DC Motor Dual Close-Loop PID Speed-Tuning System on The Basis of ABC Algorithm

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Abstract:- **T**he DC Servo Motors has top position in various servo motor mechanisms. It is important to study DC Servo motor stability for position control study. Generally transient responses of DC Servo Motor are improved by using PID controller. Currently, to provide workable initial value most tuning methods have been designed. DC servo motor stability for the speed get unstable without any controller . The stability of the system get unstable after 2 second . When the design system will work without PID controller then the stability of the current and speed of the motor is not stable . it is verifying in the form of sinusoidal waveform . For any good design system , system will work in a stable form for current and speed graph . As the graph is showing that the graphs of the DC servo motor is stable up to 2 sec. But the after 2 second the graphs will get unstable . This type of problem can damage the complete model where this type of motor will be used . In this paper we are improving the stability of the current and speed for the DC motor by apply PID controller .

Keyword :- *PID (proportional-integral-derivative)*

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I. INTRODUCTION

Servomotors are kind of rotary actuators that can have a precise control of velocity, acceleration and angular position. It comprises of a suitable motor and a sensor who both coupled to sense the position feedback. In most of the cases sophisticated controller is also used which is a dedicated module specifically designed for servo motors. Servomotors term is mostly used for a motor dedicated for usage in closed loop system as they don't fall in specific class of motors. Servomotors applications include process/industrial control, robots, CNC etc.

A type of Encoder is paired with the motor which give speed and position feedback. Position is measured in the simplest case. Measured position of the external input is compared to the controller, and output to the command position. If the position of the output is different from the required, error signal is produced inducing motor to rotate in either direction, which is required for appropriate positioning of the output shaft. The error signal approaches to zero as the position approach to required and motor finally stops [1].

The simplest of the servomotors use only position sensing through bang-bang control and potentiometer of their motor; the motor rotation is always at full speed or stopped. Servomotors of such type are are the basis of cheap and simple servos used in radio-controlled models.

Servomotors of sophisticated kind measure both the speed and the position of the output shaft. Not only this they can also control the motor speed, instead of always being at full speed. Both of these improvements, usually along with a PID controlalogorithm, bring the servomotor to its commanded position precisely and more quickly, with less overshooting [1].

Motor is a device which converts electrical energy into mechanical energy. Motor can be divided into two categories:

1. Alternating current (AC) motor
2. Direct current (DC) motor

In a simple DC motor torque for rotation is produce by the interaction between the electricity and magnetic field. Permanent magnet DC motor is better than AC motor because it provide better control on speed with high torque and is used widely in industry [5].

DC motors can be used with portable sources like batteries and solar cells which makes them more usable and provide cost effective solution because AC power supply is not available everywhere. DC motor shows response at both current and voltage. Current in the armature winding gives the torque while the voltage shows the speed of the motor [4].

The load and current has a proportional relation if the load is increased the drawing current from supply will increase to maintain the speed constant and if supply does not provide the enough current the speed will reduce. In other words applied voltage effect speed and torque is controlled by current. If the chopping circuit is used the results drawn from DC motor become more effective [3]. In lifting and transportation we mostly use low power DC motors as low power AC motors torque capability is not as good.

DC motor are used in the application where torque cannot be compromised like electric cars, railway engines, car windows, robotic applications, elevators, complex industrial mixing process and wide variety of small appliances. There are several types of DC motor but most common are brushless DC motor, servo motor, stepper motor, and brushed DC motor [2]. DC motors have three winding techniques such as series DC motor, shunt DC motor and compound DC motor.

II. SYSTEM DESCRIPTION

In order to design current regulator and speed regulator of dual close-loop DC motor control system, an important purpose of control is to have an ideal start process, dual close-loop speed-tuning system supplies instant rated voltage, when started from static state, momentary state of RPM and current.

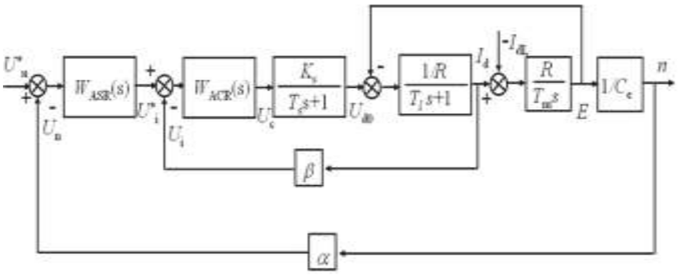

Fig 1. The double loop DC motor control system

To design a regulator that meets up the requirements described above, first of all we should design current regulator according to motor parameters. Then we design RPM regulator by assuming that each current cycle of the regulator is one step of RPM regulator; Obviously this are known, and these parameters shouldn't change throughout tuning process, however most chances are that these two conditions are not met. Dual Close-loop Speed-tuning System is sorted as coupling system, so there is strong coupling relation between current circle and speed circle, the above dual close-loop speed-tuning system is not considerably concerned with the impact that the coupling may have on the system which is surely related to the control performance of the system.

