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Performance study of induction motor using virtual instrument / Mohd Norisham Fadhly Mat Ariffen.

PERFORMANCE STUDY OF INDUCTION MOTOR USING VIRTUAL INSTRUMENT

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MAY 2006

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"I hereby declare that I have read through this report and found that is sufficient in terms of scope and quality to be awarded of the Degree of Bachelor in Electrical Engineering (Industrial Power)."

Signature : .....

Name : GAN CHIN KIM

Date : 4 MAY 2006

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This Report Is Submitted In Partial Fulfillment of Requirements for the Degree of Bachelor in Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering
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MAY 2006

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"I declare that this report is the result of my own research except as cited in the references."

Signatur :.....

Name :Mohd Norisham Fadhly b Mat Ariffen

Date : 4 May 2006

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This dedicated to my beloved father and mother.May God bless them always.

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Thank you and may God bless you all.

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ABSTRACT

The title of the project is study the performance of induction motor using virtual instruments. This project is used software and hardware equipment to accomplish the project and achieve the objective of this project. In the electrical engineering especially study in the induction motor, there is a problem where the student cannot understand at the certain part and solve the problem related to the complex system. During lab session, students take much time to get the performance of induction motor like 3 phase voltage, currents, speed, torque and other. So it is very useful to use the virtual instruments under these conditions. A virtual instrument consists of an industry-standard computer or workstation equipped with powerful application software, cost-effective hardware such as plug-in boards and driver software, which together perform the functions of traditional instruments. Virtual instruments represent a fundamental shift from traditional hardware-centered instrumentation systems to software-centered systems that exploit the computing power, productivity, display, and connectivity capabilities of popular desktop computers and workstations. By using LabVIEW virtual instruments it can converts all the performance of the induction motor in the real world to digital data and be processed by computer. The performances of the induction motor like in the waveform will appear at monitor. A PC based DAQ board system is used and plug in into the computer bus allow the instrumentation combination the computer with signal of induction motor. The data that come out will be accurate on the screen of the monitor.

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ABSTRAK

Tajuk bagi projek sarjana muda ini ialah mengkaji gerak laku Motor Induksi dengan menggunakan peralatan maya. Bagi menyiapkan projek ini, ia memerlukan kombinasi antara perisian khas dan peralatan eksperimen agar objektif utama projek ini dapat dicapai dengan jayanya. Didalam bidang kejuruteraan elektrik khususnya dalam mempelajari motor induksi, masalah akan timbul dimana para pelajar ini tidak dapat memahami sesetegah topik dan meyelesaikan masalah yang berkaitan oleh kerana sistemnya yang begitu kompleks. Para pelajar juga akan menghabiskan masa yang begitu banyak bagi mendapatkan keputusan semasa membuat eksperimen seperti nilai voltan 3 fasa,arus, kepantasan motor,daya kilas motor dan sebagainya.Oleh itu, sebagai jalan penyelesaiannya, adalah lebih praktikal untuk menggunakan satu perisian khas iaitu peralatan maya. Peralatan maya mengandungi industri komputer standard yang dilengkapi dengan aplikasi perisian, perkakasan kos efektif seperti papan pencucuk dan pemacu perisian, dimana berfungsi sama seperti peralatan mengukur yang lama. Peralatan maya merupakan satu anjakan perubahan penggunaan tradisi sistem pusat perkakasan kepada sistem pusat perisian yang menggunakan sepenuhya produktiviti komputer bagi paparan data. Dengan menggunakan peralatan maya LabVIEW ini ,ia dapat menukarkan tingka laku semasa induksi motor kepada data-data digital di dalam komputer.Segala tingkah laku induksi motor seperti graf akan terpapar di skrin komputer. Sementara itu, sistem DAQ juga akan dipasang bersama komputer bagi membolehkan kombinasi antara komputer dan signal dari motor induksi berlaku Ini membolehkan data dibaca dengan lebih tepat.

