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Comparative Analysis of Speed Control of DC Motor Using Artificial Intelligence

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ABSTRACT

The main aim of this paper is to find the most efficient method of control for a DC motor among PID, Fuzzy and Neuro-fuzzy logic controllers. DC engine could be spoken to by a nonlinear model when nonlinearities, for example, attractive immersion are considered. To give successful control, nonlinearities and instabilities in the model must be considered in the control design. The model of a DC engine is considered as a third request framework. The proposed model of Fuzzy and Neuro fuzzy logic controllers are compared with PID controller performance. Matlab simulation gives the evidence of effectiveness of the proposed techniques over the traditional PID controller.

Keywords: DC Motor model, ID Controller, Fuzzy logic controller, Neuro-Fuzzy Controller;

I. INTRODUCTION

DC machines are used widely in high power industrial applications. Controlling the speed these is the impartant task in industries. By employing a intelligent controller in speed control process increases the efficiency of the system but the main disadvantage is that tuning the controller according to the input and output level. [1-5]

In this paper the main motive is to find the efficient methodology to control the speed of a DC motor over the traditional PID controller .The varation of the speed control between the Fuzzy and Neuro-Fuzzy as a slight difference but is high over the PID controller. All the control systems suffers froms overshoot which is undesirable and their settling time for the controller with the actual speed. Recent world's systems are non-linear and their modelling is difficult and more expensive and PID controller will not perform well on those systems hence we choose fuzzy and neuro-fuzzy over those systems.

Fuzzy logic controller has been effectively connected to a extensive number of control applications. The most generally utilized controller is the PID controller, which requires a numerical model of the framework. [4][5] A Fuzzy logic controller gives a distinct option for the PID controller. The control activity in fluffy rationale controllers can be communicated with straightforward "if-then" principles. Fuzzy controllers are more adequate than traditional controllers since they can cover a much more extensive scope of working conditions than traditional controllers and can work with clamor and aggravations of a diverse nature.

II. FUZZY LOGIC CONTROLLER

1. Introduction

Fuzzy logic has quickly gotten to be a standout amongst the most fruitful of today's advancements for creating advanced control frameworks. Fuzzy logic control innovation has been broadly and effectively used in mechanical applications. fuzzy logic is a multi-esteemed rationale, that permits middle of the road

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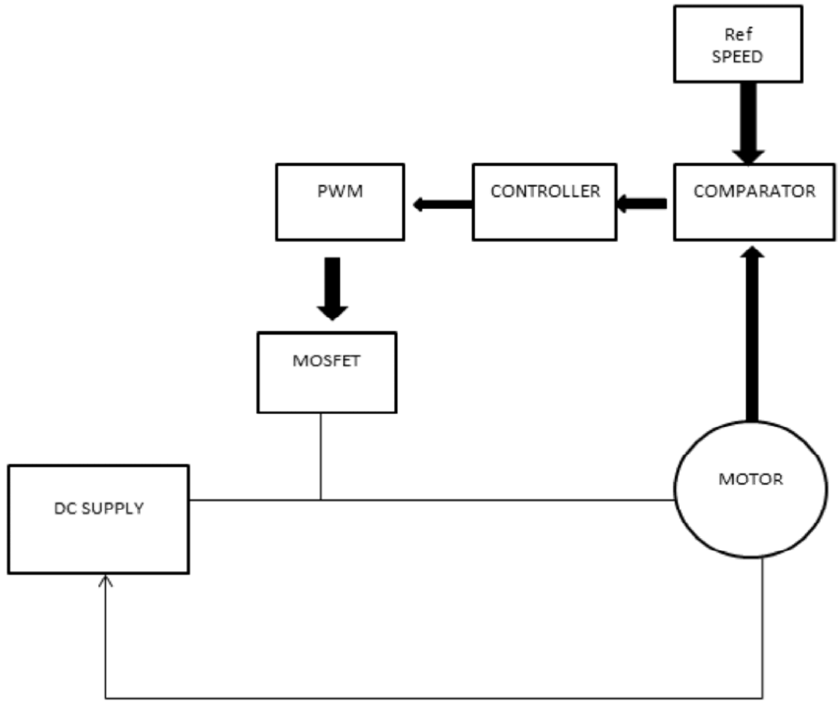

