

REAL-TIME TEMPERATURE MONITORING SYSTEM USING MATLAB

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ABSTRACT

This project involves the implement of temperature sensor for industrial related applications in real-time. The purpose of this project is to monitor and measure the temperature level of liquid or water. This project not only involves the development of the Matlab software for monitoring purpose but also includes the development of the sensor system. The sensor that will be use is the temperature sensor which can measure the temperature of liquid or water and with suitable temperature range. The sensor system should have DAQ capabilities using DAQ cards which available in the laboratory. Matlab Programming language will be use to develop interface for the sensor system. GUI (Graphical User Interface) is consists of buttons that user easily can view the temperature will be creating using Matlab software which is to monitor the temperature. The value of the temperature will be detecting automatically base on the system and transfer the value using serial USB port to the computer. Matlab will collect and record the data in graph format. In this system, the developed sensor should capable to measure temperature in real-time. The system also should capable to store and retrieve data for further analysis. The sensor system will be tested in the laboratory environment and/or in real industrial applications.

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LIST OF ABBREVIATIONS

A/D	Analog to Digital
D/A	Digital to Analog
DAQ	Data Acquisition System
GUI	Graphical User Interface
RTD	Resistance Temperature Detector
PC	Personal Computer
PTC	Positive Temperature Coefficient
USB	Universal Serial Bus
VB	Visual Basic

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The meaning of temperature is the changes of temperature or physical state such as solid to liquid, liquid to gas and one crystalline form to another. Temperature also the changes level of heat or cold of a material or device ^[12]. Temperature monitoring system is the process of monitor the temperature changes in order to prevent from failure of operation or damage of a system. This system already applies in industry such as automotive industries, air conditioning, power plant and other industries such as HVAC system, heaters and boilers.

Sensor is the sensing device that can detect or measure a physical quantity such as temperature, pressure, force and displacement. Sensor is the best device in this project system which is to measure the temperature. Sensor has two types which contact sensor and non-contact sensor. The non-contact sensor is for measuring the surface that cannot be touched during the measurement process such as plastic, silicon and glass. Contact temperature sensors measure it own temperature ^[4]. Examples of contact sensor are thermocouple, RTD and thermistor.

This project system is run and collect the data in real-time which using a software that can analyze the data in real-time. Before the software can analyze the data, must have some device that can grab the data from sensor and convert the data into a data that PC (personal computer) can understand or read which, the device is data acquisition system (DAQ). Function of DAQ is to convert the analog signal to digital signal (which can understand by PC).

The aim of this project is to develop sensor system that capable measuring and monitor the temperature changes in real-time. To perform real-time monitoring, Matlab software is use in this project and other software can be use such as Labview and Visual Basic (VB). Matlab, Labview and VB have the same function which can use it to display the output or key-in the input value or parameter. This software still have differences between each other which in Labview, the block diagram is link with GUI model and it compatible with National Instruments (NI) device. While in Matlab, simulink block diagram and GUI model is two different types of way in using this software and not link each other.

1.2 PROBLEM STATEMENT

The problem statement in this project is the measurement and monitoring of temperature in industrial liquid and material very important because it can affect the result in the final product. The Graphical User Interface (GUI) is developing using Matlab. With this GUI, user can monitor the change of temperature through user own personal computer (PC).

1.3 OBJECTIVE

The objective of the project is:

- i. To design GUI using Matlab for monitoring the change of temperature
- ii. To design and build a system with suitable range and precision of the temperature sensor
- iii. To develop sensor system which capable to monitoring temperature in real-time

1.4 SCOPES OF PROJECT

Several scope of project is:

- i. The hardware part of temperature system will be designed and development
- ii. The software for GUI and data analysis will be develop using Matlab
- iii. The working sensor system will be tested in related industrial application
- iv. The sensor should capable to monitor temperature in real-time

1.5 OUTLINED THESIS

This thesis consists of five chapters which is the first chapter is the Introduction that discuss about the background of this project, objectives, scope of this project which are for the overall summary of works. The second chapter will discuss about several theory and literature reviews that had been done in this project. In this chapter, the basic theory of sensor, type of sensor and the function of DAQ had been discussed. The process flow of the project will be discussed in Chapter 3 which is the methodology part. The second last chapter is the results and discussions part which consists of data from GUI. Finally, the last chapter which is Chapter 5 will concluded overall of the project and future recommendation that can improve this project.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter which is Chapter 2 will explain about the literature review that related to temperature monitoring system which the fact or researcher idea were taken from journals or articles related to this project. In this part consists of the types of sensor, seeback effect, DAQ and the software.

2.2 SEEBACK EFFECT

The first discovered the phenomenon of Seeback Effect is Thomas Johann Seeback in year 1800s. The voltage difference occurs between two substances when there is temperature difference between two not similar electrical conductors or semiconductors. This phenomenon is called the Seeback Effect. Seeback Effect produced small voltages which is only a few microvolts per Kelvin of temperature difference at the junction. If a large temperature difference is maintained, small-scale electrical power can be provided by the large arrays of Seeback Effect devices ^[10].

To produce a large voltage as studied in Electrical Circuit subject, in a series circuit, the output voltage is the total of load voltage that will give an increase voltage which that why the effect is pictured in Figure 2.1 below. The behaviour of thermocouple is generated from the Seeback Effect.

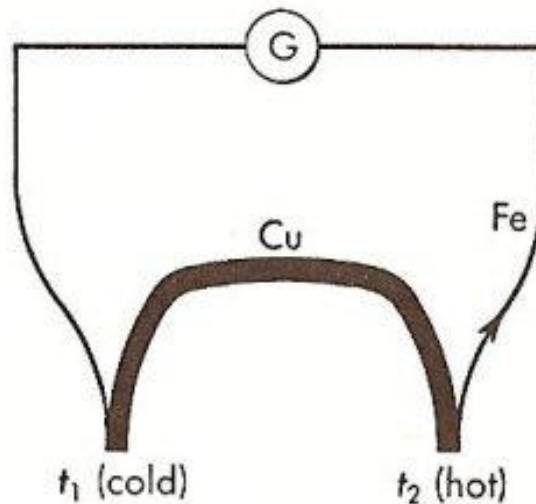


Figure 2.1: Seeback Effect

The performance of thermocouple is based on the material property which is the Seeback Coefficient. The material property and the Seeback Voltage per unit temperature is a Seeback Coefficient. An opposing electric field is created because of there is net diffusion of electrons from hot end to the cold end which is from the temperature gradient that exist over a piece of electrically conductive wire. This situation will cause a voltage over the wire which is called as Seeback Voltage. Different metals may have different signs of Seeback Coefficient and the metal Seeback Coefficient is such as Table 2.1 below ^[3].

Data for the materials is sensitive which is prone to variation. The combination of highest plus and minus Seeback Coefficients is the best choice for a thermocouple. The reason why thermocouple is in metallic is because metals cannot be fabricated in the form of thin and robust wires ^[3]. Table 2.2 shows the combined Seeback Coefficient for standard thermocouple.

Table 2.1: Seebeck Coefficient for some metals

Metals	Seebeck Coefficient
	$\mu\text{V/K}$
Antimony	47
Nichrome	25
Molybdenum	10
Cadmium	7.5
Tungsten	7.5
Gold	6.5
Silver	6.5
Copper	6.5
Rhodium	6.0
Tantalum	4.5
Lead	4.0
Aluminum	3.5
Carbon	3.0
Mercury	0.6
Platinum	0
Sodium	-2.0
Potassium	-9.0
Nickel	-15
Constantan	-35
Bismuth	-72

Table 2.2: Seebeck Coefficients for Standard Thermocouples

Type	Couples	Seebeck Coefficient
		$\mu\text{V/K}$
E	Chromel-Constantan	60
J	Iron-Constantan	51
T	Copper-Constantan	40
K	Chromel-Alumel	40
N	Nicrosil-Nisil	38
S	Pt (10% Rh)-Pt	11
B	Pt (30% Rh)-Pt (6% Rh)	8
R	Pt (13% Rh)-Pt	12

2.3 TEMPERATURE SENSOR

Sensor is the sensing device or a detector that can detect or measure a physical quantity such as temperature, pressure, force and displacement. Sensor also known as an element that changes to an electrical signal from some physical parameter. Output signal from sensor can be measured and recorded but must be converted the physical condition into an information that control system can understand ^[11]. This project is to measure temperature which sensor is the best device for this situation.

There are two types of sensor which is contact sensor and non-contact sensor. The non-contact sensor is for measuring the surface that cannot be touched during the measurement process such as plastic, silicon and glass. Contact temperature sensors measure it own temperature ^[4]. Examples of contact sensor are thermocouple, RTD, thermistor and semiconductor device.

2.3.1 THERMOCOUPLE

Temperature monitoring system is widely use in industry which is very important nowadays that will involve such a losses if not monitor it. To develop a system that will monitor and measure a temperature is by using the temperature sensor. Thermocouple is one of the temperature sensors which are inexpensive and versatile devices. Thermocouple has eight types of it, which is B type, E type, J type, K type, N type, R type, S type and T type. Each of these has their own characteristic. Table 2.3 show the difference between eight types of thermocouples.

Table 2.3: Difference of thermocouple types

Thermocouple Type	Overall Range	Typical Accuracy*	Comments
Type B Platinum(+) Rhodium (-)	100 to 1800	5 °C (at 1000°C)	-For high temperature measurements. -Give same output at 0 °C and 42 °C. -Useless below 50 °C because give same output.
Type E Chromel (+)	-200 to 900	1.7 °C	-has high output (68 µV/°C) makes it well suited to low temperature (cryogenic) use.

Thermocouple Type	Overall Range	Typical Accuracy*	Comments
Constantan (-)			-Another property is non-magnetic.
Type J Iron (+)/ Constantan (-)	-40 to 760	2.2 °C	-Limited range -less popular than type K. -should not be used above 760°C as an abrupt magnetic transformation will cause permanent decalibration.
Type K Chromel (+) Alumel (-)	-200 to 1300	2.2 °C	-‘general purpose’ thermocouple. -low cost and popular. Sensitivity is approx 41 $\mu\text{V}/^\circ\text{C}$. Use type K unless you have a good reason not to.
Type N Nicrosil (+) Nisil (-)	-200 to 1300	2.2 °C	-High stability and resistance to high temperature oxidation -high temperature measurements without the cost of platinum (B,R,S) types. - 'improved' type K and becoming popular.
Type R (Platinum 13% Rhodium (+) / Platinum (-))	-50 to 1760	1.5 °C	-high temperature measurements up to 1600 °C. - Low sensitivity (10 $\mu\text{V}/^\circ\text{C}$) and high cost - Unsuitable for general purpose use.
Type S Platinum 10% Rhodium (+) Platinum (-)	-50 to 1760	1.5 °C	-high temperature measurements up to 1600 °C. - Low sensitivity (10 $\mu\text{V}/^\circ\text{C}$) and high cost -unsuitable for general purpose use. -used as the standard of calibration for the melting point of gold (1064.43 °C) due to high stability
Type T Copper (+) Constantan (-)	-200 to 400	1 °C	-Best accuracy of common thermocouples -used for food monitoring and environmental applications.

Among all type of thermocouple, K type is the most popular and mostly use. The range for J type is between -40 to 760°C which mean that this type of thermocouple is the lower ranges of temperature and can use it for small industries and small temperature usage application. For example, a K type is the most popular thermocouple at 300 °C will produce 12.2 mV. This voltage produced show that thermocouples are self-powered and require no excitation current unlike RTDs and thermistors ^[15]. Thermocouple will produce it own voltage or in other word is self-powered but it cannot be measure using voltmeter. Thermocouple has the temperature range between -200 to 2000⁰C and it relatively a low cost and also versatile.