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CHAPTER 1

INTRODUCTION

1.1 Scenario

When study the induction motor, there is a problem where the student cannot understand at the certain part and solve the problem related to the complex system. Dynamic behavior of electric motors is a very difficult topic to study unless a computer-aided tool is used, or an experimental system is implemented together with specific a measuring devices in a laboratory environment.

In this project, it will use the computer- aided tools to visualize the performances of the induction motor such as the graph and also the waveforms. For this it is required to use special software, LabVIEW virtual instruments simulation to study the induction motor during the experiment in the lab. Using this software, it can reduce the amount of time necessary to take the data and then followed by the calculation of the certain formula. Under the simulation, the student will learn more about the dynamic behavior of an induction motor with emphasis on the starting performance. They also will get the exposure of another main characteristic like torque vs. speeds waveforms and determine the parameters of the equivalent circuit of three phase slip ring induction motor: no load test and blocked rotor test. The virtual instruments can produce results for any given parameter in the real time display. This mean the student can get the result live in the screen of the monitor while the induction motor is running. In the LabVIEW simulation, the induction motor is powered from a three-phase sinusoidal voltage source and the

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motor is started from standstill. As the induction motor is start, the LabVIEW will start to simulate the parameters that related to this project. All the results from the simulation especially the waveforms will be displayed at the monitor to see by the user.

1.2 Project Objective

The aim of this project is to run the induction motor and captured the physical parameter to the computer and display the characteristic torque vs. speed curve. A virtual instrument is a powerful application software, cost-effective hardware such as plug-in boards, and driver. Using LabVIEW which is the right software of this project, it can use to converts the performance of the induction motor and display it in the computer. It shows the real time characteristic of the experimental induction motor during it operation. Beside give the graphical views to the user, LabVIEW also give a good analysis capabilities about the measurements on the induction motor in the experiments. That mean the real time data that show is accurate.

The waveforms motion of the torque-speed can be displayed accurately on the screen based on the performance of induction motor in the real time of display. The waveform that generate on the screen display is in complete conditions and same with the theory that has been study before. With that the students can see the conditions of the starting torque, pullout torque and also the full load torque in the waveform motion. All of this happens in the real time display which the motor is still running.

Therefore by using this LabVIEW it can save the time from take the data and followed by calculation to get the results. This is because LabVIEW can produces fast and accurate result of the experiments that under run. By using LabVIEW also, lecturer can explain more briefly to the student about the characteristic of the induction motor. While for the student they found a new way to experiment the induction motor besides using traditional instruments.

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This doesn't mean that stand-alone traditional instruments such as oscilloscopes and waveform generators are not very important anymore. It is because, in the learning process, it is still depend on these instruments for the result. The results can be compared to each other for the better understanding.

1.3 Project Scope

The scope of this project is divided into two sections only. First section is focused on the software development while the second section is doing the experiments that related to the project; determine the maximum torque using TERCO equipments. Both of this scope is related to the induction motor. For the software development, the concept of virtual instruments is used to take real time reading data of experiment on induction motor.

A virtual instrument consists of an industry-standard computer or workstation equipped with powerful application software, cost-effective hardware such as plug-in boards, and driver software. Once using the virtual instruments, student can adapt a virtual instrument to particular needs without having to replace the entire device because of the application software installed on the PC and the wide range of available plug-in hardware. In this project, LabVIEW is ideal software to use for creating the virtual instrumentation. LabVIEW is an integral part of virtual instrumentation because it provides an easy-to-use application development environment designed. What is very important, by using LabVIEW can give the graphical programming environment for the torque- speed characteristic of the induction motor when induction motor operates.

In the LabVIEW, it consist 2 parts, block diagram and front panel. The block diagram is developed to the related experiments by using the suitable palette together. Wires are drowning to connect the required object together indicating the flow of data in a block diagrams. Each of the palettes has their own functions that can be used to display the required result during the experiments. So it was important to know deeply the

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function of the each icon before begin to develop in block diagram. To get more understand and information about this icon, this can be done by exploring the LabVIEW software to get more familiar with it. Figure 1.1 below shows the example of the block diagram.