Figure 1.1: Basic Block Diagram

qualities to be characterized between traditional assessments like genuine/false, yes/no, high/low what's more, developed as an instrument to manage unverifiable, uncertain, or subjective choice making issues.Fuzzy logic is a way to make machines more astute to reason in a Fuzzy way like people Fuzzz logic controller design consis of 3 sections they are

- Fuzzification
- Knowledge base
- Defuzzification

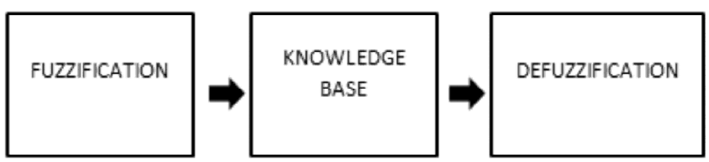

Figure 2.1: Degin of Fuzzy controller

Fuzzification

- It is the way of converting normal or fresh values into crisp values is called as Fuzzification
- It is nothing but a assigning of linguistic values to the fresh values as per the membership function

Knowledge Base

- For the principle bases an exemplary elucidation of

  Mandani was utilized. Under principle base, guidelines are developed for yields. The principles are in "If Then" organization and formally the If side is known as the conditions and the Then side is called the conclusion. A tenet base controller is anything but difficult to comprehend and simple to keep up for a non-pro end client and a proportionate controller could be actualized utilizing ordinary methods.

Defuzzification

- The mathematical way of converting the crisp values into actual values is called defuzzification
- CENTROID and MAXIMUM are the two methods for converting the crisp to normal values

2. RULEBASE FOR FUZZY LOGIC CONTROLLER

This paper shows a technique for principle base fuzzy logic controller connected to a framework. Before running the reproduction in MATLAB/SIMULINK, the fuzzy logic Controller is to be composed. This is done utilizing the FIS supervisor. FIS document is made utilizing the fuzzy logic tool compartment. The outline of a Fuzzy logic Controller requires the decision of Participation Capacities. After the suitable participation capacities are picked, a principle base is made. The arrangement of phonetic principles is the fundamental part of a fuzzy controller. The different etymological variables to outline guideline base for yield of the fuzzy logic controller are enrolled in Table I. The reaction of the fuzzy logic controller is acquired utilizing as a part of MATLAB/SIMULINK[5-10]

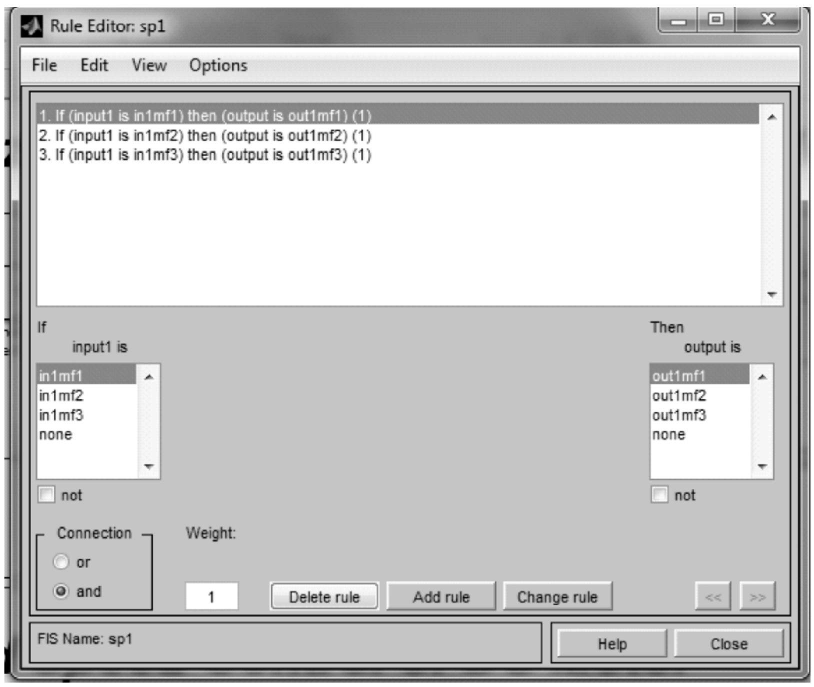

Figure 2.2: Rules for Fuzzy controller

The rules are framed as per the input applied to the fuzzy ogic controller. The input values will be of normal values those values are converted to rules by the controller and as per the rules control signals are produced. The rules are nothing but the if, else statements as per the input o and 1[8][9]. According to the inputs rules are being framed.The rule viwer for the given rules are given below

