PC-BASED MOTOR SPEED CONTROL

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BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : PC-BASED MOTOR SPEED CONTROL

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Dedicated to my family especially my parents, brothers and to all of my friends.

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ABSTRACT

Electric motors have been widely used in all sorts of application since the industrial revolution. The rotation and direction speed motors varies according to its application. Conventional method requires physical adjustment of the variable resistors to control the speed of the motor. However, such approach leads to high power losses and causes inefficiency within the designed system. Although a PWM controlled system is normally used to overcome the drawback of the conventional method, but the duty cycle of the generated signal and the exact rotation speed of the motor could not be monitored and controlled. As a result, the reliability, efficiency and accuracy of the PWM signal technique is still unpredictable. This particular project is to develop a PC-based monitoring and controlling for DC and AC motor speed control system. The developed system controls the PWM signal through the use of NI LabVIEW software and NI DAQ device (USB-6221) to monitor digitally and control the duty cycle as well as display the exact speed of the rotating motor. The PID controller will be implemented in a closed-loop form to eliminate the disturbance occur in current project. The accuracy and efficiency of the system can now be made relatively high. LabVIEW enables an intuitive graphical programming development environment for engineers to acquire, analyze and present real-world data. Real-world data can easily be obtained by interfacing the DAQ device with the LabVIEW software which suits various application purposes.

ABSTRAK

Motor elektrik telah digunakan secara meluas untuk pelbagai aplikasi semenjak revolusi perindustrian. Kelajuan dan arah pusingan motor adalah bergantung kepada aplikasinya. Kaedah yang sedia ada memerlukan penyelarasan pada perintang boleh laras untuk mengawal kelajuan motor. Namun demikian, pendekatan sebegini akan menyebabkan kehilangan kuasa yang tinggi dan menunjukkan sistem yang digunakan tidak efisien. Walaupun kaedah kawalan *PWM* telah biasa digunakan untuk mengatasi kelemahan ini, tetapi isyarat kawalan yang terhasil dan kelajuan pusingan yang sebenar tidak dapat dipaparkan serta dikawal. Justeru itu, kebolehharapan, keberkesanan serta kejituan teknik isyarat *PWM* masih tidak jelas. Projek ini bertujuan untuk membangunkan suatu sistem kawalan kelajuan motor AT secara berkomputer. Sistem yang berjaya dibangunkan boleh menjana isyarat *PWM* dengan menggunakan perisian *NI LabVIEW* dan peranti *NI DAQ (USB-6221)* bagi membolehkan pengawasan secara digital dan mengawal kitar duti disamping dapat memaparkan kelajuan pusingan motor yang sebenar. Dalam sistem kitar penutup, kawalan *PID* akan dilaksanakan dalam projek yang sedia ada untuk menyingkirkan ralat muncul dalam sistem. Tahap kejituan dan kebolehpercayaan sistem akan ditingkatkan dengan tinggi. Perisian *LabVIEW* membolehkan persekitaran pembangunan program yang dilakukan secara grafik dan ia adalah amat berguna kepada jurutera untuk memperoleh, menganalisa, dan memaparkan maklumat dari dunia sebenar. Data dan maklumat dari dunia sebenar dapat diperolehi melalui perantaramukaan di antara peranti *DAQ* dengan perisian *LabVIEW* yang sesuai untuk pelbagai tujuan dan aplikasi.

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LIST OF ABBREVIATION

PC	-	Personal Computer
DC	-	Direct Current
AC	-	Alternative Current
PWM	-	Pulse Width Modulation
DAQ	-	Data Acquisition
VI	-	Virtual Instrument
LabVIEW	-	Laboratory Virtual Instrument Engineering Workbench
NI	-	National Instrument
TC/IP	-	Transmission Control Protocol / Internet Protocol
I/O	-	Input/ Output
GPIB	-	General Purpose Interface Bus
R&D	-	Research and Development
PLC	-	Programmable Logic Controller
BASIC	-	Beginner's All-purpose Symbolic Instruction Code
USB	-	Universal Serial Bus
LED	-	Light Emitting Diode
RFI	-	Radio Frequency Interference
Op-Amp	-	Operational Amplifier
AM	-	Amplitude Modulation
GUI	-	Graphical User Interface
RPM	-	Revolution Per Minute

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CHAPTER I

INTRODUCTION

In this chapter, discusses regarding the introduction of PC-based monitoring and describing the technique used to control the speed of the DC and AC Motor. The block diagram gave the general ideas on this project. In addition, objectives, problem statement of the project and the report structure is included as well.