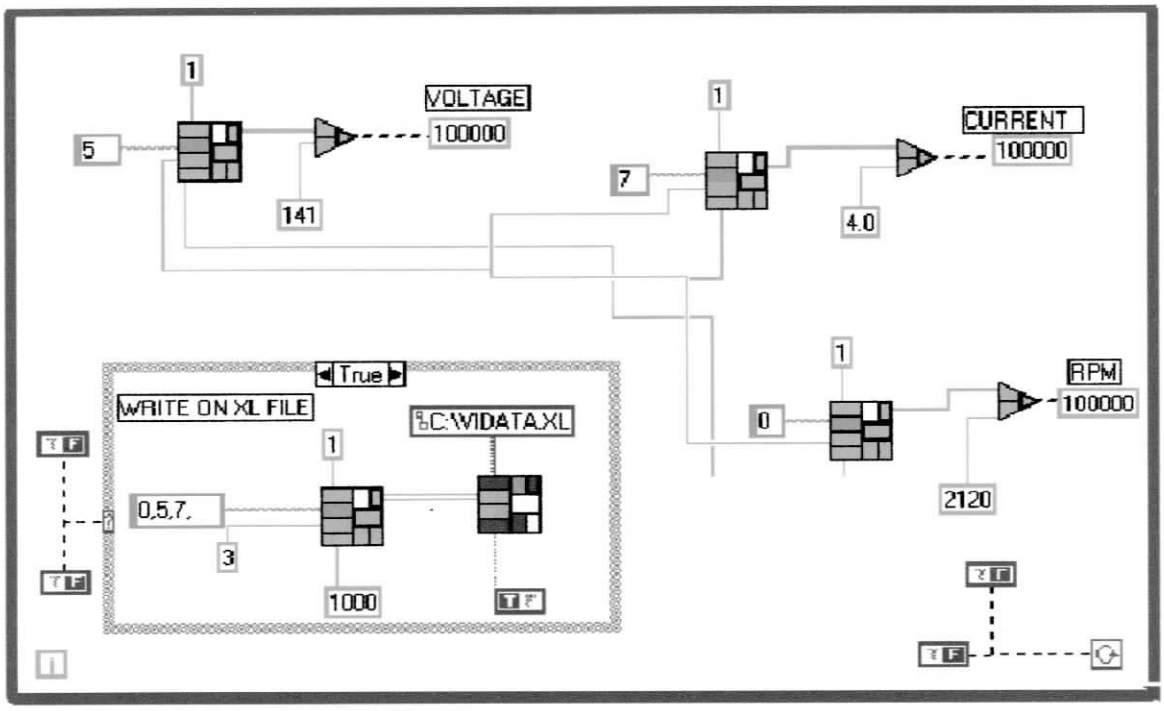

Figure 1.1: Block diagram of LabVIEW

While in the front panel there are knobs, buttons, dials, and graphs or waveforms to display. This is where the result of the induction motor can be display. The graphical waveforms of the characteristic appear on the screen when the experiment is doing. Therefore the student can variable the input by using the knobs or dial button. There is change of the result on the screen depend to the input that has been pass .Therefore, Lab VIEW can give the accurate result and interactive graphical display when it was developed. So there is no doubt the credibility of the LabVIEW. Figure 1.2 below shows the example of the front panel of LabVIEW.

