THE DEVELOPMENT OF DATA ACQUISITION SYSTEM USING ARDUINO AND MATLAB

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"I hereby declare that the work in this project is my own except for summaries and quotations which have been duly acknowledge."

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"I acknowledge that I have read this report and in my opinion this report is sufficient in term of scope and quality for the award of Bachelor of Electronic Engineering (Industrial Electronics)* with Honours."

Signature : .....

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Date : 15/06/2016

To my lovely parents and family

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ABSTRACT

Obtaining an accurate data is becoming a major issue in industrial. In this project, it is about the development of data acquisition system by using Arduino and MATLAB. This project is divided into two part, where the first part is act as an experimental and the second part is the collecting the data through application. Arduino Uno act as an interfacing device throughout the entire project and Matlab software is used as a data logger. In the first part of the project, function generator and oscilloscope is used to generate signal and pass the signal to the Arduino Uno. The Arduino Uno will read the signal from both the equipment and convert the data into digital format that is readable by laptop or computer. Next, Matlab GUI is used to display and store the data that received. The second part of the project is about the radio receiver. The Arduino Uno is connect to the amplifier of a radio and the radio is tuned to a station. The frequency that received is then transmit to Matlab software by the Arduino Uno. Next, Matlab software will received the signal for a period of time and the signal is store and replay. The system is capable to store the frequency range from 0 HZ to 1.1 kHz and the audio signal can be store in .wav file and it will update according to the time and date.

ABSTRAK

Memperoleh data yang tepat adalah menjadi isu utama dalam industri. Dalam projek ini, ia adalah mengenai pembangunan sistem perolehan data dengan menggunakan Arduino dan MATLAB. Projek ini dibahagikan kepada dua bahagian, di mana bahagian pertama adalah bertindak sebagai eksperimen dan bahagian kedua adalah mengumpul data melalui aplikasi. Arduino Uno bertindak sebagai peranti antara muka seluruh keseluruhan projek dan perisian Matlab digunakan sebagai logger data. Dalam bahagian pertama projek, penjana fungsi dan osiloskop digunakan untuk menjana isyarat dan menghantar isyarat untuk Arduino Uno. Arduino Uno akan membaca isyarat dari kedua-dua peralatan dan menukar data ke dalam format digital yang boleh dibaca oleh komputer riba atau komputer. Seterusnya, Matlab GUI digunakan untuk memaparkan dan menyimpan data yang diterima. Bahagian kedua projek itu kira-kira penerima radio. Arduino Uno adalah menyambung kepada penguat radio dan radio ditala kepada stesen. Frekuensi yang diterima kemudian menghantar kepada perisian Matlab oleh Arduino Uno. Seterusnya, perisian Matlab akan menerima isyarat untuk satu tempoh masa dan isyarat akan disimpankan. Sistem ini mempunyai keupayaan untuk menyimpan julat frekuensi dari 0 HZ untuk 1.1 kHz dan isyarat audio boleh simpan dalam fail .wav dan ia akan mengemaskini mengikut masa dan tarikh.

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LIST OF ABBREVIATION

AC	-	Alternating Current
ADC	-	Analog to Digital Conversion
COM	-	Communication
DAC	-	Digital to Analog Conversion
DSP	-	Digital Signal Processing
DAQ	-	Data Acquisition
FFT	-	Fast Fourier Transform
IDE	-	Integrated Development Environment
LED	-	Light Emitting Diode
PC	-	Personal Computer
PCB	-	Printed Circuit Board
SNR	-	Signal-to-Noise Ratio
UART	-	Universal Asynchronous Receiver/Transmitter
USB	-	Universal Serial Bus

CHAPTER 1

INTRODUCTION

This Chapter will discuss about the project background, objectives of the project, scope and thesis organization.

1.1 Project Background

Physical phenomena that occur in the real world are in analog form and it is difficult to collect the data fully. In order to collect the physical data like pressure, sound and temperature, the process to sample the analog data and storing data is one of the most importance process. Data acquisition is a process that measure the surrounding condition and then process/convert the measure data into digital numeric values that can be manipulated by the computer. Industries nowadays are more likely to use DAQ to collect the data that measure because it is much more simple and fast. Today, grow of electronics technology will lead to the process of data acquisition much more precise, flexible and dependable through electronic devices. Data acquisition process by using computer automated will allow the data collect in lesser time and fever error. Analog signals that produce by different types of transducer are obtain by most of data acquisition system. For most of the implementation, the signals need to undergo some processing, therefore analog-to-digital converter (ADC) is use to converter the analog signals to digital form to be processed.

