Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF WIRELESS MEASUREMENT DIAL GAUGE

THINESH KUMAR A/L GANESAN

Bachelor of Electronics Engineering Technology (Industrial Electronic) with Honours

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DEVELOPMENT OF WIRELESS MEASUREMENT DIAL GAUGE

THINESH KUMAR A/L GANESAN

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronic Engineering Technology (Industrial Electronic) with Honours

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2021

DECLARATION

I declare that this project report entitled “Development Of Wireless Measurement Dial Gauge“ is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Student Name : THINESH KUMAR A/L GANESAN

Date : 9 JANUARY 2022

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Industrial Electronic) with Honours.

Signature : 

Supervisor Name : TS WAN NORHISYAM BIN ABD RASHID

Date : 9 JANUARY 2022

DEDICATION

I like to dedicate this thesis to my beloved parents because they have supported me fully since I started to do this thesis. Their love and support have made me more confident to do this thesis.

ABSTRACT

In this technology era, most companies are implementing digital technology to enhance their production rate and quality. Implementation of this technology will ease the company in many perspectives and also will bring many profits. In current days, most companies are improvising their company with the latest technology as it will reduce human error mainly in process of data logging. Most of the latest developed systems are using the wireless protocol. The wireless system is used to control a system from far with no cable connection. The purpose of the system is to enhances the digital dial gauge to perform the task of wireless data logging, eliminate inaccuracies in data logging with automated data transfer, and avoid loss of data measured by saving it straight away into notepad and will be impoted to Microsoft Excel by using Visual Basic Application. ESP32 has been used to control the input and output. The digital dial gauge has been utilized for the purpose of measurement, the measured data will be transferred to laptop or personal computer via Bluetooth function of ESP32. The project is simple to handle and it is a good enhancement for the process of measuring and recording data.

ABSTRAK

Pada era perindustrian 4.0 ini, kebanyakan syarikat menggunakan teknologi digital untuk meningkatkan kadar pengeluaran dan kualiti pengeluaran mereka. Pelaksanaan teknologi ini akan memudahkan syarikat dalam banyak perspektif dan juga akan membawa banyak keuntungan. Pada masa kini, kebanyakan syarikat memperbaiki syarikat mereka dengan teknologi terkini kerana ini akan mengurangkan kesalahan manusia terutama dalam proses memasukkan data. Sebilangan besar sistem yang dibangunkan pada masa kini menggunakan protokol tanpa wayar. Sistem tanpa wayar digunakan untuk mengawal sistem dari jarak jauh tanpa menggunakan kabel. Objektif sistem ini meningkatkan pengukur dail digital untuk melakukan tugas pencatatan data tanpa wayar, menghentikan masalah ketidaktepatan dalam log data dengan pemindahan data automatik, dan mengelakkan kehilangan data yang diukur dengan menyimpannya di notepad dan akan di import ke Microsoft Excel. ESP32 telah digunakan untuk mengawal proses sistem ini dan pemindahan data ke Microsoft Excel dengan menggunakan fungsi Bluetooth. Tolok dail digital adalah digunakan dalam proses pengukuran, data yang diukur akan dipindahkan ke kemudian akan dipindahkan ke komputer riba melalui ESP32 yang mempunyai fungsi Bluetooth. Projek ini senang untuk dikendalikan dan merupakan penambahbaikan yang bagus bagi sistem pengukuran dan log data.

ACKNOWLEDGEMENTS

I would like to express my utmost gratitude to everyone who is involved directly and indirectly in my project. Special mention to my supervisor Sir Ts Wan Norhisyam Bin Abd Rashid who guided me well throughout this project, without them I were not able to finish this project.

Next, I would like to thank my parents have supported me mentally and also financially while I was doing this project as this project requires a 100 percent concentration and I cannot imagine this outcome without their care and help. Not forgetting my friends who have played a very important role in helping me to gather information and guided me thoroughly. Finally, Many thanks to CTRM company for giving me a wonderful opportunity to visualize my creativity through his project and without a doubt this project has thought me a lot.

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LIST OF SYMBOLS

Ω	-	Ohm
%	-	Percent

LIST OF ABBREVIATIONS

IoT	-	Internet of Thing
ESP	-	Espressif
GR&R	-	Gage Repeatability and Reproducibility

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CHAPTER 1

INTRODUCTION

1.1 Background

This project is developed to enhance the method that is being utilized by CTRM company in which manpower is employed to measure and record the data manually. The major objective of the project is to enhance a cost-effective and time-effective method as well as to reduce the supply of manpower for the processes of measuring and recording using a dial gauge. Hence, all these effective workers used for this work can be utilized in different departments which can raise the company's productions, sales, and profits.

Human error can be deducted when the automated method is used for data logging. Besides, a study can be done using the previous reading and used as a backup record for research and development purposes. Hence for this project, a digital dial gauge is preferred than an analog dial gauge because it will produce digital data and it would be quickly transferred to a microcontroller and it is way more accurate and precise.

1.2 Problem Statement

In this era of technology, still many industries are using manual methods to perform a measurement and to record the data. This problem is faced by CTRM company and it gives a big impact on the production rate of the company. Next, when the data is recorded manually, there are high chances of inaccuracies in data logging due to human error. Moreover, the data that has been taken and recorded manually has many possibilities to miss or get deleted

1.3 Objective

Objectives of the project:

a) To enhance the existing dial gauge to perform automated wireless data logging and recording data.

b) To eliminate inaccuracies data logging with automated data transfer.

c) To store data in Microsoft excel which decrease the probability of data lost.

1.4 Scope of Research

This are the scopes of research for this project:

a) The scope of the project is using ESP32 microcontroller to control the data transmission process

b) This ESP32 is integrated with Bluetooth connectivity that used for accurate data transmission between the microcontroller and the computer.

c) The data logged into excel is saved in xlsm file format.

1.5 Conclusion

This project focuses on the wireless dial gauge. The report of this project is separated into five chapters. The first chapter entitles 'Introduction' will explain the overview of the project, objective, scope of research, and problem statement. The second chapter entitled 'Literature review' will describe the previous research which is related to this project. This will describe the technology and method that has been used to complete the project. Next, the advantage and disadvantages of the previous research also is described in this chapter. Chapter three entitled 'Methodology' will describe the electronic components,

circuits, and wireless technology that are planned to be used for this project. Chapter four entitled 'result and discussion' which will describe about the result that has been obtained. Finally, chapter five is conclusion, this part will explain on the overview of the project and also the enhancement that can be done to the project in future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will explain the summary of the recently invented project. The researches and studies have been performed on the project, where the data is collected so that it is possible to refer to the idea of the new technologies. This also gives an idea regarding a project and also what are components and software need to be used in developing a project. The research for literature review is done with the help of certain applications such as Google Scholar, Mendeley Scopus, and others. This application has helped us to find journals related to the projects. The literature review of this project was divided into few parts such as measurement, wireless data transfer, and automated data logging system.

