Adaptive Approach for DC motor Dynamic Loading Analysis

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Abstract— In this paper proposes adaptive power system (APS), it's wont to mitigate the negative impacts levied on the platforms ensuing from giant dynamic loads. Here we tend to square measure exploitation dc motor as a result of it's many benefits. Such as, Speed management over a large vary each higher than and below the rated speed High beginning torsion, correct steep less speed with constant torsion etc. A DC motor is any of a category of electrical machines that converts electricity power into mechanical power. Several of those new systems can have extreme dynamic power profiles, together with each periodic and a periodic characteristics. By exploitation the simulation results we will analyze the planned technique. In this paper armature voltage control fuzzy logic control technique for DC motor is proposed. In that case based on motor speed error is input for fuzzy controller and based on error required armature voltage supply to the dc motor. The system model is simulating in MATLAB simulink and results are comparing with conventional PID controller based armature voltage controlling technique on same motor.

Key words: Digital, Wellbeing, Smartphone, Google, Tools, Feature, Application, Notifications

I. INTRODUCTION

The APS is analogous to the active filter idea whereby the active filter provides the present required to keep up the standard of the load current needed by the upstream power system grid. Duty cycles will vary from tiny to continuous and, for a few cases, the high power demands is on top of the potential of the ship powerhouse. A DC motor is any of a category of rotary electrical machines that converts DC electric power into mechanical power. The foremost common varieties consider the forces made by magnetic fields. Nearly every type of DC motors have some internal mechanism, either mechanical device or electronic, to sporadically amendment the direction of current flow partly of the motor. These forms of extreme power profiles cannot be supported with standard power systems.

The adaptive power system (APS) idea given during this technique may be associate degree enabling technology for sensors or weapons with massive dynamic masses that while not the APS would be incompatible with unbalance speed operation or unbalance mechanical loading conditions. The APS consists of energy storage, a two-way current supply, and innovative power management techniques. These innovative power or speed management techniques increase the energy storage utilization, therefore minimizing the energy storage size. Typical systems have centered heavily on providing well-regulated voltages and clean power to the corresponding load. If the voltage dynamics seen at the load square measure to be reduced, the output impedance of every convertor stage is reduced by victimization little series inductance values, massive shunt capacitance values, and controlling loops with high bandwidths. However, to stop the middle to low frequency load dynamics this kind of system is given from propagating back to the distribution bus and generator.

When compared with the passive filter technique (brute-force method) the APS will support the periodic load at a fraction of the dimensions and weight required. If victimization the active load technique while not excessive power dissipation as would exist (throw-away method), and for a few specific applications while not timeline restrictions as would be required if employing a refresh or recharging kind system (restricted-timeline method).

