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A Review Study Speed Control Of Dc Motor With Classical Controller and Softcomputing Technique

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Abstract — This paper presented a review study on speed control of proportional integral derivative controller for speed control of DC motor using classical and soft computing techniques. Classical controllers are generally used to control the speed of DC motors in various industrial applications. It is found to be simple and high effective but tuning of soft computing is very difficult than Classical controller for speed control of DC motor. Finally details discussion about each controller individually discussed in brief way.

Keywords— PID Controller, fuzzy logic controller, Ziegler-Nichols method, Artificial Neural Network, Genetic Algorithm

I. INTRODUCTION

DC motor is an electrical device that converts direct current electrical power into mechanical power. DC motor is commonly used in many industrial applications where wide speed ranges are required. The main advantage of DC motors is the speed control facility. The term speed control stands for intentional speed variation done by automatic controllers or by manual means. DC motors are most appropriate for wide range speed control. DC motor provides excellent speed control for deceleration and acceleration. The controllers of the speed that are conceived for goal to control the speed of DC motor to execute many tasks. Hence these are used in many variable speed drives. Since speed is directly proportional to armature voltage and inversely proportional to magnetic flux produced by the poles and adjusting the armature voltage and/or the field current will change the rotor speed. DC motors have usually been used in industrial applications especially electric cranes, electric vehicles and robotic manipulators because of its simple and continuous control characteristics [1-3].

II. RIVIEWS STUDY OF PAPER

Rinku Singhal, Subhransu Padhee, Gagandeep Kaur have Discussed on Design of Fractional Order PID Controller for Speed Control of DC Motor, in this paper Conventional PID controller is one of the most widely used controllers in industry, but the recent advancement in fractional calculus has introduced applications of fractional order calculus in control theory. One of the prime applications of fractional calculus is fractional order PID controller and it has received a considerable attention in academic studies and in industrial applications. Fractional order PID controller is an advancement of classical integer order PID controller. In many a cases fractional order PID controller has outperformed classical integer order PID controller.

Ms.Manjusha Patil has present Modelling and simulation of dc drive using PI and PID controller, in this paper Many industrial applications require high performance rotating electric drives. A proposed D C drive have a precise speed control, stable operation in complete range of speed and good transient behaviour with smooth and step less control. The purpose of developing a simulation using PI and PID control system is to get steady state and transient response of drive system. Once the type of controller has been decided then the design and analysis are done. This paper focuses modelling of separately excited DC motor for the analysis of machine under any condition and compares the step response of system with and without PI and PID controller.

Shashi Bhushan Kumar et al have Design and Simulation of Speed Control of DC Motor by Fuzzy Logic Technique with Matlab/Simulink,in this paper The design of intelligent control systems has become an area of intense research interest. A promising direction in the design of intelligent systems involves the use of Fuzzy logic controller to discover the abilities of intelligent control systems in utilizing experience via rule-based knowledge. The most commonly used controller in the industry field is the proportional plus- integral-plus- derivative (PID). PID controller requires a mathematical model of the system while Fuzzy logic controller (FLC) provides an alternative to PID controller, especially when data are not available or partly available for the system. For comparison purpose, three controllers PI, PID and FLC have been designed and implemented in the MATLAB/Simulink model to examine the performance of DC motor with different loads.

Shalandra Bhartiya et al have proposed Dc Motor Speed Control using PID- Fuzzy Logic Based Controller Dc motors are one of the electrical drives that are rapidly gaining popularity, due to their high efficiency, good dynamic response and low maintenance. Because of these specialty DC motor are widely used in industrial application. This paper proposed the performance of fuzzy PID controller over the conventional PID controller. For both the armature controlled with fixed field and field controlled with armature current DC motor is performed. The Fuzzy rules and the inference mechanism of Fuzzy logic controller are evaluated by using conventional rule lookup tables. That encodes the control knowledge in a rules form. The modeling and the modeling control and simulation of DC motor have been done using the software package MATLAB /SIMULINK.

Ch. Bhanu Prakash and R. Srinu Naik discussed on Tuning of PID Controller by Ziegler-Nichols Algorithm for Position Control of DC Motor ,in this paper As the technology is growing the new applications are coming into existence, which needs both speed control as well as position control for better and efficient performance. We have many speed control techniques such as armature voltage control, field control etc. In addition to these control techniques for better performance of the systems we need to design an algorithm, which is helpful for DC position control. The advances in the theory and practice of automatic control provide the means for attaining optimal performance of dynamic systems, improving productivity. For adjusting gain constants of PID (Proportional-Integral-Derivative) control with Ziegler-Nichols (ZN) based algorithm probably a stochastic method of approach of genetic algorithm was implemented which will give more optimal results when compared with the results obtained with untuned PID controller. This tuned PID controller is used for position control of DC motor for better performance. This work is carried through MATLAB/SIMULINK environment.