2.2 Dial Gauge

The Dial gauge is one of the most common and prominent measuring tools used in most of the industry in our country. The dial gauge function is to check the flatness of the surface and detect any minor difference in the linear measurement of the same objects. Approaches use by human gives alteration of measurement taken, the types of condition measurement need to be recorded gives the purpose of dial gauge. The aspect of measurement the condition such as the surface thickness gives the difficulty for human analysis this where the equipment like as Dial Gauge comes in, interpreting the measurement of the width, length and thickness of a sophisticated element. The precision and accuracy of

recorded measurement is important and avoid any misinterpretation to certain factor of recording. (Schlesinger, 2009).

2.2.1 Machine Vision Based Automatic Detection Method of Indicating Values of a Pointer Gauge.

In this technology era, digital technology is the most applied technology in most of the industries. As technology is getting advanced, the nation was introduced with digital meter technology. Although digital technology is more advance but still pointer gauge was famous among many fields because of its simple structure, high reliability, low cost, and simple to operate but one of the major disadvantages of this pointer gauge system is it not able to communicate with a computer to perform remote data transmission. The latest digital features have to be implemented on pointer gauge so that perform automated reading and convert the gathered data into the digital signal and kept in a computer. The manual method to measure and collect data requires a lot of manpower and it increases the companies expenditures. The implementation of this system will help to reduce the number of workers on the data collection side and the problem of inaccuracies of data logging due to human error also can be solved. First of all, in this process, the region growing method has been used to identify the location of the dial region and the center point of the gauge. Next, the adaptive threshold method under the polar coordinate system has been used to identify the circular scale region. Thirdly, the scale mark distribution diagram in the circular region is produced by using improved central projection. Hough transformation is utilized to distinguish the pointer at the dial region and get its direction. Lastly, the indicating value of the gauge is get by comparing the direction of pointer with the scale's position and this step known as the distance method.(Chi et al., 2015)

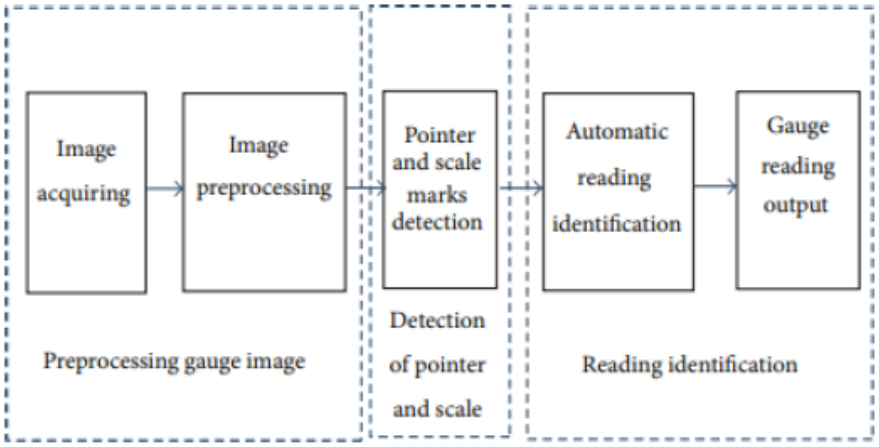


Figure 2. 1: Image analysis methods to read the pointer gauge value automatically(Chi et al., 2015)

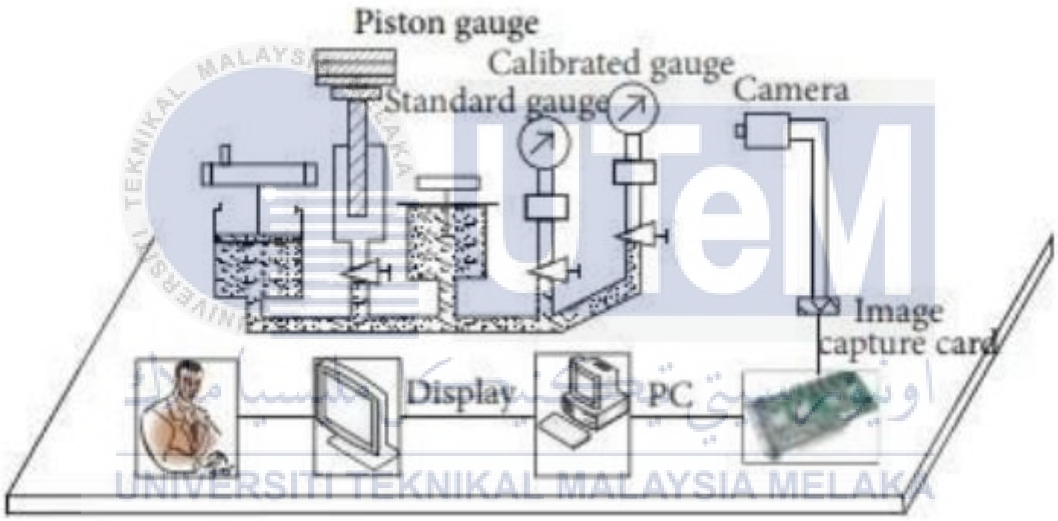


Figure 2. 2: Progress of Automatic Reading of The Pointer Gauge(Chi et al., 2015)

2.2.2 Calibration of dial indicators using machine vision

Dial indicator is one of the most prominent measuring tools in the industry. The rate of usage of this tool is frequent until it can cause damage to the device each year. The damage of the dial indicator maybe cannot be seen through our eyes but it affects the measurement value of the dial indicator. The manual calibration can be done but this problem most cannot be identified with the method. When measured data have error it will affect the next process and finally will cause loss for the company. The calibration of the dial indicator

using machine vision will provide a detailed picture of the problem. Apart from that, this project is it is cheap in terms of costing and easy to install. This method utilized the function of a video camera and a motor-driven length transducer. Michelson interferometer is used to measure the displacement of a dial indicator rod. An angular transistor which was equipped with a phototransistor is put on the dial indicator. This system consists of two length transducer and a red led ring light together with a camera. A ring light was set in a higher position so that no light so the shadow will fall on the glass of the dial indicator. The transducer were utilized to measure the point of the stage and that data has been used as a source to remove the error. The implementation of this system, it makes possible to check many points on the dial indicator scale.(Hemming & Lehto, 2002)

