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# Speed Control of DC Motor – A Review

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**Abstract:** *This paper aims to provide an overview of the work of the various tuning controls to control the speed of a DC motor. A DC motor is widely used in the industry, even as the cost of maintenance is higher than that of an induction motor. DC-motor-speed-control, it has attracted a lot of research and several methods have been developed. All of the controllers have been widely used in many fields, such as process control, manufacturing, automation, automotive industry, etc. The soft-computing configuration is quite complex, than that of a conventional controller for controlling the speed of a DC motor. The setting of the CONTROLLER parameters is important, because these parameters have a great influence on the stability and the performance of the system.*

**Keywords:** Proportional Integral Controller, PID Controller, Ziegler-Nichols, Neural Network Controller, fuzzy logic controller, Linear Quadratic Regulator (LQR) Technique

## I. INTRODUCTION

DC motors are widely used in the industry, robot, and appliances, due to their reliability, flexibility, and low cost, which is the speed of the motor, and the position of the control is required. In this article, we consider the various types of conventional controllers, and intelligent controllers are used to regulate the speed control mode of a DC motor. Direct current (DC) motors have variable functions, which are widely used in the VSD. The DC motor can provide a high starting torque, and speed to get out of the control of a wide range of products. These applications require high speed control accuracy and good performance. DC-motor-performance-greatly improved the performance of AC motors as well as DC motors provides excellent control of the deceleration and acceleration. DC motors have a long tradition of being used as a variable-speed machines and a wide variety of options and have come to the fore. In this case, the motor will need to be carefully controlled in order to ensure a high quality result. The Speed of the controllers, which are designed to increase the speed of a DC motor, to carry out many tasks .There are many different types of controllers that the Ordinary controller, the Proportional-integral Controller, PID controller, Ziegler-Nichols Controller, Neural Network Controller, Fuzzy Logic Controller and a Linear Quadratic Controller. In this article, we will look at the various controllers can be used to increase the speed of a DC motor.

## II. CONVENTIONAL CONTROLLER

An important issue for modern management industries is to develop methods, concepts, techniques, technologies for the development of process management systems that must be flexible, self-improvement, self-organizing, and self-evaluating and self-improvement. Over the years, the control of processes and systems in the industry has been traditionally performed by experts using standard integrated equity control (PID) controls due to its simplicity, low cost creation and efficiency in many operating conditions. Standard control systems have temporary and static state problems such as overshoot, resolution time and wake-up time. Various technologies and modifications have been used to overcome these difficulties, including the automatic tuning of the integrated derivative control (PID), adaptation techniques and compensation strategies. Automatic editing processes are required for satisfactory control of control parameters.

### 2.1 Proportional Integral Controller

The p-i controller has a proportional in addition to an critical term inside the forward route, the crucial controller has the belongings of creating the consistent nation error zero for a step trade, even though a p-i controller makes the steady nation blunders 0, for the reason that maximum of the procedure can't paintings with an offset, they must be controlled

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at their set points and which will obtain this, more intelligence have to be brought to proportional controller and that is achieved with the aid of offering an critical action to the authentic proportional controller. So the controller becomes proportional –fundamental controller .Pi controller so long as errors is present the controller keeps changing its output and as soon as the mistake is 0 or it disappears the controller does no longer change its output. Integration is the mode that removes the offset or the mistake but from time to time it is able to make brief reaction worse. In pi controller the output of the controller is modified proportional to the essential of the error.

Since maximum of the manner cannot work with an offset, they should be controlled at their set points and in order to gain this, greater intelligence ought to be delivered to proportional controller and that is performed through providing an necessary motion to the original proportional controller. So the controller becomes proportional –indispensable controller

Beneath pi controller as long as mistakes is gift the controller maintains converting its output and as soon as the mistake is 0 or it disappears the controller does not alternate its output.

Integration is the mode that removes the offset or the error but sometimes it may make transient response worse.