II. PROPOSED METHODOLOGY

A. PID Controller based Adaptive Power System

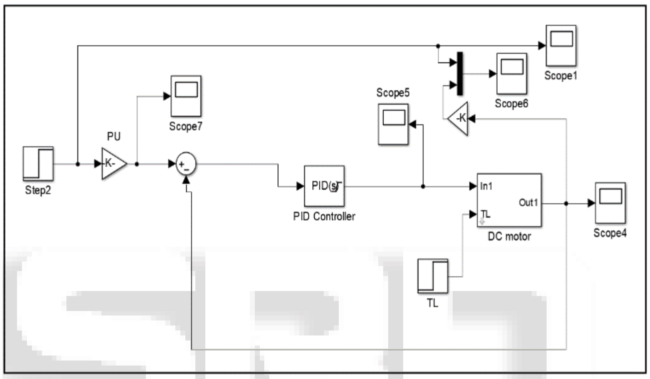

Fig. 1: MATLAB simulink model for APS for DC motor using PID controller

B. PID Controller tunning

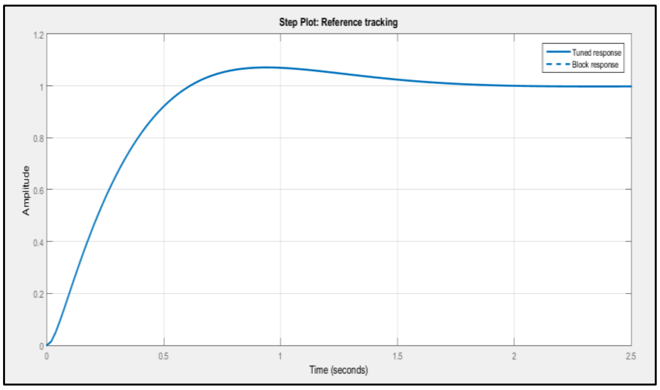

Fig. 2: PID controller tuning window for reference signal trapping

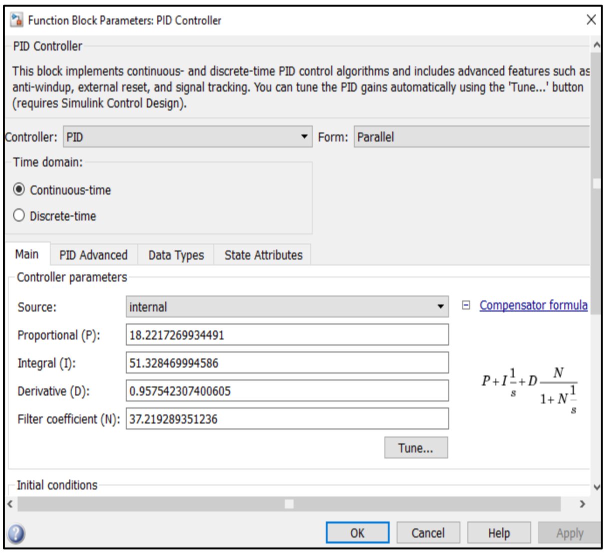

Fig. 3: PID controller gain values after successful tuning in MATLAB simulink

Figure 2 shows the PID controller tuning graphs in which tuning of PID controller with plant or with system is done automatically using MATLAB simulink. The tuning done with reference of reference speed of machine so that to adjust the proportional gain Kp, integral gain Ki and derivative gain Kd of PID controller.

Figure 3 shows the adjusted PID controller gains after successful tuning of PID controller. In that case Proportional gain Kp, integral gain Ki and derivative gain Kd are respectively 18.2217, 51.3284 and 0.9575 respectively.

C. MATLAB simulation results for model-1

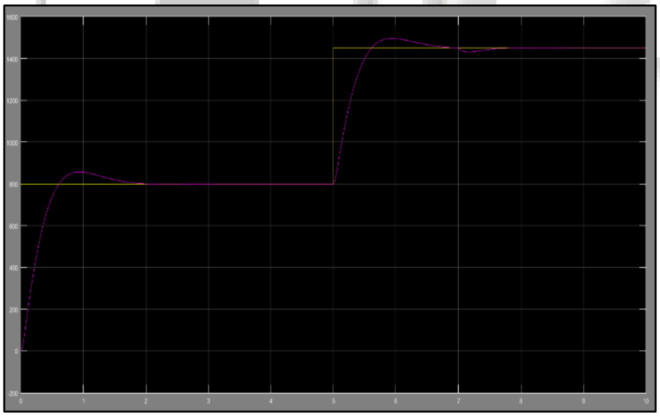

Fig. 4: Reference speed vs PID controller controlled speed graph in MATLAB simulink scope

Figure 4 shows the speed response of DC motor with respect to reference speed in which the purple color shows the speed response of DC motor and yellow color line is reference speed.

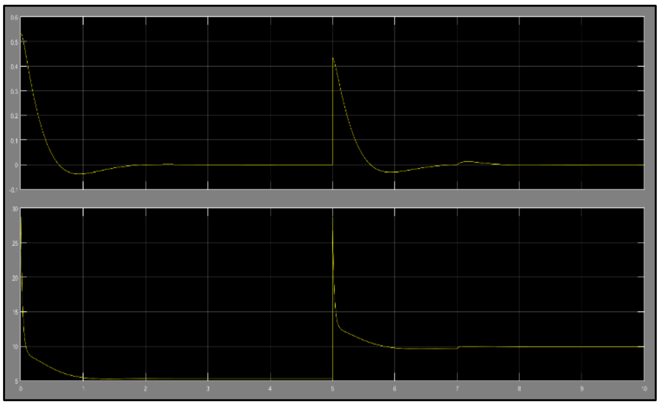

Fig. 5: Upper graph for speed error in pu while lower graph for corresponding armature voltage using PID controller as APS

Figure 5 shows the speed error and their corresponding armature voltage controlling action in which it is clear that as speed error increases then corresponding controlling armature voltage also increases and wise versa. Speed error is increases means reference speed more than actual output, hence armature voltage require more increase the actual speed of motor so that to achieve error zero.

