

**REAL TIME PID POSITION CONTROLLED
DC MOTOR DRIVES**

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APRIL 2009

“I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references.”

Signature :

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Date : APRIL 2009

To my dearest family and friends
For their support, encourage and motivation.

“I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)”

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Submitted By:

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**This Report is Submitted in Partial Fulfillment of Requirements for the Degree of
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ABSTRACT

Generally, control system is a device or set of devices to manage, command, direct or regulate the behavior of other devices or systems. Control system has 2 common classes; they are logic or sequential controls, and feedback or linear controls. In other word, control system is for controlling the operation of system which operates automatically or manually. The “Real Time PID Position Controlled DC Motor Drives” project is about to design the controller in order to control the position of DC motor. This project wants to control DC motor with a PID controller for different load. The different load gives the different performance of output response. MATLAB software is using to simulate and design the PID controller for get the performance requirement of DC motor. Then, the controller coefficients will transmit to the hardware configuration. Therefore, this project can help the students to understand the concept of control system and make the learning process more interesting.

ABSTRAK

Pada umumnya, sistem kawalan adalah satu alat atau set alat untuk mentadbir, mengarahkan, menghalakan atau mengaturkan ciri-ciri sesuatu peranti atau sistem. Sistem kawalan lazimnya mempunyai 2 kelas iaitu logik atau kawalan berterusan dan maklum balas atau kawalan mendatar. Selain daripada itu, sistem kawalan adalah untuk mengawal operasi sistem lain secara automatik atau manual. Projek “Real Time PID Position Controlled DC Motor Drives” tentang mereka pengatur supaya dapat mengawal kedudukan motor DC. Projek ini menghendaki untuk mengatur motor DC dengan pengatur PID untuk beban yang berlainan. Beban yang berlainan meberikan perlaksanaan keluaran yang berbeza. Perisian MATLAB digunakan untuk simulasi dan mereka cipta pengatur PID untuk mendapatkan spesifikasi motor DC. Kemudian, pekali-pekali pengatur akan dipindahkan kepada perkakasan. Oleh itu, projek ini boleh membantu pelajar untuk memahami konsep sistem kawalan dan membuat proses pembelajaran lebih menarik.

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LIST OF ABBREVIATIONS

AC	Alternating Current
ADC	Analog-to-Digital Converter
C	Capacitor
DAQ	Data Acquisition System
DC	Direct Current
EMF	Electromagnetic Force
K	Gain
PC	Personnel Computer
PCB	Printed Circuit Board
PID	Proportional-Integrated-Derivative
PWM	Pulse Width Modulation
SP	Set Point
T _s	Settling Time
T _p	Peak Time
%OS	Percent Overshoot

CHAPTER 1

INTRODUCTION

The “Real Time PID Position Controlled DC Motor Drives” project is designed to develop a firmware (hardware and software). The purpose of this project is to apply the theory of PID control system to real implementation and analyze the operation of PID controller for DC motor position control application. In addition, this project covers the software programming and hardware configuration to get the output response. This chapter will discuss about the background of the project, the concept of the control system, the concept of the project, the objectives, the scope of the project, and problem statement.

1.1 BACKGROUND OF THE PROJECT

The motion control is the position and/or velocity of configuration by controlled using some type of device such as a hydraulic pump, linear actuator, or motor drives generally a servo. For this project, the device that uses to control position is DC motor drives because servo motion control is reliable option for providing advanced positioning performance. Moreover, DC motor is relatively simple and eases to control the system.

Control system is obscure concept imaginatively or theoretically. This matter will give difficulty to students to study concept control system with profounder. This project can gives opportunity to student to study and understand real idea of control system. This project is a simple application to see the motion of plant which it controls by the controller. So, it can facilitate for student especially to more understand about the control system. Furthermore, more sophisticated technology in electronic field current makes control system more complicated.

1.2 THE CONCEPT OF THE PROJECT

The overall concept for this project can be illustrated as shown in Figure 1.1 below. The PIC16F877A circuit board gives the directive via the program in microC to give the program for microcontroller. Then the personal computer gives the direction and position command via Visual Basic 6.0. Then the plant will move followed the instruction that given.

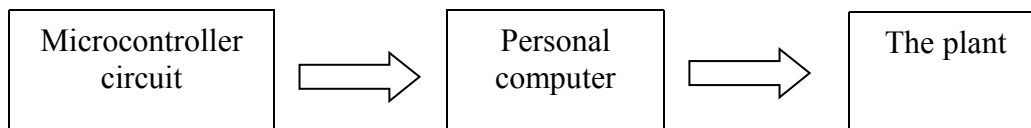


Figure 1.2: The concept of the project

1.3 THE OBJECTIVES OF THE PROJECT

The main objective of this project is to develop the controller for position controlled of DC motor using PID controller. This project required to design and builds a functional hardware and designs a control system program for the controller. Indirectly, this project enable students understand characteristics of PID controller and facilitate learning process. The objectives of this project are:

- i. To perform a modeling DC motor.
- ii. To develop the operation of PID controller for DC motor position control application.
- iii. To analyze the performances of DC motor with different position.
- iv. To display the result obtained via Microsoft Visual Basic 6.0.