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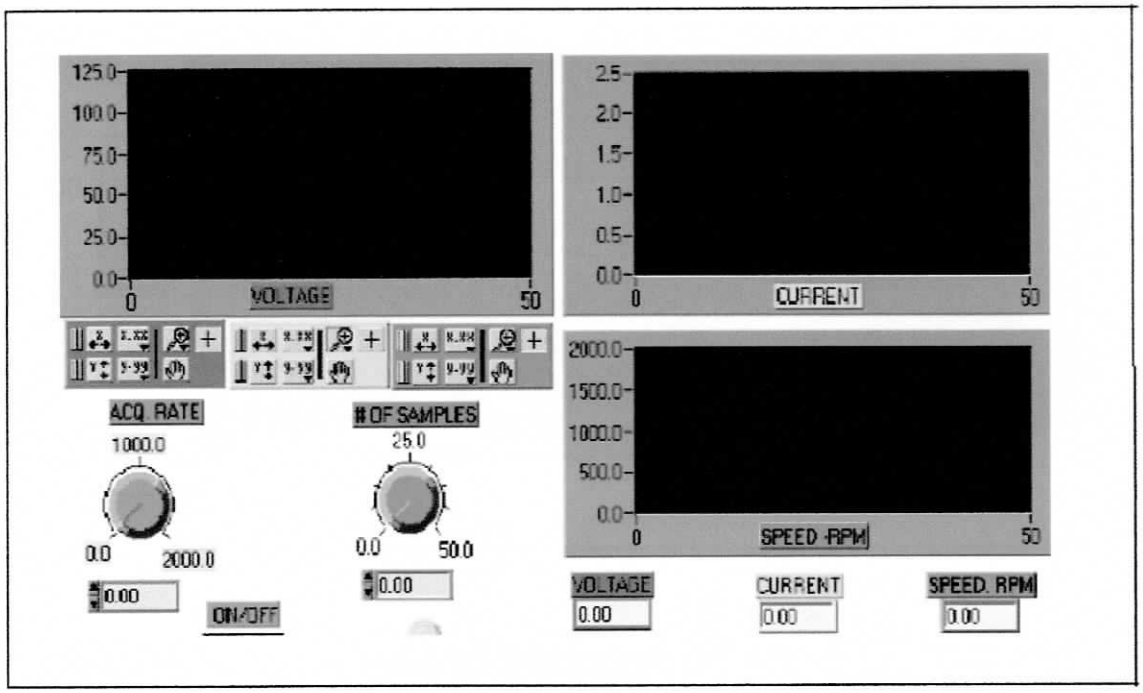

Figure 1.2: Front panel of LabVIEW

A PC based DAQ data acquisition board system also very important to this project. It will plug in into the computer bus to allow the instrumentation combination the computer with signal from the induction motor that under running. A DAQ board will effectively and accurately acquire the signal such the generated voltage that come from the torque transducer and torque measuring unit. Figure 1.3 shows the DAQ board that use to take in this project.

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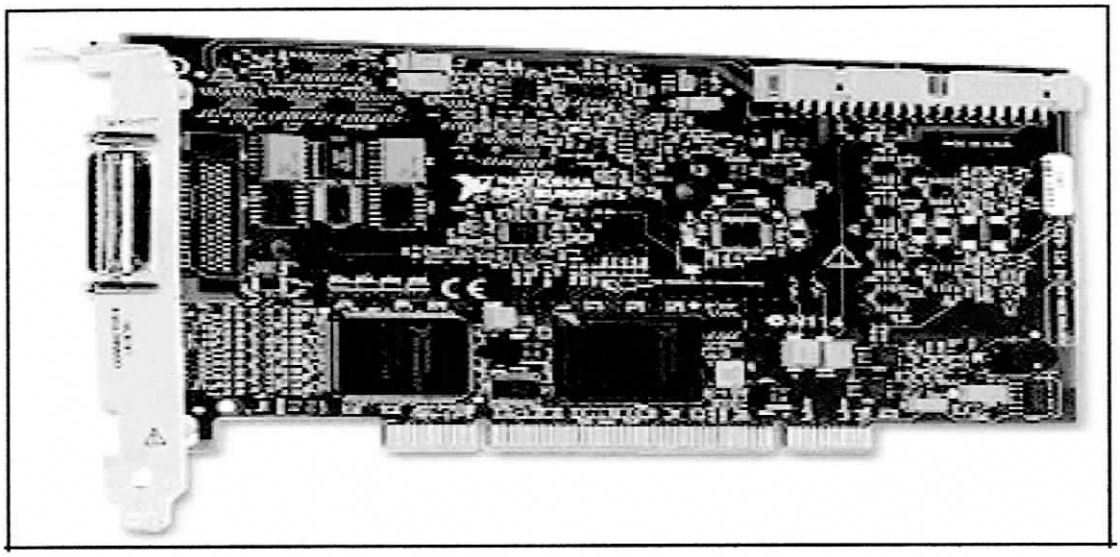