1.1 Introduction to PC-Based Control System

The beginning of a sweeping change is upon the control and instrumentation world. With the availability of robust hardware, open technology and real-time, Windows-based operating systems, PC-based control is emerging as a new control paradigm for increasing manufacturing productivity. PC-based control offers open and more intuitive traditional solutions at a lower total system cost and easier migration to future technologies. Easier development, integration, portability, and access ensure a flexible and efficient solution.

Industry analysts and major global manufacturers agree that PC-based control is the future. Today, more than 20 vendors offer PC-based control as an integral part of industrial automation product lines, and one of them is National Instrument (NI) LabVIEW. The number continues to grow as industry leaders include PC-based solutions. It is important to understand PC-based control and, more importantly, the

benefits and challenges accrued when committing to this next level of control technology.

Manufacturers around the world look to PCs to play a bigger role in their control systems. PCs are already an accepted platform for system supervisory control, monitoring and reporting, as well as off-line data management and analysis. Manufacturers have already realized the flexibility of the PC and the easy-to-use open architecture of Windows-based software applications for the manufacturing environment.

In this project, the DC and AC motor's speed are controlled by using the LabVIEW 8.5 software package from the National Instrument (NI) by using PC. There are many methods that have been used to control the DC and AC motor's speed, the conventional method is by adjusting the supply voltage of the motor but this method is inefficient because the power losses is high. So, to solve this problem, Pulse Width Modulation (PWM) technique had been used to make the control of DC and AC motor are more efficient, it is called the hardware controlling technique. The PWM signal can easily be generated with the combination of LabVIEW 8.5 software and data acquisition device (DAQ).

For the DC motor part, it is PC-based monitoring and controlling for motors speed control. It is an opened-loop system, it only can achieve up to control the speed of DC motor, detecting the speed of motor, and switching the direction of motor. In order to improve the current project, closed-loop DC motor control system will be implementing to correct the error of the motor's speed and maintaining the speed.

For the AC motor part, it needs variable frequency drive as a controller in order to use DAQ-USB6221 for real time monitoring and controlling do provide interfacing between hardware and software. Despite of that, it also can be used to perform other functions such as displaying the detected speed and controlling the direction of the motor.

a) DC Motor Block Diagram

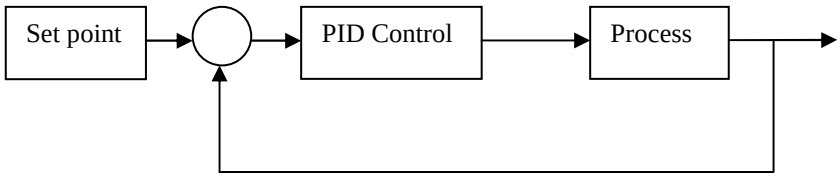

Figure 1.1: DC Motor Closed-Loop System

The general idea of the closed-loop system can be described based in Figure 1.1. This idea is closed-loop system with PID controller. Initially of the system need to set duty cycle as a Set Point, the value must be permanent and cannot be vary. Then the next block is PID Controller, the PID Controller is construct as parallel type. It need set value of the Ziegler-Nichols Rule as tuning rule. Output of PID Controller connected to Process block, then the output of PWM signal as a reference point feedback to summing junction.