The thermocouple sensor has a small output voltage in the millivolt range. A monolithic thermocouple amplifier with cold junction compensation (AD595) is used to amplify the output voltage ^[5]. The basic operation of thermocouple is based on the physical principles if two dissimilar metal wires are joined together at one end and a

small voltage difference is generated across two unheated end which is called as thermoelectric emf or also called as Seebeck voltage. This phenomenon is known as Seebeck effect. This is proved that thermocouple is self-powered. Cold-junction compensation is a signal conditioning technique that employed when using thermocouple for measurement.

Based on Figure 2.2 below, sensing junction and reference junction must be connect each to a different temperature, then the voltage difference can be detected. This voltage different will be zero if the junctions are at the same temperature and will increase as the temperature of one junction relative to the other is changed until a peak is reached ^[12]. Each wire have different thermoelectric sensitivities or known as Seebeck coefficient which mean for every 1°C difference in temperature, the Seebeck voltage which it value is same as Seebeck coefficient is induced. The relationship between Seebeck voltage and temperature is proportional which produce a linear graph only for small changes in temperature which shows in Figure 2.4 ^[6].

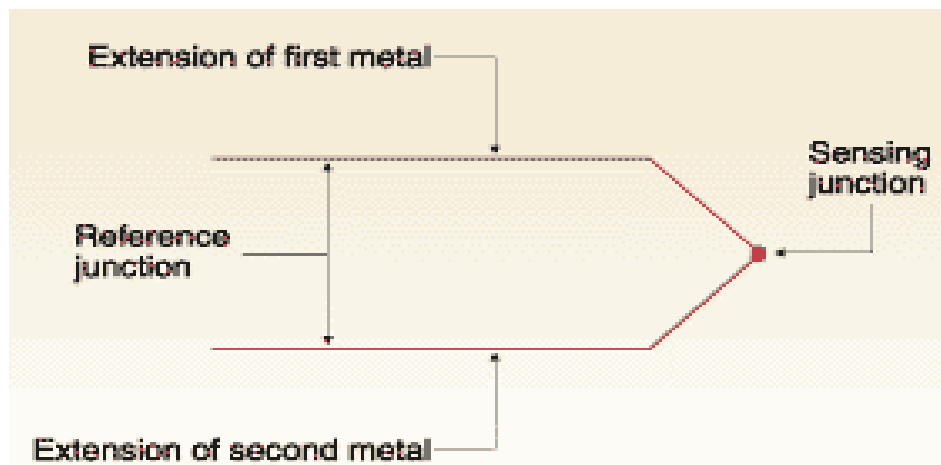


Figure 2.2: Thermocouple construction



Figure 2.3: Temperature Sensor type

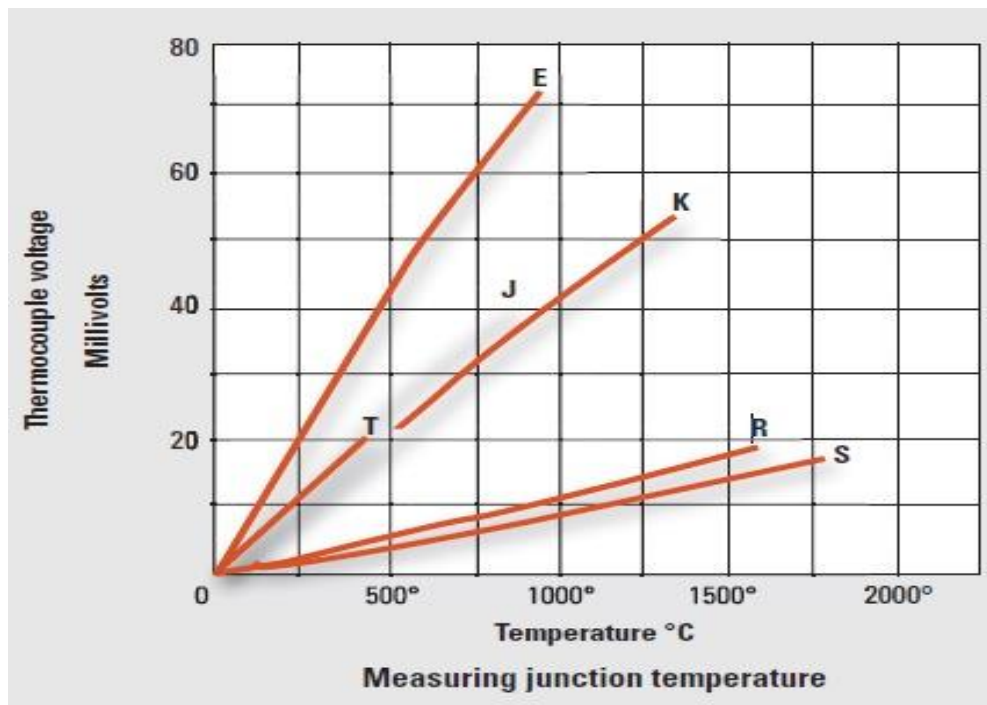


Figure 2.4: The relationship between temperature and Seebeck Voltage

2.3.1.1 EXPOSED JUNCTION THERMOCOUPLE

There are three types of thermocouple which one of it is exposed junction type. Such as its name, this type of thermocouple junction or measuring point were exposed to the surrounding environment or without any protection tube and comes out of the tip of the sheath ^[16]. Protection tube is a tube to protect the element from harsh environments. The most common methods to form the junction are a twist-and-

weld procedure or butt-welded ^[1]. The maximum temperature may be lower if the probe sheath diameter is smaller will causes the response faster.

This thermocouple has it limited in use to apply at dry, noncorrosive and non pressurised although have the best response time but lowest radiation error and least conduction error which much better than grounded junction type. Response time is a time constant that required by sensor to reach 63.2% of a step change in temperature. This type of thermocouple is best suited for air measurement and usually for measuring the temperature of gas or solid materials. Measuring tip of this thermocouple need to be seal or cover it with an insulating paint or epoxy to avoid moisture enters into the thermocouple.

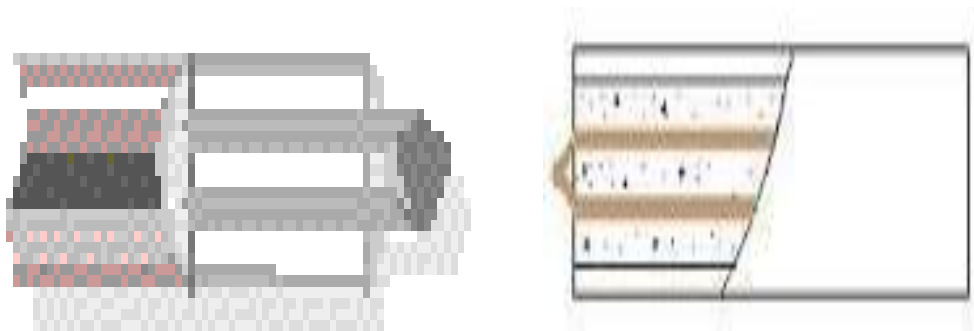


Figure 2.5: Exposed Thermocouple

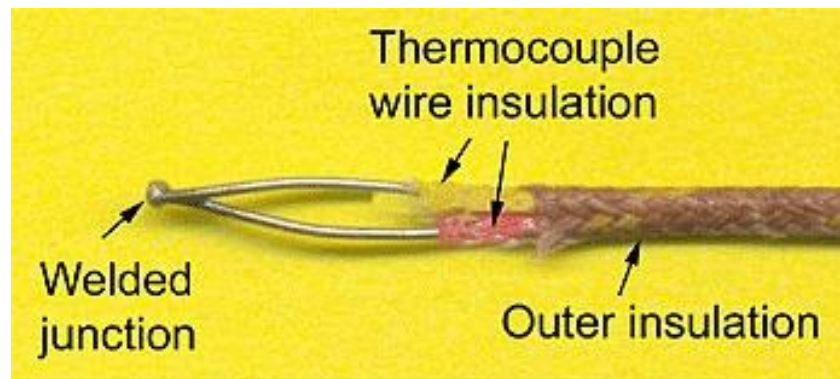


Figure 2.6: Namely parts of exposed thermocouple

2.3.1.2 GROUNDED JUNCTION PROBE THERMOCOUPLE

Another type of thermocouple is the grounded junction probe thermocouple which is different from exposed junction where the wire at the tip is physically welded or melt together to the inside of the probe wall which is referred as the sheath of the probe and allow them to solidify and forming a completely sealed integral junction ^[1]. Through the probe wall, good heat is transfer from the outside to the thermocouple junction. The common material of the sheath includes stainless steel and Inconel. Cause of broad chemical compatibility, stainless steel is preferred but support lower temperature range than Inconel.

The advantages of the grounded junction are fast response time, more accurate reading at short distance but most vulnerable to electrical ground loops, noise pickup and the possibility that the thermo elements may alloy with the sheath are the disadvantages of this thermocouple ^[1]. Rather than bending and welding the wires to the tip, it is better to bending and welding to the inside wall of the sheath to achieve fast response time. This thermocouple is more rugged and capable tolerating physical and mechanical abuse ^[16]. This junction type is for measuring static or flowing corrosive gas and liquid temperatures and also used in high-pressure conditions.

Noise is one of the disadvantages of this type of thermocouple. Noise is the signals that are the same on both wires which can be minimised. To ensure both wires pick up the same noise signal, the cable are twisted together. If there still a remaining noise, used analog to digital converter (ADC) to average out the remaining noise ^[8].

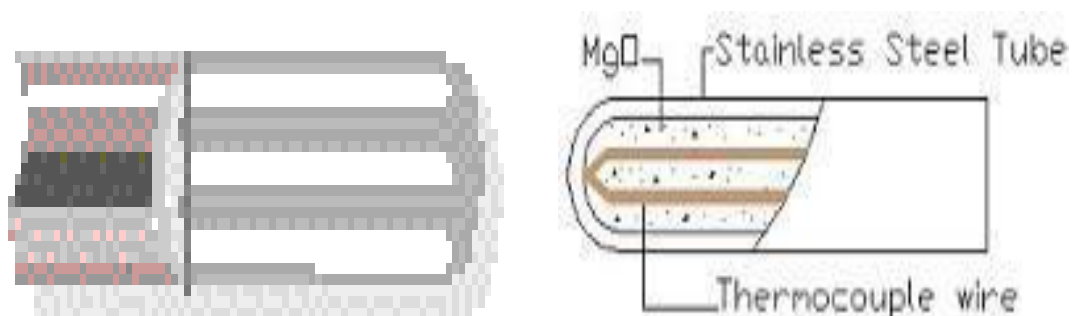


Figure 2.7: Grounded Thermocouple

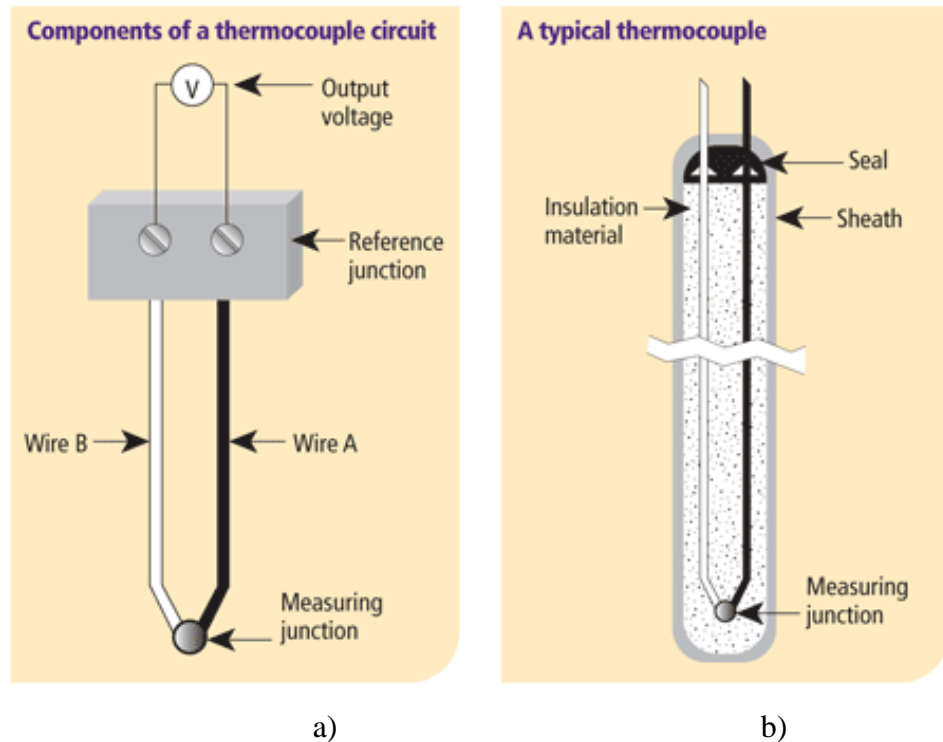


Figure 2.8: a) Components of a thermocouple circuit and b) A typical thermocouple