Figure 1.3: PCI 6221 DAQ board

After software development, it is continue with the experiment setup. The experiment will determine the maximum torque by using lab sheet from the TERCO electrical machine experiments. This is very suitable because it is related to the project. From this experiment, the data of torque and speed will display on the torque transducer and torque measuring unit. But these only display the data and not the waveforms characteristic which is the objective of this project. To display these data in the waveform, LabVIEW is use. With the combination both hardware and software setup, the result can be obtained and achieve the objective.

1.4 Problems Statements

Induction motor converts the electrical energy to the mechanical motion. That means the characteristic of motor torque – speed need to understand first before get familiar with the operation of the induction motor. There is a lot of question has to be answer about the characteristic of torque-speed. Among of them are:

1) How does the torque change as the load change?
2) How much torques can induction the motor supply at starting conditions?

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3) How much does the speeds of induction motor drops as the shaft load increase?

To find out the answer to these and similar question, it is necessary to clearly understand the relationship among the motor torque and speeds. When the torque –speeds characteristic is plot, it is as Figure 1.4.

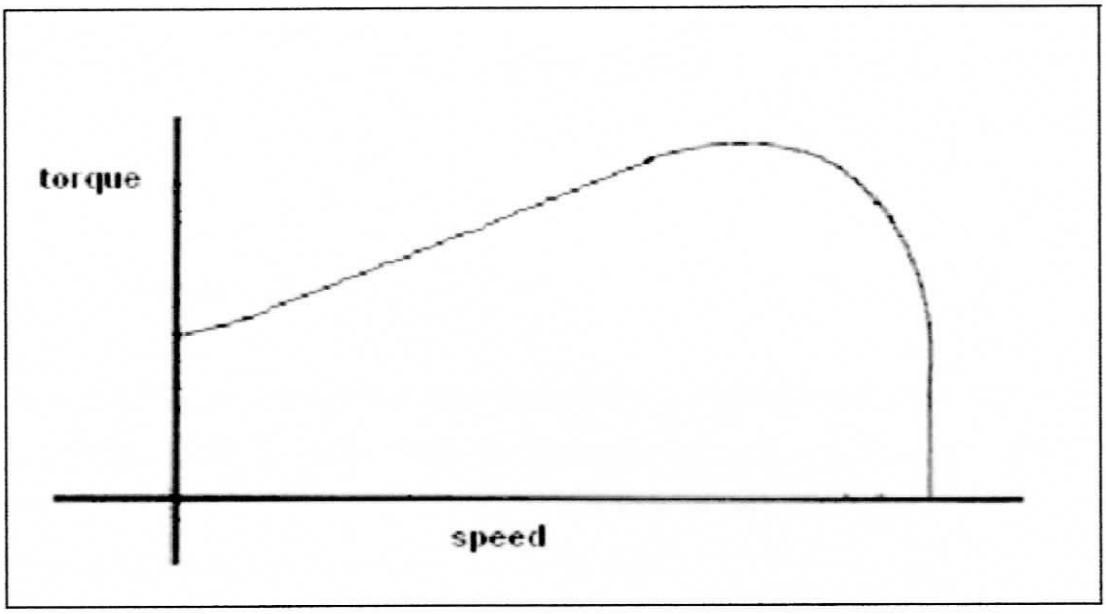

Figure 1.4: Torque –speeds curve

To get these, the lab session will be held. The student will measure some values like rpm, frequency, current, and the voltage .After the measuring was finished, that main parameter, the induction motor torque –speeds characteristic can be calculated base on the certain formula. Then the graph of the torque- speed characteristic can be plotted same to the Figure 1.3. Since the experiment is doing and quantities are calculated, the student cannot see the motion of the curve. How the behavior of the torque change as the speed is increase cannot be seeing by the students on live. So it is easy for the students if there is graphical motion of the curve displayed together.