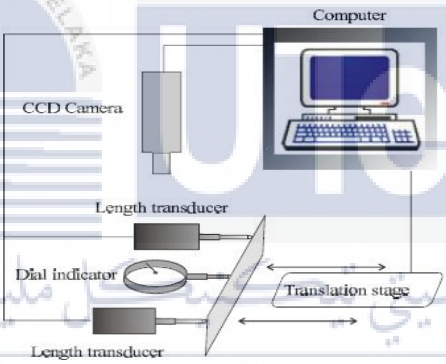


Figure 2.3 Working principle of the device(Hemming & Lehto, 2002)

2.2.3 Digital dial gauge using potentiometer

Digital dial indicator is developed to measure the flatness of a surface. The length travelled by the knob is calibrated by utilizing. A potentiometer was adjusted to get the distance travelled by the knob in the linear range. GUI software has been utilized to present the digital output. Several components have been used in this project, those components are Door latch to implement the vertical movement mechanism. Next, a Forex board was used to create the casing of the device. A slider model potentiometer is applied to detect the displacement and provides output voltage in form of analogue. Arduino Uno is used to

retrieving the output from the potentiometer and transfer it to the computer. Double-sided tape is used to attach the latch and potentiometer to the forex casing. Spring is used to establish plunger action. A burette Stand is used to hold the device. The knob which will move is attached to the potentiometer which is in a set in a linear area. Two software was used in making this project, the first one is Arduino Ide and the second one is python. Arduino ide is utilized to program the Arduino board and python was used to create the user interface. The Arduino will be connected to the computer by using a USB cable(Rajan, 2019)

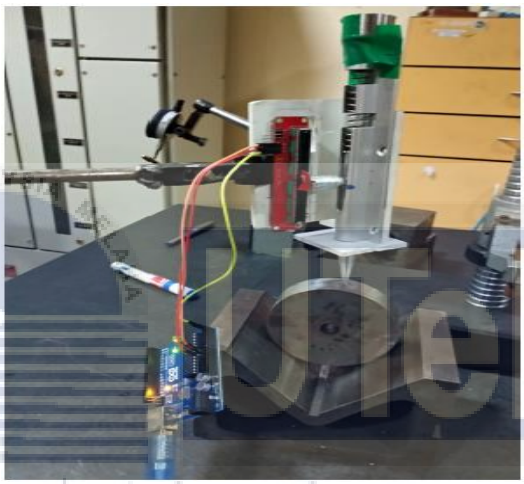


Figure 2.4: The design of the device(Rajan, 2019)

2.3 Wireless Technology In Industrial Network

Communication or data transfer without the usage of wire can be done by using wireless technology. This technology establishes a network for information transfer. Wireless technology is cost-effective as it does not require the usage of wire. In this technology era, most of the devices and electronic gadgets are using wireless technology and most of the industry is now implementing this automation to increase their productivity. The industrial uses wireless technology as it will help them to enhance their subsystem and to reduce the cost in terms of no cable being used, makes wireless technology famous among the nation and widely are being used industrial system. moreover, wireless technology has

very high quality and timing requirements compared to previous wired technology, as it is covered by the Fieldbus system. (Andreas Willing, 2005)

2.3.1 Bluetooth Low Energy: Wireless Connectivity for Medical Monitoring

Health is one of the most prominent matters that need to be taken extra care of as the value of a life cannot be compromised with money. In most of the European countries, they have developed a system that applies wireless electronic monitoring systems to check and observe their health level. With the aid of this system, the patients who are under monitoring do not have to stay longer in hospitals. patients could remain at home and observe their health level with the aid of this monitoring system.

Next, this system also assists the patient to reduce the money that has to pay for home visits medical staff for recording daily health reading because the nurses do not have to come daily to take the reading and only need to come when there is a need or request from the patients. The daily health reading measurement will be transmitted wirelessly. There are some problems to patients who are using this technology has to be improvised, so it can be utilized wider. As an example, the power consumption in this technology has to be low, where the small batteries can be used for long hours and the maintenance fees will not be very high as the battery is small. Finally, the exchange of data has to be checked and upgraded rapidly to assured that it could be joined and interacted with latest manufactured products or gadgets.(Omre & Keeping, 2010)

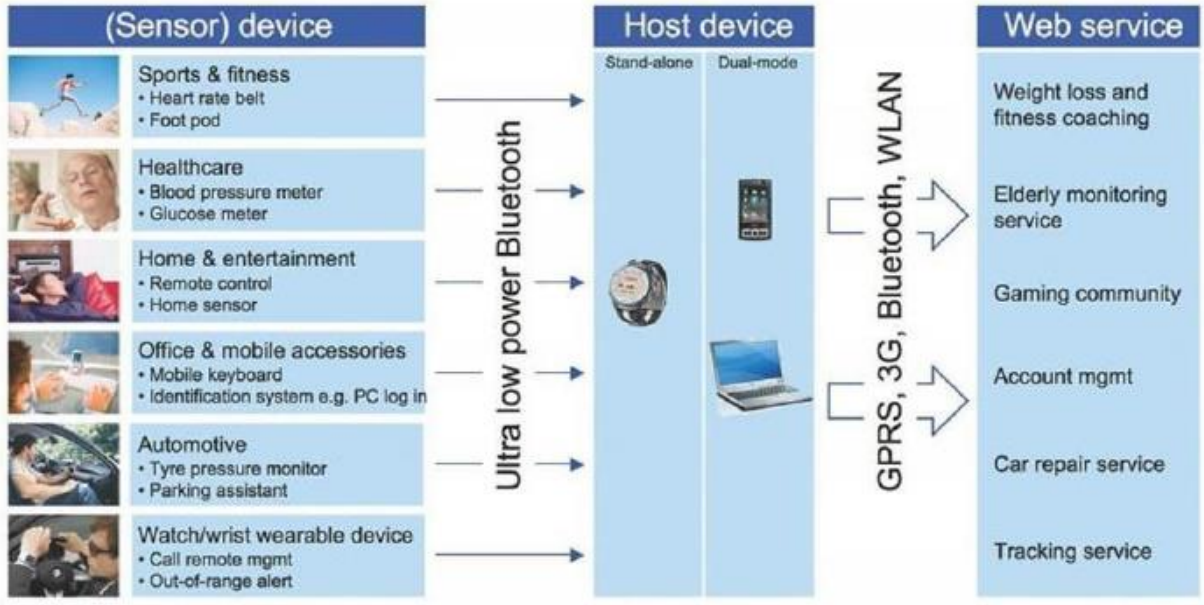


Figure 2.5 : Work flow of Bluetooth Module(Omre & Keeping, 2010)

2.3.2 Wireless Arduino Based Weather Station

Weather forecasting can be done by retrieving the output value of some specified sensors. This helps people to stay alert before bad weather going to hit by referring to forecasting design. The major advantage of this system is this device works under the principle of lower power consumption with high accuracy in output data. This device can be placed in so many places as it small and portable. The device can be used to measure the moisture level of the soil, rate of rain, temperature, and surrounding humidity. The data of the sensor will be saved in web server which means it can be viewed from everywhere and at any time.