2.3.2 RESISTANCE TEMPERATURE DETECTOR (RTD)

RTD sensor is stand for Resistance Temperature Detector which is measure changes in resistance that result from changes in temperature which same as the thermistor. The any metal electrical resistance varies according to its temperature which is in the most cases, resistance directly proportional with temperature at a specific rate which has a positive temperature coefficient (PTC). The practical operating range of RTD is between -250 to 850°C and the most RTD used is the Pt100 because it has a resistance of 100Ω at 0°C . RTD is much more costly and slower responding than others sensors but RTD become more accurate and more linear by using a platinum resistance element.

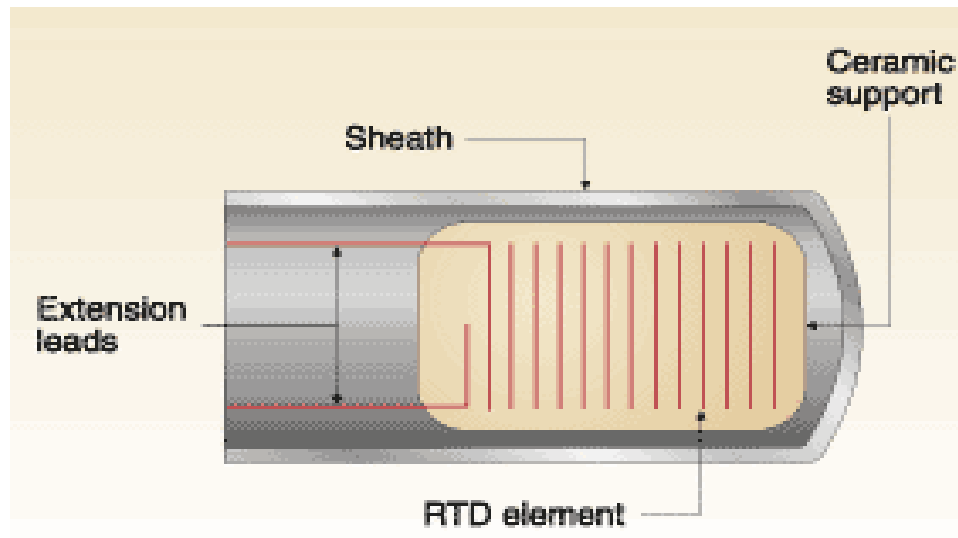


Figure 2.9: RTD Construction

2.3.3 THERMISTOR

Thermistor has a limited temperature range between the previous two sensors which is -100 to 300°C . Thermistor cannot cover this high range and a thermistor cannot stand alone because of lack of standards which means it is often necessary to buy the sensor and measuring equipment together ^[15]. RTD and Thermistor is the same in terms of heating which is its self-heating and because of that, these both sensors cannot have too large current which can make the sensor damage. The change of temperature of thermistor is so large, so that, thermistor can provide good accuracy and resolution.

2.3.4 SEMICONDUCTOR SENSOR

LM35DZ is the temperature sensor type semiconductor device. This device is linear voltage production and the exchange of temperature is same like other three sensors which are in degree Celcius ($^{\circ}\text{C}$). LM35DZ can operate between temperature ranging from -55°C to $+100^{\circ}\text{C}$ ^[7].

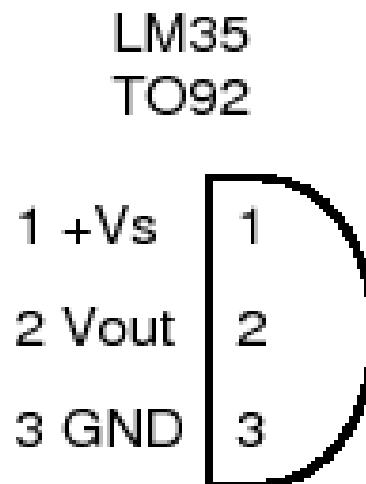


Figure 2.10: Pinout of LM35

Table 2.4: Advantages and Disadvantages of Sensor

	Thermocouple	RTD Sensor	Semiconductor	Thermistor
Advantages	-Self-powered -No self-heating -Low cost -High temperature range -Use for wide temperature range	-Accuracy -Stability -Linearity	-Cheap -Ease to use -More accurate than thermistor -Sealed	-Low to moderate cost -Accuracy -Sensitivity
Disadvantages	-Low accuracy -Low stability -Low output signal -Non-linear output is produced	-Expensive -Self-heating	-Using amplifier circuit	-Low linearity -Self-heating -Cannot standalone

2.4 DAQ

Data Acquisition System or called as DAQ is a system or device that converts a signal from analog to digital and a process of measuring such as voltage, current, temperature, pressure or sound. DAQ is used to interface hardware through computer, so, before computer can receive data, DAQ must convert the data into a signal that computer can understand which is in digital signal. DAQ is a device which converts a signal into other signal, this is show that DAQ need a device which can give it input signal and also need a device which can read and display the value or data. This is means that a combination of modular hardware and flexible software is needed to transform PC into a user defined measurement or control system. The devices are a sensor, signal conditioning equipment and a software such as Matlab, Labview and Visual Basic.

Besides A/D and D/A converters, data acquisition and distribution systems may employ one or more of the following circuit functions: transducers, amplifiers, filters, nonlinear analog functions, analog multiplexers and sample-holds (Son, 2005). DAQ also has in Universal Serial Bus (USB) formed which just plug-in to the USB port at computer. There have many advantages in using USB as interface which is personal computer (PC) will automatically detect and install necessary drivers, were inexpensive instrument than Ethernet or Data Logger instruments and do not need an external power source cause powered via the USB cable. Figure 2.11 shows two type of USB DAQ and Figure 2.12 show the symbols of USB. As in Figure 2.13, temperature transmitter has the same purpose as DAQ which measure a physical phenomenon such as current, voltage, resistance and temperature.



a)



b)

Figure 2.11 USB DAQ: a) NI USB 6009 and b) NI USB-TC01

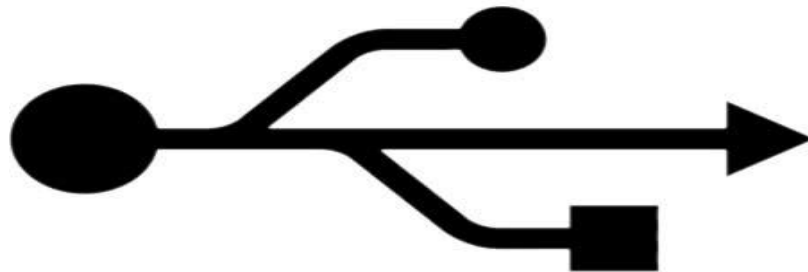


Figure 2.12 USB Symbol



Figure 2.13: DIN rail type of transmitter

2.5 MATLAB GUI

As state before, Matlab is use in this project. Matlab is one of the varieties of Computer-Controlled Measurements and Analysis which mean that Matlab can be design to control a system, to measure and analyze data. Labview and Visual Basic (VB) are other examples of Computer-Controlled Measurements and Analysis which normally use in design system. Matlab software is use because it can read and display the data capture from sensor. To display the data capture, need to design the GUI (Graphical User Interface) for easy user to read and used because it will display at user computer which mean that GUI will create a system user friendly which is human interact with computers.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Methodology is a chapter that will discuss about the method that used in this project. This chapter discuss the flow of the project until successful which until result is generated. The parts in this chapter are consists of instruments, hardware, software and flow chart.

3.2 INSTRUMENTS

In this part will discuss about the instruments used in this project which consists of USB-TC01, thermocouple type J and MATLAB software.

3.2.1 NI USB-TC01

NI USB-TC01 is a product from National Instruments (NI). NI USB-TC01 is a thermocouple measurement device with NI InstantDAQ Technology which this product is function as DAQ but only suitable for thermocouple measurement type J, K, R, S, T, N, E and B. Figure 3.1 below is the picture of NI USB-TC01 which needs to plug-in the standards miniplug type thermocouple for easy connection. The purpose of NI USB-TC01 is to read the data from the thermocouple and display data by using MATLAB software. Figure 3.2 show the thermocouple type J and Figure 3.3 shows the thermocouple miniplug.



Figure 3.1: NI USB-TC01



Figure 3.2: Thermocouple J type



Figure 3.3: Thermocouple Miniplug

3.2.2 Thermocouple Type J

Type J thermocouple is the lowest range of temperature among others types. This means that type J thermocouple is use for a small application. Figure 3.4 and Figure 3.5 below is the thermocouple type J which consists of two types such as Grounded Probe thermocouple and Exposed Junction Thermocouple. Exposed Junction Thermocouple has the best response time but limited in use to dry, noncorrosive and non pressurised. The Grounded Probe Thermocouple is less response time than Exposed Junction Thermocouple.



Figure 3.4: Grounded Probe Thermocouple



Figure 3.5: Exposed Junction Thermocouple

3.2.3 MATLAB Software

MATLAB Software is used in this project to display the data captured from NI USB-TC01 by creating the Graphical User Interface (GUI) for easy to monitor and analyse. This is the important part in this project which without using this MATLAB software, the project is not successful because the result for this project

cannot be display. Figure 3.6 below is the blank layout of GUI which has several of tools that use for different function. As in Figure 3.3 there are tools such as GUI components, design area, align object, menu editor and property inspector.

Blank layout of GUI in Figure 3.3 is a layout to create a GUI by using the GUI component that consists of static text, edit text, axes, push button and others. All this component has their own function which static text is for display text or number, edit text is to key-in text or number, axes is for display graph and push button is to on, off or reset operation. Just drag the component icon into the design area to start design the GUI. To align the component, click the align object icon and set the alignment value. Each of the GUI components has property inspector that can be edit by double click at the component to view the property inspector such as in Figure 3.7. Property inspector has item that can be edit such as background color, rename the component, change font size and others. The menu editor is to add menus to GUIs. There such a step to create MATLAB GUI.

