International Journal of Electrical and Electronics Research ISSN 2348-6988 (online)
Vol. 3, Issue 4, pp: (128-132), Month: October - December 2015, Available at: www.researchpublish.com

Different Controllers for Position Control of DC Motor- A Review

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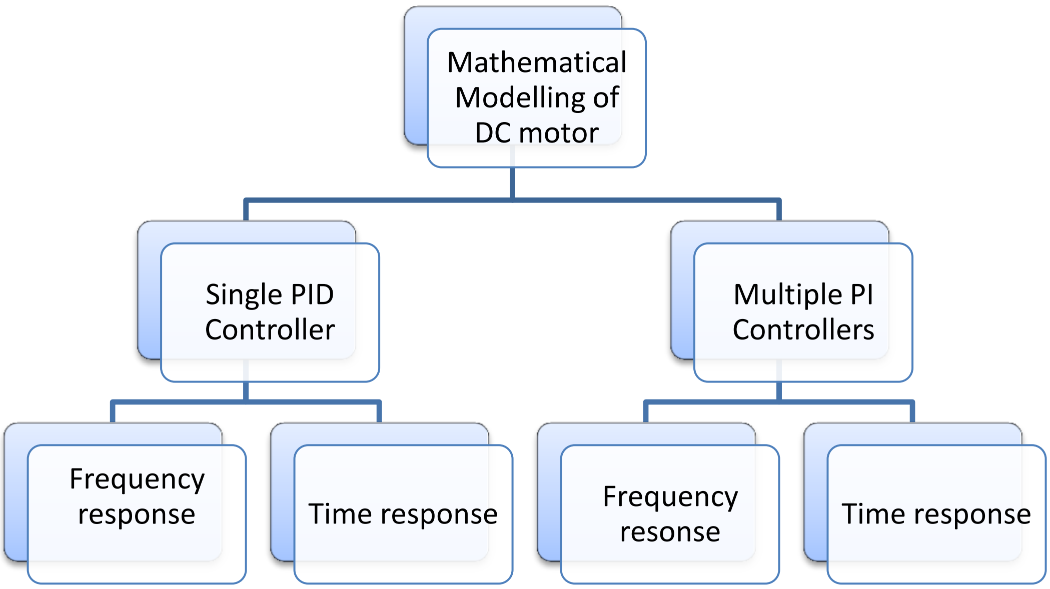
Abstract: **In this paper, the performance of controllers is evaluated. To evaluate the performance of the controller, time response and frequency response analysis is carried out. PID and PI controllers are used to control the position of DC motor.**

Keywords: **PID controller, PI controller, simulation.**

I. INTRODUCTION

Simulation is a mathematical model of a process, which attempts to predict how the process would behave if it is constructed in real life. After simulation of the model, control of the model is necessary. There are different ways to control a process. This paper gives a brief idea of controlling techniques and different aspects of controller design for a plant or process taken into consideration. In any of the control application, controller design is the most important part. There are different types of controller. The controller can be conventional in nature or intelligent in nature. The conventional controller doesn't possess the human intelligence; where in the intelligent controller human intelligence is embedded with the help of certain soft computing algorithms. After the design of controller is performed; the performance evaluation part comes in to light. The designed controller has to give optimal control results irrespective of every situation like plant and equipment non linearity, equipment saturation. The objective of this dissertation is to evaluate the performance of conventional controllers. Block diagram show the performance evaluation scheme implemented in this dissertation. To evaluate the performance of the controller, time response and frequency response analysis is carried out.



II. REVIEW

N. Tutkan, D. Madenetet al. Direct current (DC) motors have been widely used in many industrial applications such as electrical vehicles, steel rolling mills, electric cranes, and robotic manipulators due to high performance of speed control and position control and also due to precise, wide simple and continuous control characteristics. DC motors are characterized by: ability to produce full continuous torque, controlled braking is relatively simple and low cost as compared with similar AC drives at high powers. In this applications speed and position are generally controlled by proportion-integration (PI), proportion-derivation (PD), and proportion-integration-derivation (PID) controller. PID controller is simple, robust and more preferable compare to PI or PID because of many advantages [1].B. Allaoua, B. Gasbaoui, B. Mebarki Although the simple structure and robustness of PID control method, optimally tuning coefficient of proportion, integration and derivation have been quite difficult via conventional methods such as Ziegler-Nichols, Karl-Astrom etc.[2]