D. Adaptive power system using Fuzzy Logic Controller (Model-2)

Figure 6 shows the fuzzy logic control based armature controlling technique for DC motor controlling. In that case input of fuzzy logic controlling is speed error and change in error and output of controller is armature voltage control. DC motor subsystem model is design using mathematical modeling which is shown in figure 7.

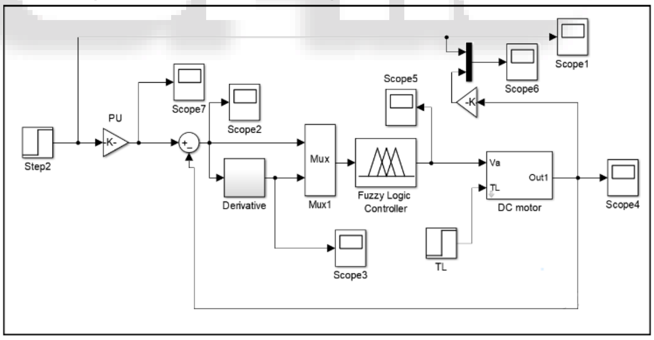

Fig. 6. Proposed matlab simulation model for DC motor power system

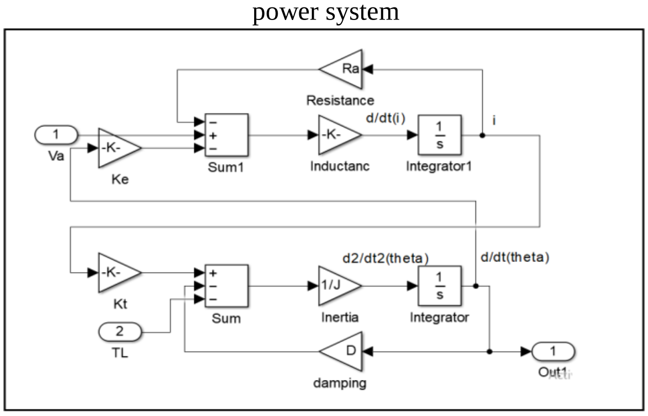

Fig. 7: DC motor modeling in MATLAB simulink

E. Fuzzy logic controller

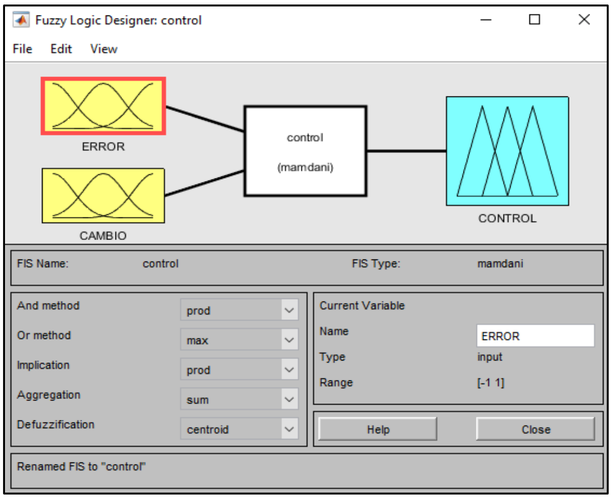

Fig. 8: Fuzzy logic controller design tool in MATLAB simulink

Figure 5.11 shows the Fuzzy logic controller designing window in which input and output membership function was design for controlling the armature voltage input of dc motor modeling. The value of different membership functions with range shown in table I, II and output membership function ranges shown in table III.