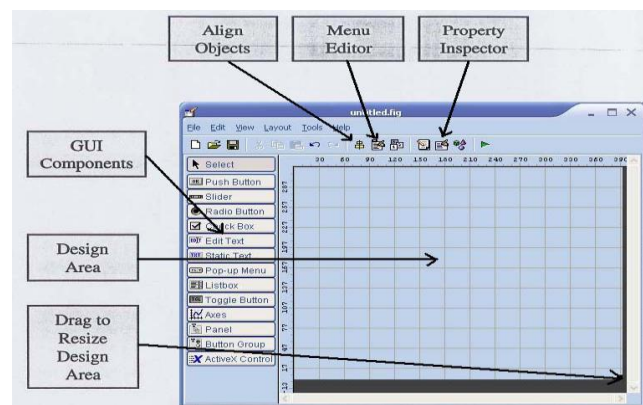


Figure 3.6: Blank layout of GUI

The first step to create GUI is by drag the component needed and then design a rough layout in design area or roughly draw a layout in a piece of paper first and after that draw back in the design area. The design of layout is including the gap between each component which can be edit using the align editor.

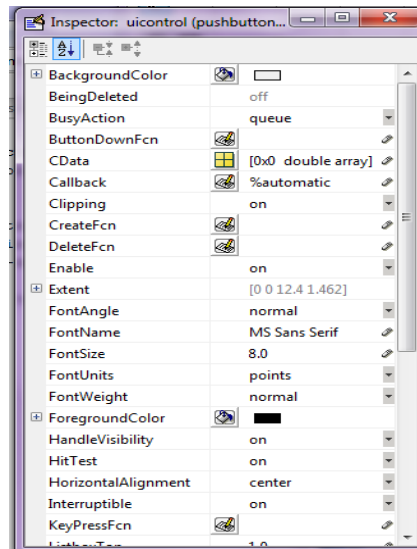


Figure 3.7: Property Inspector

After done setting the property inspector for all components, then save the file which the file will be save in MATLAB folder. Two files will be created in the same folder when save the file but, the created file will have different extents but same name as GUI layout file. The two files created is fig-file which actual GUI that already run which the grid line will not appear and can key-in data after the source code have no error and M-file is a MATLAB code which contain the generated and edited source code of the GUI that has been created. Figure 3.8, Figure 3.9, Figure 3.10 show respectively the example of actual GUI, example of design GUI layout and example of M-file ^[11].

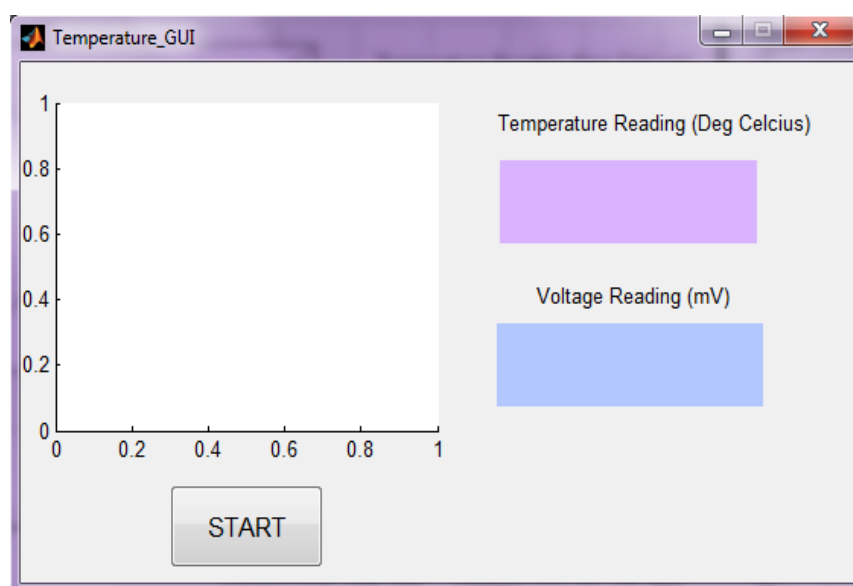


Figure 3.8: Example of Actual GUI

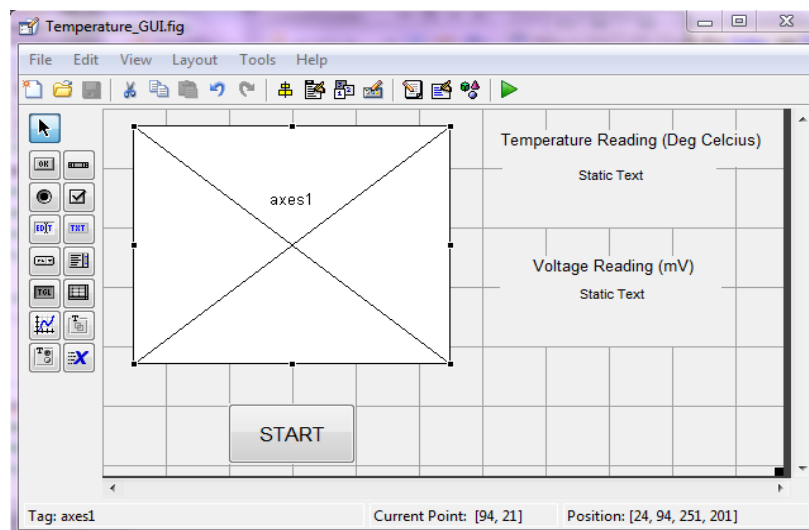


Figure 3.9: Example of Design GUI Layout

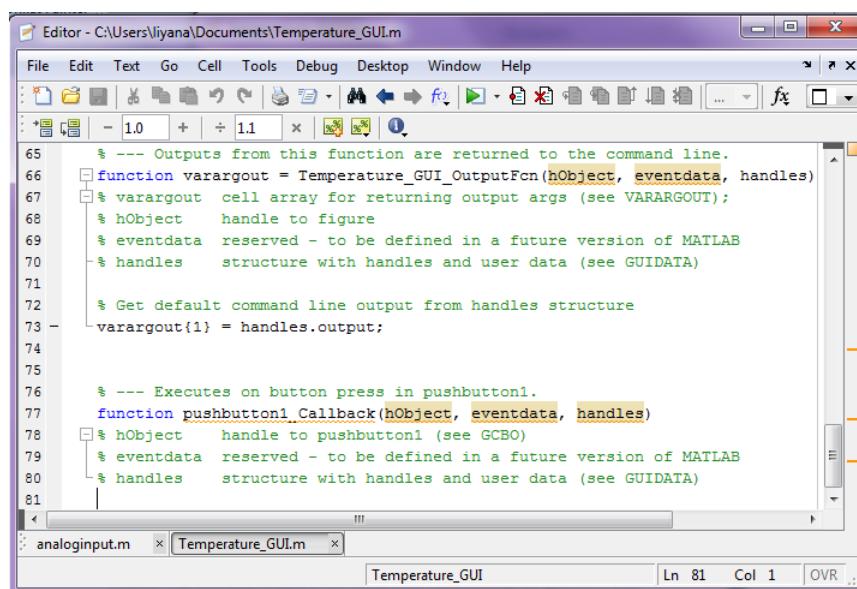


Figure 3.10: Example of M-file

3.3 HARDWARE

Figure 3.11 is the simplified block diagram for this project which is starting from the sensing device which is the thermocouple type J sensor and connects with the NI USB-TC01 DAQ and through the MATLAB software as interface to PC. Hardware connection for this project is shows in Figure 3.12. overall system

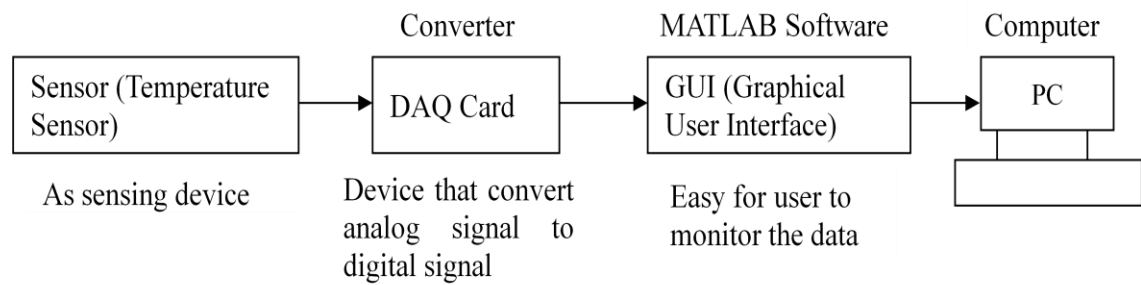


Figure 3.11: Simplified Block Diagram



Figure 3.12: Real Diagram of Hardware

Figure 3.13 below show the construction of hardware during the experiment of mixed water. The NI USB-TC01 readings are compared with the thermometer readings to prove that the NI USB-TC01 reading is not much difference with the thermometer. The experiment is done with measured the 600ml normal water temperature and 10 readings is taken for 10 minute. Then mixed the normal water with a plastic of ice cube and also measure is taken for 10 minute. After that, the mixed water is added the hot water about 600ml and then measure the temperature for 10 minute and 10 readings is taken. Figure 3.14 show the device used during the experiment.



Figure 3.13: Construction of Hardware

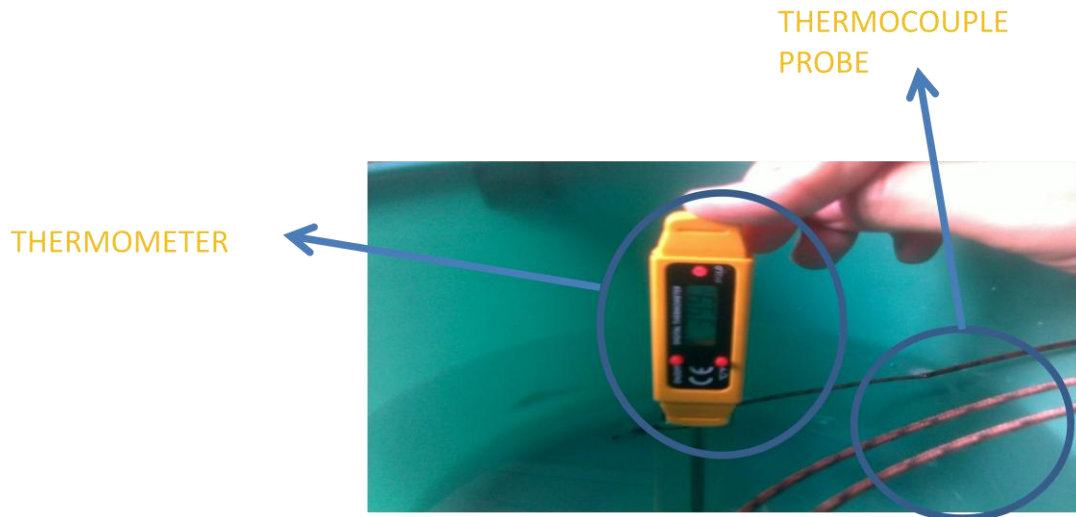


Figure 3.14: Device Name

3.4 SOFTWARE

The software use in this project is MATLAB software that needs to interface with NI USB-TC01 DAQ. Before or after creating a GUI, either one, need to set the Measurement & Automation Explorer to detect the driver nidaqmx and create a virtual interface. The first step is to open the Measurement & Automation Explorer and will show as Figure 3.13 below.