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CHAPTER II

BACKGROUND STUDY

2.1 Literature Review

Some literature study has been made to get more understand about this project. The research has been made on the book, work paper and also from the LabVIEW website. From this study it can give general idea how to start this project. It shows some of the example theory that can be related to this project.

Firstly is Virtual Instrumentation in an undergraduate electrical machine labs, by Thomas.W.Gedra, School of Electrical and Computer Engineering ,Oklahoma State University [1]. This paper discussing is related to the project that will be done. Most of the lab now use DAQ and VI to collect and visualize the data like torque, speed and angular as well as computer control of the mechanical load provide by the dynamometer. The laboratory setup is described and a few of the new capabilities including real time phase display of AC data and spectra analysis and are highlighted.

Most of the data has been collect using traditional analog voltmeter, ammeter wattmeter and also digital meter. This method can be upgrade by using the DAQ capabilities including computer signal acquisition, processing and display software. In this paper, the hardware and software improvement have been made. Virtual instrument refers to the use of computer signal acquisition, processing, and display. For this Lab VIEW software is used. It consist two pieces. One is the actual panel of the instrument,

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containing control and indicator. This is the part which is used during the collection and analysis the data. The knob can be turned by grabbing it with the mouse. The other part is wiring diagram. This show how the data was collected, processed and routed. But the wiring diagram is not just a visual representation of the computer: it is the program.

The signals are passed on to the DAQ board located to the PC. In addition to buffered channel, there is provision for two unbuffered channel which called the dynamometer's analog torque and speed output. Under LabVIEW, DAQ can acquire any or all of these channels and pass the collected data. Figure 2.1 below shows the configuration of digital acquisition system.

