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Pid Speed control of Dc Motors

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ABSTRACT:*: This paper presents open loop and closed loop responses of the armature controller DC motor to various types of inputs. The aim is to eventually design a control system using P, I, D and combinational of them controllers for a faster and more stable response. The Ziegler Nichols tuning method is used to tune the PID parameters. The various responses were recorded experimentally and for comparison and discussion. A mathematical model of the engine is derived for use in theoretical analysis and simulation. A comparison of theoretical results and simulations is done with empirical findings to verify their reliability, and Matlab program is used for simulation.*

Keywords: *DC motor, P control, D controller, I control, PID control, Matlab.*

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I. INTRODUCTION

The Integrated Derivative Proportional control unit (PID) is a three-time controller and one of the control strategies introduced at the beginning from last time. PID Controller has become a standard controller in many industrial because of it is flexibility, relative simplicity, and satisfying

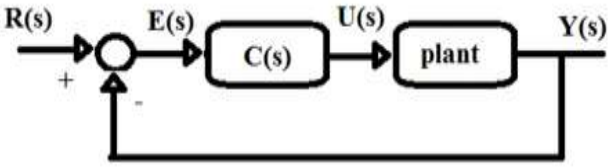

Figure 1 feedback control system

Technology development in the past few years has led to the replacement of analog controllers into digital controllers whose input and output are defined in a separate time-frame [7]. The digital control the output response of the system as it closes as possible for the required response. It is used extensively in controlling variables such as temperature in thermal systems, position or velocity in mechanical systems, the output response of the system as it closes as possible for the required response. It is used extensively in controlling variables such as temperature in thermal systems, position or velocity in mechanical systems, voltage, current and frequency in electrical systems [1, 2]. processors. [8]. There are many benefits of using a digital controller such as better reliability, expandability, and flexibility, process by maintaining digital computer. Digital controllers are either digital circuits, digital computers or microprocessor-based system for digital devices is used as an essential part of the console, usually in the form of a programmed As performance. The aim of using the feedback control system with PID controller is to monitor the Figure 1 shows the cluster diagram of the note monitoring system. There are several ways to tune the PID controller parameters to obtain the best satisfactory control system response. Ziegler-Nichols tuning method is the most popular method among all methods to adjust control. The Ziegler-Nichols synthesis of the PID controller algorithm includes calculating static parameters for the three variables [3]. The function of transferring a PID controller (in the domain s) is generally written in a parallel shape as it is in equation (1) [4] or at the time a constant form as given by equation (2)

$$\mathrm{C(s) = Kp + Ki\frac{1}{S} + KdS} \qquad (1)$$

$$\mathrm{C(s) = Kp(1 + \frac{1}{Ti\,S} + Td\,S)} \qquad (2)$$

Where Kp is a relative gain, KI is an integral gain (k = Kp/Ti), K D is a derivative gain (KD = Kp * td), Ti is a fixed integral time and TD is a fixed derivative time [6]. As possible lower prices [9] should. The most common procedure for calculating a separate PID controller starts by designing an analog PID controller and then applying the Euler conversion for a separate PID controller [10, 11]. The Euler method (rear differential) is implemented for the PID controller in the z Domain for numerical integration, where = $\frac{Z-1}{TZ}$ This gives a separate transfer function from the PID controller as shown in the command in Equation 3 or Equation 4 [12].

$$C(z) = Kp + \frac{KiTz}{z-1} + \frac{Kd(z-1)}{Tz} \quad (3)$$

$$C(z) = \frac{go\ z2 + g1\ z + g2}{Tz\,(z-1)} \quad (4)$$

Where
$go = Kp\ T + Ki\ T^2 + Kd$
$g1 = Kp\ T - 2Kd$
$g2 = Kd$
$T = \text{sampling time}$

There are many algorithms for numerical integration and numerical differentiation, the following, equation (3) is not unique to the system of the digital PID controller. However, equation (3) is the most preferred transport function for many commercial PID controllers available. By using this equation, it is easy to get a P, PI, PD, and PID controller by assigning an appropriate gain of zero [13]. In general, the parameters of the PID control system unit can be very difficult, inaccurate and take a lot of time when applying for high order. Also, digital can be of this complex controlled system. Because of this, it can be used to simplify the control of the analog PID controller of the controlled system with less time and more accurate based on different terms.

II. MATERIALS AND METHODS

This paper presents the Ziegler-Nichols method as a basic method of adjusting PID control parameters and manual tuning method to further improve the control system response specifications. Control methods provide control unit parameters in the form of formulas or algorithms. It ensures that the building of the control system obtained is stable and meets the specific and required objectives.

Ziegler-Nichols Step Response Method

The first design method introduced by Ziegler-Nichols is based on the fact that the step-by-link response is recorded from a stable system. In this way, the response curve should be the S-step, which is characterized by the delay time of L and constant time t. The parameters are determined from the response of the unit step of the process, as shown in Fig. 2 [21].