Figure 3.15: Front page of Measurement & Automation Explorer

After that, it will appear as in Figure 3.14 below and it searched for the NI USB-TC01 under the Devices and Interfaces. Then, it will show the serial number of the NI USB-TC01 and NIDAQmx driver version. Next, clicks create task and box as in Figure 3.15 is displayed as below. Then, clicks the Analog

Input→Temperature→Thermocouple and list of channel is displayed as in Figure 3.16. Lastly, enter the name for the task in the space box as in Figure 3.17 and click finish to display the task name under NIDAQmx Tasks such in Figure 3.18.

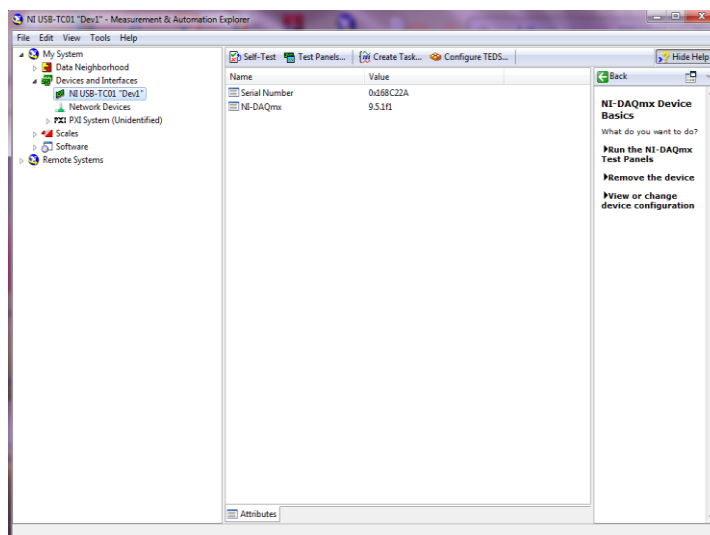


Figure 3.16: Displayed NI USB-TC01 ID

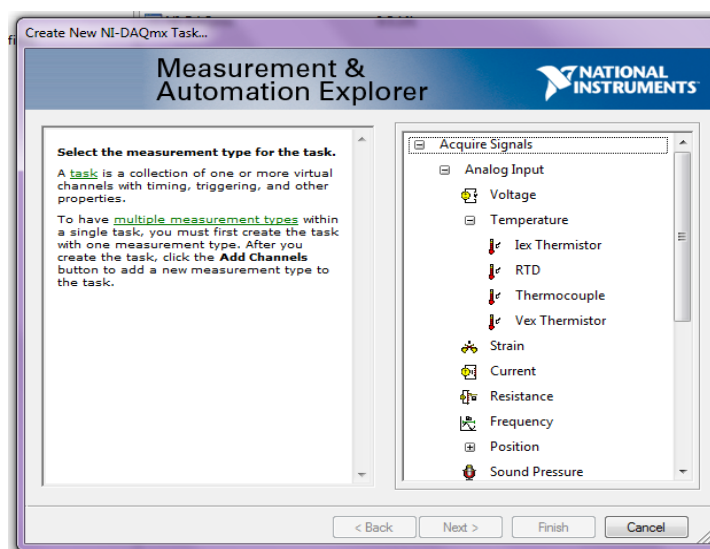


Figure 3.17: Analog Signal Setting

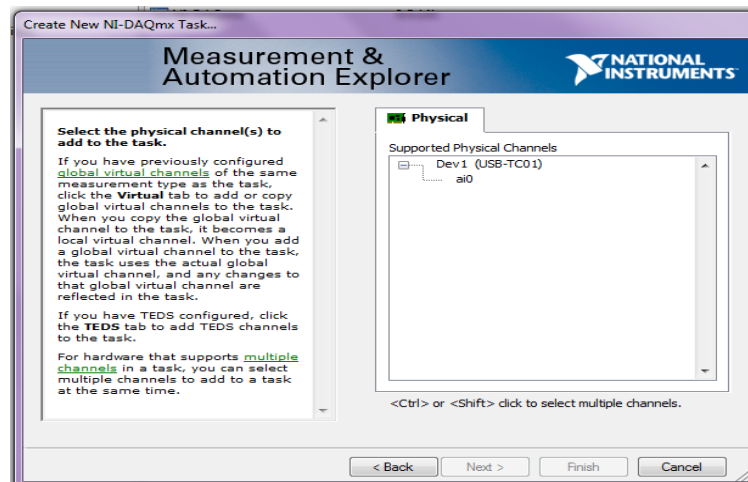


Figure 3.18: Displayed Channel

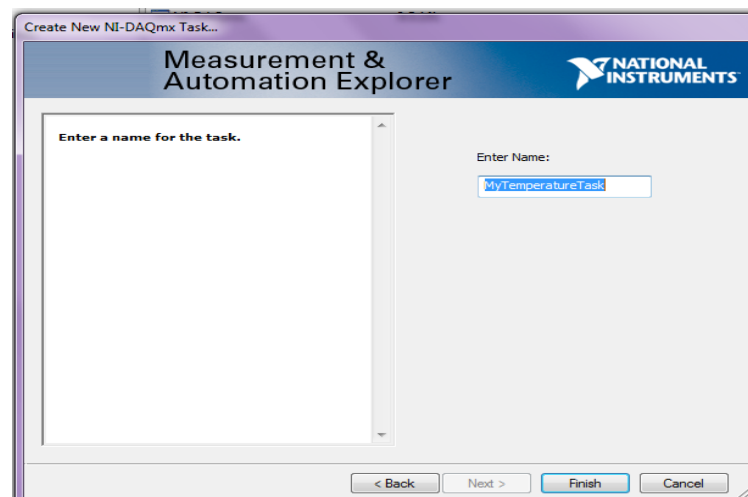


Figure 3.19: Create Task Name

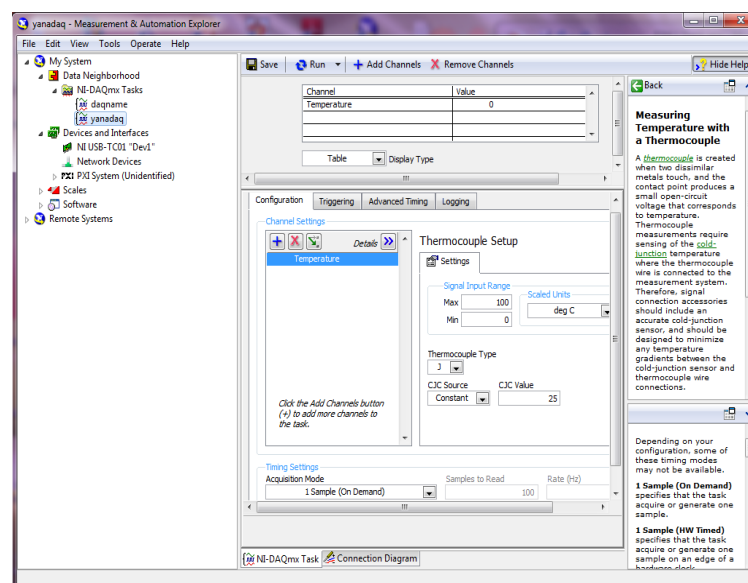


Figure 3.20: Displayed Tasks

The command below is to know version use, manufacturer ID, channels and others and to detect the thermocouple use in this project. The command is write in the Command Window as in Figure 3.19 below.

```
>> daq.getVendors()

ans =

Data acquisition vendor 'National Instruments':

    ID: 'ni'
    FullName: 'National Instruments'
    AdaptorVersion: '3.0 (R2011b)'
    DriverVersion: '9.5.1 NI-DAQmx'
    IsOperational: true

Properties, Methods, Events

    ID: 'ni'
    FullName: 'National Instruments'
    AdaptorVersion: '3.0 (R2011b)'
    DriverVersion: '9.5.1 NI-DAQmx'
    IsOperational: true

Methods for class daq.ni.ni:

    addlistener      horzcat
    cat              isvalid
    delete          ni
    disp             vertcat
    get
    getOperationalSummary

Events for class daq.ni.ni:

ObjectBeingDestroyed

>> daq.getDevices

ans =

ni Dev1: National Instruments USB-TC01
    Analog input subsystem supports:
        -0.080 to +0.080 Volts range
        Rates from 0.0 to 0.0 scans/sec
        1 channel
    'Voltage','Thermocouple' measurement types
```

Properties, Methods, Events

```

IsSimulated: false
Vendor: National Instruments
ID: 'Dev1'
Model: 'USB-TC01'
Subsystems: [1x1 daq.ni.AnalogInputInfo]
Description: 'National Instruments USB-TC01'
RecognizedDevice: true

```

Methods for class daq.ni.DeviceInfo:

```

addlistener disp      isvalid
cat      get      vertcat
delete      horzcat

```

Events for class daq.ni.DeviceInfo:

```
ObjectBeingDestroyed
```

```
>> daq.createSession('ni')
```

```
ans =
```

```

Data acquisition session using National Instruments hardware:
Will run for 1 second (1000 scans) at 1000 scans/second.
No channels have been added.

```

Properties, Methods, Events

```

NumberOfScans: 1000
DurationInSeconds: 1
Rate: 1000
IsContinuous: false
NotifyWhenDataAvailableExceeds: 100
IsNotifyWhenDataAvailableExceedsAuto: true
NotifyWhenScansQueuedBelow: 500
IsNotifyWhenScansQueuedBelowAuto: true
Vendor: National Instruments
Channels: empty
IsRunning: false
IsLogging: false
IsDone: false
RateLimit: empty
ScansQueued: 0
ScansOutputByHardware: 0

```

ScansAcquired: 0

Methods for class daq.ni.Session:

```
addAnalogInputChannel  prepare
addAnalogOutputChannel queueOutputData
addCounterInputChannel release
addCounterOutputChannel removeChannel
addlistener            resetCounters
cat                    startBackground
get                    startForeground
horzcat                stop
inputSingleScan        vertcat
invalid                wait
outputSingleScan
```

Events for class daq.ni.Session:

```
DataAvailable
DataRequired
ErrorOccurred
ObjectBeingDestroyed
```

```
>> s = daq.createSession('ni');
>> s.addAnalogInputChannel('DEV1','ai0', 'Thermocouple');
Warning: A channel that does not support clocked sampling
was added to the session. Clocked operations using
startForeground and startBackground will be disabled. Only
on-demand operations using inputSingleScan and
outputSingleScan can be done.
```

```
>> tc = s.Channels(1);
>> set(tc)
      Units: [ Celsius | Fahrenheit | Kelvin | Rankine ]
ThermocoupleType: [ Unknown | J | K | N | R | S | T | B | E ]
      Range: 0 to +750 Celsius
      Name: {}
>> tc.ThermocoupleType = 'J';
>> tc.Units = 'Celsius';
>> tc
```

```
tc =
```

Data acquisition analog input thermocouple channel 'ai0' on device 'Dev1':

```
      Units: Celsius
ThermocoupleType: J
      Range: 0 to +750 Celsius
      Name: empty
```

```

        ID: 'ai0'
        Device: [1x1 daq.ni.DeviceInfo]
        MeasurementType: 'Thermocouple'

Properties, Methods, Events

        Units: Celsius
        ThermocoupleType: J
        Range: 0 to +750 Celsius
        Name: empty
        ID: 'ai0'
        Device: [1x1 daq.ni.DeviceInfo]
        MeasurementType: 'Thermocouple'

Methods for class daq.ni.AnalogInputThermocoupleChannel:

addlistener delete    horzcat    vertcat
cat          get      isvalid

```

Events for class daq.ni.AnalogInputThermocoupleChannel:

ObjectBeingDestroyed

```

>> [data,time] = s.startForeground();
plot(time, data)
The session contains channels that do not support clocked
operations using startForeground and startBackground. Only
on-demand operations using inputSingleScan and
outputSingleScan can be done.

>> s=daq.createSession('ni');
s1=daq.createSession('ni');
>> ch=s.addAnalogInputChannel('Dev1','ai0','Thermocouple');
chout=s1.addAnalogOutputChannel('Dev1','ai0','Thermocouple');
s1.outputSingleScan(1);
[data,timeStamp,triggerTime]=s.startForeground();
s1.outputSingleScan(0);
Warning: A channel that does not support clocked sampling
was added to the session. Clocked operations using
startForeground and startBackground will be disabled. Only
on-demand operations using inputSingleScan and
outputSingleScan can be done.
The requested subsystem 'AnalogOutput' does not exist on
this device.

