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Design of PI, PID, PD controller for DC motor speed
controls using analog circuitry / Mohd Hafiez Ismail.

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MOHD HAFIEZ BIN ISMAIL

MAY 2008

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"I hereby declare that I have read this project and in my opinion this project is sufficient in terms of scope and quality for the Bachelor of Electrical Engineering (Industrial Power)"

Signature	:	....
Supervisor's Name	:	**AZRITA BINTI ALIAS**
Date	:	**7 MAY 2008**

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MOHD HAFIEZ BIN ISMAIL

This Report Is Submitted In Partial Fulfillment Of Requirements For The Degree of Bachelor In Electrical Engineering (Industrial Power)

Fakulti Kejuruteraan Elektrik
Universiti Teknikal Malaysia Melaka

MAY 2008

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"I hereby declare that this report is a result of my own except for the excerpts that have been cited clearly in the references".

Signature : ....

Name : **MOHD HAFIEZ BIN ISMAIL**

Date : **7 MAY 2008**

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To my beloved parents, lecturers and friends for their support, advices, prayer and inspiration to me

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In the name of Allah S.W.T The Most Beneficient. The Most Merciful. It is with deepest sense of gratitude of the Almighty Allah who gave me strength and ability to complete this project.

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ABSTRACT

This project focuses on design the controller of PI, PD and PID using analog circuitry for the DC motor speed control. The software such as MATLAB will be used to simulate the design before hardware implementation. Nowadays, Dc motor has been widely use in electrical engineering, electronic engineering, even manufacture engineering. Such as for robot, machine, lift and some of electric equipment. In this project, the controller of PI, PD, and PID will be analyze for the effectiveness of the motor movement for running system and control the load. Beside that; the usage controller PI, PD, PID will be able to control all speed motor either it was on running or not. In this project, MATLAB software will be used to do the simulation. In the end this project, the controller should be able to prevent damage occurs at the motor and also always stable in good condition.

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ABSTRAK

Projek ini adalah bertujuan untuk menghasilkan sebuah alat pengawal yang terbaik dengan menggunakan pengawal PI, PID, PD untuk menentukan kelajuaan operasi sebuah motor arus terus. Perisian seperti Matlab digunakan untuk simulasi litar yang telah dihasilkan sebelum merekacipta sebuah projek. Dewasa ini, motor arus terus sangat luas digunakan dalam kejurutereaan elektrik, kejuruteraan mekanikal, kejuruteraan pembuatan dan kejuruteraan elektronik. Antaranya dalam rekacipta sebuah lif, mesin industri, robot atau barangan berasaskan elektrik. Dalam projek ini, alat pengawal PI, PID, PD digunakan untuk menjalankan operasi motor bagi mengawal beban dalam operasinya. Selain itu, penggunaan pengawal ini berkebolehan untuk mengawal setiap kelajuaan motor. Dalam projek ini, perisian MATLAB digunakan untuk simulasi litar. Oleh itu, alat pengawal ini dapat mengurangkan berlakunya kerosakan pada motor dan juga membolehkan motor berada dalam kedudukan yang terbaik

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CHAPTER 1

INTRODUCTION

1.1 Background

This project focuses on design the controller of PI, PD and PID using analog circuitry for the DC motor speed control after modelling DC motor. Dc motor has been widely use in electrical engineering, electronic engineering, even manufacture engineering. Such as for robot, machine, lift and some of electric equipment. In this project, the controller of PI, PD, and PID will be analyze for the effectiveness of the speed motor movement for running system and control the load. Beside that; the usage controller PI, PD, PID will be able to control all speed motor. This controller also should be able to prevent damage occurs at the motor and also always stable in good condition.

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1.2 Problem Statement

The PID controller calculation involves three separate parameters; the Proportional, the Integral and Derivative values. To fully understand PID concept, proportional control determines the output control variable based on how much the process variable differs from a set point. For example, if the speed of a motor is dragged down 10% due to a load increase, a corrective speed signal increase of 10% is generated. In a perfect world, this increase in speed command should bring the motor speed back to normal. Integral control is added to proportional control. This will increase the corrective signal if the error (decrease is speed) accumulates over a period of time. In other words, if the proportional corrective action does not bring the motor back up to speed soon enough, the integral control will generate additional corrective action. "Like, hey motor, I told you to speed up, but you seem to be a little slow to correct your speed. So, here is a little more power to help you get your speed back up as soon as possible". Derivative control is also added to the proportional control. It is used to compensate for how quickly or suddenly a change occurs. If a motor changes speed gradually, the derivative control barely kicks in, if at all. But, if a heavy load is suddenly dumped onto the motor, such as on a conveyor belt, the motor speed will decrease quickly. The derivative control reacts to the suddenness of process variable change. In our example, the quicker the change in motor speed, the greater is the corrective action of the PID loop. "Like, hey motor, your speed changed real suddenly. This really got my attention. So, to get your RPM back to normal as soon as possible, here is a little more power to help you get your speed back up right now". So that, with using PID controller any speed DC motor will be control. Dc motor can be sharp in good speed condition to avoid some error occurs and also to reduce motor be avoid damge when usage this controller. Then, DC motor can easy to control or adjust at any speed specially to high, medium or low speed for starting and running to make sure that condition of motor will be able in stable condition.

