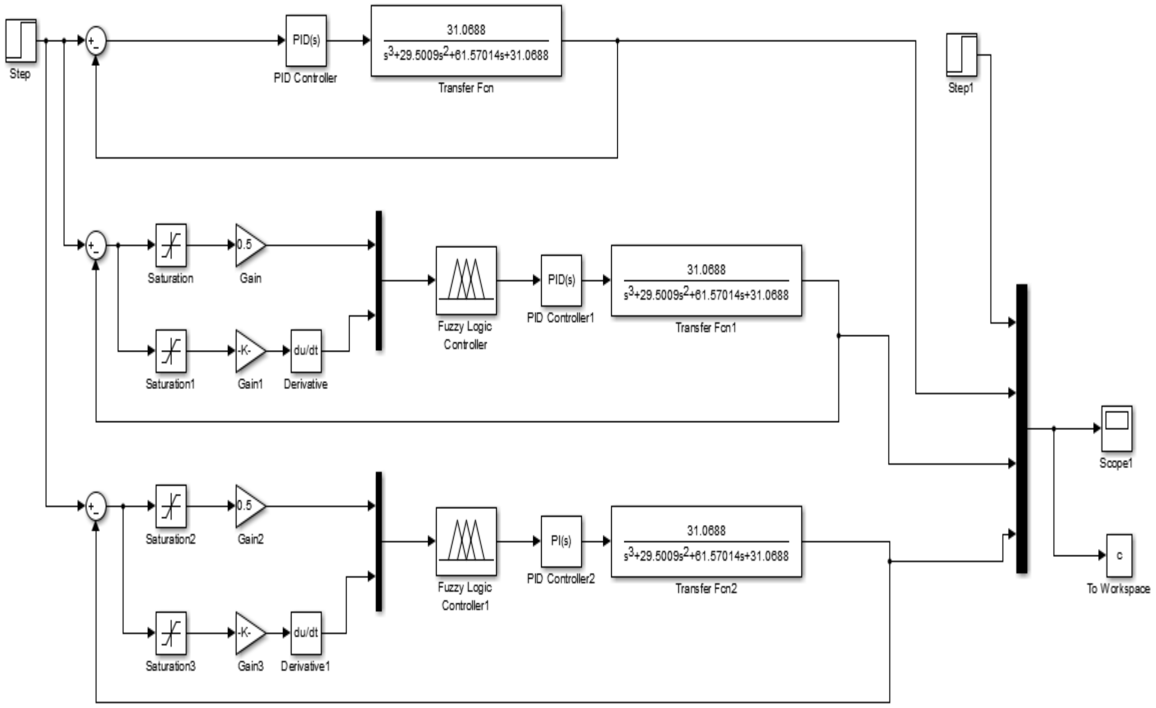
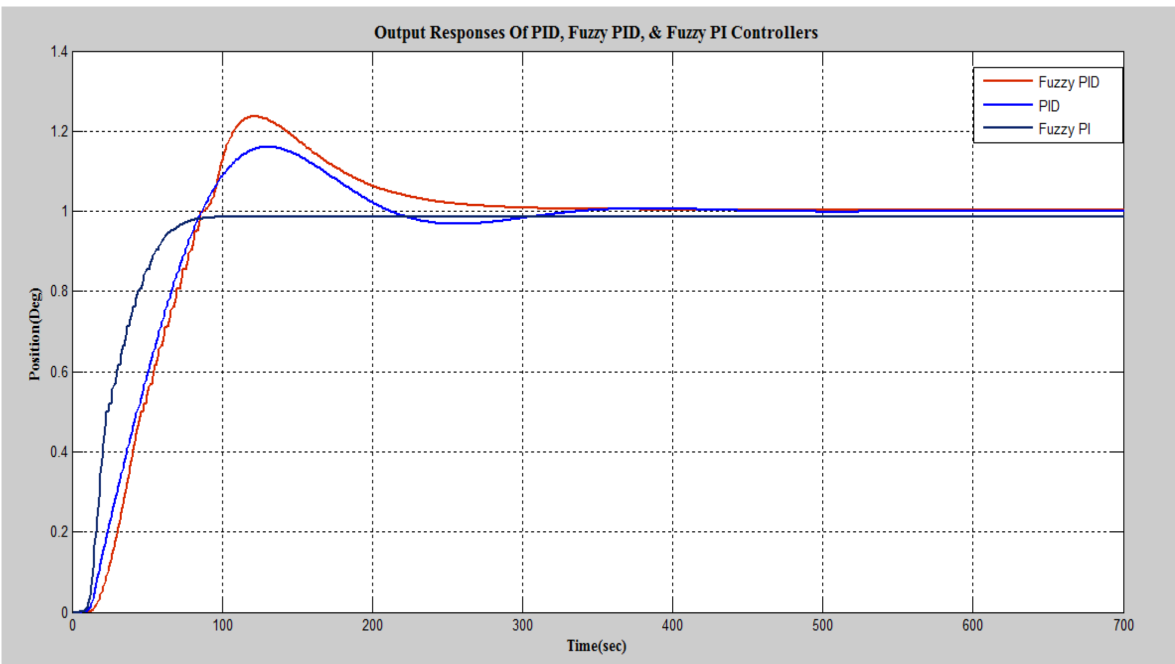
4. Comparison





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VIII. CONCLUSION

Here we Compare PID, Fuzzy PI and Fuzzy PID with respect to rise time, settling time, overshootsit is seen that the Fuzzy controller safeguards the fancied reaction, even within the sight of burden unsettling influence and changing contra1 situations. This guarantees the controller's vigor. Here we finalize the Fuzzy PID is best in terms of All parameters. The decision of guidelines and enrollment capacities has impressive impact on Fuzzy Controller execution, e.g., rise time, settling time, overshoots and so forth. It is watched that utilizing the superposition of various resulting dynamic at specific area of space, for the same mixes of forerunners, execution of FLC is enhanced impressively as far as settling time and overshoot. The blend of two arrangements of standards with same precursors however distinctive resulting diminishes the settling time and overshoot.

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