Position Control of DC Motor Using PI Controller

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***Abstract*-The dc motor is the backbone of industrial applications. The error between measured position and desired position is used to calculate the direction and magnitude of drive applied to the motor. By applying the control theory such system is achieved best. If not result can be oscillatory, poor or even terrible. In this project the mathematical model for the position control of the dc motor is designed and tested through the MATLAB/Simulink software.**

***Keyword*- Position control, PI controller, separately excited DC motor, PI speed controller and PI torque controller.**

I.INTRODUCTION

In general on the basis of dc motor excitation the dc motor are classified into two types. They are separately excited and self excited dc motor. In this project we used separately excited dc motor. Hence its field winding and armature are excited from two different sources. The fundamental of electric drives, power electronic circuits, devices and application are explained in detail [1-3].

The field of motor is connected directly to the power supply for the speed control. At the same time it is necessary for torque and speed control. The variable speed, reliability and high performance are three main characteristics of an electric drive system due to which it can be easily controlled. For low horsepower dc drives are low cost. In addition to this for overhauling loads dc regenerative drives are used. By field control method and armature control method wide range of speed control both above and below the rated speeds are achieved. Therefore dc motors are used in fine speed applications such as in paper mills and in rolling mills.

II. CONSTRUCTION AND WORKING PRINCIPLE OF DC MOTOR

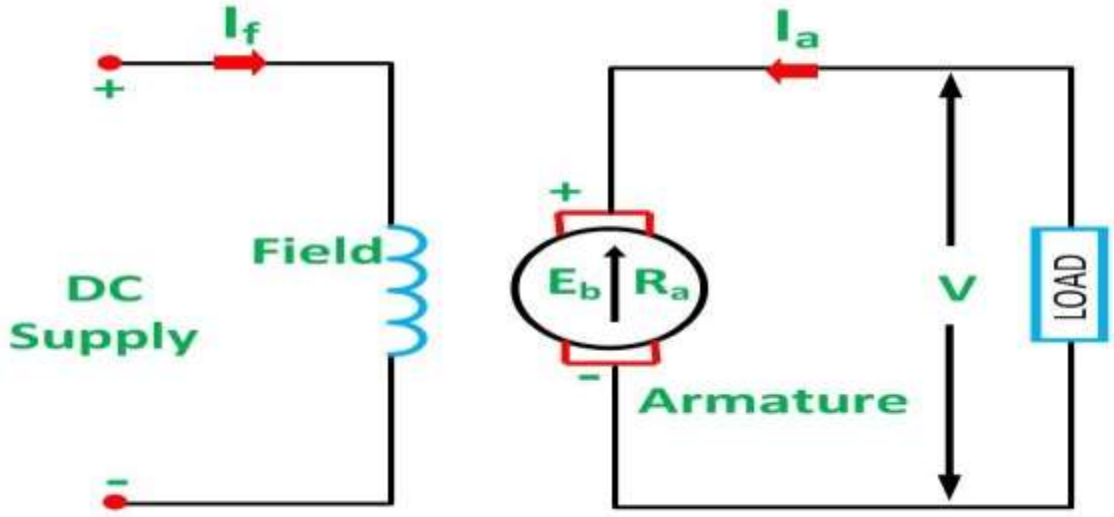

Figure {1} DC motor

In the figure {1} with separate supply the separately excited dc motor has field and armature winding. To excite the field flux the field winding of the dc motor is used. For mechanical work current in armature circuit is supplied to the rotor through brush and commentator. The field flux and armature current interaction produces rotor torque. Okbuka and raju singh has explained about the performance characteristics of controlled separately excited dc motor and stability analysis of separately excited dc motor respectively [4-5]. The working principle of separately excited dc motor is listed in points below.

Point 1: The field current {if} excites the separately excited dc motor.
Point 2: In the circuit armature current {ia} flows.
Point 3: To balance load torque at particular speed. The motor develops a back emf and torque.
Point 4: Any change in armature current has no effect on the field current {if independent of ia}.
Point 5: The field current {if} is much less than the armature current {ia}.