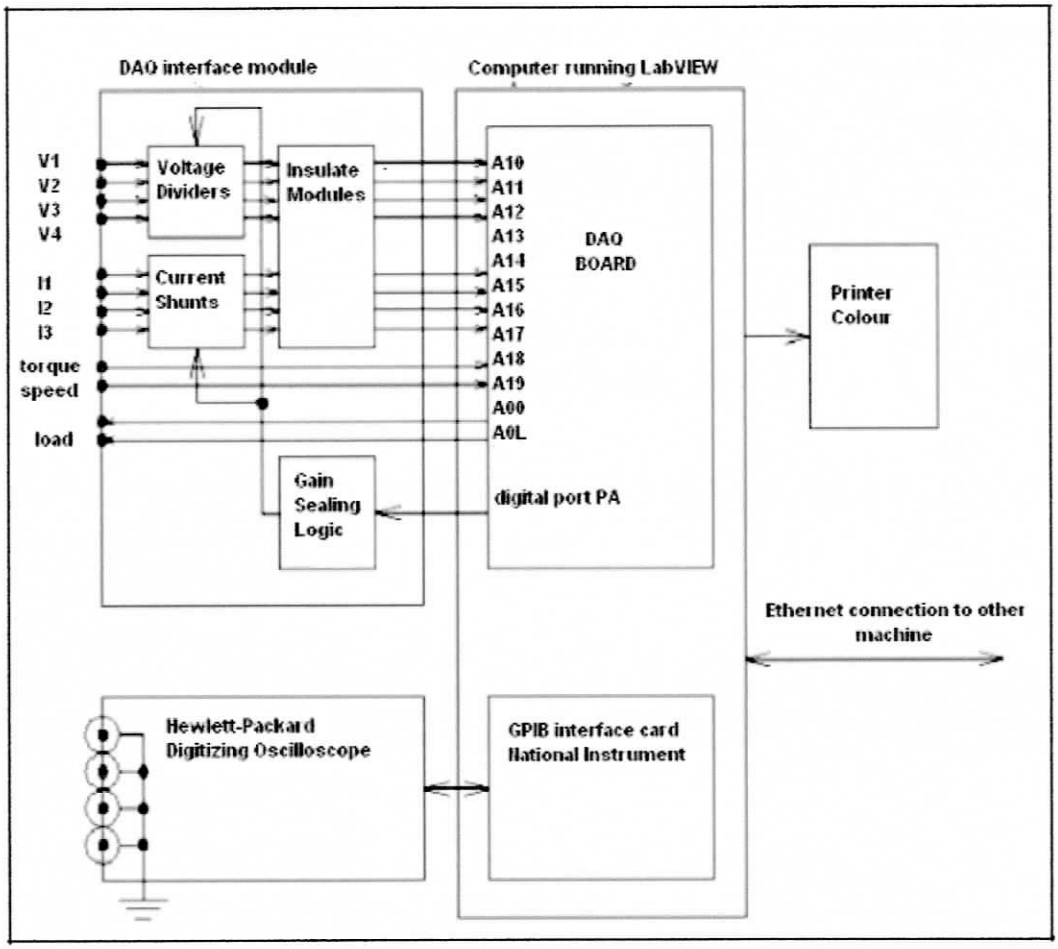

Figure 2.1: Configuration of digital acquisition system

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Secondly is Tutorial and Example code, http://www.ni.com [2]. This gives the example of various block diagram and front panel. From this example, it can use as the guided to develop own block diagram and front panel. Figure 2.2 below shows the example of the block diagram and Figure 2.3 shows the example of front panel that relate to the project.