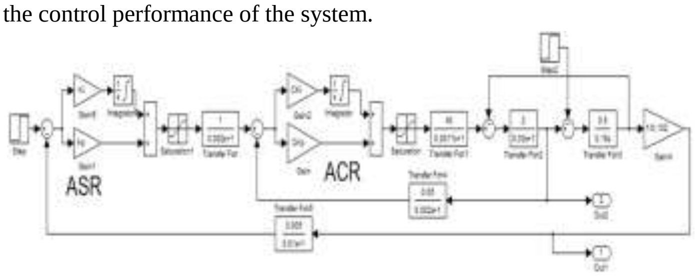

Fig 2. DC Dual Close-loop PID speed-tuning System

ASR is RPM tuning section; ACR is current regulating section. Feedback time of current is a constant 0.002, average time of out-control of three phase bridge-tied circuit is 0.0017, electromagnetic time is constant 0.5; electrical & mechanical time is constant 0.18, motor electromotive force is constant 0.132; thyristor device magnifying coefficient is 40; total resistance of armature circuit is 0.5; Feedback coefficient of RPM is 0.005; feedback coefficient of current is 0.05, Ui is input signal of rated current regulator. Step 1 is the given RPM input; Step 2 is loaded current ld class jump. Out 1 and out 2 are respectively the ports from RPM and current circle to workspace.

The two main features of dual close-loop DC speed-tuning system are that RPM and current of motor are controlled respectively by two independent regulators, and output Ui from RPM regulator is given by current regulator. Current circle is able to regulate current ld against RPM tolerance varies, the function of current inner circle is to lead current ld to its given value Ui, when Ui is fixed, it regulates constant current. When RPM is lower than given RPM, effect of ASR integrating will increase output, given current will increase, and voltage ld will be increased by current circle regulation, motor obtains accelerative torque, motor RPM increases; when virtual RPM is higher than given RPM, output of ASR will be decreased eg given current is decreased, armature current is decreased by current circle regulation, motor electromagnetic torque is decreased, thus RPM is decreased.

III. PROBLEM STATEMNT

When the design system will work without PID controller then the stability of the current and speed of the motor is not stable . it is verifying in the form of sinusoidal waveform . For any good design system , system will work in a stable form for current and speed graph . As the graph is showing that the graphs of the DC servo motor is stable up to 2 sec. But the after 2 second the graphs will get unstable . This type of problem can damage the complete model where this type of motor will be used .

IV. PROPOSED METHODOLOGY

A proportional-integral-derivative controller (PID controller) is a control loop feedback mechanism (controller) widely used in industrial control systems. A PID controller calculates an *error* value as the difference between a measured process variable and a desired set point. The controller attempts to minimize the *error* by adjusting the process through use of a manipulated variable.

The PID controller algorithm involves three separate constant parameters, and is accordingly sometimes called three-term control: the proportional, the integral and derivative values, denoted *P* ,*I* , and *D*. Simply put, these values can be interpreted in terms of time: *P* depends on the *present* error, *I* on the accumulation of *past* errors, and *D* is a prediction of *future* errors, based on current rate of change.[1] The weighted sum of these three actions is used to adjust the process via a control element such as the position of a control valve, a damper, or the power supplied to a heating element. For a discrete time case, the term PSD, for proportional-summation-derivative, is often used.[2]

A PID controller relies only on the measured process variable, not on knowledge of the underlying process, making it a broadly useful controller.[3] By tuning the three parameters in the PID controller algorithm, the controller can provide control action designed for specific process requirements. The response of the controller can be described in terms of the responsiveness of the controller to an error, the degree to which the controller overshoots the setpoint, and the degree of system oscillation. Note that the use of the PID algorithm for control does not guarantee optimal control of the system or system stability.

Some applications may require using only one or two terms to provide the appropriate system control. This is achieved by setting the other parameters to zero. A PID controller will be called a PI, PD, P or I controller in the absence of the respective control actions. PI controllers are fairly common, since derivative action is sensitive to measurement noise, whereas the absence of an integral term may prevent the system from reaching its target value due to the control action.