III.PROPOSED PI CONTROL TECHNIQUE

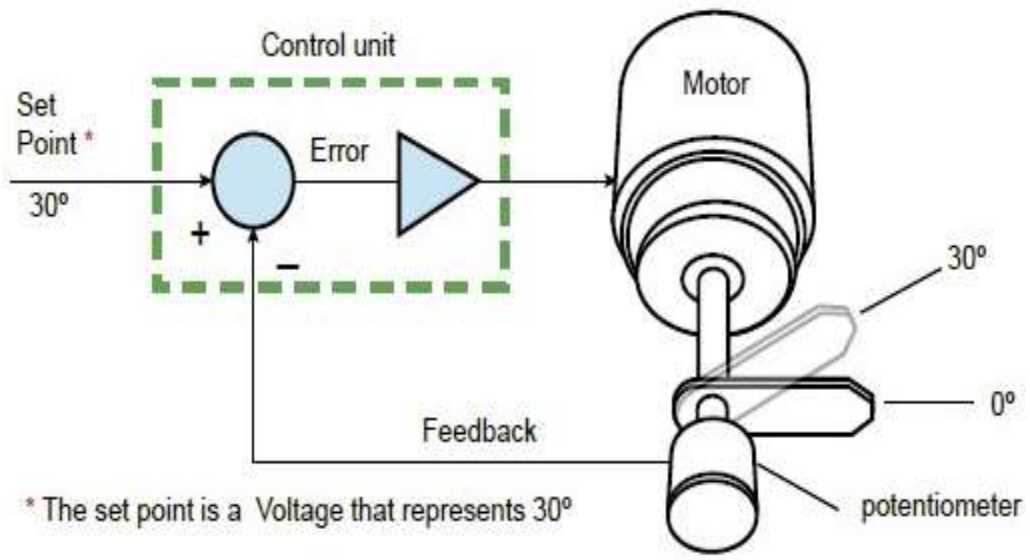

Figure {2} Proposed PI control technique

The Figure {2} shows the proposed PI control technique. Singh, Dewangan and Afrasiabi has explained in detail about the chopper control, PWM based automatic closed loop control and DC motor control respectively[6-8]. Manasa has designed a PID controller model for the position control of dc motor [9]. The PI control are operated under four rules as follows;

Rule 1: From the mathematical model of dc motor find what needs to be improved.
Rule 2: The proportional constant is added to improve rise time.
Rule 3: The integral control is used to eliminate the steady state error.
Rule 4: Adjust Kp and Ki value until the design requirement is met.

IV.MATHEMATICAL EQUATIONS OF SEPERATELY EXCITED DC MOTOR

Armature equation,

$$V_a = E_g + I_a R_a + L_a \left\{ \frac{dI_a}{dt} \right\} \rightarrow Equation.1$$

Armature resistance in ohms {Ra}
Armature inductance in Henry {La}
Armature voltage in volts {Va}
Armature current in amps {Ia}
Motor back emf in volts {Eb}
Torque equation,

$$T_d = J \frac{d\omega}{dt} + B\omega + T_L \rightarrow Equation.2$$

Load torque in Newton-Meter {T_L}
Friction co-efficient of the motor {B}
Moment of inertia in Kg/m^2 {J}
Torque developed in Newton-Meter {T_d}
Angular velocity in rad/sec {w}

