

DESIGNING OF ADVANCED PROCESS CONTROL USING FUZZY PID FOR SPEED CONTROL OF THE DC MOTOR & PERFORMANCE COMPARISON WITH THE CONVENTIONAL CONTROL ALGORITHMS

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Abstract— As we all know about the PID control and quite well aware of its performance too. As it's highly acceptable and widely used technique for any closed loop system. But one simple question change our view It's Nice to have or vital to have? So next question arise is what is vital in this case? What can provide more better and smooth control then PID?

Here it comes APC Advance process control. This is more proven approach to achieve better and smooth control then the conventional PID control. Next question arise is what exactly is this APC and How it works to achieve better and smooth control.

Depending on an individual's background, advanced control may mean different things. It could be the implementation of feedforward or cascade control schemes; of time-delay compensators; of self-tuning or adaptive algorithms or of optimization strategies.

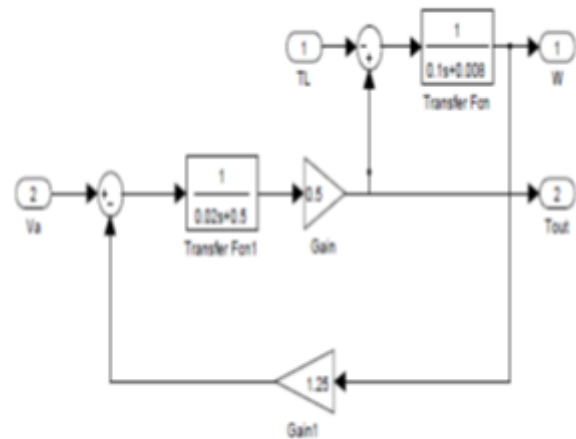
As of my understanding I prefer to regard advanced control as more than just the use of multi-processor computers or state-of-the-art software environments. Neither does it refer to the singular use of sophisticated control algorithms. It describes a practice which draws upon elements from many disciplines ranging from Control Engineering, Signal Processing, Statistics, Decision Theory, and Artificial Intelligence to hardware and software engineering.

Here we developed fuzzy controller for speed control of DC motor & made the performance comparison with the conventional PID & Cascade PID controller. Then further we made cascade loop of Fuzzy & PID in order to take advantage of both controller & eliminate the negatives. All implementation & results checked in MATLAB/Simulink.

I. INTRODUCTION

1.1 Mathematical Model of the DC Motor

Following diagram shows the implementation of mathematical model of the DC motor. The parameter values of the DC motor has been given below in order to design the DC motor.



MATHEMATICAL MODEL OF DC MOTOR

Armature resistance (R_a)	0.5Ω
Armature inductance (L_a)	0.02 H
Armature voltage (V_a)	200 V
Mechanical inertia (J_m)	0.1 Kg.m ²
Friction coefficient (B_m)	0.008 N.m/rad/sec

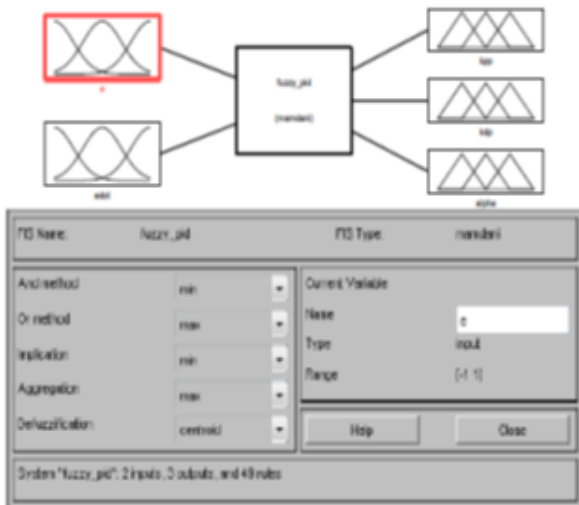
Back emf constant (k)	1.25 V/rad/sec
Rated speed	1500 r.p.m
Motor torque constant	1 N.m/A

1.2 Fuzzy Building & Rule Table of the Fuzzy Parameter.

Following table shows the rules for K_p & similarly we can implement for the K_i and K_d . in order to implement the fuzzy logic in the MATLAB/Simulink this rule table get use. Below the typical implementation of the Fuzzy rules with 2 in (E & EC) & 3 out (K_p, K_i, K_d) has been shown.