If the PID controller parameters (the gains of the proportional, integral and derivative terms) are chosen incorrectly, the controlled process input can be unstable, i.e., its output diverges, with or without oscillation, and is limited only by saturation or mechanical breakage. Instability is caused by *excess* gain, particularly in the presence of significant lag.

Generally, stabilization of response is required and the process must not oscillate for any combination of process conditions and set points, though sometimes marginal stability (bounded oscillation) is acceptable or desired.

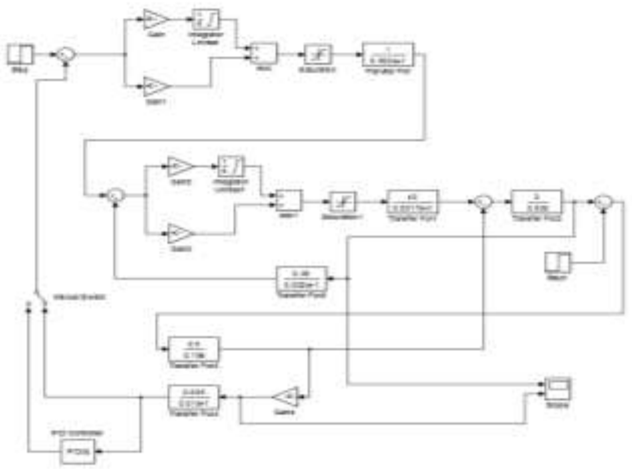

Fig 3:- System design for PID and without PID

We are using PID controller for stability of the system. Using the switch for change the controller .

V. RESULTS

Dc electric motor is a main component for any electrical machine . The stability of the motor is very important point for the Design motor. Without any controller Dc motor is unstable . According to graph it is showing that up to 2 second the system is stable but after 2 second it is unstable .It is getting unstable in sinusoidal form . The graph1 is showing the graph for the current of the motor . Graph 2 is showing the graph for motor of the speed .

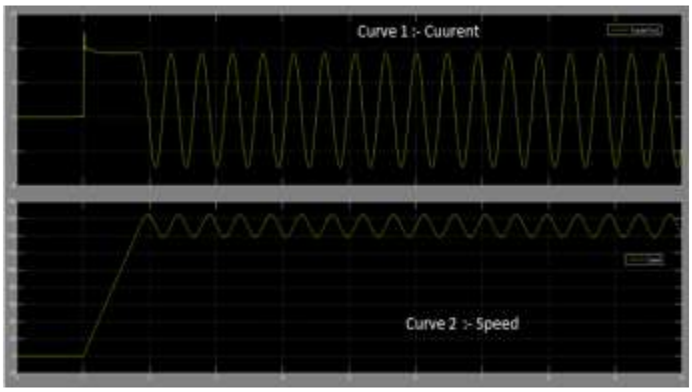

Fig 4 :- Without PID controller Output Graphs

WITH PID CONTROLLER

Motor Current Graph :- When we apply the PID controller the stability of the system get increase . as the graph is showing that the stability of the system get stable after 6 second . The graph is showing that after 2 second the system is getting some stability but the graph of the current is increasing. It get stable at 6 second . After 6 second the system is getting continue constant .

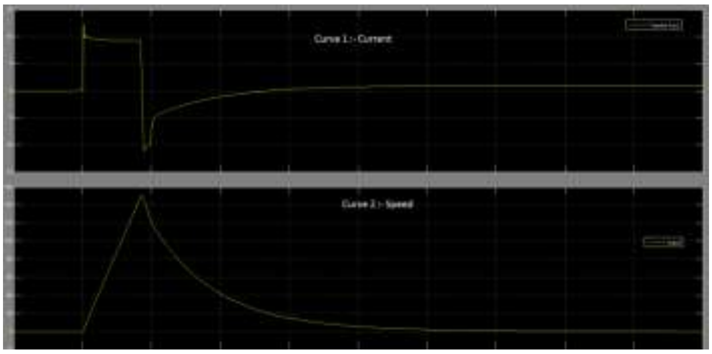

Fig 5:- PID controller output graphs

Dc Motor Speed Graph :- For the graph of the speed ,it is getting some stability at the 2 second but after that it is continue decreasing. We have to stable it . After 6 second the speed of the system get stable .

VI. CONCLUSION

According to the design system , base paper contains some issue for the stability of the sped and current . The stability have important role for nay design system . the speed of the motor was getting change according to time . It is not the stable . The stability for the current is also very low . We apply the PID controller for improve the performance of the system . After apply PID controller the system stability for the current and speed is getting stable after 6 second .

In the future we can improve the stability for the speed and graph by the Fuzzy logic and Neural network . These two are the future methodology for which the results can be improved.

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