Several sensors and a microcontroller is used in this project. Arduino uno will control all the sensors. Next, DHT-11 is applied to measure the surrounding temperature and humidity. A rain sensor was utilized to detect whether it is raining or not. BMP180 pressure sensor also has been attached to the Arduino to take the measurement of surround pressure. the soil moisture sensor was used to detect the moisture rate of the soil. WiFi shield has been

used to transfer the data with the help of Thingspeak to send the result to the cloud and the output can be visualized from there.(Katyal, Amber; Yadav, Ravi; Pandey, 2019)

Figure 2.6: Data view in ThingSpeak (Katyal, Amber; Yadav, Ravi; Pandey, 2019)

2.3.3 Smart Home for Elderly Care, based on Wireless Sensor Network

In this technology era, most of the elderly people stay alone in their home because all their kids stay in other parts of the country due to work purposes. As we are getting older, people start to have the problem of forgetting and this may cause the problem in terms of the safety factor. Wireless Sensor Network-based smart home system is created to aid the old people to make their work simple and enhance their safety.

ZigBee technology is a wireless network, which used for monitoring and also controlling. The major benefits of using ZigBee is it is using a battery that integrated low power consumption technology, cheap in term costing and have a good range in term of

network. Zigbee network has divided into three device types. The first one ZigBee Coordinator which is used to organize frequency channel utilized for this network and permits device to join it. Next, ZigBee End Device which employed to send and receive messages. ZigBee Router is to transmit a message from one node to another node. Sensors, switches, GSM, and microcontrollers were utilized in this project. Those sensors are LM 35, which is used to detect temperature. Next, is the MQ-6 sensor which is used to detect gas leakage. The magnetic switch is used to ensure whether the door is closed or not. Arduino Mega 2560 is used to control all the sensors and switches. The ZigBee is used to transfer the sensor output data wirelessly to a computer and from there the data will be analysed by LabView software and the output value of each sensor can be seen on LabVIEW. The alert message is sent to the mobile phone and voice is played on speaker if the value of any sensor is more than the preset value.(Ransing & Rajput, 2015)

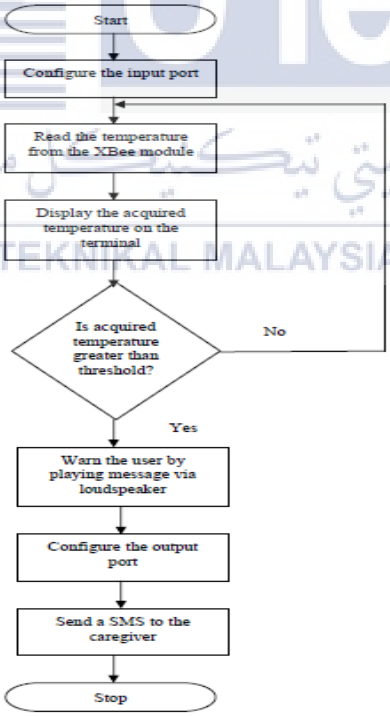


Figure 2.7: Flow of data processing in LabVIEW(Ransing & Rajput, 2015)

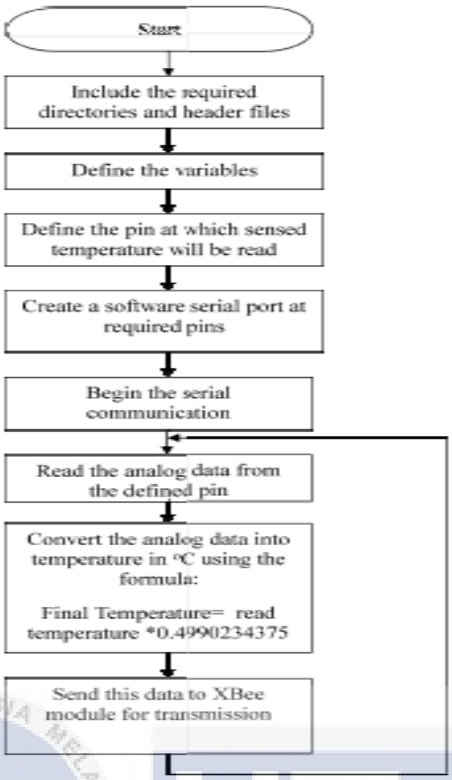


Figure 2.8: work flow of Arduino ATmega2560. (Ransing & Rajput, 2015)

2.4 Application of wireless technology

In this technology era, most of the systems or gadgets are using the technology of microcontroller or integrated circuit computer. This microcontroller act as the brain to controls the instrumentation the system. There are several varieties of microcontrollers that are available in market. The examples of the microcontroller is Arduino, ESP32 Boards, Raspberry Pi and many others. These microcontrollers are easy to study and understand how to use it. The processing time of the data is very quick and can be easily get connected to another system to perform some operation. The number of latest technology increases day by day because it is easy to understand, cheap and high reliability, with the help of technology many problems can be solved easily.

2.4.1 Real Time Energy Measurement Using Smart Meter

Measuring the power by using hall current sensor and alert users about their power usage is the main objective of this project. As the number modern technology users such as phone, PlayStation and the computer increases, the usage of electricity also increases drastically. people use electricity beyond the limit due to no alert or reminder given to them and they only realized when they received the monthly electricity bill. This device will monitor the power usage and will notify the user when it exceeds a specified level, with help of this meter user will stay alert and no need to spend more money on the electricity bill. The wireless network technology of ESP8266 has been interfaced with Arduino Uno to Arduino Yun to transfer the data of the sensor. ESP8266 is used as a Wi-Fi module for this project because it is cheap and can be used for many IOT applications. Arduino Uno is used because the price of this board is cheap and easy to be programmed. Next, Arduino Yun is integrated with Wi-Fi and ethernet port, which ease the process of establishing communication with ESP8266. This project also integrated with a data logging system for the purpose of data logging into Microsoft Excel, which helps to monitor the usage of power. (Pawar et al., 2017)