1.4 THE SCOPE OF THE PROJECT

The scope of this project is to present an inventive design related to learning control system application for use in teaching process. In order to present this design, the project comprise of a circuit board related to the block appearing on the block diagram of a control system. This project has a control circuit and display the output response of the controllers.

This project has the implementation of hardware and software which we can more understand for this application. This project has a control circuit which using PIC16F877A as controller. Then, the plant will convert the signal from MicroC programming to personal computer. The output response will display via Microsoft Visual Basic. The hardware is the DC motor known as the circuit board and the plant. The plant of DC motor is to show the movement of the difference position.

1.5 PROBLEM STATEMENT

In industry, PID controller is the widest kind of automatic control. It is because PID Controller is the comparatively simple structure and slight variations to be relevant in industry. The theoretical and the real application must be related to make the learning process easy to understand and can show the theory and practical. The main problem is to present the PID controller in control system particularly to transform theoretical in the form of a real time application. Therefore, to take in hand this problem, we will need more understanding in control system basic and practical.

This project is the best solution to apply the theory of the control system that learned in lecture to real implementation. Theoretically, the PID controller is a system which has calculation and rules. Hence, the students are difficult to understand fully the concept of control system. By such, this project can implement the concept of control system to the real configuration. By doing this project can help the students to understand the characteristics of PID controller in control system. The characteristics of PID controller in control system are performing in real time.

CHAPTER 2

LITERATURE REVIEW

This chapter will discuss about the important concept of control system and analysis described in “Real Time PID Position Controlled DC Motor Drives” project. There is the information concern control system, PID controller and the DC motor control. The research of literature review is to give explanation theoretically which related in this project and describe the currency of system project.

2.1 HISTORY OF CONTROL SYSTEM

Control system was existed before evolution of humanity and started essentially in the ancient world. Human realize about existence of the control system when they know that control system can improve and help them to facilitate and easiness their routine live. Therefore, many biological control systems were built into the earlier residents of our earth.

Many members’ scientist ancient times do various experiments and test study for get correct theory on control system. Various improvements also are done by scientist so that they get correct conclusion and can use by next generation. The logical theories uses for accomplish the complex problem where related to the control

system. It is because the control system is an abstract and difficult to fully understand. The table below is about briefly history of control system.

Table 2.1: History of control system

NO.	YEAR	NAMES	DESCRIPTION
1.	1736-1819	James Watt	He invented the flyball speed governor to control the speed of steam engines. In this device, two spinning flyballs rise as rotational speed increases.
2.	1745	Edmund Lee	He patented the first of the millwright's devices, the fantail.
3.	1911	Elmer A. Sperry	He invented a gyroscope for use in the stabilization and control of ships.
4.	1922	Nicholas Minorsky	He presented the automatic steering of ships and developed a three-term controller, thereby becoming the first to use the proportional-integral-derivative (PID) controller.

Modern society has sophisticated control systems which are crucial to their successful operation. Existence control system is based on several reasons which control system very important in our live. The reasons are power amplification, remote control, convenience of input form and compensation for disturbance. From definition, control system is a device or a collection of devices that control the behavior of other devices. The system can be controlled and adjusted the desired input response to give a difference output response. But some devices are not controllable. A control system is also connection of components or related components to describe the behaviors of the system. We cannot see the behavior of the control system with roughly eye but with have implement the control system to configuration to know the characteristics and behaviors of control system.

Figure 2.1 shows the simplified description of a control system while the Figure 2.2 shows the dynamics response of a control system.

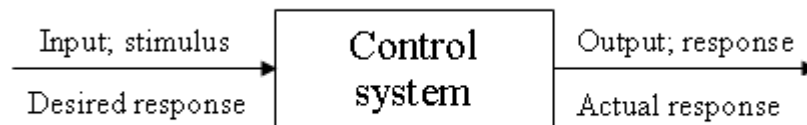


Figure 2.1: Simplified description of a control system

The control system receive the desired input response to give an output response which known as actual response.