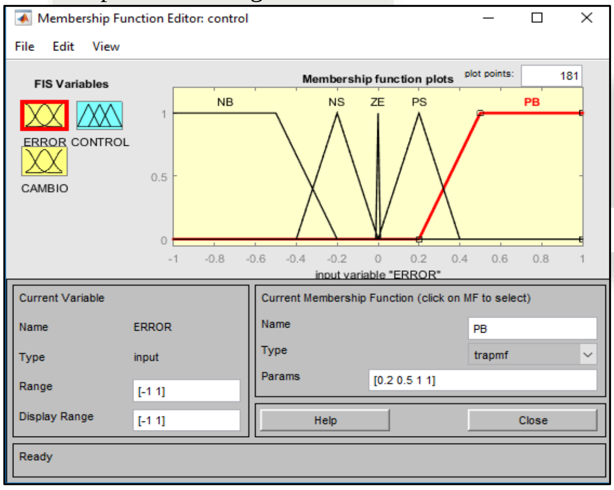

Fig. 9: Fuzzy membership function designing for speed ERROR signal

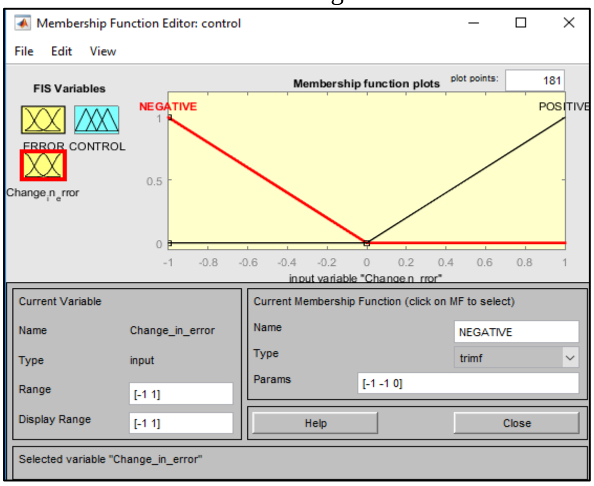

Fig. 10: Fuzzy membership function for speed change in error signal

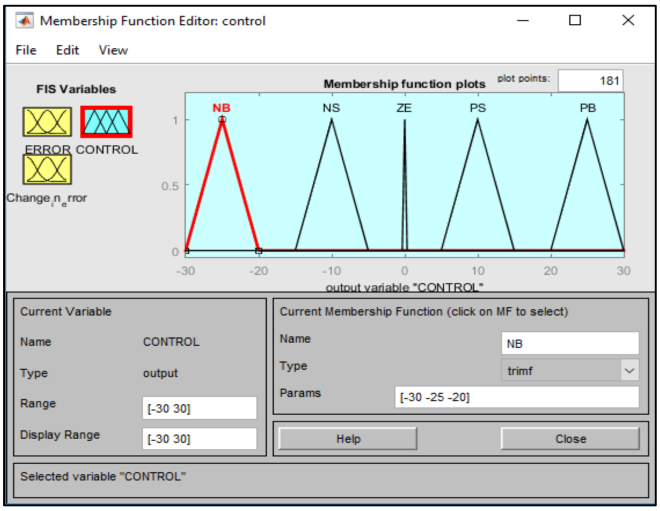

Fig. 11: Fuzzy membership function for control output (Armature voltage control)

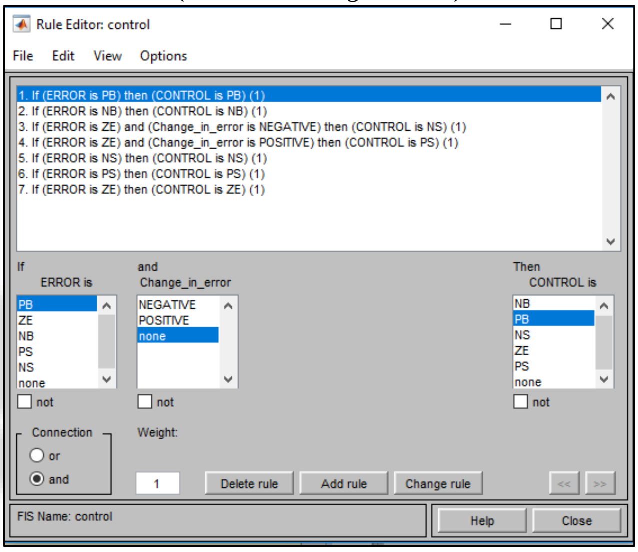

Fig. 12: Fuzzy rule base designing window in MATLAB simulink

Figure 12 shows the fuzzy rule base designing window in which seven rule base is design based on two speed error and change in error signal and one corresponding controlling armature voltage.