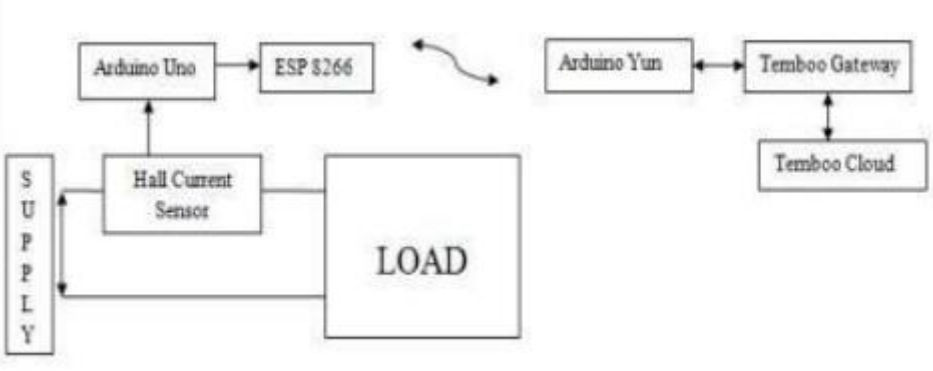


Figure 2.9: Connection diagram of the Smart Meter.(Pawar et al., 2017)

2.4.2 Internet of Things Based Smart Home System Using ESP32 Microcontroller

In recent days many people have a problem of forgetting to turn off an electrical appliance when they are not in use and this lead to a drastic increase in electricity bill. next, some people unable to turn on or off any electrical appliances because of their health condition which not let them walk. This has made people who not able to walk depend on some other people to turn on or off electrical appliances. As technology is developing day by day, most people are like to utilize automatic appliances which they trust that it will make their life easier and they can have a good life. The main reason to develop the project of Internet of Things Based Smart Home System Using ESP32 Microcontroller is to make people life easy and to assist disabled people. With the implementation of this system, people can turn on the electrical appliances at their home even though they are far from home. This method operates the switching by an online server. Ubidots STEM MQTT server and ESP32 which is used turn on or off the electrical devices like fan.

The relays are controlled by ESP32 to control high current devices. MQTT server is being utilized to give instructions to control the output. Web-based control buttons are designed using ubidots which means a user may turn on or off any electrical appliances online until the internet network available. Other than that, three LEDs were utilized to detect the condition of ESP32. The led will blink if the microcontroller is in a state of connecting to a router and if it is connected, all the three led will not be blinking but remain on in a steady state. When the internet connection absent, it will straight away exit from the loop plus started to execute a manual method which means the user can turn on or off an electrical appliance by pressing the switch manually, and when this situation happened a red led is turned on.(Marek Babiuch and Jiri Postulka., 2020)

2.4.3 Low Cost Wireless ECG Patch using ESP32

Cardiovascular Illness caused many people to die every day. This problem can be solved from getting worse it is detected at the early stage, which means full-time monitoring is a must. This is because the behaviour of the heart cannot be judged and cannot figure out when the heart will become abnormal. An electrocardiograph device (ECG) is a standard tool to monitor heart electrical signals by skin surface. wearable ECGs. are popular among people and they can be divided into three categories which are patch, strap, smartwatch, and shirt. A patch is the most popular because it provides extra benefits in its flexibility to locate the electrode. The electrode location for each user is a various character of heart disease and some users can set the electrode where they feel comfortable. The wet electrodes are used for good quality signal and the adhesive electrode is utilized to hold the patch that has been placed on the skin. The signal from wet electrode will be filtered and amplified. Most of the current ECG patch only present Heart Rate variability(HRV) without record it or send it. The waveform capturing quality must be good to get an accurate HRV calculation. Some of the current wireless ECG patches only have a Right Arm and Left Arm and they do not have Right Arm Drive, this can lead to a low Common Mode Rejection Ratio which is also known as (CMRR). RLD is extremely important to improve the CMRR. wireless ECG patch is capable to transfer ECG waveform and determine the HRV. ESP32 has been used for transfer the data as it is integrated with a Bluetooth Classic, Bluetooth Low Energy, and the Wi-Fi module. (Sugandi et al., 2020)

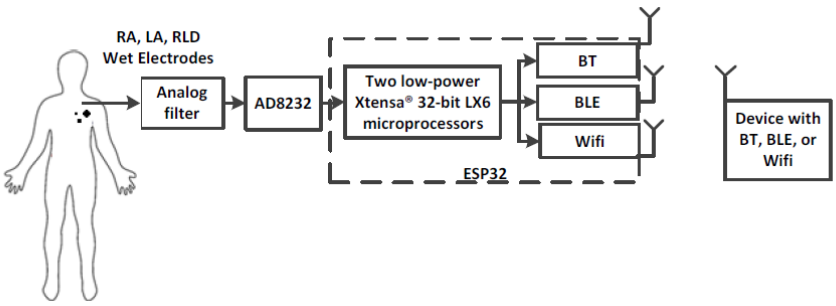


Figure 2.10: process flow of the system (Sugandi et al., 2020)

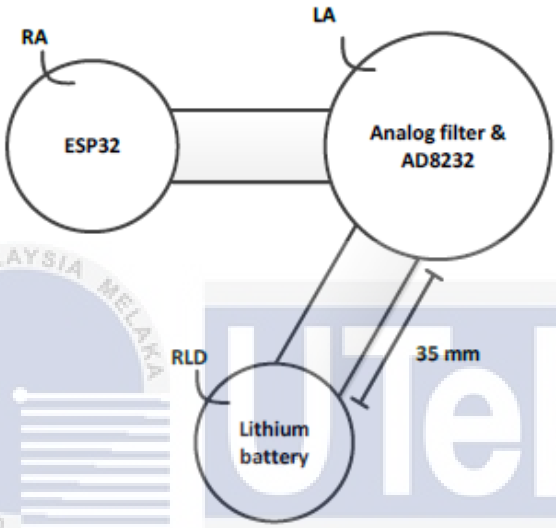


Figure 2.11: Components of ECG patch(Sugandi et al., 2020)

2.5 Wireless Data Logging System

The title of data logging is also known as the data recorder and it is mostly used in standalone data acquisition systems or devices. This system included some digital and analogue input that will be observed and the results inputs will be kept in a local memory. the usage of modern technology such as wireless health monitoring and wireless data transmission has been created with the joining of wireless system technology and data logging technology. The joining of wireless technology together with the data logging system This system will collect few amounts of data, even though the amount of data is small but will be very prominent. Most of data logging application has the features of creating a

discrete event controller, which is able of generating rule-based tasks to address the data. (Aditya N Das, 2009).