3. SPEED CONTROL USING FUZZY CONTROLLER

The model above gives the speed control of a simple Dc motor using a fuzzy logic controller. It is done by sensing the speed of the DC motor by a speed sensor and the actual speed gets compared with the Ref speed and PWM for the convertor is generated by the controller and optimum switching of MOSFET takes place and the speed is varied.

The output waveform shows the difference between the actual speed and the speed produced after the implementation of fuzzy logic controller.

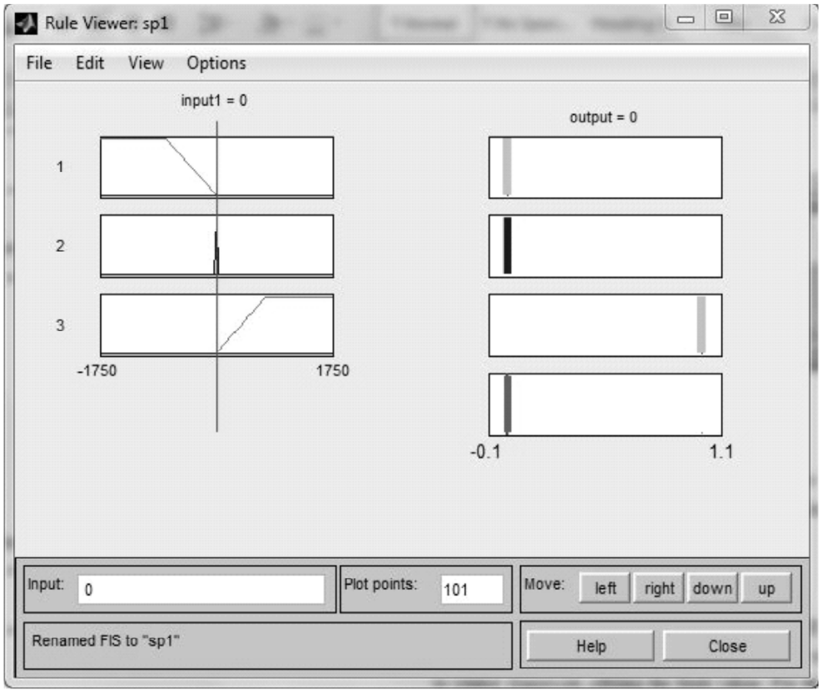

Figure 2.3: Rule viewer for Fuzzy controller

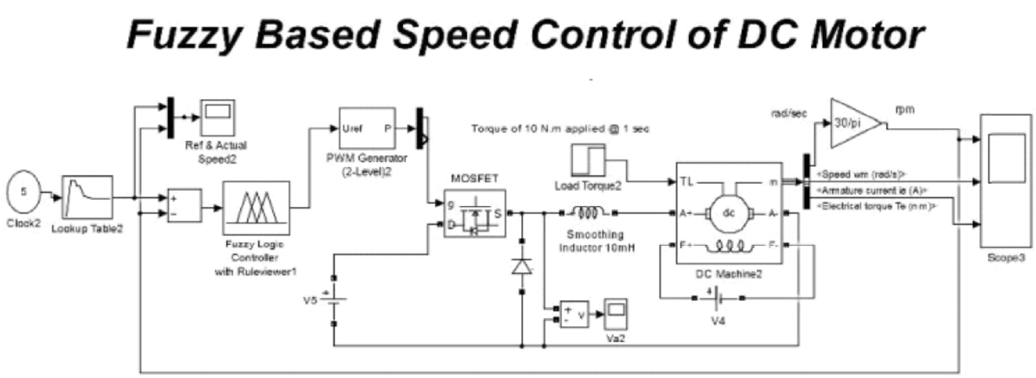

Figure 2.4: Speed control using Fuzzy controller

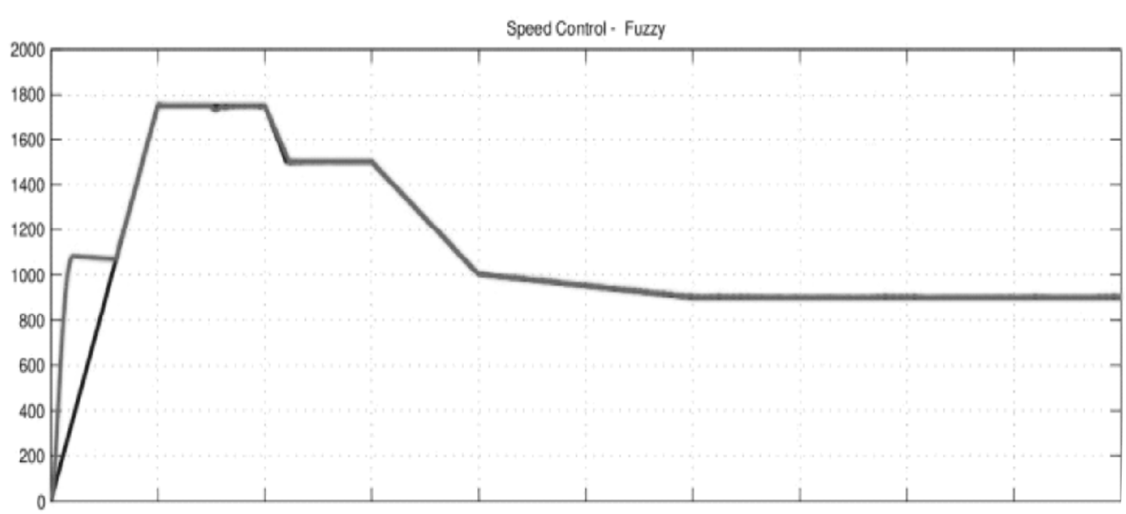

Figure 2.5: Output waveform

III. PID CONTROLLER

1. DESIGN OF PID CONTROLLER