```

Figure 3.21: Source Code

3.5 FLOW CHART

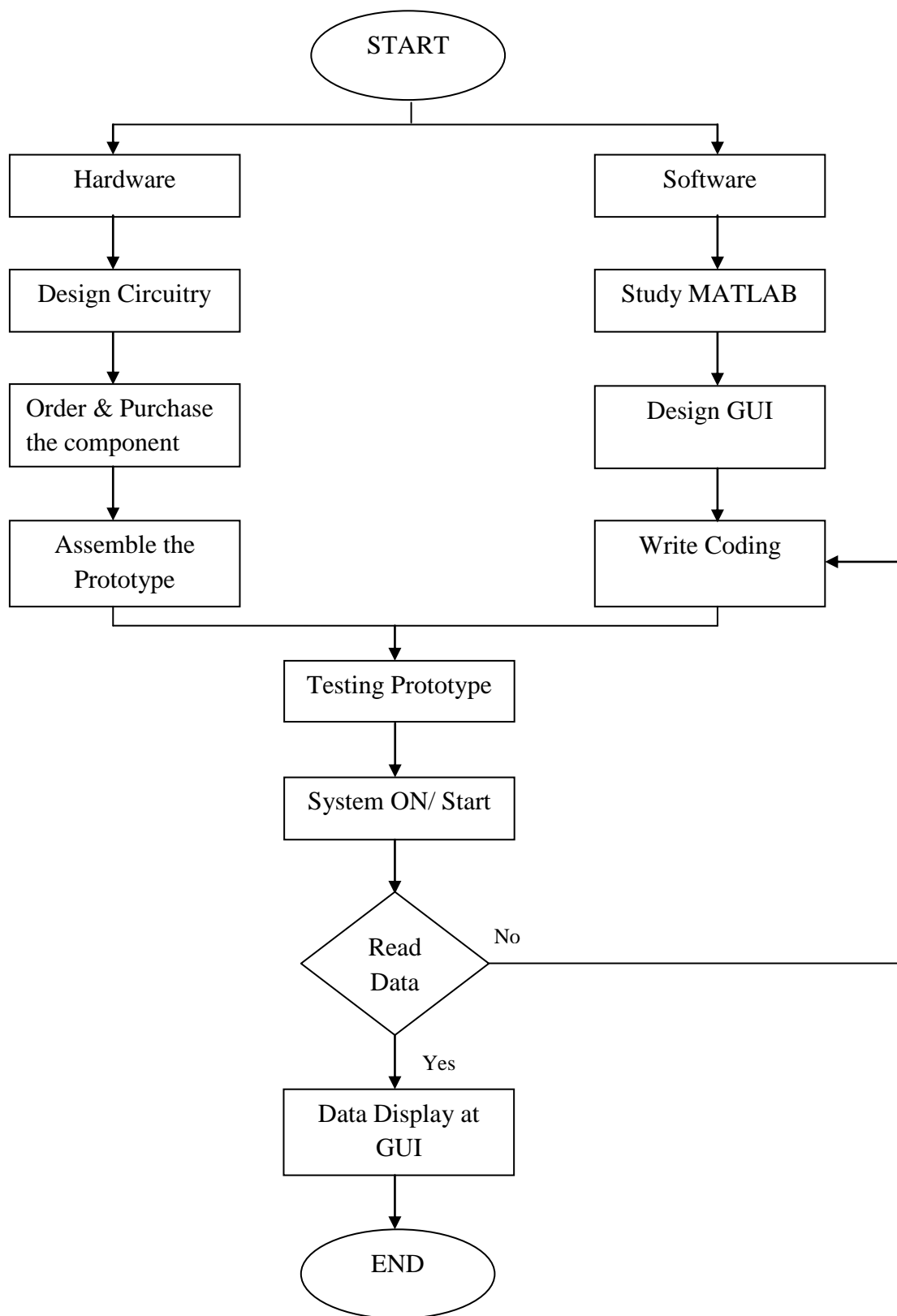


Figure 3.22: Flow Chart

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

In this part will discuss about the results of this project that produce from the temperature sensor which is thermocouple type J. The graph displayed will also be considered and analyse in this part.

4.2 RESULTS

In the experiment, the result is taken in 10 minute for each condition. The result is displayed as Table 4.1, Table 4.2 and Table 4.3 for each condition.

Table 4.1: Normal Water

Time (min)	NI USB-TC01 ($^{\circ}\text{C}$)	Thermometer ($^{\circ}\text{C}$)
1	29.4422	30.0
2	29.4889	30.0
3	29.4970	30.0
4	29.4460	30.0

5	29.4836	29.9
6	29.4567	30.1
7	29.4755	30.1
8	29.4073	30.1
9	29.4583	30.0
10	29.4422	30.0

The result in Table 4.1 above show that the temperature reading for NI USB-TC01 and thermometer are in range from 29.4 °C to 30.1 °C. The data is converted in graph form which shows in Figure 4.1 below. This figure show that the reading for NI USB-TC01 almost a straight line. At fifth minute, the reading for thermometer is the lowest reading which is 29.9 °C and in 6th, 7th and 8th minute show the highest reading for thermometer.

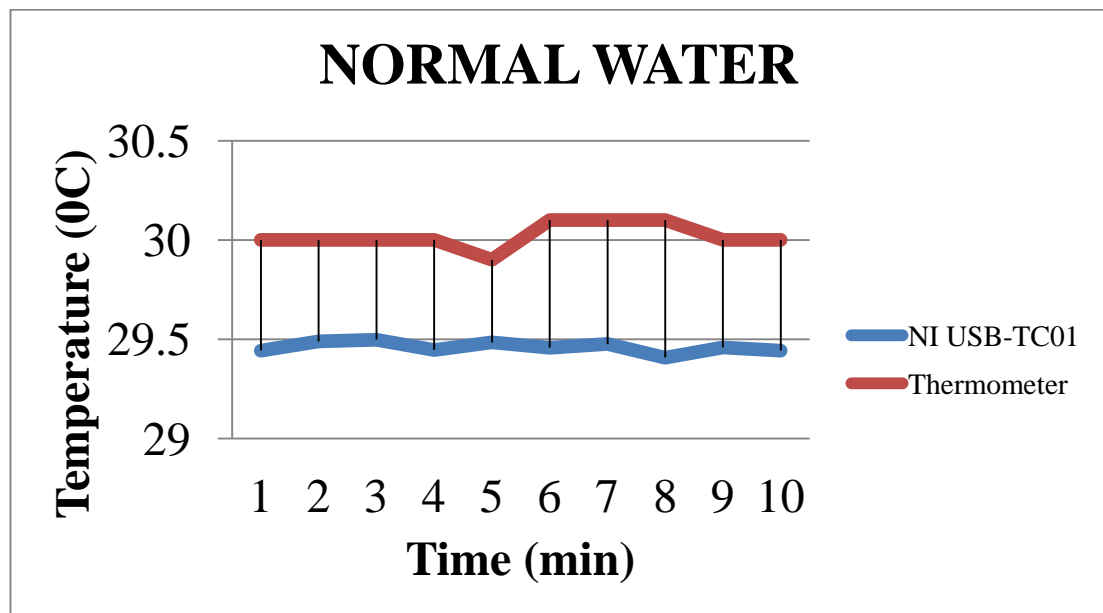


Figure 4.1: Graph form of Normal Water

Table 4.2 below show the result for cold water condition which at first minute show the highest readings and at third minute show the lowest readings for both NI USB-TC01 and thermometer. The data is tabulated in graph form which as Figure 4.2 below. The figure shows that both device readings are almost the same with each other. From third minute until 7th minute, clearly show the gap of both readings. The gap is actually the difference of reading between NI USB-TC01 and thermometer readings.

Table 4.2: Cold Water

Time (min)	NI USB-TC01 ($^{\circ}\text{C}$)	Thermometer ($^{\circ}\text{C}$)
1	13.4492	13.9
2	10.0988	10.8
3	8.3462	8.9
4	8.5049	9.5
5	9.0984	10.2
6	9.8419	9.6
7	9.1613	10.0
8	9.9551	10.2
9	10.3523	10.4
10	10.6936	10.9

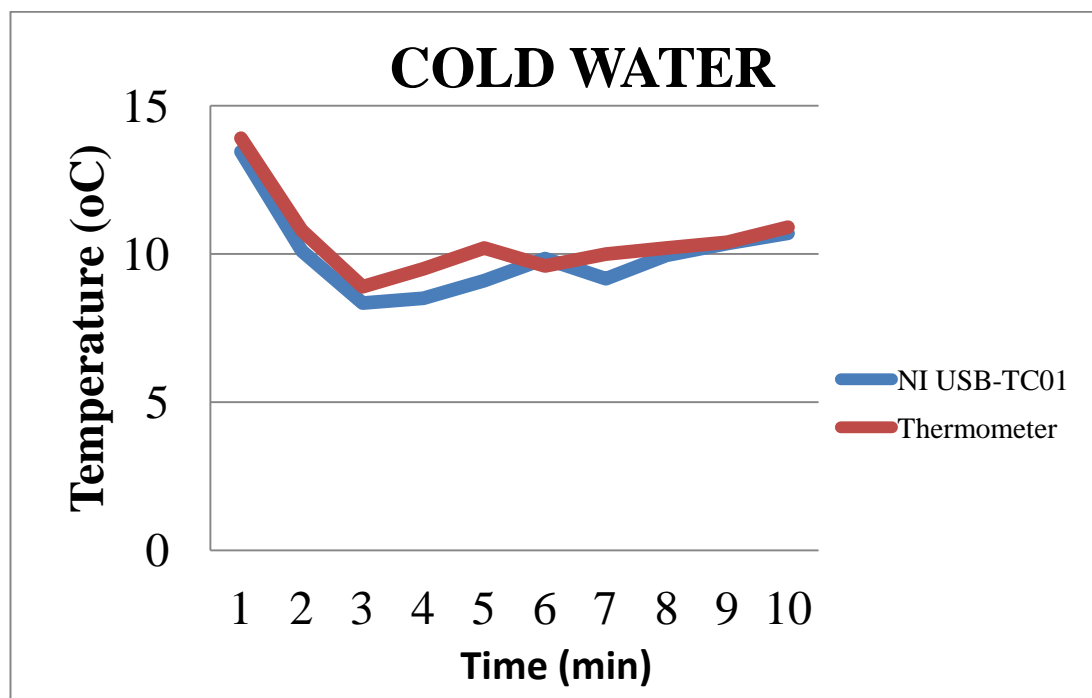


Figure 4.2: Graph form of Cold Water

The data generated when inserted a hot water is as in Table 4.3 below. The highest readings for NI USB-TC01 and thermometer are 42.5328°C and 42.3°C respectively. The difference between highest readings and lowest reading for NI USB-TC01 and thermometer are 3.5068°C and 1.2°C . This is show that the readings from first minute until 10th minute show there are not much difference between each other.

