OBJECTIVE

The objective of this project is to successfully demonstrate the speed controlling of separately excited DC motor using PID controller on the MATLAB.

OVERVIEW

A Separately excited DC motor is a type of a DC motor in which the armature and the field supply are given through different sources. The main difference between this and other type of DC motors is the fact that in these types of DC motor, the armature current does not flow through the field windings, as the field winding is excited from a separate external source of DC supply.

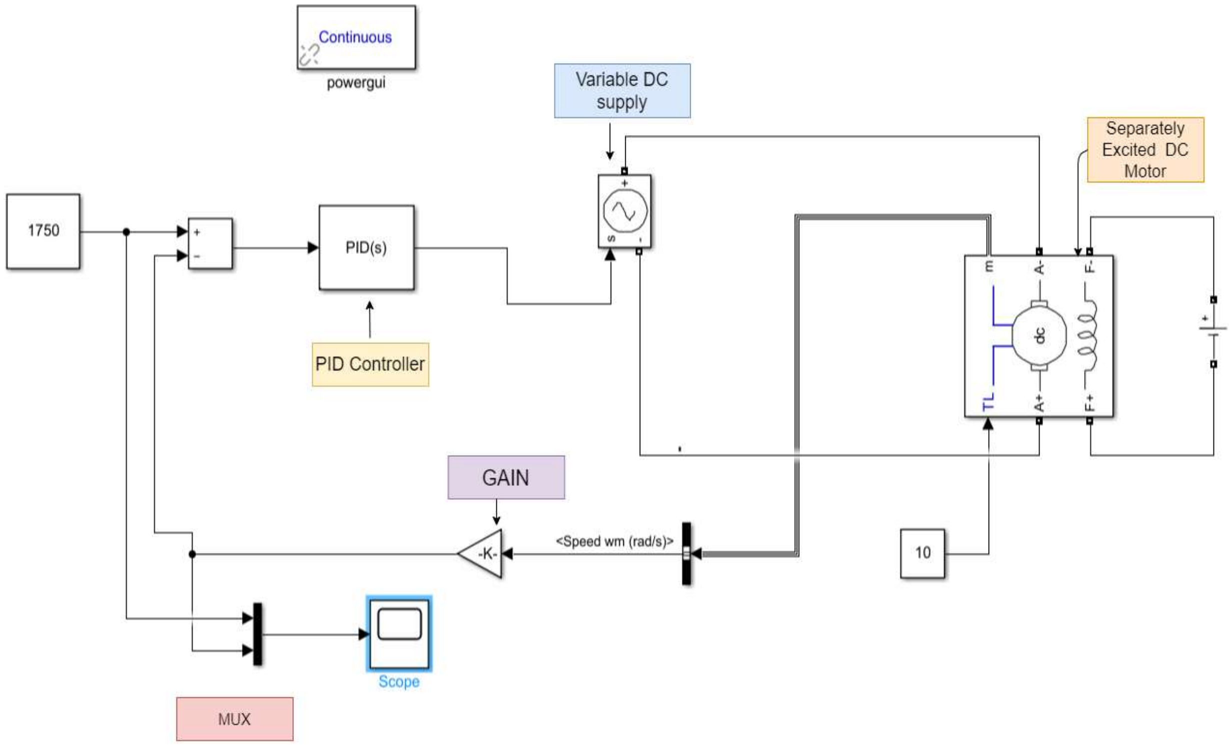
From the Torque equation of DC motor, we know $T_g = K_a \varphi I_a$

So the torque in this case can be varied by varying field flux φ, independent of the armature current I_a.