The parameters of the PID controller is obtained by Ga based optimization technique although the controller is good but it is not robust to diviation produced by the system.

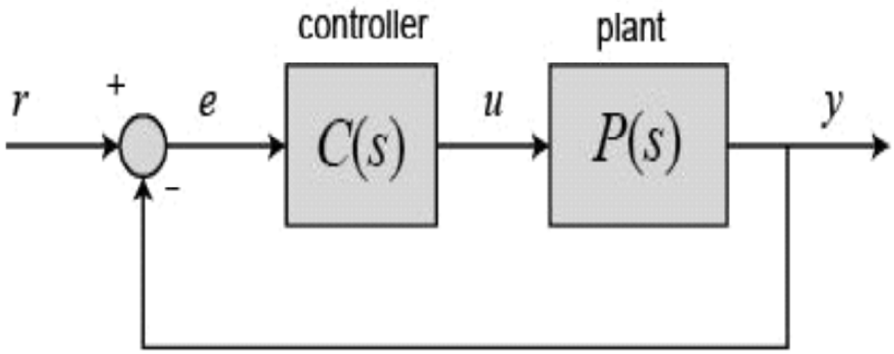

Figure 3.1: Block representation of PID controller

The variable (e) speaks to the following blunder, the contrast between the coveted data esteem (r) and the genuine yield (y). This mistake signal (e) will be sent to the PID controller, and the controller processes both the subsidiary and the indispensable of this blunder signal.[11-13] The control signal (u) to the plant is equivalent to the corresponding increase (K_p) times the extent of the blunder in addition to the basic addition (K_i) times the essential of the mistake in addition to the subsidiary increase (K_d) times the subordinate of the blunder.