P. M. Meshram and Rohit G. Kanojiya has discuss on Tuning of PID Controller using Ziegler-Nichols Method for Speed Control of DC Motor, In this paper, a weighted tuning methods of a PID speed controller for separately excited Direct current motor is presented, based on Empirical Ziegler-Nichols tuning formula and modified Ziegler-Nichol PID tuning formula. Both these methods are compared on the basis of output response, minimum settling time, and minimum overshoot for speed demand application of DC motor. Computer simulation shows that the performance of PID controller using Modified Ziegler-Nichols technique is better than that of traditional Ziegler-Nichols technique.

Amit Atri, Md. Ilyas et al [10] has Speed Control of DC Motor using Neural Network Configuration, This paper introduces the concept of Artificial Neural Networks (ANN) in estimating and controlling the speed of separately excited DC motor. The Neural Network scheme consists of two parts: one is the neural estimator, which is used to estimate the motor speed and the other is the neural controller, which is used to generate a control signal for a converter. These two neural networks are trained by Levenberg-Marquardt back propagation algorithm. Standard three layer feed forward neural network with sigmoid activation functions in the input and hidden layers and purelin in the output layer is used. Simulation results are presented to demonstrate the effectiveness and advantage of control system of DC motor with ANNs in comparison with the conventional control scheme.

G.MadhusudhanaRao and Dr. B.V.Sanker Ram has proposed A Neural Network Based Speed Control for DC Motor, This paper introduces the new concept of Artificial Neural Networks (ANNs) in estimating speed and controlling the separately excited DC motor. The neural control scheme consists of two parts. One is the neural estimator, which is used to estimate the motor speed. The other is the neural controller, which is used to generate a control signal for a converter. These two networks are trained by Levenberg-Marquardt back propagation algorithm. Standard three layer feed forward neural network with sigmoid activation functions in the input and hidden layers and purelin in the output layer is used. Simulation results are presented to demonstrate the effectiveness and advantage of the control system of DC motor with ANNs in comparison with the conventional control scheme.

S. A. Deraz has presented Genetic Tuned PID Controller Based Speed Control of DC Motor Drive, Due to its extensive use for motion control systems in industry, tuning of the proportional-integral-derivative (PID) controller parameters has been the focus of intensive research. In this paper, a novel tuning method for the parameters of PID controller based speed control of DC motor using genetic algorithm (GA) is proposed. The main advantage of the proposed method is that the mathematical model of the system under control is not required, so it is useful in many industrial processes that have no obvious or complicated model. In addition, this method allows determining the best values of PID parameters for a specified overshoot, rise time, settling time, and steady-state error. The DC motor with the designed PID controller is modelled and the simulation results are obtained. The obtained results are compared with those of conventional Ziegler Nichols (ZN), GA based integral absolute of the error (IAE) index, and GA based mean of the squared error (MSE) index methods.

M. B. Anandaraju et al have discussed on Genetic Algorithm: An approach to Velocity Control of an Electric DC Motor, DC motor is a vital component in most of the process control industries. PID controllers are extensively used in DC motors for speed as well as position control. Tuning of PID controller parameters is an iterative process and needs complete optimization to achieve the desired performance. Genetic algorithm (GA) which is a well established tool for optimization has been used to extract PID controller parameters for the velocity control of the DC motor. Different error models are used for evaluating the fitness function. Velocity control is demonstrated using MATLAB/SIMULINK modeling..

III. SPEED CONTROL FOR DC MOTOR WITH DIFFERENT CONTROLLER

3.1 PID CONTROLLER

Proportional plus Integral (PI) controllers are widely used in industrial practice for more than 60 years. The development went from pneumatic through analogue to digital controllers, but the control algorithm is in fact the same [16]. The combination of proportional, integral and derivative control action is called PID control action. PID controllers are commonly used to regulate the time-domain behavior of many different types of dynamic plants. These controllers are extremely popular because they can usually provide good closed-loop response characteristics.

Consider the feedback system architecture that is shown in Fig. 1 where it can be assumed that the plant is a DC motor whose speed must be accurately regulated.