COMPONENTS USED

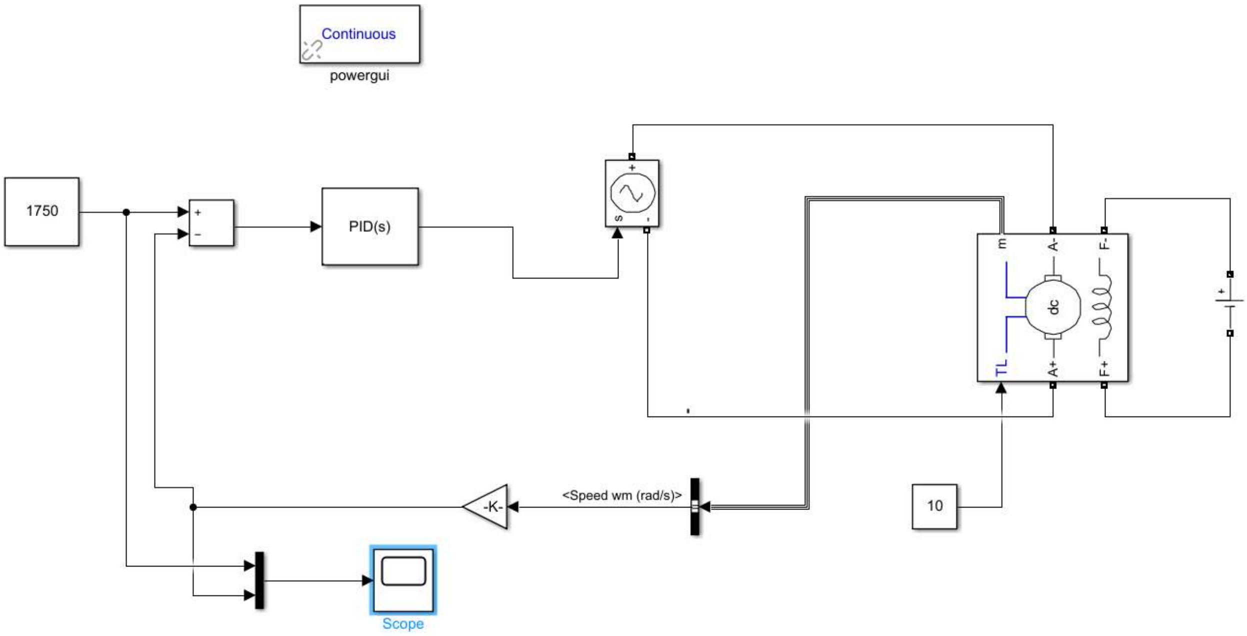
- Separately excited DC motor
- PID Controller
- Variable DC supply (For Armature)
- Constant DC supply (For Field)
- Gain (Amplifier)
- Adder
- Mux
- Bus selector