In PI Controller the output of the controller is changed proportional to the integral of the error.

The mathematical expression of the PI Controller is:

$$u(t) = K_p e(t) + K_i \int_0^t e(t)dt$$

Where, Ki = Integral gain of the PI controller.

PI Controller has the following disadvantages:

- The response is sluggish at the high value of the integral time Tn.
- The control loop may oscillate at the small value of integral time Tn.

Proportional-Integral-Derivative (PID) Controller

Pid controllers are in all likelihood the maximum extensively used industrial controller. In PID controller proportional (p) control isn't always capable of get rid of consistent state error or offset errors in step reaction. This offset may be eliminated with the aid of integral (I) control action. Fundamental manipulate gets rid of offset, however may additionally lead to oscillatory response of slowly decreasing amplitude or even increasing amplitude, each of that are errors, initiates an early correction action and has a tendency to increase stability of machine.

The three adjustable PID parameters, the most often chosen as follows:

- Controller gain
- Integral time
- Derivative time

Although a PID controller has only three functions, it is not easy to find good values for them in a systematic process. In fact, on a visit to a technology company, it is often a major part of the PID controllers are poorly configured.

- The PID controller includes all three of the functions of the control, proportional, integral, and derivative.
- The PID controller calculates and displays a remedial action to correct the error between the process of shutting down, and to the point, which applies to the process of quickly and properly.

The output of the controller or the controlled variable is one that is achieved through the addition of elements like P, i & D, as well as the associated factors.

The ideal continuous-time PID controller is set up as follows:

Ideal PID controller in continuous time is given as

$$y(t) = K_p \left( e(t) + \frac{1}{T_i \int_0^t e(t)dt} + T_d \frac{de(t)}{dt} \right)$$

Laplace domain representation of ideal PID controller is

$$G_c(s) = \frac{Y(s)}{E(s)} = K_p \left(1 + \frac{1}{T_i s} + T_d s\right)$$

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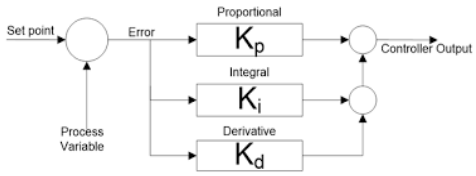


Fig. 1 Block diagram of PID controller

## III. NEURAL NETWORK CONTROLLER

A neural network contains simple factors running in parallel. In truth, it's far a hugely parallel allotted processor that shops experiential understanding and makes it available to be used while wanted. In the use of neural networks for gadget identity, schooling facts may be received by means of looking at the enter-output behavior of a plant. This manner is referred to as "one step beforehand prediction" and the structure is called time not on time neural network. In designing and schooling an ANN to emulate a characteristic, the simplest constant parameters are the quantity of inputs and outputs of the ANN, that are primarily based on the input/output variables of the characteristic. The selection of the wide variety of hidden neurons is based on revel in. It's also extensively prevalent that most of hidden layers are sufficient to research any arbitrary non-linearity. The lower back-propagation education method adjusts the weights and bias in all connecting hyperlinks within the nodes in order that the distinction among the real output and target output are minimized for all given education styles the time behind schedule neural network is a multilayer neural community and has four inputs. The ANN has one hidden layers, which encompass 2 neurons with tan sigmoid activation characteristic. The output layer of the ANN has handiest one neuron with natural linear activation feature. Neural networks are terrific tools, which permit the development of quantitative expressions without compromising the recognized complexity of the hassle.

The neural network consists of junctions which can be related with links, also called processing units. For each junction a number is ordered, this range is called weight. The weights are the gear for the lengthy distance statistics storing in the neural network, the mastering system happening with the best modification of weights. Those weights are modified so that the community input/output conduct is in consonance with the environment, which give the input statistics.