In data acquisition system, software play an important role. Data acquisition software can use to analyze data and it can also control the collecting of data then eventually display on the monitor. Nowadays, many new products allow people to perform

remote data acquisition using internet .Several types of microcontroller include PIC, AVR, and ARM can be used to interface the analog-to-digital converter (ADC) and also computer. Along the evolution of computer technology, embedded system has become an important branch of computer technology development. Embedded system has series of advantages, such as small volume, low power dissipation, low cost and high security and reliability, etc, at present, it has been widely used in consumer electronics, industrial control, network communication, automobile, military and national defense, etc. The development of network technology greatly expands the application of embedded technology. Therefore, this project is to develop a data acquisition system using MATLAB and Arduino. The system should be integrated in a PC.

1.2 Problem Statement

Manual data collection by using a pen or by observation is not accurate as by using data acquisition system. The time taken for the process of collecting data manually is long and slow compared to the used of devices. Next, the high cost of DAQ card causes large industrial applied the system only in large project rather than small project. Then, the developing and troubleshooting on an electronic circuit, it is difficult to see the problem on a circuit by naked eye without any testing equipment.

Data acquisition system is now a demand for most of the industrial process control today. The high demand of the system is because data acquisition system could monitor several hundred inputs and display on the screen of computer and even can make calculations in a short period of time. This process helps most of the industrial based on the computer output and gave users a more comfortable feeling to this process.

1.3 Objectives

The objectives of this project is:

1. To develop a data acquisition system using Arduino and MATLAB.
2. To acquire data from difference source.
3. To analyze the performance of the system by compare with oscilloscope.

1.4 Scope

In this project, the aim is to develop a data acquisition system by using arduino and MATLAB. Therefore the analog input signal has to pass through an Arduino Uno which is an interfacing device between the computers. The Arduino Uno will performed analog-to digital conversion before the signal pass into the computer. The software that used to display the data that received is MATLAB, and it is function to store the data and display as well. A radio is used to produce an audio signal and the signal is transfer into the interfacing device which is an Arduino Uno to perform the conversion of ADC and MATLAB software is used to store and play the data.

1.5 Thesis Organization

Chapter 1: In this chapter, it will described about the introduction and the history of Data Acquisition System. The problem statement that stated will described about the reason for developing of this project. The objectives, scope of work, significant study of the project and thesis organization.

Chapter 2: It is about the analysis of the previous researcher from different region of country. Different kind of techniques and procedures that related to this project are applied.

Chapter 3: Explanation of the method that will be used to conduct in this project. Software MATLAB is used to display and store the data that have collected. Arduino Uno microcontroller is used as an interfacing device between a radio and PC. A radio is used

to produce an audio signal as an input to the Arduino Uno and perform analog-to-digital conversion (ADC). The readable digital value is then process in MATLAB to store and display the data.

Chapter 4: The analyze result of the complete circuit and the performance of Data Acquisition System that has been implemented.

Chapter 5: In this chapter, it shows the overall conclusions of the project. There are some issues in recommendation or suggestion rises about this field of study of the project.

CHAPTER 2

LITERITURE REVIEW

This chapter will explain about the relevant projects that had been done by researchers, the methods and materials that used will as references to this project.

2.1 Data Acquisition System Overview

Data acquisition system is actually a system that collect any useful data by measurement, characterization, or monitoring. The accuracy, resolution, channel and the speed requirement for a particular data acquisition system is always in the consideration and most of the time these are the specific parameter to be consider. A basic general idea of data acquisition system is made up of a sensor, signal conditioning, acquisition hardware (A/D converter) and a computer with software to run and display. The block diagram of data acquisition system is shown in the figure below.