2.5.1 A Low Cost, Versatile Data Logging System for Ecological Application

The revolution of technology brought up the problem of climate changes and these changes have gave a big impact on all living things on this earth. Nano Logger is a project that works to collect data of climate changes that affect the marine life. This project is developed using the Arduino platform. in this project, few sensors have been used for example thermocouple sensor to detect the surrounding temperature. Next, infrared sensor has been used to monitor the heartbeat rate of the marine life. The Arduino has been selected to be used in this project because the price of the board is much cheaper compared to other microcontrollers and to does not need special knowledge to operate it. This system also able to generate an environmental logger network to detect different type of neighbouring environment within the geographical scales. moreover, the system has great reliability as it has been used for a long time to monitor marine life. The problems that occurred in Arduino also can easily be detected and can be fixed. The availability of this system caused more people not to use other microcontrollers which is very complex and hard to understand the working principle. The data retrieved from Arduino can be easily kept on computer and memory card. The Arduino can operate for long hours as it does not require high power to operate. finally, as the Arduino can be easily connected with other devices, this helps to transfer data from Arduino to Microsoft excel. (Gandra et al., 2015)

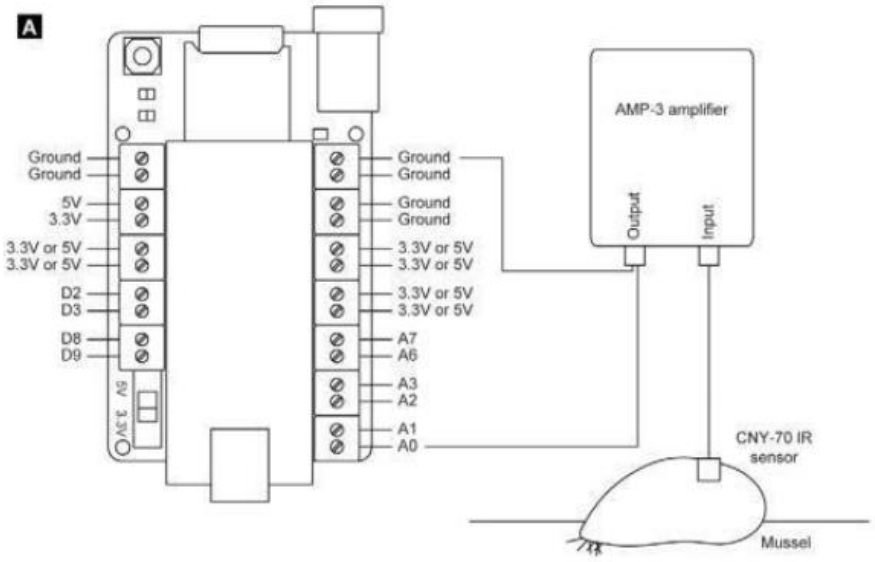


Figure 2.12 : Nanologger attached to Sensor(Gandra et al., 2015)

2.5.2 Using Chemduino, Excel and PowerPoint As Tools for Real-Time Measurement Representation in Class.

The gathering of the data and record it manually will require some time and energy while conducting a study using the hands-on method. For example, while conducting laboratory work student faces some difficulties to conduct the lab and record the data manually at the same time and this leads to some problem such as inaccuracies data recorded and data loss. The implementation of digital technology is needed to avoid the problem stated above from happening and to make sure that the result recorded is accurate. The data can be transferred to the computer by using the Internet of things (IOT) technology, where the Arduino act as the microcontroller and the PLX-DAQ is used to transfer the data to a computer. moreover, for some research such as researches about chemicals, it requires collecting many types of data from different type of sensors. The data that commonly collected in an experiment regarding chemicals is temperature, pH value, and acid or alkaline. All the measured data has to be transferred to a computer and kept in Microsoft Excel or other applications based on what we programmed in Arduino. This automated data

transfer will make sure recorded data from losing and easy to monitor.(Walkowiak & Nehring, 2016)

Figure 2.13 : PLX-DAQ system(Walkowiak & Nehring, 2016)

2.5.3 PLX-DAQ-Based Wireless Battery Monitoring System for Obstacle Avoidance Robot

In this era of industrial revolution 4.0, many companies have utilized robots to perform some tasks. The major problem in this implementation is the robots operate using battery power and which caused them to have short power life. The monitoring of the battery status of a robot is a very prominent matter that has to be considered for them to operate without any interruption. The wireless battery status monitoring system is developed. The electronic components that have been utilized in this project are hall current sensors, ATMEGA microcontroller, and the Bluetooth module HC-05. This system will keep on monitoring the status of the battery's voltage and current while the battery is discharging or when the robot is in a move. The hall current sensor and the voltage divider circuit have been used to detect the draining of the battery and this data will be sent to the microcontroller and

then will be transferred to Microsoft Excel using the Bluetooth functionality and the data can be viewed in Microsoft Excel with the utilization of Parallax Data Acquisition application. The PLX-DAQ software is utilized to provide communication between Microsoft Excel and the microcontroller. The data will be displayed in two methods the first one is tabulated form and the next one is the graphical form.(Sreenivas Rao & Shivakumar, 2020)

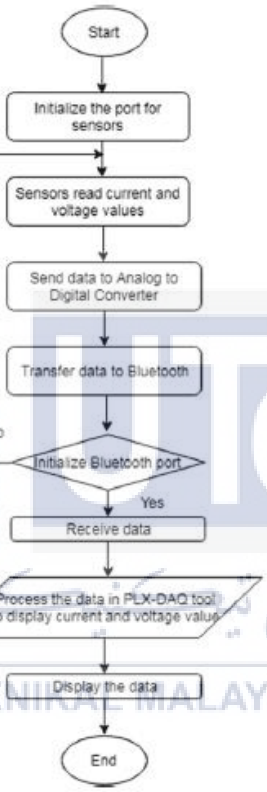


Figure2.14:Flowchart of the system(Sreenivas Rao & Shivakumar, 2020)

2.6 Comparison of Past Related Research

Project tittle	Advantages	Disadvantages
Machine Vision Based Automatic Detection Method of Indicating Valuesof a Pointer Gauge(Chi et al., 2015)	• Enhancing the pre-existing system does not effect the existing features of the system. • New system gives benefit to the workers and also the company	• The project developed in a wide scale. • application of the latest technology will cause the installation of the display screen on each dial gauge
Calibration of dial indicators using machine vision(Hemming & Lehto, 2002)	• Able to check many points on the scale of dial gauge • Low cost in terms of development and installation	• The size of the system is bigger and complex

Digital dial gauge using potentiometer(Rajan, 2019)	• Low development cost • Easy to develop	• Has to calibrate rapidly to avoid inaccuracies of data
Bluetooth Low Energy: Wireless Connectivity for Medical Monitoring(Omre & Keeping, 2010)	• Can be used for long hours as the power usage of this system is low. • Data can be monitor wirelessly.	• As Bluetooth is energy efficient the speed of transferring data is slow. • There is limitation in the distance range of the Bluetooth connection.