One of the most useful control algorithms in linear and nonlinear control systems is proportional-integral-derivative (PID) control. PID control for position regulation of dc motors is a popular basic example evoked in many linear control textbooks [3], [4]. Notwithstanding, the PID control of dc motors can lead to an unstable closed-loop system as long as the PID gains are unsuitably selected. Depending on the signals available for measurement, the PID control can be implemented evoking several structures [5], [6].Now a days, many heuristic methods has been used for tuning of PID controller parameters. Thomas and Poongodi proposed to determination of the PID controller parameters in position control of DC motor using the genetic algorithm [7]. Nagaraj et al. used soft computing techniques for tuning of PID controller parameters [8]. Al-Hamouz and Al-Duwaish utilized genetic algorithm for a new variable structure DC motor controller [9]. Xia et al. investigated speed control of brushless DC motor using genetic algorithm based fuzzy controller [10]. Gargari and Lucas designed optimal PID controller using imperialist competitive algorithm [11]. Moghaddaset al. utilized optimization algorithm for determination PID controller parameters in speed control of DC motor [12]. Nasri et al. proposed optimization algorithm for optimum design PID controller in speed control of linear brushless DC.

The development of PID control theories has already started in early sixties. PID control has been one of the control system design methods of the longest history. PID controller is mainly to adjust an appropriate proportional gain (K_P), integral gain (K_I), and differential gain (K_D) to achieve the optimal control performance [13].

The proportional-integral-derivative (PID) controller is widely used in many control applications because of its simplicity and effectiveness. Though the use of PID control has been a long history in the field of control engineering, the three controller gain parameters are usually fixed. The disadvantage of PID controller is poor capability of dealing with system uncertainty, i.e. parameter variations and external disturbance [14][15][16][17]. To improve system response, optimal control is used to design controller for DC motor. In this method, by using state feedback and solve Riccati equation, feedback gain is computed. In simulation, by using only LQR method, system's response cannot track reference in presence of load torque. To solve this problem some researchers combined LQR with intelligent system [18]. An approach to stabilization and trajectory tracking control for systems is feedback linearization [19-21]. In input-output linearization method, system model converts to the linear canonical model, then, control signal are produced by using state feedback. To consider the efficiency of LQR and feedback linearization method, [22] used them and show the LQR method can make better response. In this paper, we show that this new controller can make stable response in presence of load torque and output of system can track reference with minimum error.

III. DC MOTOR

Almost every mechanical movement that we see around us is accomplished by an electric motor. Electric machines are a means of converting energy. Motors take electrical energy and produce mechanical energy. Electric motors are used to power hundreds of devices we use in everyday life. Motors come in various sizes. Huge motors that can take loads of 1000's of Horsepower are typically used in the industry. Some examples of large motor applications include elevators, electric trains, hoists, and heavy metal rolling mills. Examples of small motor applications include motors used in automobiles, robots, hand power tools and food blenders.

Micro-machines are electric machines with parts the size of red blood cells, and find many applications in medicine. Electric motors are broadly classified into two different categories: DC (Direct Current) and AC (Alternating Current). Within these categories are numerous types, each offering unique abilities that suit them well for specific application. In most cases, regardless of type, electric motors consist of a stator (stationary field) and a rotor (the rotating field or armature) and operate through the interaction of magnetic flux and electric current to produce rotational speed and torque. DC motors are distinguished by their ability to operate from direct current. There are different kinds of D.C. motors, but they all work on the same principles.

IV. PID CONTROLLER

PID (proportional integral derivative) control is one of the earlier control strategies. Its early implementation was in pneumatic devices, followed by vacuum and solid state analog electronics, before arriving at today's digital implementation of microprocessors. It has a simple control structure which was understood by plant operators and which they found relatively easy to tune. Since many control systems using PID control have proved satisfactory, it still has wide range of applications in industrial control. According to a survey for process control systems conducted in 1989, more than 90% of the control loops were of the PID type. PID control has been an active research topic for many years. Since many process plants controlled by PID controllers have similar dynamics it has been found possible to set satisfactory controller parameters from less plant information than a complete mathematical model. These techniques came about because of the desire to adjust controller parameters in situ with a minimum of effort, and also because of the possible difficulty and poor cost benefit of obtaining mathematical models. The two most popular PID techniques were the step reaction curve experiment, and a closed-loop "cycling" experiment under proportional control around the nominal operating point Tuning of PID Controller.

The basic configuration of the SISO control system is shown in the block diagram below (Fig. 5.). theblock diagram gives the notation used for the signals in the control system. Theblock diagram gives the notation used for the signals in the control system.