Table 4.3: Hot Water

Time (min)	NI USB-TC01 ($^{\circ}\text{C}$)	Thermometer ($^{\circ}\text{C}$)
1	39.5883	41.1
2	39.3737	40.5
3	39.0260	40.7
4	42.5328	42.0
5	41.6103	42.3
6	41.1435	41.9
7	40.7537	41.7
8	40.4436	41.6
9	40.1520	41.4
10	40.2862	41.2

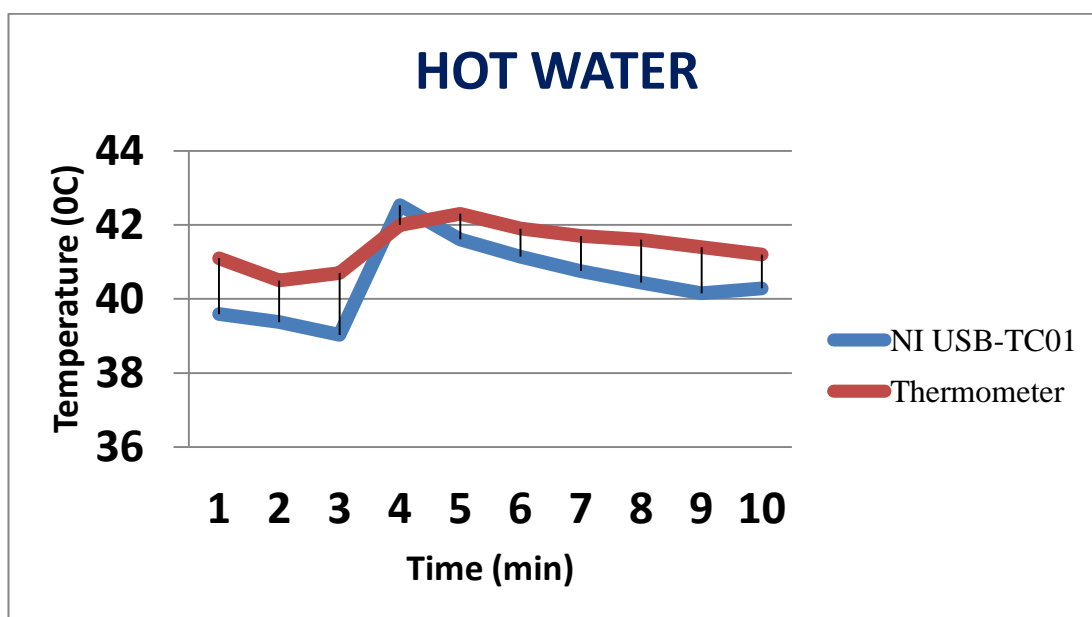


Figure 4.3: Graph form of Hot Water

Figure 4.3 show the data in graph form. This figure clearly shows there is a difference between both devices. From this figure, the highest value between both devices is 42.5328°C which is hold by NI USB-TC01. The gap between red line and blue line is the difference of reading between both devices.

All the data from all condition which are Normal Water, Cold Water and Hot Water condition is combined together in form of graph show in Figure 4.4 below. The graph shows that the data for devices, NI USB-TC01 and thermometer are the same between each other. This is show that this device is valid to use together.

Table 4.4: Combination all data

Time (min)	NI USB-TC01 (°C)	Thermometer (°C)
1	29.4422	30
2	29.4889	30
3	29.497	30
4	29.446	30
5	29.4836	29.9
6	29.4567	30.1
7	29.4755	30.1
8	29.4073	30.1
9	29.4583	30
10	29.4422	30
11	13.4492	13.9
12	10.0988	10.8
13	8.3462	8.9
14	8.5049	9.5
15	9.0984	10.2
16	9.8419	9.6
17	9.1613	10
18	9.9551	10.2
19	10.3523	10.4
20	10.6936	10.9
21	39.5883	41.1
22	39.3737	40.5
23	39.026	40.7
24	42.5328	42
25	41.6103	42.3
26	41.1435	41.9
27	40.7537	41.7
28	40.4436	41.6
29	40.152	41.4
30	40.2862	41.2

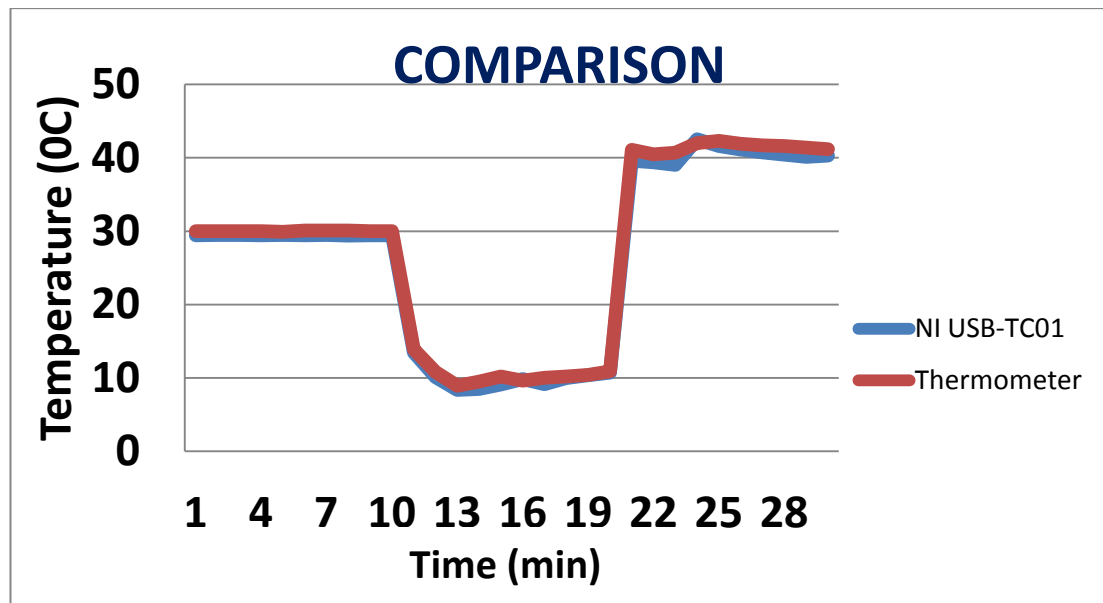


Figure 4.4: Comparison graph

The expected results for this project is the graph waveform will occurs when the start button is clicked and the value of temperature and voltage will be appears. The graph is generated depending on the temperature readings. Figure 4.5 is the result of GUI created and Figure 4.6 is the command.

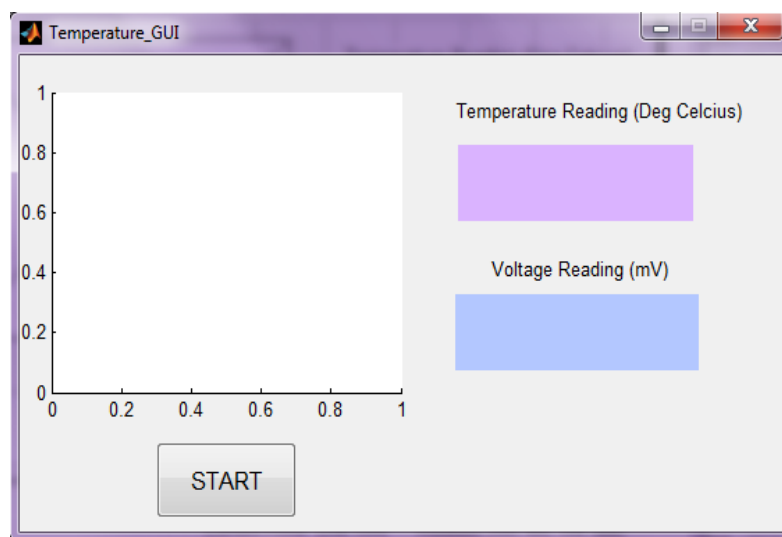


Figure 4.5: GUI Result

```
clear all
clc
daqhwinfo
daqsupport
daqregister('nidaq')
v = daq.getVendors
```

```

d = daq.getDevices
s = daq.createSession ('ni')
s.addAnalogInputChannel('DEV1', 'ai0', 'Thermocouple')
s.NumberOfScans = 60000;
tc = s.Channels(1)
set(tc)
tc.ThermocoupleType='J';
tc.Units='Celsius';
tc
n=1;
times=datestr(now)
[data,times] = s.inputSingleScan()
while ((data>=29)&&(n<=10))
times=datestr(now)
[data,times] = s.inputSingleScan()
n=n+1;
end
while ((data<=13)&&(n<=10))
times=datestr(now)
[data,times] = s.inputSingleScan()
n=n+1;
end

```

Figure 4.6: Command Code

-----General Information -----

Current Time & Date:

16-Jun-2012 21:01:15

Operating System:

Microsoft Windows [Version 6.1.7600]

Hardware Configuration:

x86 Family 6 Model 5 Stepping 5, GenuineIntel

The measured CPU speed is 2394 MHz

RAM is 1972 MB

Swap space is 7828 MB

PROCESSOR_ARCHITECTURE = x86

PROCESSOR_ARCHITECTURE = AMD64

MATLAB version:

7.13.0.564 (R2011b)

Data Acquisition Toolbox version:

Name: 'Data Acquisition Toolbox'

Version: '3.0'

Release: '(R2011b)'

Date: '08-Jul-2011'

MATLAB License Number:

161052

-----Memory Information: -----

MemoryLoad = 91 %

TotalPhys = 1.93 GB

AvailPhys = 169.18 MB

TotalPageFile = 4.00 GB

AvailPageFile = 1.65 GB

TotalVirtual = 4.00 GB

AvailVirtual = 2.92 GB

UsedDaq = 0.00 bytes

-----MATLAB root directory: -----

C:\Program Files (x86)\MATLAB\R2011b

-----Data Acquisition Toolbox directory: -----

C:\Program Files (x86)\MATLAB\R2011b\toolbox\daq

-----DAQ Legacy Interface Hardware Available: -----

ToolboxName: 'Data Acquisition Toolbox'

ToolboxVersion: '3.0 (R2011b)'

MATLABVersion: '7.13 (R2011b)'

InstalledAdaptors: {3x1 cell}

-----Adaptor List -----

'nidaq'

'parallel'

'winsound'

-----nidaq adaptor: -----

-----Registering adaptor: nidaq -----

Successfully registered nidaq adaptor

-----Adaptor Information for adaptor nidaq -----

adaptorInfo =

AdaptorDllName: [1x74 char]

AdaptorDllVersion: '3.0 (R2011b)'

AdaptorName: 'nidaq'

BoardNames: {'USB-TC01'}

InstalledBoardIds: {'Dev1'}

ObjectConstructorName: {" " "}"

-----Adaptor DLL Name -----

C:\Program Files

(x86)\MATLAB\R2011b\toolbox\daq\daq\private\mwnidaqmx.dll

Size: 427520, Date: 14-Aug-2011 03:54:12

This adaptor is developed and supported by MathWorks.

-----Adaptor Name -----

nidaq

-----Object Constructor Names -----

-----Additional Adaptor Information for adaptor nidaq -----

NIDAQ Traditional is not installed.