V. SIMULATION MODEL OF DC MOTOR USING HB CURRENT CONTROL TECHNIQUE

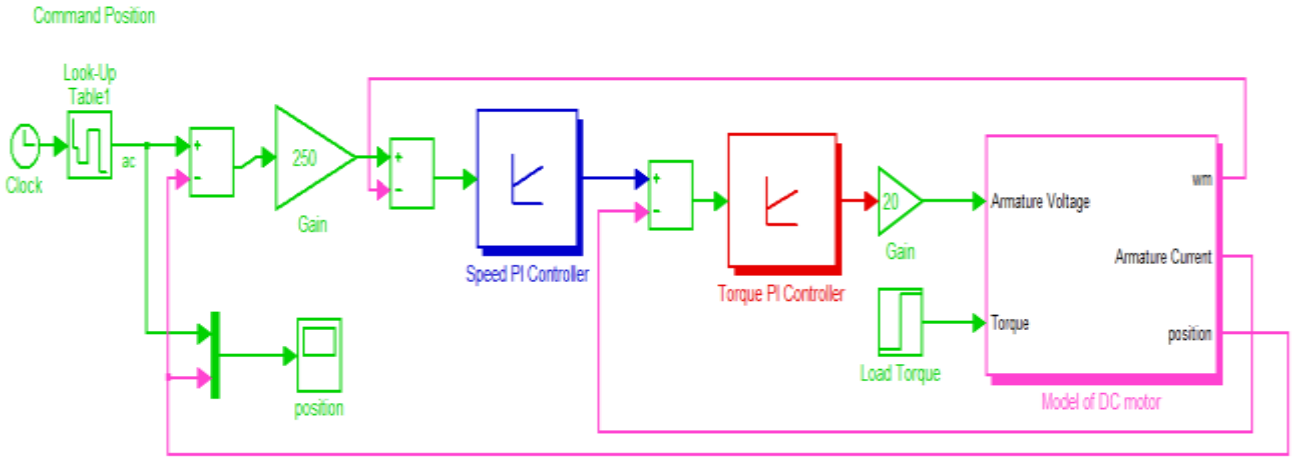

Figure {3} Simulation model of position control dc motor

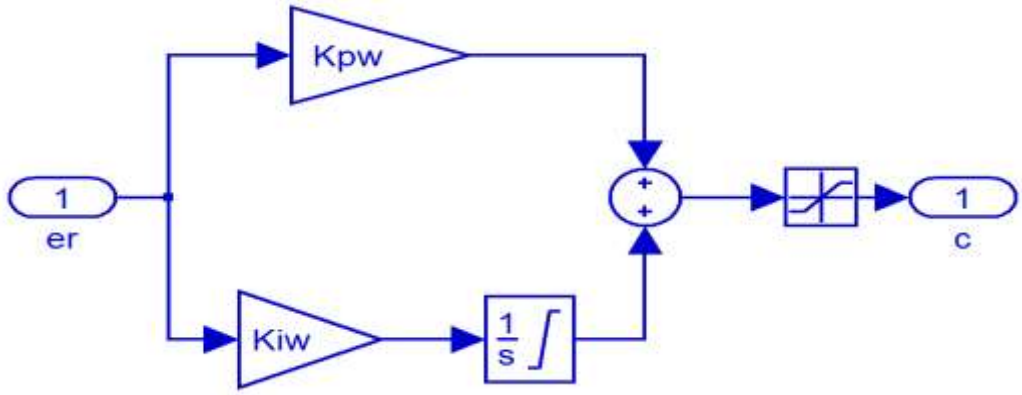

Figure {4} Subsystem simulation model of Proposed PI speed control technique

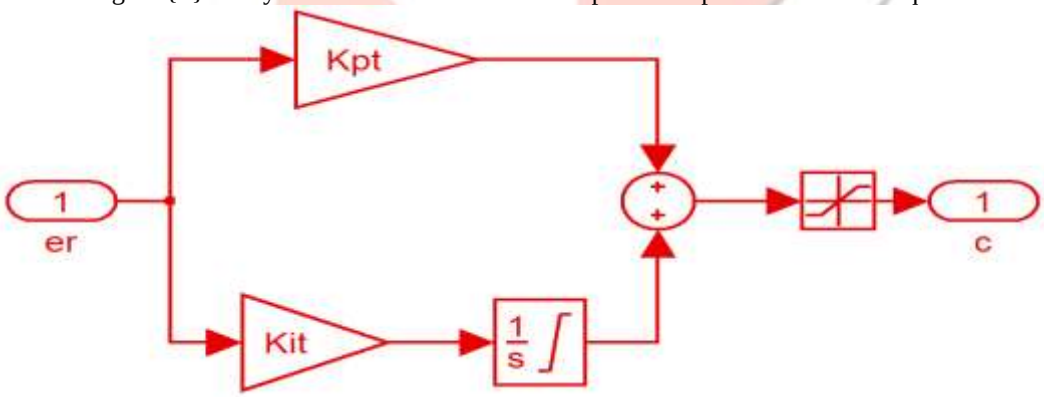

Figure {5} Subsystem simulation model of Proposed PI Torque control technique

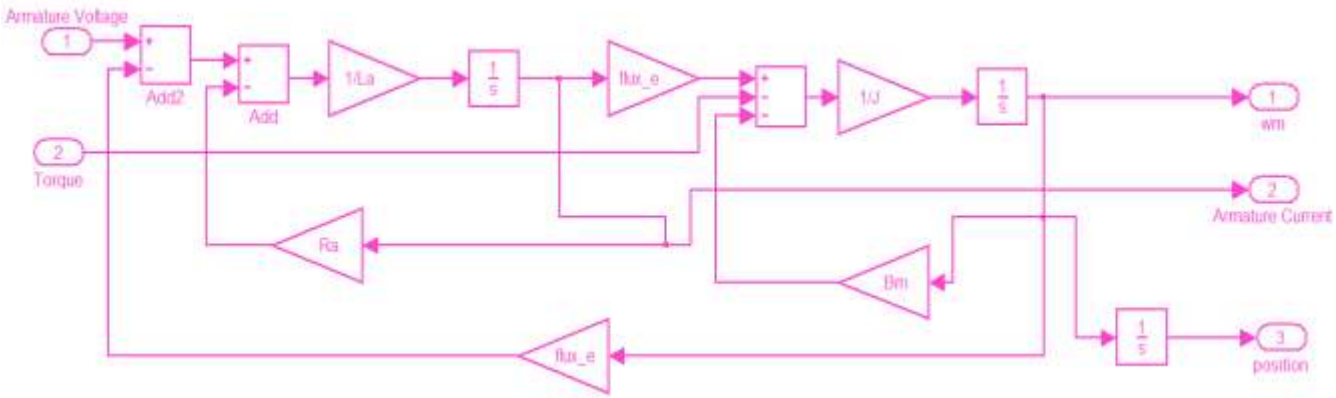

Figure {6} Subsystem simulation model of dc motor

VI.SIMULATION RESULTS

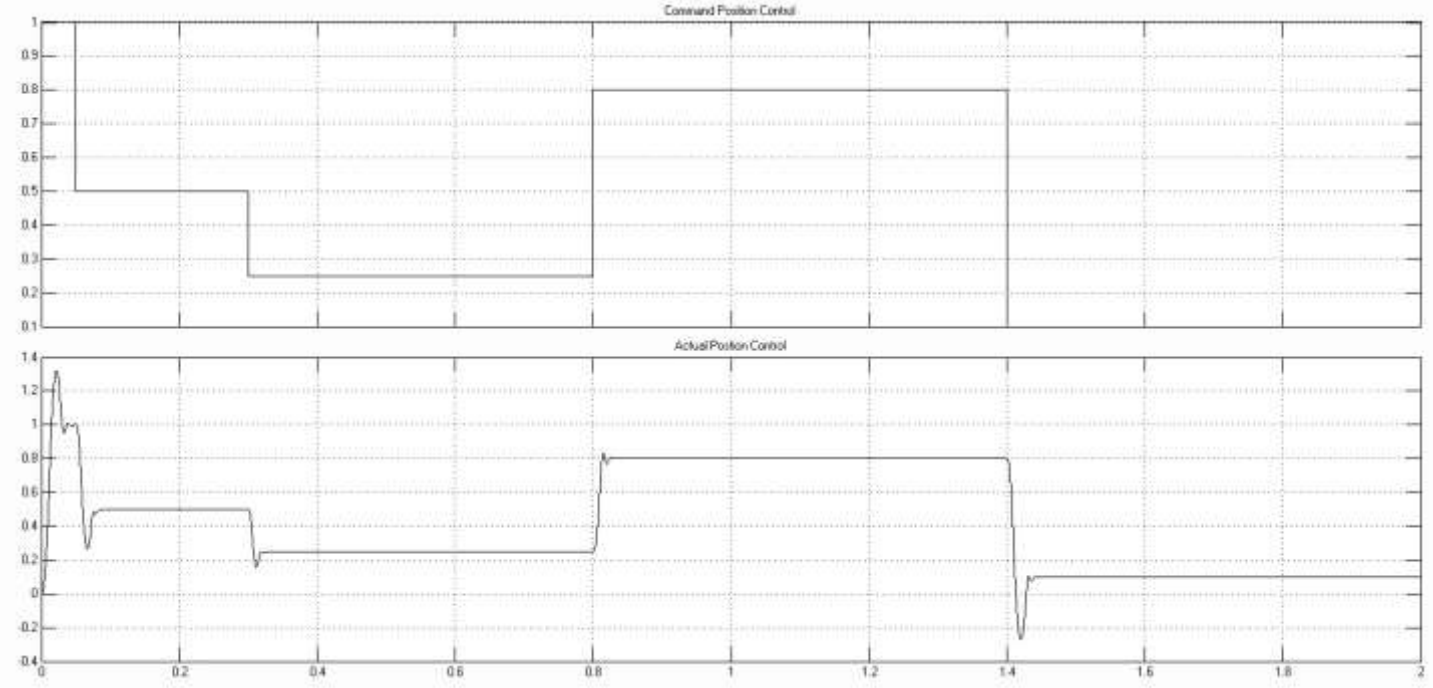

Figure {7} Position Control Reference and Actual

VII.CONCLUSION

The industrial application needs high performance motor drives. The dc motor is used as an adjustable speed machine for this wide range of option is evolved. The advantages of dc motor are vibration free operation, quiet, independent knowledge of the system position and good efficiency. If a system must be accurate, quiet, fast and efficient then dc motor is the good choice.

VIII.REFERENCES

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IX.BIOGRAPHY

Mr.J.Vikramarajan received his Master degree in Power Electronics and Drives and Bachelor degree in Electrical and Electronics Engineering from VIT University, India. He has published several international research books and journals. His research interests are electrical machines, power electronic applications, power quality, power electronic converters and power electronic controllers for renewable energy systems.