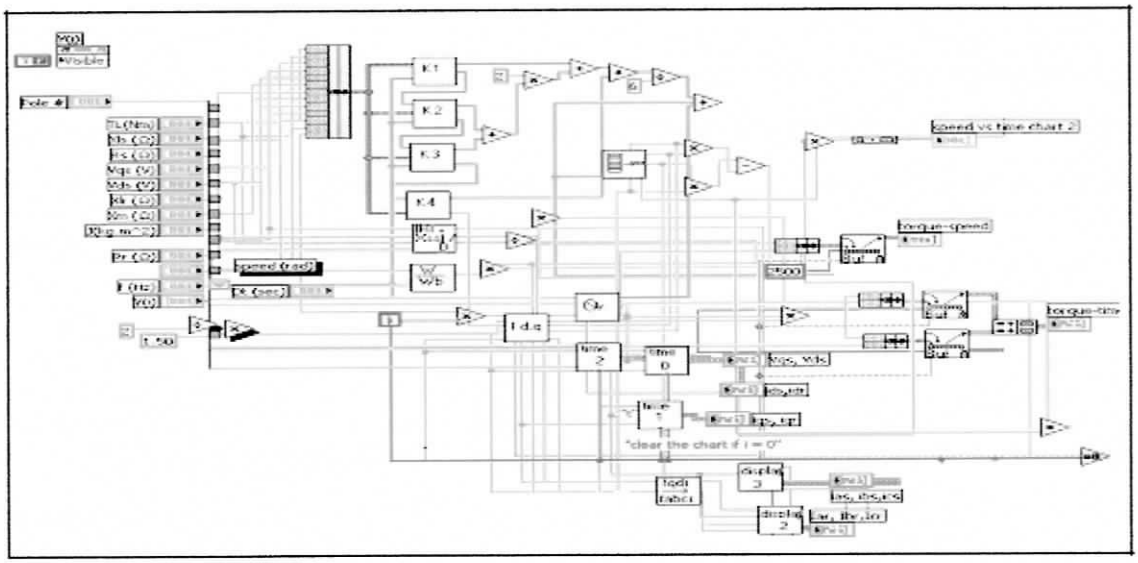

Figure 2.2: Example of block diagram

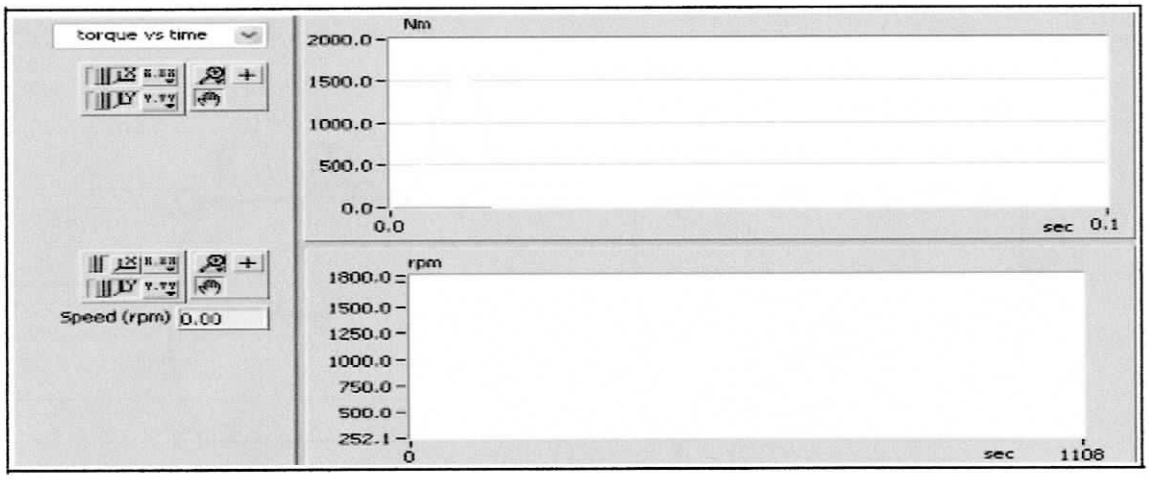

Figure 2.3: Example of front panel

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2.2 Project Theory

2.2.1 Torque and Speed

Torque – speeds characteristic is the main behavior of the induction motor. By study this torque- speed characteristic, the student able to understand the concept of induction motor. Although there is the theory from the physical standpoint, but it is necessary here to show the derivation of the induction motor induced torque equation. This is because it will include the calculation to calculate. These calculations actually are need in the experiment to plot the curve [3].

i) Torque

Refer to the Figure 2.4 the air gap power supplied to one phase of the motor can be seen to be:

$$P_{AG,1\phi} = I^2{}_2 \frac{R_2}{s} \tag{2.1}$$

Therefore, the total air gap power is:

$$P_{AG} = 3I^2{}_2 \frac{R_2}{s} \tag{2.2}$$

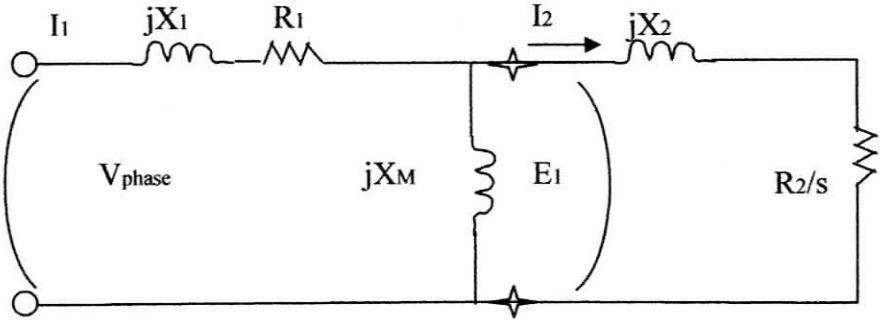

Figure 2.4: Per phase equivalent circuit of induction motor

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