b) AC Motor Block Diagram

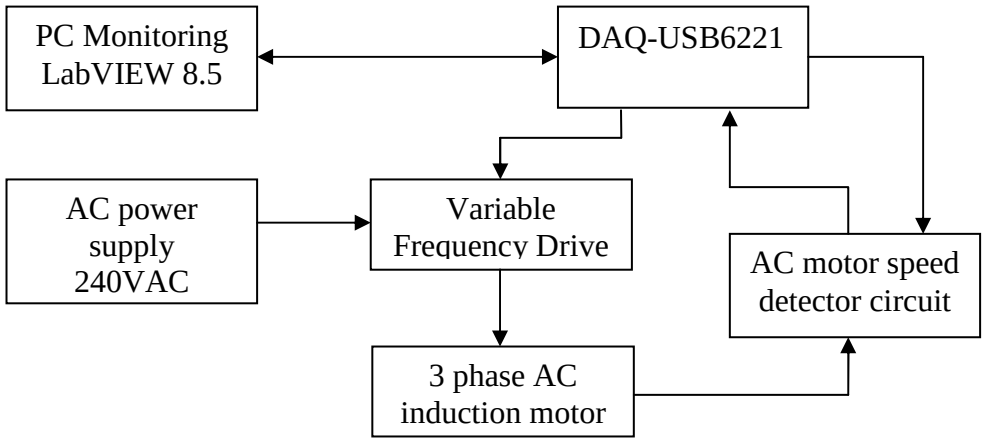

Figure 1.2: AC Motor Block Diagram

The general idea of the project can be described based in Figure 1.2. A PC with the installed NI LabVIEW 8.5 software for monitoring and controlling is used to interface with the AC motor speed controller and speed detector circuit. The NI USB-6221 DAQ device supplied 5 Volt to the speed detection circuit as a power supply. The variable output voltage can be generated with the combination of the PC and DAQ device. Variable output voltage is used to vary the speed of the AC motor. The speed in RPM can be measured and displayed on the Virtual Instrument front panel.

1.2 Project Objectives

There are several objectives that need to be achieved at the end of PSM. The objectives are listed as below:

i. To upgrade the existing project from DC motor opened-loop system to close system with PID control.

ii. To develop the interactive front panel that can monitor and control both DC and AC motor.

iii. To interface the DC&AC motor with the PC-based system by using LabVIEW 8.5 through DAQ-USB6221.

iv. To ease the users in controlling or monitoring the speed of DC and AC motor by using the PC instead of physical controlling method.

1.3 Problem Statement

a) DC Motor Closed-Loop System

For the existing project done by senior, some disadvantage has found in this project, there is no close loop system design for the DC motor operation part. The

open loop system cannot feedback the “speed” signal to compare with set point. Due to this advantage, PID control method is applied to design the close loop system in order to overcome the problem. From the PID controller, need to set Kp, Td and Ti value to tune the graph output signal to be smooth.

b) Hardware Controller and the Software

By using the DAQ-USB6221 device, the sampling process can be quickly done right after the signal is sent from the DC&AC motor. The sampled result can be shown on the LabVIEW front panel in the rapid of time instead of by using the manual sketching and calculation.

c) PC-Based System Controlling and Monitoring Method

The accuracy and the safety level of controlling the speed of DC&AC motor physically are lower than controlling the speed by using PC. The errors produced will definitely very small if the PC-Based system is used.

d) Reason for Select LabVIEW Software

The reason of selecting the LabVIEW software to develop the Virtual Instrument of the interactive front panel is to ease the designer while develop the front panel to interface with other devices. LabVIEW software is the Graphical Programming Language; therefore it is easier to learn if compared to other programming language like Basic, C, Pascal, Matlab and etc.

1.4 Scope of Work

The scope of work in this project is started as given:

i. LabVIEW graphical programming software is selected to create the interactive of the Virtual Instrument which is called Front Panel where create the screen should consist of push buttons, meters, graphs, and other controls and indicators.
ii. The design of PID compensator is introduced in this DC motor upgrading section. The PID compensator is probably the most commonly used compensator in feedback control systems. With the compensator input and the output, the PID compensator is defined by the equation.
iii. Data acquisition device is used to obtain the signal from the AC motor. Data is entered via a mouse or keyboard; the results are then viewed on the computer screen through the indicator i.e. the meter and graphs.

1.5 Report Structure

This thesis is a documented report of the ideas generated, the theories and concepts applied, the activities performed and the final product of this project produced. The thesis consists of five chapters and each chapter is described as below:

Chapter 1, the introduction of PC-based monitoring and describing the technique used to control the speed of the DC and AC Motor. The block diagram gave the general ideas on this project. In addition, objectives, problem statement of the project and the report structure is included as well.

Chapter 2, the background study of the project along with the literature review is performed and documented about the theoretical concept applied in completing the project. Background studies on the PID controller and AC motor operation method are stated throughout this project.

Chapter 3 is the introduction of methodology for the project, design flow and construction of the project. Brief description is given about each procedure in the completion of the project.

Chapter 4 shows overall result and discussion of the result as well as the comparison with the conventional method. Hardware prototyping and the developed LabVIEW Virtual Instrument front panels, the created LabVIEW block diagrams about the project are shown in order to strengthen the result.

Chapter 5 is the final part of the thesis which concludes the Final Year Project. This chapter includes the application of the project and the recommendation that can be implemented for future references.