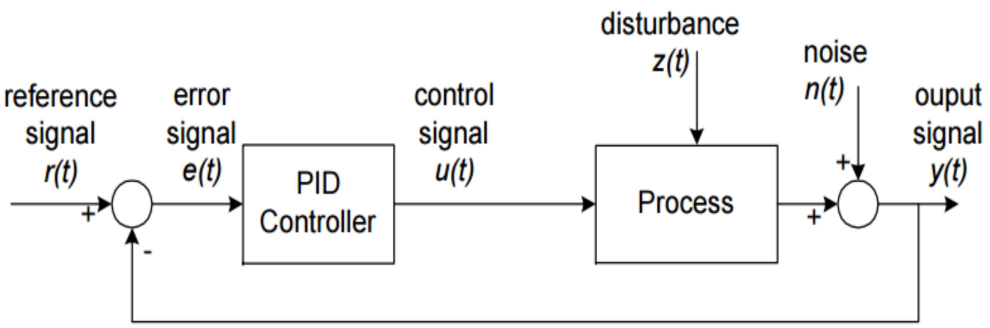


Figure 5. SISO control system

•The block marked "Process" in Figure 5 includes all the elements of the control system which are considered as the parts of the process: actuator, plant, and sensor.

•The mathematical model of the process can be very complex, with complicated static and dynamic description.

•The identification of a complex model requires a lot of engineering effort.

•Since the performance obtained from control system with the PID controller is limited, many PID controller tuning methods use simple models which have similar complexity as the PID controller.

•These models require simple identification experiments and capture dominant dynamic properties. Usual representation of these models is low-order (first or second order) transfer function in Laplace domain.

•On the other hand, some tuning methods for PID controllers were developed for more complex process models (e.g. higher order models, models with nonlinear characteristics) because of successful and widespread use of PID controllers in industry.

A PID controller consists of the three terms: proportional (P), integral (I), and derivative (D). Its behavior can be roughly interpreted as the sum of the three term actions:

•P term gives a rapid control response and a possible steady state error.

•I term eliminates the steady state error; D term improves the behavior of the control system during transients.

V. PI CONTROLLER

Two different PI controllers are used for controlling the position of DC motor. First PI controller is used to control the speed of the motor which receives the error from the difference between the reference speed and the actual speed. A gain is introduced before the first PI controller which relates the position error with the speed. While the second PI controller is introduced to maintain the torque so that a particular position is maintained. Complete simulated system is shown in the Figure 18 and Figure 19, Same DC motor model is used with the same data. Figure 18 shows the DC motor model and Figure 19 shows the DC motor model with the two PI controllers.

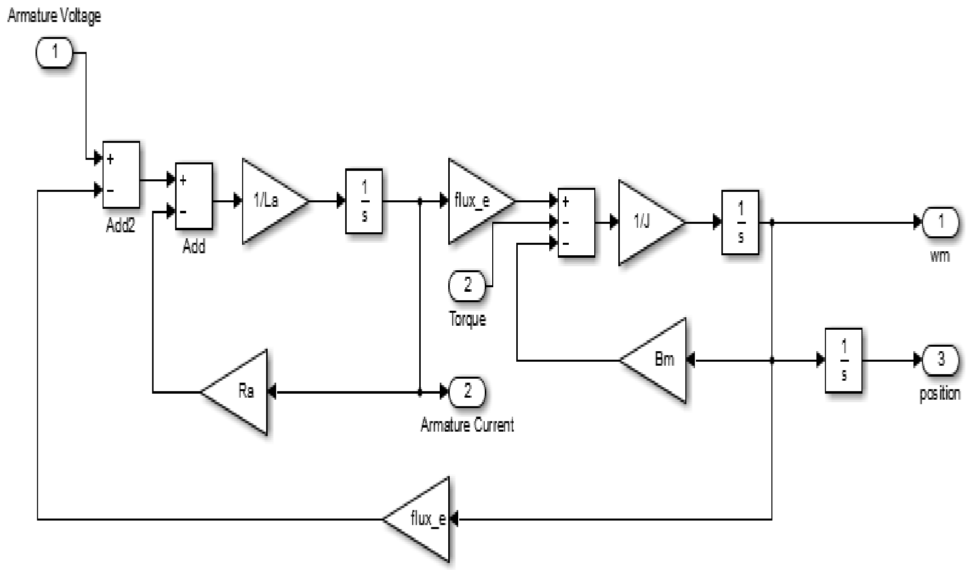


Figure 1. Simulation Model of a D.C. motor

VI. CONCLUSION

The designing of the project includes study of DC motor and selecting optimized controller which should have low peak overshoot and less settling time. In this section, proposed controller is analyzed and the various parameters are obtained by varying the gain parameters of the controller. It is seen that the proposed controller is capable of handling the position of DC motor with respect to the reference and provides good control. Matlab/Simulink platform is used to simulate the proposed models

ACKNOWLEDGEMENT

I thank Dr. Gursewak Singh Brar (H.O.D of Electrical Department) and Prof. Maninder Kaur (Assistant Professor of Electrical Department).

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