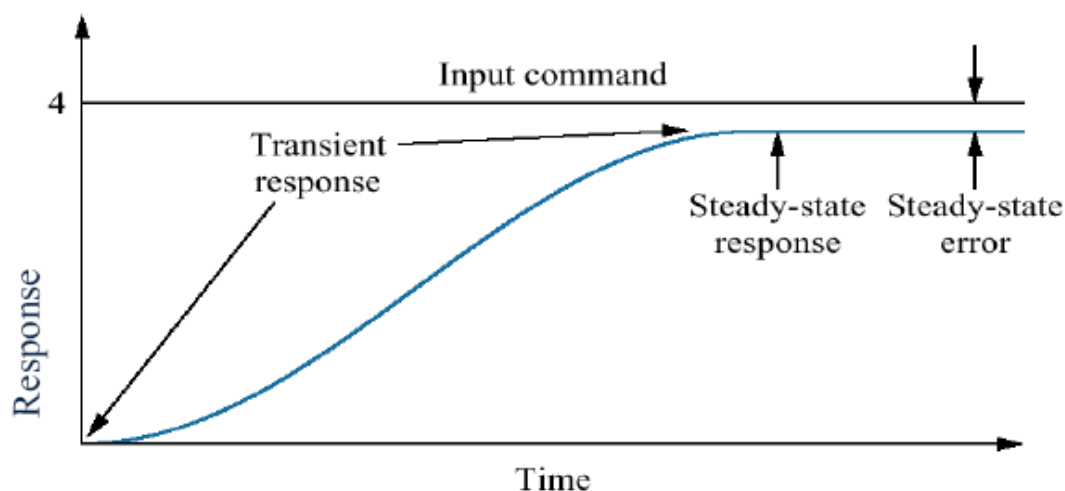


Figure 2.2: Dynamic Response of Control System

The response will changes increasable until reach a steady-state response which this point is critical point. The changes of response are called transient response until the point of steady-state response. The differences of input command and the steady-state response is known as steady-sate error. The differences value of gain will make the steady-state error also change.

2.2 THE CONCEPT OF THE CONTROL SYSTEM

Control system has 2 types which is open-loop controller and closed-loop controller. An open-loop controller or a non-feedback controller is a type of controller which computes its input into a system using only the current state and its model of the system. A characteristic of the open-loop controller is that it does not use feedback to determine if its input has achieved the desired goal. This means that the system does not observe the output of the processes that it is controlling. Consequently, a true open-loop system can not engage in machine learning and also cannot correct any errors that it could make while closed-loop control systems typically operate at a fixed frequency. When the frequency is changes to the drive signal, the sampling rate is also changes and certainly not any faster.

A closed-loop control system is a feedback controller which the ability to reduce the system stability. A closed loop control system is not like the open loop control system which the changes of the errors will give inaccurate output. The one of characteristics of control system is the transient response can adjusted until satisfactory. If the open loop control system does not provide a satisfactory response, the process must be replaced or modified. But in closed-loop control system can adjusted the desired response by adjusting the feedback loop parameters. Many control system have extraneous disturbances signals which provide inaccurate output, with have feedback systems, the distortions or unwanted disturbances can be reduces.

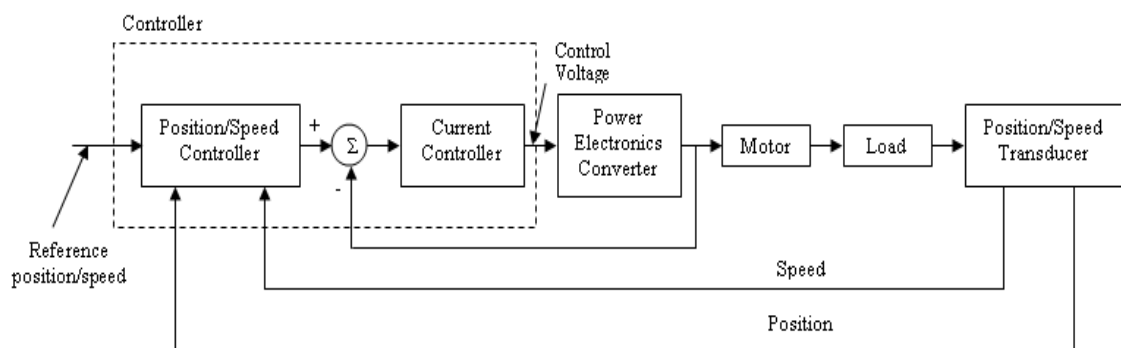


Figure 2.3: Closed-loop position/speed DC servo motor

2.2.1 Open-loop Control System

In general, open-loop control means those send signals or desired input response to some devices to perform a certain action and accomplishment. The actions that perform are output response outcome from control system. Briefly, open-loop control system does not have a feedback loop. It means the open-loop control system does not continuously update its input and thus is not self-correcting. An open-loop control system is controlled directly from an input signal because there no feedbacks loop. The basic units of the open loop control system type consist only of an amplifier and a motor. The amplifier receives a low- level input signal and amplifies it enough to drive the motor to perform the desired job. The controller receives the input from input transducer and the output response will perform via the plant. The plant is to display the output response because control system is abstract to understand behaviors or characteristics of control system without the plant.

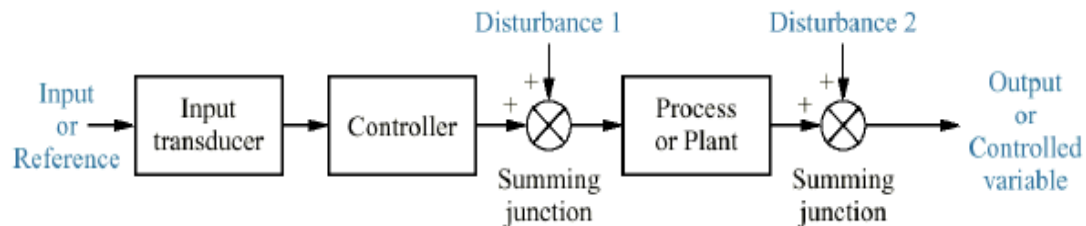


Figure 2.4: Open-loop system

2.2.2 Closed-loop Control System