-----parallel adaptor: -----

-----Registering adaptor: parallel -----

Successfully registered parallel adaptor

Error displaying DAQHWINFO for adaptor parallel

Could not get information for parallel. PARALLEL: Could not start the WINIO.SYS device driver.

-----winsound adaptor: -----

-----Registering adaptor: winsound -----

Successfully registered winsound adaptor

-----Adaptor Information for adaptor winsound -----

adaptorInfo =

AdaptorDllName: [1x75 char]

AdaptorDllVersion: '3.0 (R2011b)'

AdaptorName: 'winsound'

BoardNames: {'Microphone (Realtek High Defini'}

InstalledBoardIds: {'0'}

ObjectConstructorName: {1x3 cell}

-----Adaptor DLL Name -----

C:\Program Files

(x86)\MATLAB\R2011b\toolbox\daq\daq\private\mwwinsound.dll

Size: 117248, Date: 09-Jul-2011 13:50:06

This adaptor is developed and supported by MathWorks.

-----Adaptor Name -----

winsound

-----Object Constructor Names -----

analoginput('winsound',0)


```
analogoutput('winsound',0)
```

```
-----Creating analoginput('winsound',0) object for adaptor winsound -----  
-----
```

Display Summary of Analog Input (AI) Object Using 'Microphone (Realtek High Defini'.

Acquisition Parameters: 8000 samples per second on each channel.

8000 samples per trigger on each channel.

1 sec. of data to be logged upon START.

Log data to 'Memory' on trigger.

Trigger Parameters: 1 'Immediate' trigger(s) on START.

Engine status: Waiting for START.

0 samples acquired since starting.

0 samples available for GETDATA.

AI object contains no channels.

ans =

AdaptorName: 'winsound'

Bits: 16

Coupling: {'AC Coupled'}

DeviceName: 'Microphone (Realtek High Defini'

DifferentialIDs: []

Gains: []

ID: '0'

InputRanges: [-1 1]

MaxSampleRate: 96000

MinSampleRate: 5000

NativeDataType: 'int16'

Polarity: {'Bipolar'}

SampleType: 'SimultaneousSample'

SingleEndedIDs: [1 2]

SubsystemType: 'AnalogInput'

TotalChannels: 2

VendorDriverDescription: 'Windows Multimedia Driver'

VendorDriverVersion: '6.1'

-----Creating analogoutput('winsound',0) object for adaptor winsound ----

Display Summary of Analog Output (AO) Object Using 'Speakers (Realtek High Definiti'.

Output Parameters: 8000 samples per second on each channel.

Trigger Parameters: 1 'Immediate' trigger on START.

Engine status: Waiting for START.

0 total sec. of data currently queued for START.

0 samples currently queued by PUTDATA.

0 samples sent to output device since START.

AO object contains no channels.

ans =

AdaptorName: 'winsound'

Bits: 16

ChannelIDs: [1 2]

Coupling: {'AC Coupled'}

DeviceName: 'Speakers (Realtek High Definiti'

ID: '0'

MaxSampleRate: 96000

MinSampleRate: 5000

NativeDataType: 'int16'

OutputRanges: [-1 1]

Polarity: {'Bipolar'}

SampleType: 'SimultaneousSample'

SubsystemType: 'AnalogOutput'

TotalChannels: 2

VendorDriverDescription: 'Windows Multimedia Driver'

VendorDriverVersion: '6.1'

-----DAQ Session Based Vendors Available: -----

Data acquisition vendor 'National Instruments':

ID: 'ni'

FullName: 'National Instruments'

AdaptorVersion: '3.0 (R2011b)'

DriverVersion: '9.5.1 NI-DAQmx'

IsOperational: true

-----DAQ Session Based Devices Available: -----

ni Dev1: National Instruments USB-TC01

Analog input subsystem supports:

-0.080 to +0.080 Volts range
 Rates from 0.0 to 0.0 scans/sec
 1 channel
 'Voltage','Thermocouple' measurement types

-----Session Based Device Details: -----

-----Device Details for vendor: ni -----

-----Device 1 -----

ni Dev1: National Instruments USB-TC01

Analog input subsystem supports:

-0.080 to +0.080 Volts range
 Rates from 0.0 to 0.0 scans/sec
 1 channel
 'Voltage','Thermocouple' measurement types

CouplingsAvailable: DC

SampleType: Scanning

InputTypesAvailable: Differential

RangesAvailable: -0.080 to +0.080 Volts

Resolution: 20

RateLimit: 0.0 to 0.0

MeasurementTypesAvailable: [1x2 cell]

DefaultMeasurementType: 'Voltage'

NativeDataType: 'double'

NumberOfChannelsAvailable: 1

SubsystemType: AnalogInput

-----MATLAB path: -----

MATLABPATH

C:\Users\liyana\Documents

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-----End test -----

This information has been saved in the text file:
daqtest.txt

If any errors occurred, please visit the MathWorks Technical Support Web
Site
at http://www.mathworks.com/contact\_TS.html

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Figure 4.7: DAQtest Result

4.3 DISCUSSION

From the data in Table 4.1 show that there not much difference between all the readings because of the temperature for normal water is normally between range 29°C to 30°C . The data in Table 4.2 show the reading for cold water after mixing the normal water with a plastic of ice cube and the reading for first minute show 13.4492°C for NI USB-TC01 and 13.9°C for thermometer show that the temperature not well mix with the normal water yet and after third minute the temperature change

to 8.3462°C for NI USB-TC01. This is show that the temperature at that time is well mix together with the normal water and after fifth minute to 10th minute, the temperature change because of mix with air temperature.

In Table 4.3 show the result after mixed the hot water into the normal water and cold water mixed. The results for NI USB-TC01 show that the first minute after mixed the hot water, the temperature is at 39.5883 and the temperature is decrease until third minute. The fourth minute the temperature is increase to 42.5328 which is the highest temperature among the data. This is show that a plastic of ice cube is effect the temperature after added hot water into the mixed water.

In Figure 4.5 above shows the result which does not appear the graph waveform because of the command in Figure 4.6 getting warning which the channel does not support clocked sampling and because of that, startForeground and startBackground command cannot be used. As replace to startForeground command, the inputSingleScan command can be used to produce the data from NI USB-TC01.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

In a conclusion, in designed GUI using MATLAB for monitoring the change of temperature by created MATLAB GUI and inserted relevant command to the generated editor in constructed a working GUI but because of NI USB-TC01 is not supported the clocked sampling, the data generated is not continuous and the graph cannot be displayed. The output graph should give a result that is the same with NI USB-TC01 temperature. As in the comparison graph in Figure 4.4 showed that the temperature graph for NI USB-TC01 is the same with thermometer graph. In developed a sensor system which capable to monitoring temperature in real-time, the result from NI USB-TC01 is compared with thermometer result during the experiment. A system with suitable range and precision of the temperature sensor is designed and build, with tested the thermocouple with material whether liquid or water that in the range of thermocouple type J which is from -40°C to 760°C .

The advantages in measuring in real-time is can monitor the changes in that time and can take action if the is error occurs. There still some difficulty in implementation technique due to the hardware involves. The NI USB-TC01 is needed to communicate between MATLAB software and the thermocouple type J.

Using the NI USB-TC01, which not compatible with MATLAB without NIDAQmx driver cause a difficulty in programming part. Not only must install the NIDAQmx driver but must know the minimum version required (refer appendixes) of MATLAB software in using the NI USB-TC01.

5.2 PROBLEM OF PROJECT AND PROPOSED SOLUTION

Several issues encountered during the implementation process which is MATLAB software cannot detect the NI USB-TC01. This can be solved by know the minimum version required of MATLAB software and download the win32bit version even though the PC version is win64bit. To solve this issue also must install the NIDAQmx driver with the latest version is better.

Another issue is when the warning displayed after run the analog input command. The warning written as below:

Warning: A channel that does not support clocked sampling was added to the session. Clocked operations using startForeground and startBackground will be disabled. Only on-demand operations using inputSingleScan and outputSingleScan can be done.

Based on the warning written above, the only solution for this problem is to use the inputSingleScan command to grab the data from NI USB-TC01. With using InputSingleScan command can generate the data from NI USB-TC01, the data displayed not in continuous form which have a data in each time but the data is display in a single data per run.

5.3 FUTURE RECOMMENDATION

In future, I recommend using a various type of temperature sensor such as RTD (Resistance Temperature Detector) and Thermistor. This both sensor measure the changes in resistance which the result maybe not same with thermocouple because a few factor in term of construction of RTD and Thermistor, accuracy and resolution, and the circuit design. Using different types of thermocouple is also recommended because there are eight types of thermocouple with different range that can be test and compare with each other result.

In upgrading or generating the good result for this project, using other software that compatible with NI USB-TC01 device such as Labview and Visual Basic (VB) or maybe by upgrading the latest version of MATLAB software can recognize this device. GUI (Graphical User Interface) is the best method use to display the result and easy for user to analyse the result.

REFERENCES

- [1] Hashemian, H. M. (2008, October). *The Versatile Thermocouple*. Retrieved from InTech:<http://www.isa.org/InTechTemplate.cfm?Section=InTech&template=/ContentManagement/ContentDisplay.cfm&ContentID=73202>
- [2] Knapp, W. P. (1996). Input/Data Acquisition System Design for Human Computer Interfacing.
- [3] Lasance, C. J. (2006, November). *The Seebeck Coefficient*. Retrieved from Electronics Cooling: <http://www.electronics-cooling.com/2006/11/the-seebeck-coefficient/>
- [4] M. Kassim, M. N. (2011). A Web Based Temperature Monitoring System. *International Journal of Multidisciplinary Sciences and Engineering* , 17-24.
- [5] M. Mokhtar, M. S. (2010). Design of a Wireless Temperature Acquisition System for Laser cutting Process. *International Journal of Electrical & Computers Sciences IJECS-IJENS* , 41-46.
- [6] Molki, A. (2010). Simple Demonstration of the Seebeck Effect. *Science Education Review*, 9(3), 2010 , 103-107.
- [7] Nazlia Omar, M. F. (2009). Development of Real-Time Temperature and Voltage Monitoring System for Semiconductor Devices. *European Journal of Scientific Research* , 168-177.
- [8] Picotech. (2002, January). *Thermocouple-A Quick Guide*. Retrieved from Azom.com: <http://www.azom.com/article.aspx?ArticleID=1208>
- [9] Recktenwald, G. W. (July, 2010). Conversion of Thermocouple Voltage to Temperature. *Mechanical and Materials Engineering Department* , 1-23.

- [10] Rouse, M. (2008, December). *Seeback Effect*. Retrieved from Search Networking: <http://searchnetworking.techtarget.com/definition/Seebeck-effect>
- [11] Saidin, M. Z. (2008). Development of Sensor using Graphical User Interface. *Bachelor Thesis* , 1-26.
- [12] Sinclair, I. R. (2001). *Sensors and Transducers*. Britain: Newnes.
- [13] Smith, S. W. (2004). *Student Reference Manual for Electronic Instrumentation Laboratories*. Pearson Education, Prentice Hall.
- [14] Son, J. W. (2005). Data Acquisition System (DAS) in General. *Handbook of Measuring System Design* .
- [15] Tong, A. (2001). Improving The Accuracy of Temperature Measurement. *The International Journal of Sensing for Industry* .
- [16] Yoder, J. (n.d.). *Thermocouple Technology: A Matter of Resistance and Metal*. Retrieved from InTech:
http://www.flowresearch.com/articles/InTech%203_17_00.PDF
- [17] MATLAB forum: <http://www.mathworks.com>

APPENDICES