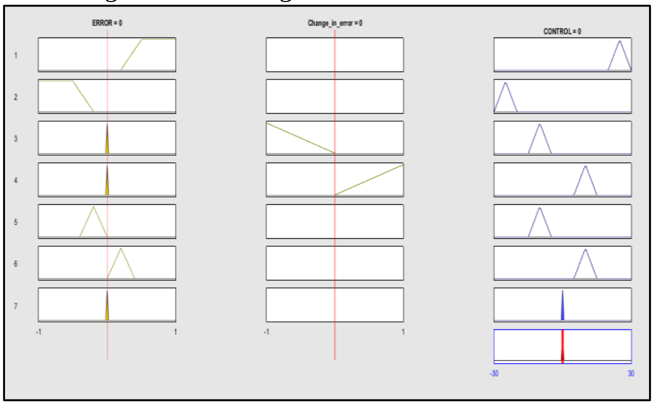

Fig. 13: Fuzzy rule viewer in MATLAB simulink

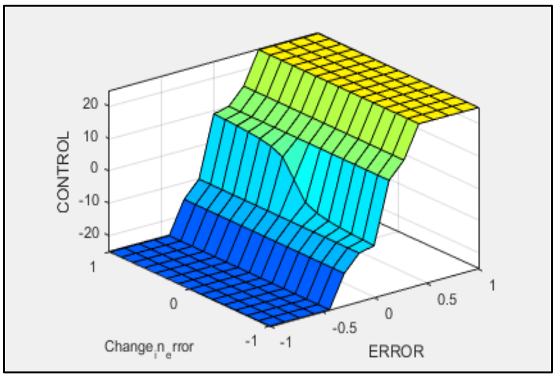

Fig. 14: Fuzzy logic controller controlling surface in MATLAB simulink

F. *Adjusting Fuzzy Membership Functions and Rules*

In order to improve the performance of FLC, the rules and membership functions are adjusted. The membership functions are adjusted by making the area of membership functions near ZE region narrower to produce finer control resolution. On the other hand, making the area far from ZE region wider gives faster control response. Also the performance can be improved by changing the severity of rules.

G. *Design of Membership Function (MF)*

Fuzzy set error	Numerical range	Shape of membership function
Negative Big (NB)	-0.2 to -0.5 to -1 to -1	Trapezoidal
Negative Small (NS)	-0.4 to -0.2 to 0	Triangular
Zero (ZE)	-0.01 to 0 to 0.01	Triangular
Positive Small (PS)	0 to 0.2 to 0.4	Triangular
Positive Big (PB)	0.2 to 0.5 to 1 to 1	Trapezoidal

Table 1: Membership function speed error

Fuzzy set error	Numerical range	Shape of membership function
Negative	-1 to -1 to 0	Triangular
Positive	0 to 1 to 1	Triangular

Table 2: Membership function of change in speed error

Fuzzy set error	Numerical range	Shape of membership function
Negative Big (NB)	-30 to -25 to -20	Triangular
Negative Small (NS)	-15 to -10 to -5	Triangular
Zero (ZE)	-0.1 to 0 to 0.1	Triangular
Positive Small (PS)	5 to 10 to 15	Triangular
Positive Big (PB)	20 to 25 to 30	Triangular

Table 3: Membership function of output of FLC

H. *Fuzzy Rule Base*

Fuzzy rule base for fuzzy logic controller are as follows

Rule 1: If ERROR is positive big (PB) then control is Positive Big (PB).
Rule 2: If ERROR is negative big (NB) then control is negative big (NB).
Rule 3: If ERROR is zero (ZE) and change in error is Negative then control is negative small (NS)
Rule 4: If ERROR is zero (ZE) and change in error is positive then control is Positive small (PS)
Rule 5: If ERROR is Negative small (NS) then control is negative small (NS)
Rule 6: If ERROR is Positive small (PS) then control is Positive small (PS)
Rule 7: If ERROR is Zero (ZE) then control is Zero (ZE)

I. *Simulation results for model-2*

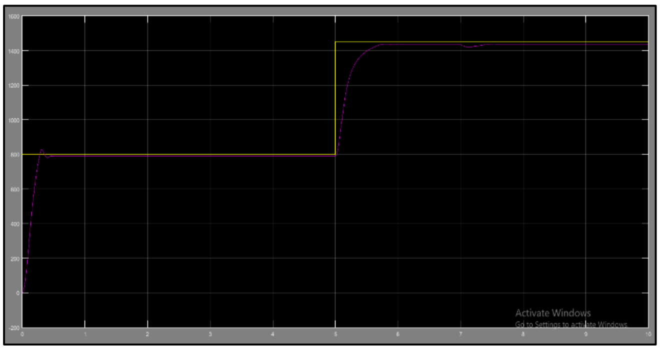

Fig. 15: Reference speed and actual speed control of fuzzy logic controller

Figure 15 shows the speed response of DC motor using fuzzy logic based armature voltage control method. In that case y-axis shows the speed in rpm while x-axis shows the simulation runtime in seconds. The fuzzy logic based power system model is control the speed of motor efficiently as compare with PID controller.