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1.3 Objectives

The aim of this project was to design PID controller for speed DC motor. The main objectives are :

i) To design the hardware of PI, PID, PD controller for dc motor speed.

ii) To simulate the output response PI, PID, PD using MATLAB.

iii) To make an analysis from the comparison of the output between hardware and software about DC motor speed controller.

1.4 Scopes of Project

Literature study and references about PID controller for speed DC motor had been done to know the function of DC motor speed control using PID controller. Main component such as omp-amplifier, DC motor 30V, oscilloscope and other are used to build this project. This project also used MATLAB software and PROTEUS use to make simulation, doing data collection and mathematical modeling, direct measurement using oscilloscope.

1.5 Report Structure

In this report, it consists eight chapters namely introduction, literature review, PID controller theory, project methodology, software development, analysis of circuit PID controller, project result and conclusion. Introduction explained about the importance of DC motor in engineering nowadays and the advantages using PID controller for speed DC motor. It also explained about the project scope that will guide throughout this project development. Literature review describes about to design circuit PID controller for DC speed motor. These journals helped as guidelines and gave a brief idea about what design circuit should have and how to implement it in designer circuit for educations and engineering world.

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PID controller theory consists of the formulas and theories that are being used related to PID controller such as in proportional, integral and derivative. Project methodology defined the method that being used in developing this project. This method helped me to organize time and work so that the project runs as planned. Software development describes the process to simulation of circuit design to get output data for comparison. It also showed the advantages usage of MATLAB in developing the project interactively.

Analysis of PID controller circuit describes the analysis that has been done throughout the project development. Project result showed the results that have been achieved throughout the project development. It is also show the result from hardware for comparison with output data from simulation software MATLAB. Conclusion discussed about future development, suggestions, and improvement that can be added to the project in the future.

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CHAPTER 2

LITERATURE REVIEW

This chapter reviews existing project created to get in idea about the project design, specification, and any information that related to improve the project. This literature review includes studies, research and software development concerning design PID controller application. In later of this chapter, some review about PID controller for DC motor position controls that proposed to fulfill this project will also be reported.

2.1 Introduction

As we know in engineering word, DC motor have been widely used in electrical engineering, electronic engineering, even manufacture engineering. Such as for robot, machine, lift and some of electric equipment. Such as for robot, machine, lift and some of electric equipment. We must decide what the best way to control speed DC motor. Hence, PID controller is the best solutions for this.

What is PID controller? PID stands for Proportional-Integral-Derivative. This is a type of feedback controller whose output, a control variable, is generally based on the error between some user-defined set point and some measured process variable. Each element of the PID controller refer to a particular action taken one the error.

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Proportional: error multiplied by a gain, K_p. This is an adjustable amplifier. In many systems K_p is responsible for process stability: too low and the process variable can drift away; too high and the process variable can oscillate.

Integral: the integral of error multiplied by a gain, K_i. In many systems K_i is responsible for driving error to zero, but to set K_i too high is to invite oscillation or instability or integrator windup or actuator saturation.

Derivative: the rate of change of error multiplied by a gain, K_d. In many systems K_d is responsible for system response: too high and the process variable will oscillate; too low and the process variable will respond sluggishly. The designer should also note that derivative action amplifies any noise in the error signal.

2.2 Example Review

2.2.1 Example: PID Design Method for the Pitch Controller

In the Pitch Controller Modeling page, the transfer function was derived as

$$\frac{\theta(s)}{\delta(s)} = \frac{1.151s + 0.1774}{s^3 + 0.739s^2 + 0.921s} \quad (2.1)$$

The input (elevator deflection angle, delta e) will be 0.2 rad (11 degrees), and the output is the pitch angle (theta).

The design requirements are
Overshoot: Less than 10%
Rise time: Less than 2 seconds
Settling time: Less than 10 seconds
Steady-state error: Less than 2%

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The transfer function of a PID controller is:

$$K_P + \frac{K_I}{s} + K_D s = \frac{K_D s^2 + K_P s + K_I}{s} \qquad (2.2)$$

We will implement combinations of proportional (Kp), integral (Ki), and derivative (Kd) controllers in a unity feedback system shown below to study the system output. The figure 2.1 below shows that combination of Kp, Ki and Kd.

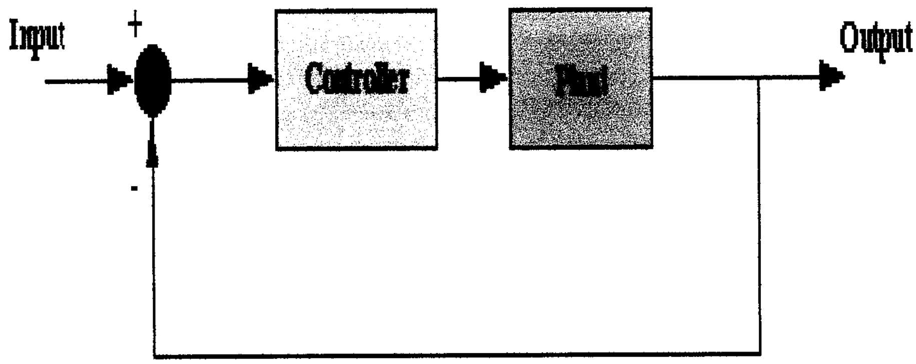

Figure 2.1 : Combinations of proportional (Kp), integral (Ki), and derivative (Kd) controllers in an unity feedback system

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