## IV. FUZZY LOGIC CONTROLLER

Fuzzy logic began with Lotfi El-Zadeh's theory of fuzzy sets, proposed in 1965. It is used in many fields, from control theory to artificial intelligence. Fuzzy logic has rapidly become one of the most successful of the modern technologies for the development of complex control systems. Fuzzy logic control technology is widely and successfully used in industrial applications. Fuzzy logic is a multivalve logic that allows you to determine intermediate values between the standard accounts, such as: true/false, yes/no, high/low, and it was published as a contribution to the problems of unclear or incorrect, or the qualitative decision-making problems.

Fuzzy logic control is based on the logic of relations. Vague knowledge, which is used for the display of the linguistic variables. The similarities between fuzzy logic and fuzzy set theory, as well as the relationship between the operators of the logic, and set theory. Figure 2 show the general structure of the FLC. FCS has been processed for language and definition, while the other controllers to work for the accuracy of the parameters of the system model. However, there is a lack of knowledge of the management of the process, which can lead to poor results [19].

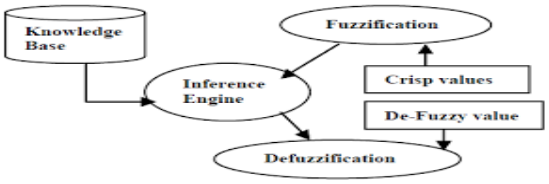


Fig. 2: fuzzy knowledge base system

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## V. LINEAR QUADRATIC REGULATOR (LQR) TECHNIQUE

LQR manipulate that designed is assessed as most reliable manipulate systems. That is an important characteristic of manage engineering. It has completely fine robustness assets [21]. These appealing belongings appeals to the working towards engineers. As a result, the linear quadratic regulator principle has received huge attention when you consider that 1950s. The liner quadratic regulator method seeks to discover the optimum controller that minimizes a given price characteristic (overall performance index). This fee function is parameterized by using matrices, q and r, that weight the nation vector and the device enter respectively. These weighting matrices regulate the consequences at the tour of kingdom variables and manage signal. One sensible technique is to q and r to be diagonal matrix. The fee of the elements in q and r is associated with its contribution to the value feature. To locate the manipulate regulation, algebraic riccati equation (are) is first solved, and an ideal feedback advantage matrix, if you want to cause top of the line results evaluating from the described price feature is received. Linear quadratic regulator design technique is widely known in modern-day superior manage theory and has been extensively used in many packages. The standard theory of the surest control is presented in dissertation. Below the assumption that every one nation variables are available for remarks, the LQR controller design method begins with a defined set of states which can be to be controlled. The principle of top-rated manage is involved with working a dynamic machine at minimal cost. The case wherein the system dynamics are described through a hard and fast of linear differential equations and the price is described by a quadratic function is known as the lq trouble. The performance measure to be minimized consists of output errors signals and differential manage power. The q matrix may be decided from the roots of the function equation. Each pc simulations and experiment consequences exhibit that the effectiveness of the most desirable layout of LQR controller linear-quadratic regulator (lqr) top-quality manage. The function of linear quadratic regulator (LQR) is to reduce the deviation of the velocity of the motor. The velocity of the motor is specifying on the way to be the enter voltage of the motor and the output will be evaluate with the enter. The output need to be similar to or about the same as the enter voltage. The blessings of used LQR are it is straightforward to design and will increase the accuracy of the kingdom variables by estimating the nation. The pleasant function of the LQR manage in comparison to pole placement is that rather of having to specify wherein n eigen values have to be placed a hard and fast of overall performance weighting are certain that might have more intuitive appeal. The overall performance measure is a quadratic characteristic composed of state vector and control input.

## VI. CONCLUSION

In this document, an attempt was made to assess the different sources of literature in classical control methods adopted by the various researchers in the process of tuning a PID controller to control the speed of a DC motor is to be optimized for the best possible result. This article presents the current status of the PID controller, the setup program to control the speed of a DC motor with the use of traditional methods for the examination

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