CIRCUIT

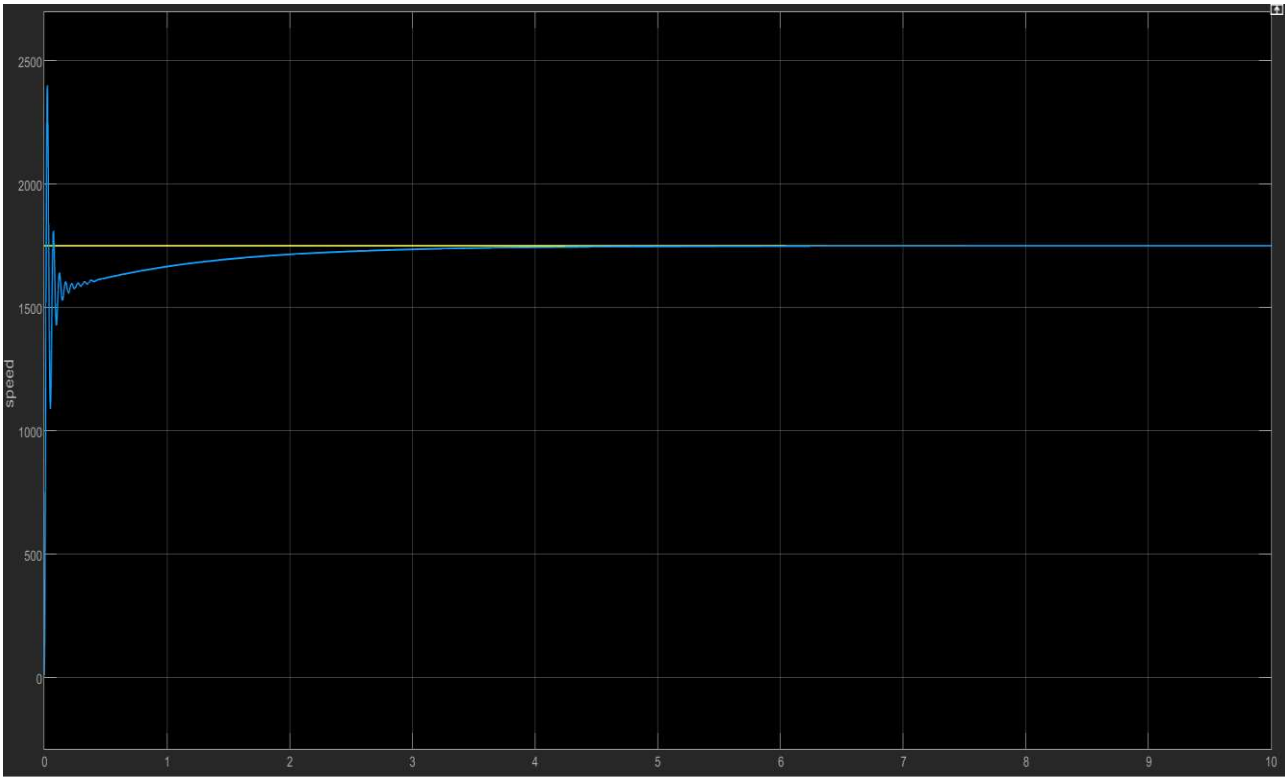


Continuous
powergui
Variable DC supply
Separately Excited DC Motor
1750
PID(s)
PID Controller
GAIN
-K-
<Speed wm (rad/s)>
10
Scope
MUX