Wireless Arduino Based Weather Station(Katyal, Amber; Yadav, Ravi; Pandey, 2019)	• Able to work in low power consumption mode • Low cost components were used • Flexible to place any where as the system is small	• Unable to transfer data if there is interruption in Wi-Fi connection
Smart Home for Elderly Care, based on Wireless Sensor Network(Ransing & Rajput, 2015)	• Ease some task of the elderly • Enhance the safety of elderly people by alerting them when any of the sensor value is more than preset value	• Limitation in terms of distance of data transmission range

Real Time Energy Measurement Using SmartMeter.(Pawar et al., 2017)	• ESP8266 works as Wi- Fi module which makes Data can be accessed wirelessly.	• The circuit has been constructed using many electronic components.
Internet of Things Based Smart Home System Using ESP32 Microcontroller. (Marek Babiuch and Jiri Postulka., 2020)	• It is increasing the safety of the house • Alert message will be sent to owner's phone number if any mishaps when we are not at home	• The system is quite complex
LOW COST WIRELESS ECG PATCH USING ESP32(Sugandi et al., 2020)	• Flexible to use • Low power consumption increases the device's life • Low cost	• The battery has to change rapidly • The electrode has to change rapidly

A Low Cost, Versatile Data Logging System for Ecological Application(Gandra et al., 2015)	• Affordable data logging system can be developed using Arduino and sensors	• Not user friendly as we need collect the microsd card and then transfer or kept the data in to computer
Using ChemDuino, Excel, and PowerPoint as Tools forReal-Time Measurement Representation in Class.(Walkowiak & Nehring, 2016) .	• Low cost data logging project by using Arduino and sensors • organized and secured Automated Data logging into Microsoft Excel with PLX-DAQ	• The data logging will be continuous if not monitored and controlled which can cause the computer to be slow when high amount of data has been logged into computer.

PLX-DAQ-Based Wireless Battery Monitoring System for Obstacle Avoidance Robot.(Sreenivas Rao & Shivakumar, 2020)	• Easy to view and analyze data as it is displayed in graphical and tabulated method	• Limitation in distance of data transfer

2.7 Differences Between ESP8266 and ESP32

Specification	Esp8266	Esp32
Wi-Fi	Yes	Yes
Bluetooth	No	Yes-Bluetooth 4.2 and Bluetooth low energy
ADC	10bit	12bit
MCU	Xtensa Single-core 32-bit L106	Xtensa Dual-Core 32-bit LX6 with 600 DMIPS
Frequency	80MHz	160MHz

Table 2.1: Comparison between ESP8266 and ESP32

2.8 Conclusion

A study about the previous research is done, based on that study, I can conclude that a dial gauge is a tool utilized to measure the flatness of the surface. The data from the dial gauge can transfer to excel by using wireless technology. The data can be transferred using Bluetooth or Wi-Fi protocol and this connection can be established by using ESP32 or ESP8266. The difference between these two components is ESP8266 only has Wi-Fi connectivity but ESP32 has wi-Fi, classic Bluetooth, and Bluetooth low energy connectivity. For this project, I planned to transfer data to Microsoft Excel by using the Bluetooth functionality of ESP32 nodeMCU.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter explained the technology and the technique that planned to be utilized in the process of developing the project workflow. The automated data recording system utilizing the electronic dial gauge eases the process of measurement and also data logging. The development of this project is divided into some categories. The fundamental category is the construction of a hardware circuit by using electronic components to retrieve the result and transferred it wirelessly. The second category refers to the utilization of the software so that the electronic board can be programmed to perform a specific task.

3.2 Process Flow

The process flow chart explains how this project is planned and the progress of the project goes based on the planning made. The planning for each week is made after had a meeting with the project supervisor. The project flow chart defines each method that planned to be utilized to finish the project successfully.