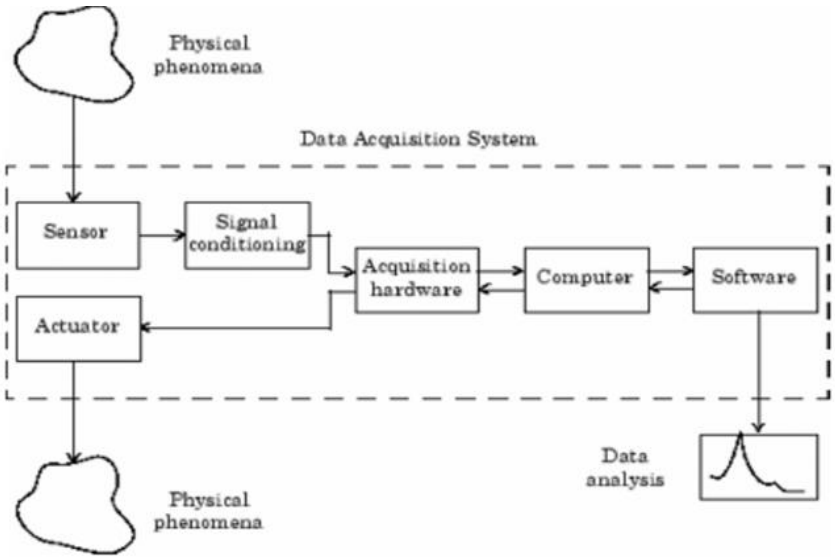

Figure 2.1: Basic block diagram of Data Acquisition System [31]

2.2 Signal Conditioning Process

Signal conditioning process include filter, amplifying, linearization, attenuation, excitation, common-mode rejection and so on. Signal that generated from sensor or transducer before converted into digital signals, this process will improve the quality of the signal generated. Amplification process is the most common type of signal conditioning process. Increase the signal-to-noise ratio (SNR) and increases the resolution of the input signal are the two main important function of signal amplification. For example, a pressure sensor has an input signal of about millivolt which is probably too low for an analog-to-digital converter (ADC) to process, therefore it has to bring up the voltage level to that required by the ADC.

2.2.1 Operational Amplifier

Operational amplifier are also commonly known as op-amps and it is a basic block of an analog electronics circuit. Operational amplifiers work ideally linear in DC amplification, so they are widely used for filtering, signal conditioning, perform mathematical operational and so on. [25]

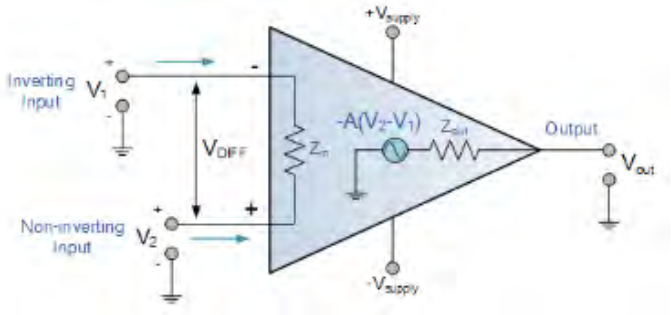

Figure 2.2: The basic layout of an Op-Amp [25]

An operational amplifier has high input impedance usually up to few megaohms and the output impedance is low as well which is below 100 Ω. The basic circuit in an op-amps is building by using difference amplifier with at least one output and two input the plus (+) and minus (-). Both the input will have different output, the plus (+) input will results an output which the phase is the same as the signal applied, while the minus (-) input will have an opposite polarity to the output. [26]

2.3 Hardware

Hardware plays important role in this project. The hardware that used will include computer, radio, Arduino Uno. The hard disk and the processor that are in the laptop or PC will affect the performance. The hard disk is to provide the storage space to the data that need to store and the processor is used to run the software weather the running speed is fast or slow. While the radio is generally to provide an audio signal. The Arduino Uno is the place where the analog signal have to convert into digital format so that the software in the laptop or PC could be perform.

2.3.1 Computer

Personal computer play an important role in the system. The computer that use will affect the performance of DAQ system because of the data transfer rate that used. Hard drive is the limiting factor for acquiring large amounts of data. System that need to receive high rate of frequency signal, therefore a larger free disk space must have in computer so that it can hold the data completely. High-frequency signal always need a