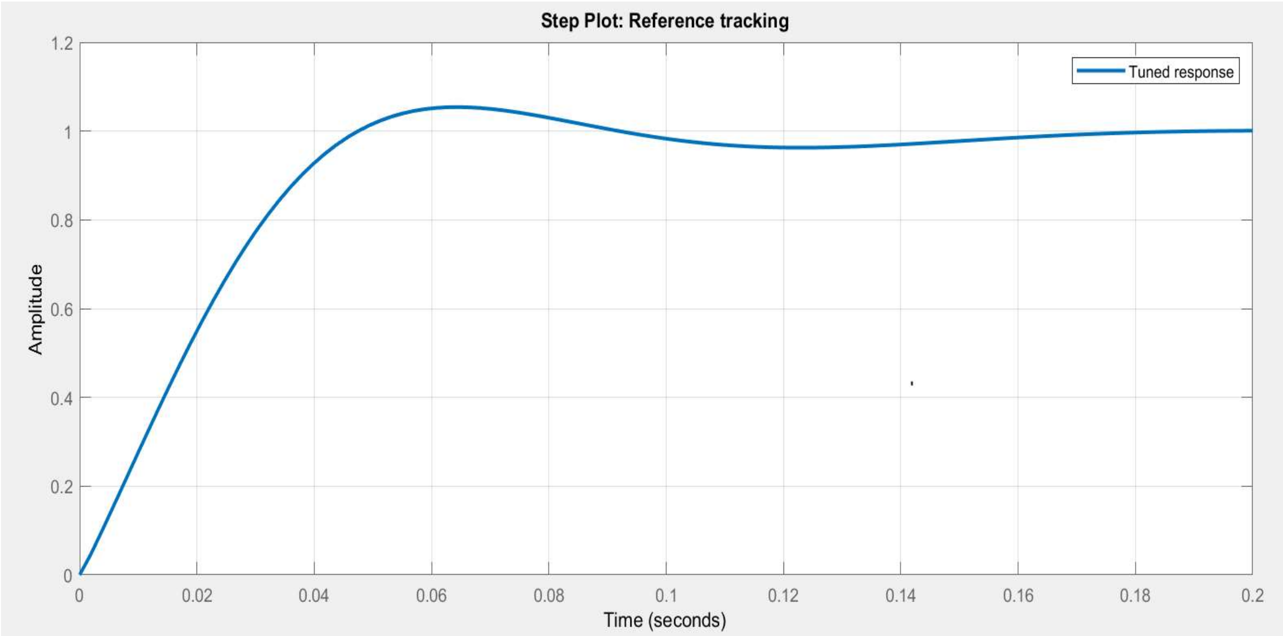
WORKING AND SIMULATION



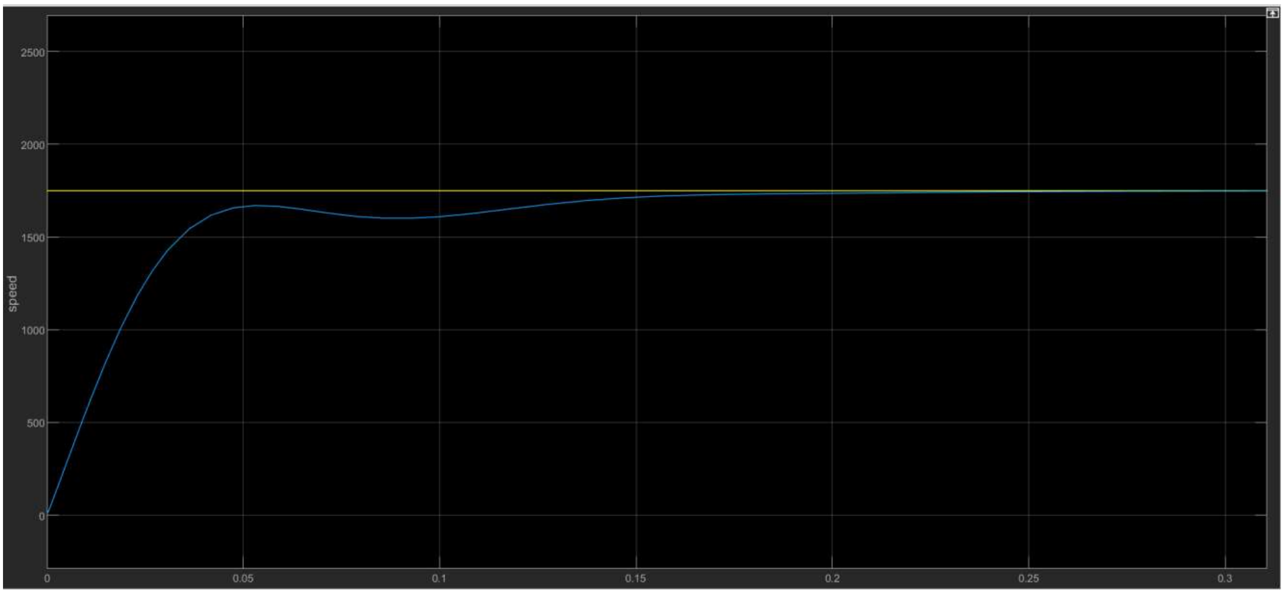
SPEED Vs Time Plot (Before tuning of PID controller)



<u>Tuning of PID controller</u>



<u>Speed Vs Time plot</u> (After the PID tuning)