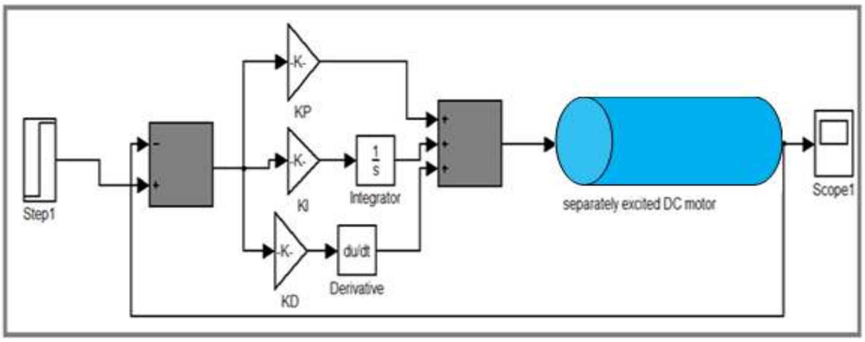

Fig 1 PID controller with DC motor

The controller attempts to minimize the error by adjusting the process control input. The PID controller calculation (algorithm) involves three constant parameters called the proportional (P), integral (I), derivative (D) values, these value can be interpreted in terms of time. P depends on the present error, I on the accumulation of past error, and D is the prediction about future error, based on current rate of change. The weighted sum of these three is used to adjust the process via a control element such as the position of a control value, or power supplied to a heating element The PID controller is placed in the forward path, so that its output becomes the voltage applied to the motor's armature the feedback signal is a velocity, measured by a tachometer .the output velocity signal C (t) is summed with a reference or command signal R (t) to form the error signal e (t). Finally, the error signal is the input to the PID controller [17].

PID controllers have been widely used for control systems. The most critical step for applying the PID controller is the tuning of its parameters. The tuning process needs a lot of time and effort. In the worst case, the bad tuning leads to a poor performance of the controlled system. The goal of the tuning process is to determine the PID controller parameters that satisfy the performance specifications of the controlled system, such as the rising time, the maximum overshot, the settling time and the steady state error. However, it is difficult to obtain the desirable values of these requirements simultaneously. As shown in Table 1, for example, larger values of proportional gain results in faster response while overshoot is increased. Therefore, an optimum tuning technique is of great importance [12].

TABLE-1 Effects of Increasing Pid Controller Parameters [12]

Parameter	**Rise time**	**Settling time**	**Overshoot %**	**Steady state error**
Proportional Action	Decrease	Small change	Increase	Decrease
Integral Action	Decrease	Increase	Increase	Eliminate
Derivative Action	Small change	Decrease	Decrease	Small change

3.2 Fuzzy Logic Controller

Fuzzy logic control (FLC) is a control algorithm based on a linguistic control strategy which tries to account the human's knowledge about how to control a system without requiring a mathematical model. Fuzzy control systems are knowledge-based or rule-based systems. The heart of a fuzzy system is a knowledge base consisting of the so-called fuzzy IF-THEN rules. A fuzzy IF-THEN rule is an IF-THEN statement in which some words are characterized by continuous membership functions. The approach of the basic structure of the fuzzy logic controller system is illustrated in Fig.2.

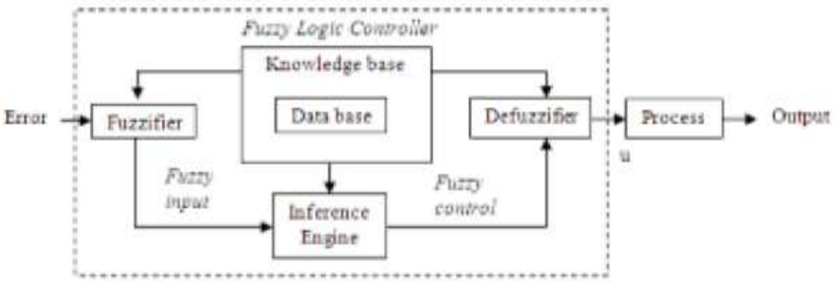

Fig 2. Fuzzy Logic Controller

The Fuzzy Logic controller consists of four basic components: fuzzification, a knowledge base, inference engine, and a defuzzification interface. Each component affects the effectiveness of the fuzzy controller and the behavior of the controlled system [16]. In the fuzzification interface, a measurement of inputs and a transformation, which converts input data into suitable linguistic variables, are performed which mimic human decision making. The results obtained by fuzzy logic depend on fuzzy inference rules and fuzzy implication operators. The knowledge base provides necessary information for linguistic control rules and the information for fuzzification and defuzzification. In the defuzzification interface, an actual control action is obtained from the results of fuzzy inference engine [17].