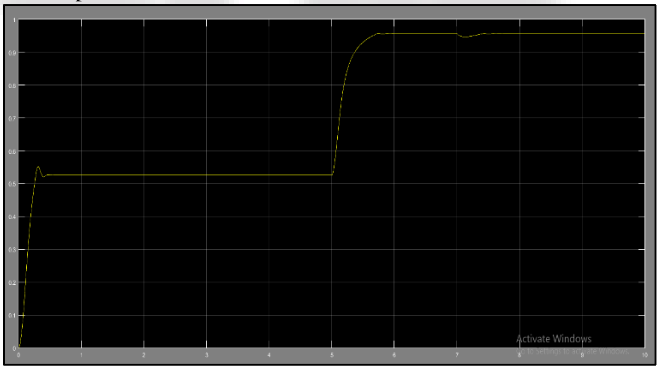

Fig. 16: Speed verses time characteristics of DC motor

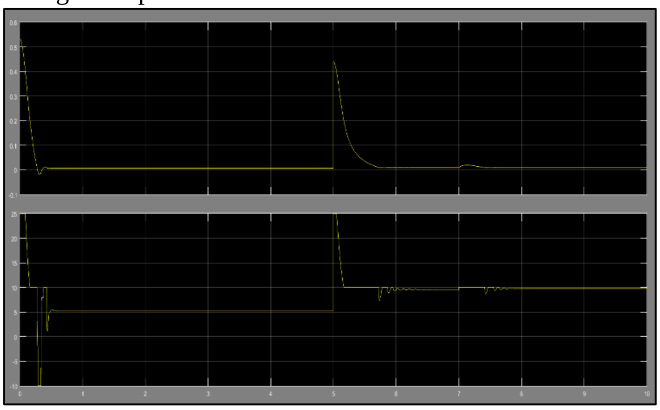

Fig. 17: Fuzzy logic controller output response

Figure 17 shows the speed error and their corresponding armature voltage control action by fuzzy logic controller. It is clear that when speed error increases then corresponding controlling output voltage is also increase and vice versa.

J. Comparative results for FLC and PID controller based APS

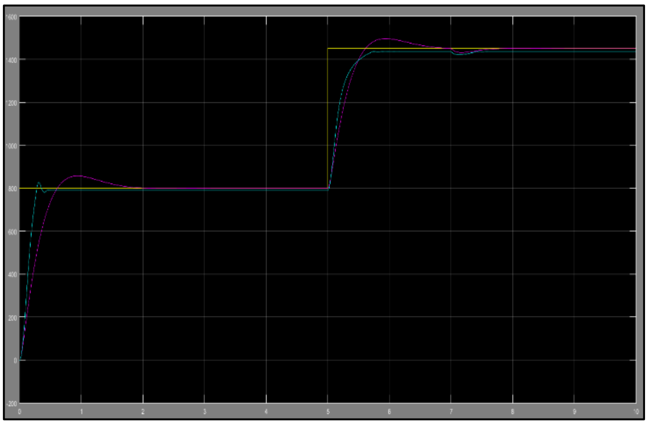

Fig. 18: comparison of response of PID (Purple) and FLC (Blue) with respect to reference speed (Yellow)

Figure 18 shows the comparison of speed response of DC motor using fuzzy logic based power system (green color) and PID controller based armature control power system (purple). It is clear that the speed control by fuzzy logic controller is more efficient and fast as compare with PID controller. The different parameters from figure 5.23 calibrated shown in table IV.

Parameters/Controller types	PID	FLC
Rise time (Sec)	0.475	0.24
Settling time (Sec)	1.85	0.44
Peak overshoot (rpm)	857.7	827.5
Peak time (Sec)	0.966	0.31
Steady state error (rpm)	1.5	11

Table 4: Time response analysis of PID and FLC based APS

From table IV, it concluded that when compared FLC controller with the conventional PID controller, FLC 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 base APS.

III. Conclusion

In this method, we use Fuzzy logic controller for providing proper rated armature voltage to DC motor armature winding so that output torque or speed of motor control as per load requirement. Hence FLC act as APS system for DC motor type dynamic loading conditions.

The speed control of the DC motor is performed using PID and FLC in MATLAB environment. The results show that the FLC approach has minimum overshoot, minimum transient and steady state error, which show more effectiveness and efficiency of FLC than conventional PID controller.. Actually, the proposed APS using FLC improves the performance in both transient and steady state response in comparison to the PID controller based APS.

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