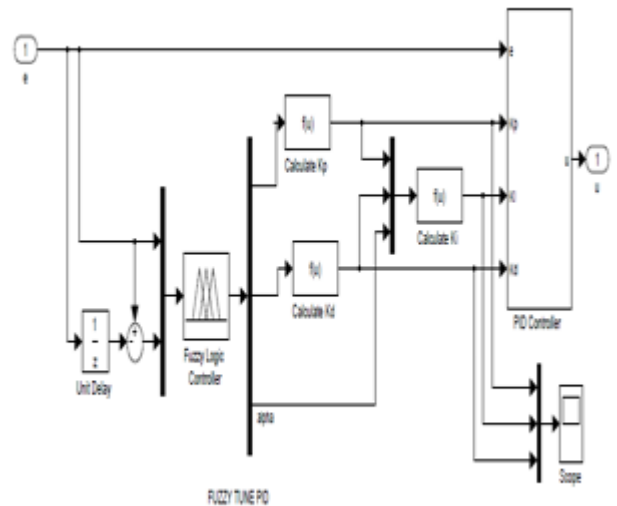
E/EC	NB	NM	NS	Z	PS	PM	PB
NB	B	B	B	B	B	B	B
NM	S	B	B	B	B	B	B
NS	S	S	B	B	B	S	S
Z	S	S	S	B	S	S	S
PS	S	S	B	B	B	S	S
PM	S	B	B	B	B	B	S
PB	B	B	B	B	B	B	B

Rule table for K_p



Rule Building of the fuzzy logic controller in MATLAB/Simulink

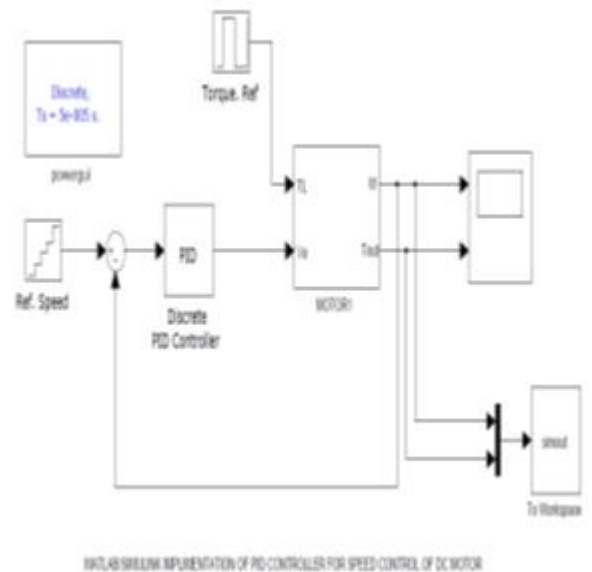
Now as per the above design, the implementation & designing of the same fuzzy controller can be done in the MATLAB/Simulink. Typical implementation has been shown below.