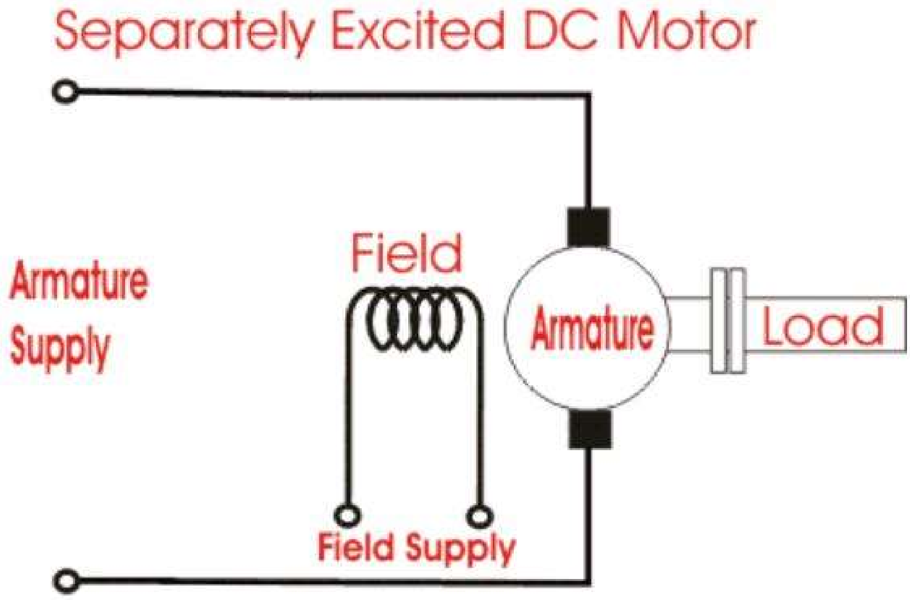


WORKING

According to the predetermined model of separately excited DC motor, field supply is given. Then according to our load/requirement, we set a reference speed for motor which we have to achieve whenever we increase or decrease the load. For the armature supply, a variable voltage source is connected through PID controller. The main purpose of choosing variable supply is that, the armature will define how much current is needed to achieve a definite speed for every type of load connected. Now the rps output from the bus selector is converted to rpm through the GAIN. Now the Gain supplies its output to the adder and from there to the PID controller. Now the PID controller with the help of auto tune method (first we have to give some input so that PID controller do by its own) sets the motor rpm to our need as fast as it can. This supply then goes to the variable voltage source and then to the armature of motor.

DESCRIPTION OF MAJOR COMPONENTS USED

Separately Excited DC Motor:



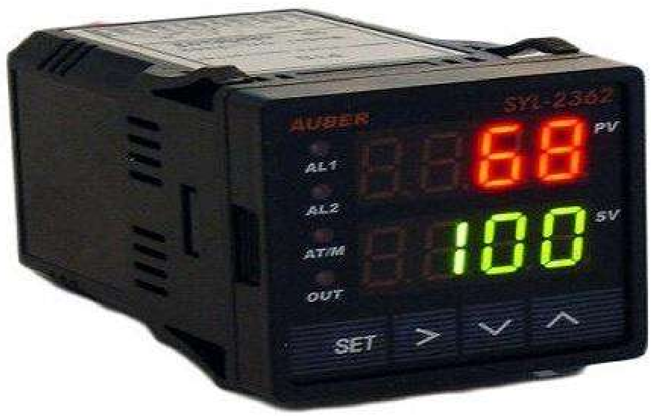
As the name presents, in the case of a separately excited DC motor, the main supply is given separately to the armature and field windings. The major distinguishing fact in these forms of DC motor is that the armature current does not move across the field windings as the field winding is powered from a separate external supply of DC. From the torque equation of motors, we know that:

$$Tg=Ka\phi Ia$$

So, the torque, in this case, can be changed by modifying the field flux (φ), independent of the current of the armature (I_a). The figure below presents the separately excited DC motor.

Here, the field coil is powered from a separate DC voltage supply, and the armature coil is also powered from another source. Armature voltage supply may be variable but, an independent fixed DC voltage is applied to induce the field coil. Therefore, those coils are electrically separated from each other, and this junction is the main feature of this type of motors.

PID Controller



The term PID stands for proportional integral derivative and it is one kind of device used to control different process variables like pressure, flow, temperature, and speed in industrial applications. In this controller, a control loop feedback device is used to regulate all the process variables. A closed-loop system like a PID controller includes a feedback control system. This system evaluates the feedback variable using a fixed point to generate an error signal. Based on that, it alters the system output. This procedure will continue till the error reaches Zero otherwise the value of the feedback variable becomes equivalent to a fixed point. The PID uses three control behaviours.