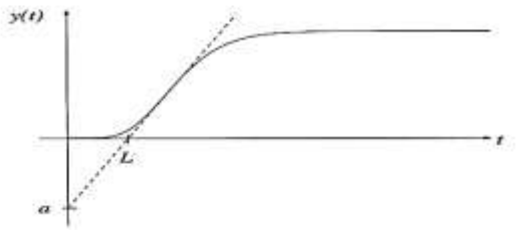

Figure 2 Open Loop System Step Response

The point at which the regression of a step response has a maximum value is determined first, and then the shadow is drawn at this point. The intersection between the tangent and the temporal axes gives the parameter L, while the intersection between the tangent and the Y line (t) = K gives the parameter T [21]. The values of PID parameters can be given directly as a function of a = KL/T and L, as shown in table 1 [22].

Controller	Kp	Ti	Td
P	1/a	-	-
PI	0.9/a	3L	-
PID	1.2/a	2L	L/2

Table 1. Ziegler-Nichols Tuning Formula for Step Response Method

1) Ziegler-Nichols Frequency Method.

Method 2 is used to increase Kp from 0 to a value called critical value KCR it exhibits the first output of continuous oscillations. To do this, the first set of Ti = TD and TD = 0, then the gain and critical value of KCR and the corresponding PCR period can be determined using the standard dung method. The Ziegler-Nichols formula used to set each of the PID parameter values as shown in table 2 [23]. This mode can be applied to the unstable system to make it constant [23].

Controller	Kp	Ti	Td
P	0.5Kcr	-	-
PI	0.45Kcr	Pcr/1.2	-
PID	0.6Kcr	0.5Pcr	0.125Pcr

Table 2. Ziegler-Nichols Tuning Formula for Frequency Method

2) Manual Tuning Method (s-domain)

The preceding method summarizes the individual effects of the PID controller three statements on the performance of the closed loop in table 3 [17]. This table can be used to manually support the tuning of PID controller parameters [17].

Controller	Rise time Tr	Overshoot Os%	Settling time Ts	Steady-state error ess
Increase P gain KP	Decrease	Increase	Small increase	Decrease
Increase I gain KI	Small decrease	Increase	Increase	Eliminate
Increase D gain KD	Small increase	Decrease	Decrease	Minor change

Table 3. Effects of Independent P, I and D on the System Response

This table is very useful for manual control of a PID controller, starting with the parameter values obtained from the Ziegler-Nichols methods, by monitoring the effect of those parameters on the system response to a step by system unit. Manual tuning is a simple method but requires a lot of experience while working on it, and it takes a very long time to get the required response [1].

III. RESULTS AND DISCUSSIONS

Manual PID Adjustment in theoretical calculation it is clear from the recent conclusion that the superstructure was very high, and the system was constantly slow to get the final status fixed. Table 3 was used for manual tuning method to set PID control parameters by trial and error to obtain a satisfactory result for the user system. These required results are displayed for manual tuning of PID control parameters in table 4. Since the PID controller is used for university education and technical Education for students, manual synthesis is only discussed. Here as far as possible, the increased Kp increases the speed of response, the lower Ti and Td resulting in a reduction of over-response and time-leveling as much as possible.

Controller	Kp	Ti	Td
PID	6.4	1	7
Tr		Overshoot%	Ts
PID	1.4	20.1	7.09

Table 4. PID Parameters and Response Specification

Finally, the system response specifications will be as shown in table 5. The response of the controlled system required is shown in Figure 7. This figure shows that the response of the control system at a separate time is faster than the response of this system in continuous time; At the same time more overshoot appear. System response can be controlled at a separate time by changing PID controller values parameters and sampling time.

Controller	Kp	Ki	Kd
PID	6.4	0.9	6.4
Tr		Overshoot%	Ts
PID	1.2	25.3	6.83

Table 5. PID Parameters and Response Specification

IV. CONCLUSIONS AND RECOMMENDATIONS

The exact performance of any engine is the required feature of any industrial application.

As the age of the engine increases its performance also decayed with aging, so it is desirable to evaluate the performance of the engine from time to day. The traditional method of calculating output performance indicators consumes a very long time. The PID-based conduction algorithm worked satisfactorily for the testing system. The important observations made during the studies are

1) The time solution for the suggested PID approach is not only part of the time taken by the traditional algorithm.

2) The proportional controller Kp will have the effect of reducing the height of the time and limit but never eliminate the constant case line always.

3) The K internal controller will have the effect of eliminating the error in a stationary condition but may make a transient response worse.

4) Kd derivative controller will have effect to increase system stability and reduce bypass and improve transient response.

5) output performance obtained by natural value in PID control is very close proximity to correct accuracy.

6) Matlab used to simulate the entire search is a sophisticated software and easy to use. It must be noted that the efficiency of the speed algorithm can be easily improved by using more efficient learning techniques and dynamic weight selection algorithm and show results on the use of the amplifier process (op_amp) optimization technique. Exceeding 95% to 98% is obtained so as to shoot the optimizer in a fixed error signal that is meaningless before in the results presented in this paper can be effectively implemented in engineering education courses related to the engineering of the automated control system. These can reduce the time required to design a PID controller and solve the more complex tasks in the design of the process life control. Moreover, it can be used in the Matlab-based simulation program to check the PID controller design. Teaching control systems in engineering courses for undergraduate students creates a more user-friendly environment in the classroom that will benefit students significantly in the field.

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