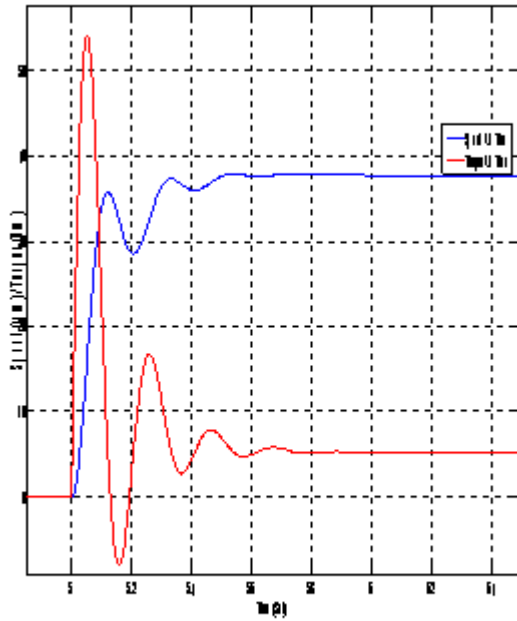


II. IMPLEMENTATION

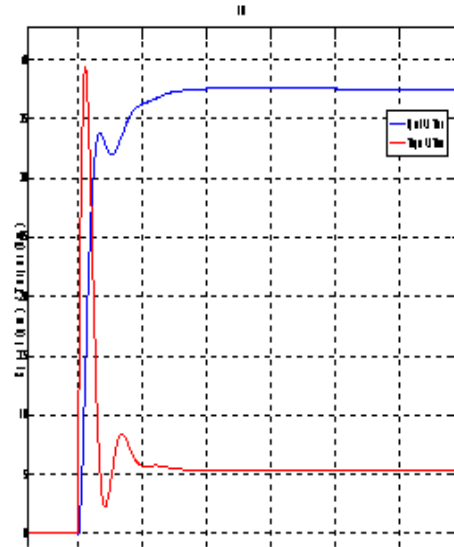
Speed control of DC motor with four different controllers has been given below. The speed & torque output with respect to given Ref. Speed & Ref. Torque has been shown below.

A. PID Speed control Implementation & Results.



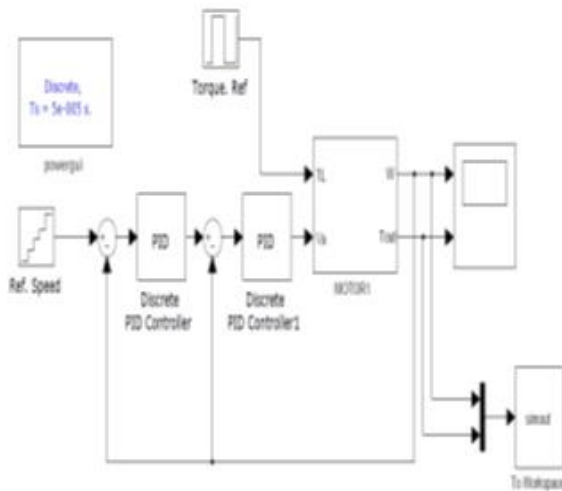


Speed & Torque output for PID Controller



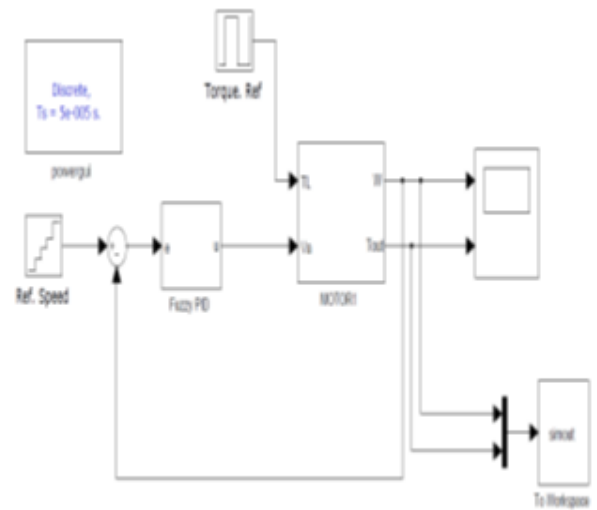
Speed & Torque output for CASCADE PID Controller

B. CASCADE PID Speed control Implementation & Results.



Simulink Implementation of PID Controller for Speed Control of DC Motor

C. FUZZY Speed control Implementation & Results.



Simulink Implementation of Fuzzy Controller for Speed Control of DC Motor

III. PERFORMANCE COMPARISON

The statistic of the performance comparison between all above four controller has been given below which gives the clear idea that how the combination of the Fuzzy and PID in cascade loop gives the best performance compare to all other traditional controllers.