2. PROPORTIONAL AND INTEGRAL CONSTANTS

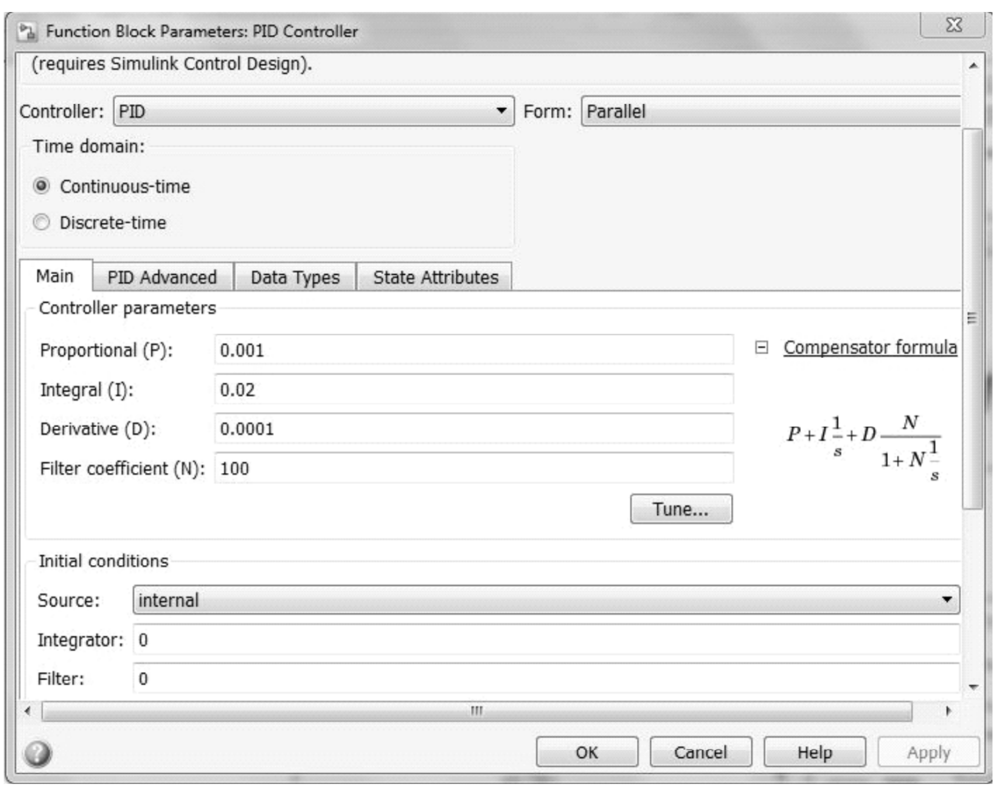

Figure 3.2: Proportional and Integral Constants

This block shows the proportional and integral constans for the given PID controller once the parameters are given tuning of the controller takes places and the signals are produced.

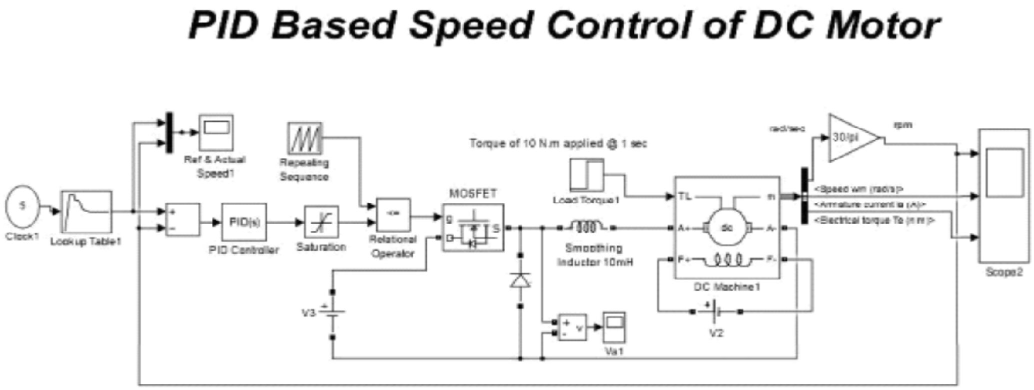

Figure 3.3: Speed control by PID controller

The simulation model consist of speed control of a DC motor using the traditional PID controller. The control signals are generated based on the proportional, integral derivative which is given as the input to the PID controlleras shown in fig 3.3.