3.3 ZIEGLER-NICHOLS TUNING METHOD

A simple method of computing the parameters of a PID controller developed by Ziegler and Nichols and published in 1942 is known as Ziegler-Nichols step response method. This method is applied to the open loop step response of the load coupled DC motor [18].its show in figure 3. The Zeigler Nichols Open-Loop Tuning Method is a means of relating the process parameters - delay time, process gain and time constant - to the controller parameters - controller gain and reset time. It has been developed for use on delay-followed-by-first-order-lag processes but can also be adapted to real processes [19].

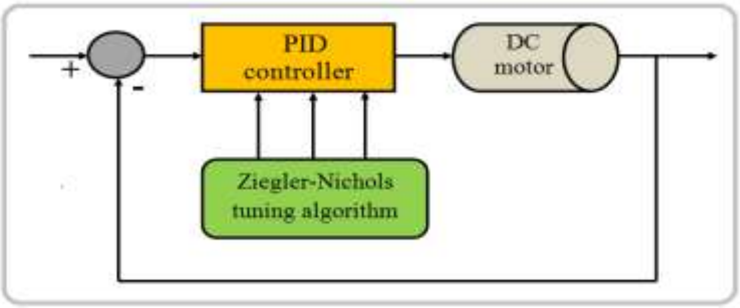

FIG 3.Zeigler Nichols algorithm with PID controller [9]

The best tuning method for the PID controller was given by Ziegler and Nichols, which was now accepted as standard technique in control systems practice. Both techniques make prior assumptions on the system model, but do not require that these models are specifically known. Ziegler-Nichols formulae for specifying the controllers are based on plant step responses.
The performance measure to be minimized contains the following objectives of the PID controller that will be studied separately [9].

1. Minimize the rise time, time required for system response to rise from 10% to 90% (over damped); 5% to 95%; 0% to 100% (Under damped) of the fmal steady state value of the desired response.

2. Minimize the maximum overshoot, Maximum overshoot is the maximum peak value of the response curve measured from the desired response of the system.

3. Minimize the settling time, Time required for response to reach and stay within 2% of final value.

3.4 ARTIFICIAL NEURAL NETWORK

Neural networks are wonderful tools, which permit the development of quantitative expressions without compromising the known complexity of the problem. . The artificial neural network is a massively parallel, non-linear adaptive system containing highly interacting elements called neurons or perceptrons. The artificial neural networks are based on crude models of the human brain and contain many artificial neurons linked via adaptive interconnections (weights). They are adaptive function estimators which are capable of learning the desired mapping between the inputs and the output of the system.

This makes them ideal in circumstances where simplification of the problem, in order to make it mathematically tractable, would lead to an unacceptable loss of information. As pointed out by Ziman, there is a fine balance between over-idealizing the initial hypothesis in order to make it amenable to mathematical analysis, and abandoning reality.
Neural networks resemble the human brain in the following two ways:

- A neural network acquires knowledge through learning.
- A neural network's knowledge is stored within inter-neuron connection strengths known as synaptic weights.

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons [6].

3.5 GENETIC ALGORITHM

Genetic algorithm (GA) is a heuristic mimicking the natural evolution process and is routinely used to generate useful solutions to optimization problems. In this work the genetic algorithm is used to derive the PID controller parameters by optimizing the error in the DC motor angular velocity. In GA a population of strings called chromosomes encodes the possible solutions of an optimization problem and evolves for a better solution by process of reproduction. The process of evolution starts from a population of randomly generated individuals. Optimization is achieved in generations where in each generation, the fitness function evaluates each individual in the population and multiple individuals are selected stochastically based on their fitness. These selected individuals are modified to form a new population. The algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population. The various steps in GA based optimization are detailed below [13, 20].

Initialization

From the initial population few individual solutions are generated. The population is generated randomly, covering the entire range of possible solutions.

Selection

In each generation, individual solutions are selected by evaluating the fitness function and the fitter solutions have a
higher probability of selection

Reproduction

Next set of population for the successive generation is generated by a process called reproduction and involves crossover (recombination) and mutation. These results in a new set of population derived from the fitter solutions of the previous population. Generally the average fitness of the population is heightened as compared to the population of the previous population.

Termination

The process of optimization is halted once a termination condition is achieved. The termination condition can be either .The number of generations or the solution satisfying an optimum criterion.

IV. CONCLUSION

In this paper, an attempt has been made to review various literatures for the speed control of DC motor with introduced by the different researcher’s article. This paper review article is also presenting the current status of tuning controller for speed control of DC motor using classical and soft computing techniques.

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