	PID	C.PID	FUZZY	FUZZY PID
SETTLING TIME OVER	2.8	2.5	4.9	2.43
SHOOT	0.05	0.07	0.03	0.03
PEAK TIME	0.3	0.293	0.61	0.3

	PID	C.PID	FUZZY	FUZZY PID
STEADY STATE ERROR	50	39.5	26.25	16

Performance Comparison Table

IV. CONCLUSION

Furthermore, as we have seen in the simulation results we can conclude that in order to suppress the overshoot error of PID Controller, cascade PID gives better performance and smooth response.

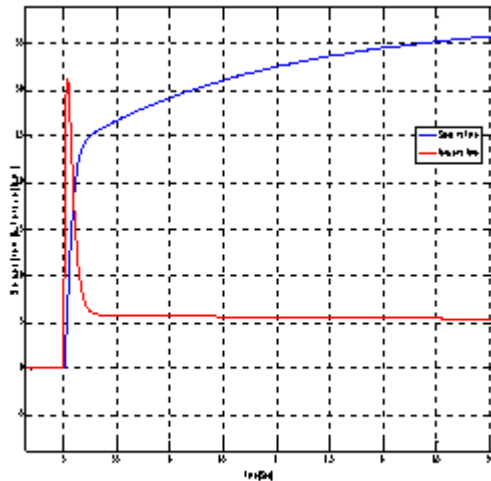
But that too have some disadvantage like good for only linear system and steady state error, so it is proposed to use Fuzzy (Fuzzy-PID) controller, where the PID gains are tuned by using fuzzy logic concepts and the results show that this design can effectively suppress the error to 0 % while keeping the advantages of fuzzy controller.

In order to achieve highly precision output furthermore it has been observed & recommended to use Advance process controller using Fuzzy –PID Cascaded with PID controller. This model take the full advantage of the PID & Fuzzy both and also eliminate the negative points of the each other. Hence, it is concluded that the conventional PID controller could not be used for the proposed fuzzy logic based controller design can be a preferable choice to achieve better performance.

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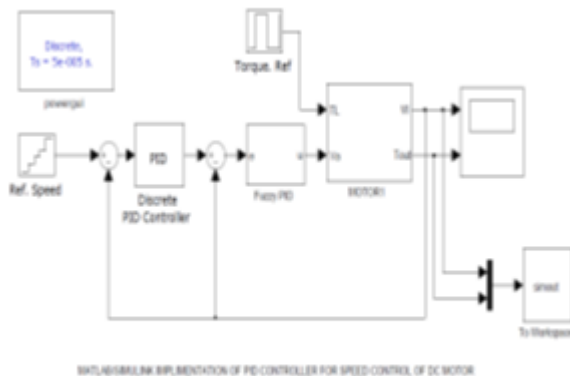
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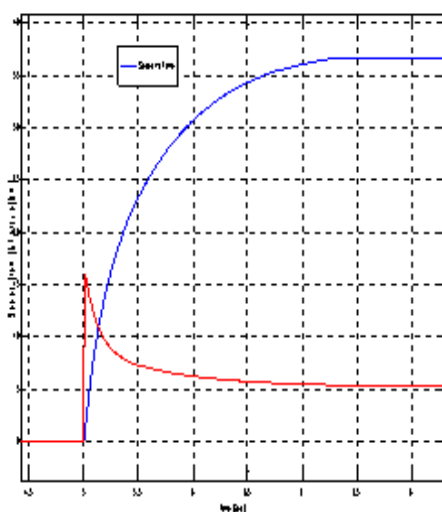


Speed & Torque output for Fuzzy Controller

D. CASCADE FUZZY PID Speed control Implementation & Results.



IMPLEMENTATION OF PID-CONTROLLER FOR SPEED-CONTROL OF DC MOTOR



Speed & Torque output for CASCADE Fuzzy PID Controller

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