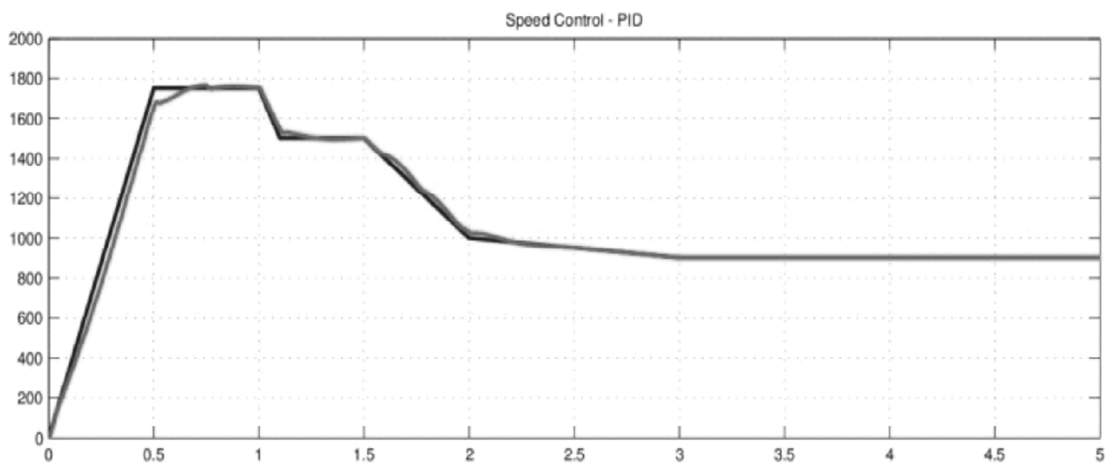

Figure 3.4: Output waveform by PID controller

The output shows that the speed generated by the PID controller doesn't match with the actual speed hence the proposed model is designed in such a way that it matches the actual speed.

IV. NEURO FUZZY CONTROLLER

1. Introduction

In the base of artificial intelligence Neuro-fuzzy refers to the combination of fuzzy and neural network logic.It was proposed by J. S. R. Jang. Neuro-fuzzy hybridization results in a half and half shrewd framework that synergizes these two procedures by consolidating the human-like thinking style of fuzzy frameworks with the learning and connectionist structure of neural systems.

2. Speed Control

The speed control of DC motor is done by framing neural networks combined with fuzzy logic. In the simulation about 3000 data's are embedded to the controller to frame the neural network[14]