P- Controller:

Proportional or P- controller gives an output that is proportional to current error e (t). It compares the desired or set point with the actual value or feedback process value. The resulting error is multiplied with a proportional constant to get the output. If the error value is zero, then this controller output is zero.

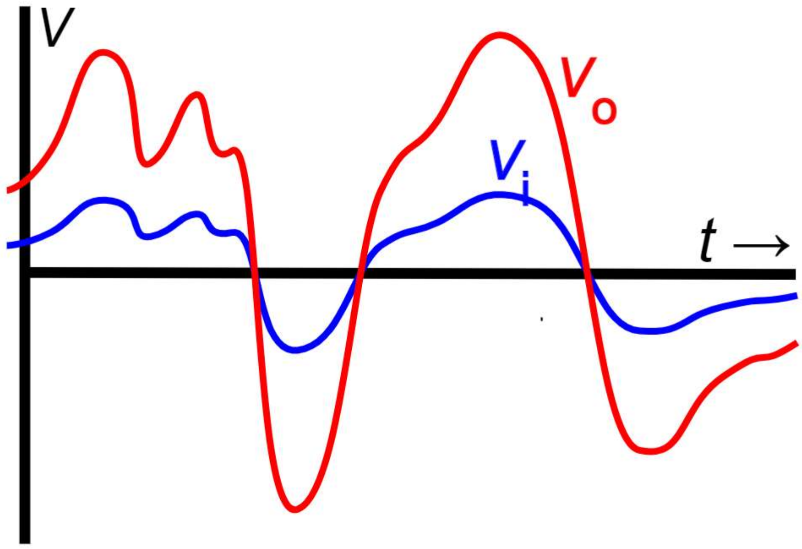
I-Controller

Due to the limitation of p-controller where there always exists an offset between the process variable and setpoint, I-controller is needed, which provides necessary action to eliminate the steady-state error. It integrates the error over a period of time until the error value reaches zero. It holds the value to the final control device at which error becomes zero.

D-Controller

I-controller doesn’t have the capability to predict the future behaviour of error. So, it reacts normally once the setpoint is changed. D-controller overcomes this problem by anticipating the future behaviour of the error. Its output depends on the rate of change of error with respect to time, multiplied by derivative constant. It gives the kick start for the output thereby increasing system response.

GAIN



In electronics, **gain** is a measure of the ability of a two-port circuit (often an amplifier) to increase the power or amplitude of a signal from the input to the output port by adding energy converted from some power supply to the signal. It is usually defined as the mean ratio of the signal amplitude or power at the output port to the amplitude or power at the input port. It is often expressed using the logarithmic decibel (dB) units ("dB gain"). A gain greater than one (greater than zero dB), that is amplification, is the defining property of an active component or circuit, while a passive circuit will have a gain of less than one.

CONCLUSION

This project is not just to show the simulation of dc motor with the help of PID controller but this meant more than this. The main aim of this project is to use this circuit in the autonomous vehicle such as rover, autonomous drones etc. For an autonomous vehicle, we will connect this PID controller to Arduino boards which can be controlled by the ROS software, and we can easily code the program for the vehicle motion as we desire. This type of vehicles can be used at a place where human interference is prohibited like radioactive areas, remote locations where proper supply of goods is difficult task.

REFERENCES

- https://www.elprocus.com/the-working-of-a-pid-controller/
- https://en.wikipedia.org/wiki/Gain_(electronics)
- Rekha kushwah, Sulochana Wadhwani, “Speed Control of Separately Excited Dc Motor Using Fuzzy Logic Controller” International Journal of Engineering Trends and Technology (IJETT) - Volume4 Issue6- June 2013
- https://in.mathworks.com/help/physmod/simscape/index.html?s_tid=CRUX_lftnav
- https://www.electrical4u.com/