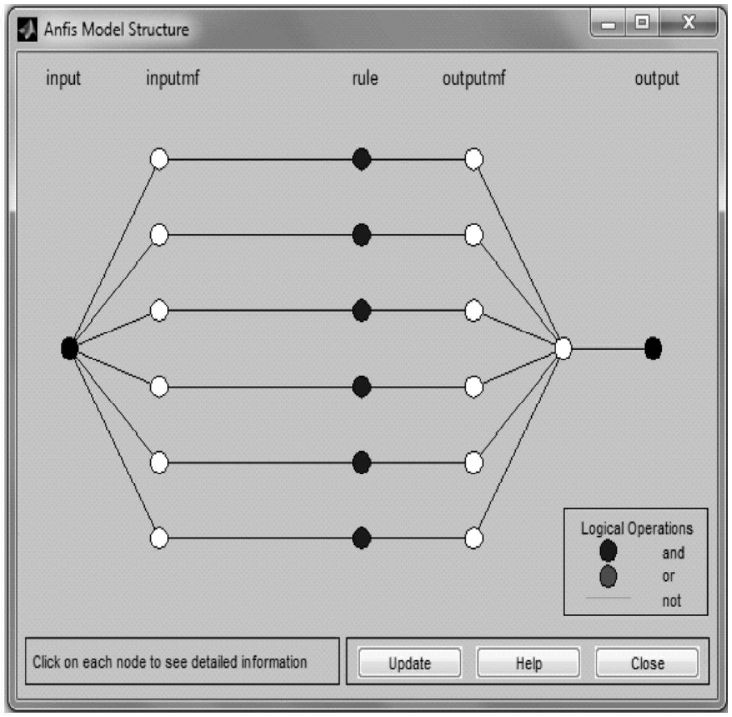

Figure 4.1: Neural structure

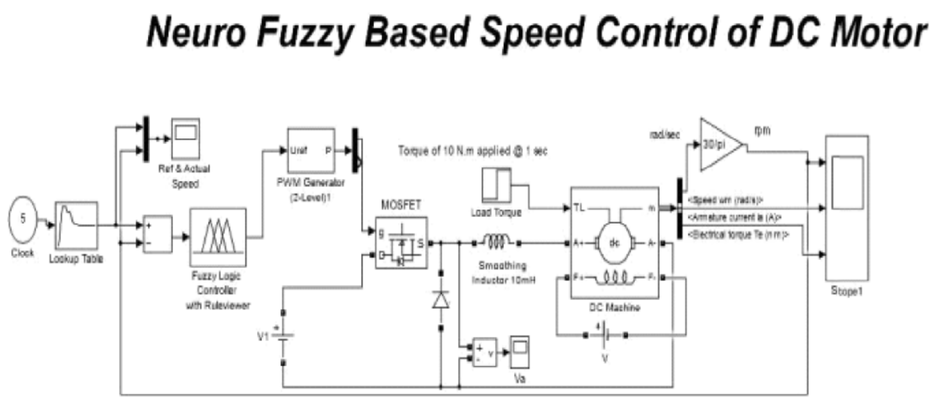

Figure 4.2: Speed control using neuro fuzzy

The speed control is done by the control signals that are generated from the neuro fuzzy controller by the rules which is the combination of Neural networks and fuzzy logics.The fig 4.2 shows the speed control of DC motor by Neuro fuzzy controller.

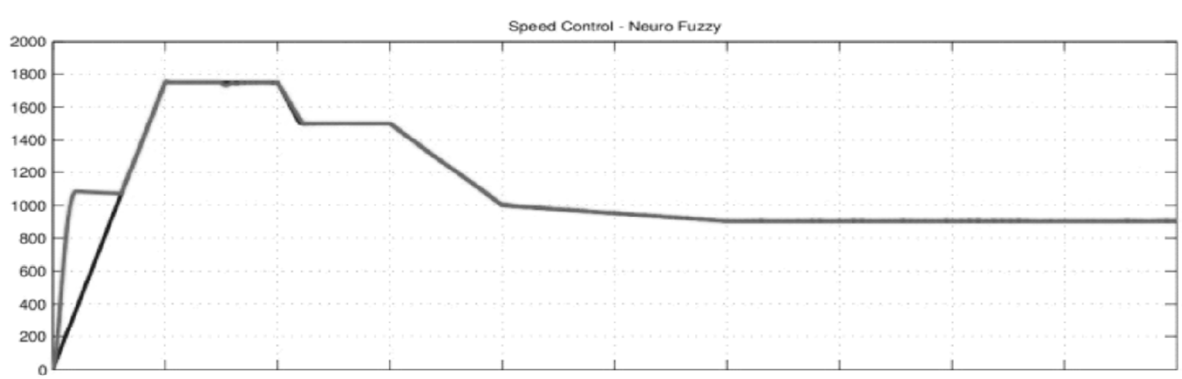

Figure 4.3: Output waveform

The output waveform consist the speed torque curve in which the modulated speed gets matched with the actual speed with less time interval compared to the traditional or nonlinear PID controller. [15]

V. CONCLUSION

This paper presents a new technique To control the speed of a DC motor in a effective manner. The nonlinear controller lags the actual speed by large time interval but the designed technique with Fuzzy and Neuro fuzzy logic controller matches the actual speed with lesser time interval. The difference between the fuzzy and neuro fuzzy controller will be of 0.001% which are designed for accuracy.Hence the new technique developed to control the speed within desired time interval will increase the efficiency of the motor as well as the system.

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