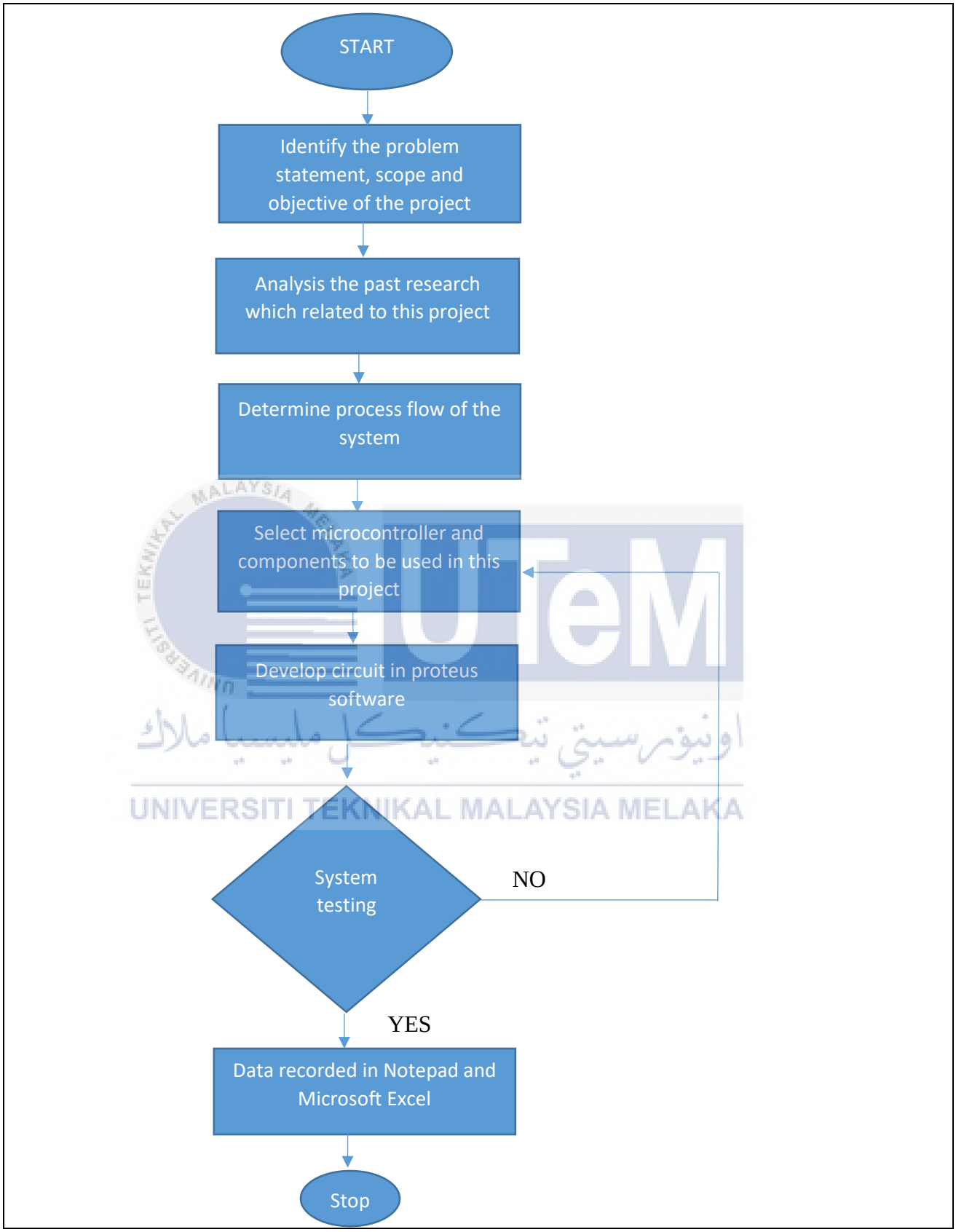


Figure 3. 1: Flow Chart of Project development

3.2.1 Identification of the Problem Statement

The problem statement is to know what are the difficulties facing by CTRM company in the process of measuring and recording data from the dial gauge. As they are using a manual method in the process of measuring and recording data caused a big impact on their production rate because it requires a huge time to complete the process before sending it for the next process. Next, there are high possibilities for inaccuracies in data logging when the data is inserted manually. finally, the possibility of the data gone missing is very high.

3.2.2 Analysis Literature Review

This section will discuss the analysis on the past research which related to this project to identify what are the technology, electronic components, and method used in the previous project that can be implemented on this project to solve all the listed problem statement. In conducting this analysis, the thesis report of the project related to dial gauge, wireless technology, application of wireless technology, and wireless data logging system has been studied.

3.2.3 System Flow

The flow chart will summarize the route taken along the process flow towards the development wireless measurement dial gauge. The development of the project is classified into two designated parts and one of them is the development of the hardware. The hardware is design to retrieve data from the dial gauge, which is apparently then connected to ESP32 which transfers the digital signal received from the dial gauge and transfer it to the personal computer

via Bluetooth. Next, the utilization of software to establish communication between the computer and the dial gauge via Bluetooth.

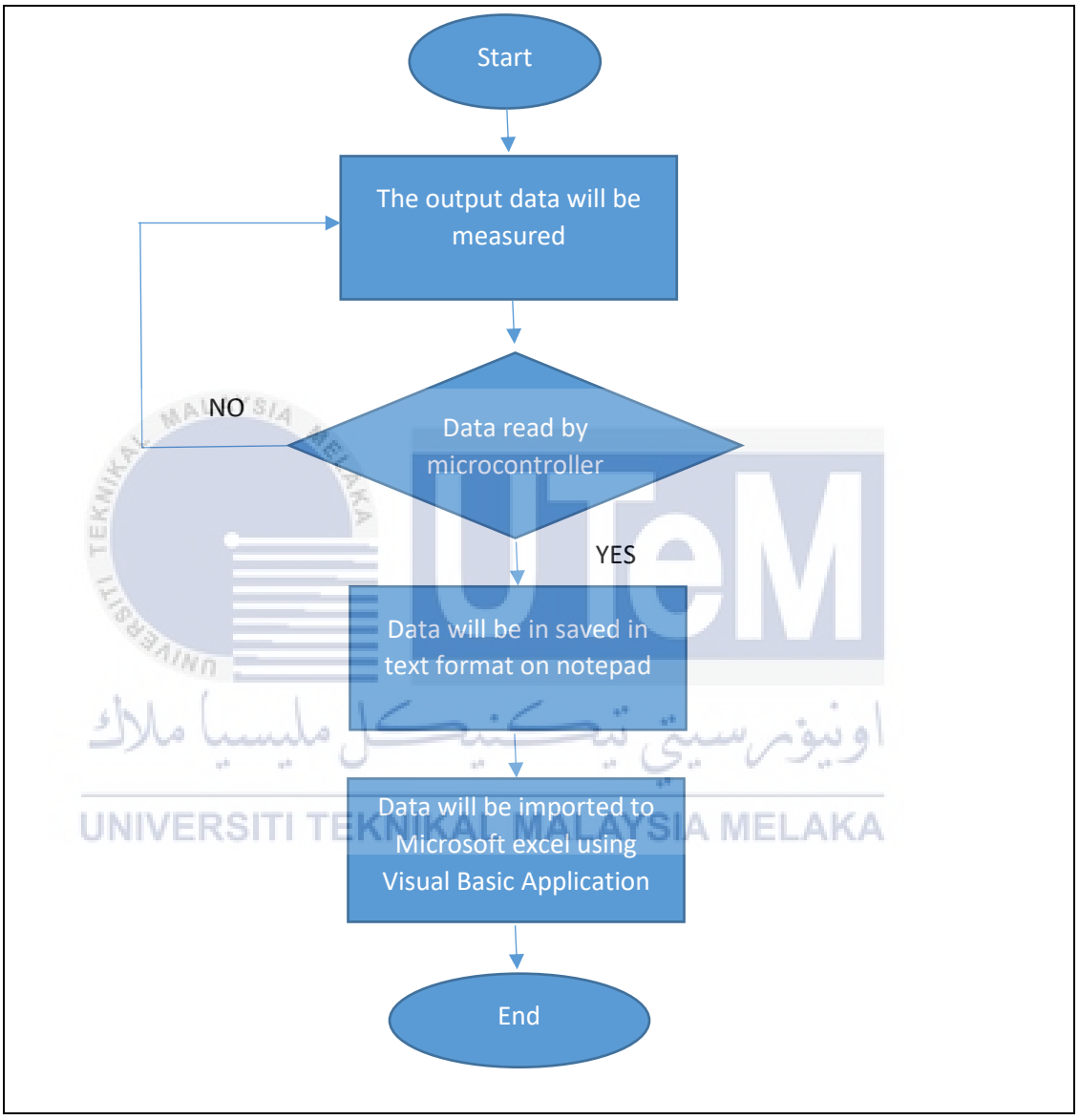


Figure 3.2: Flow Chart of System works

3.3 Project Component

The electronic components should be select wisely as it plays an important role and it should follow the requirements of CTRM Company. The studies made has aided to select the correct electronic components that need to be utilized to complete this project. Few factors have to be taken into consideration in performing this project such as:

- The size of the project has to be small and portable as it will be easy to carry while taking data
- This system is easy to handle and collected data stored in Microsoft excel properly.
- The development expenses of this project are inexpensive and the functionality is worth the money that has been paid

3.4 Designing Hardware Circuit

The name and function of each pin the dial gauge have been identified by referring to the datasheet of the dial gauge. A simple circuit has been designed by using 47KΩ resistor to protect the dial gauge. A push button with 10KΩ were used. The designed circuit is then connected to ESP32 to program

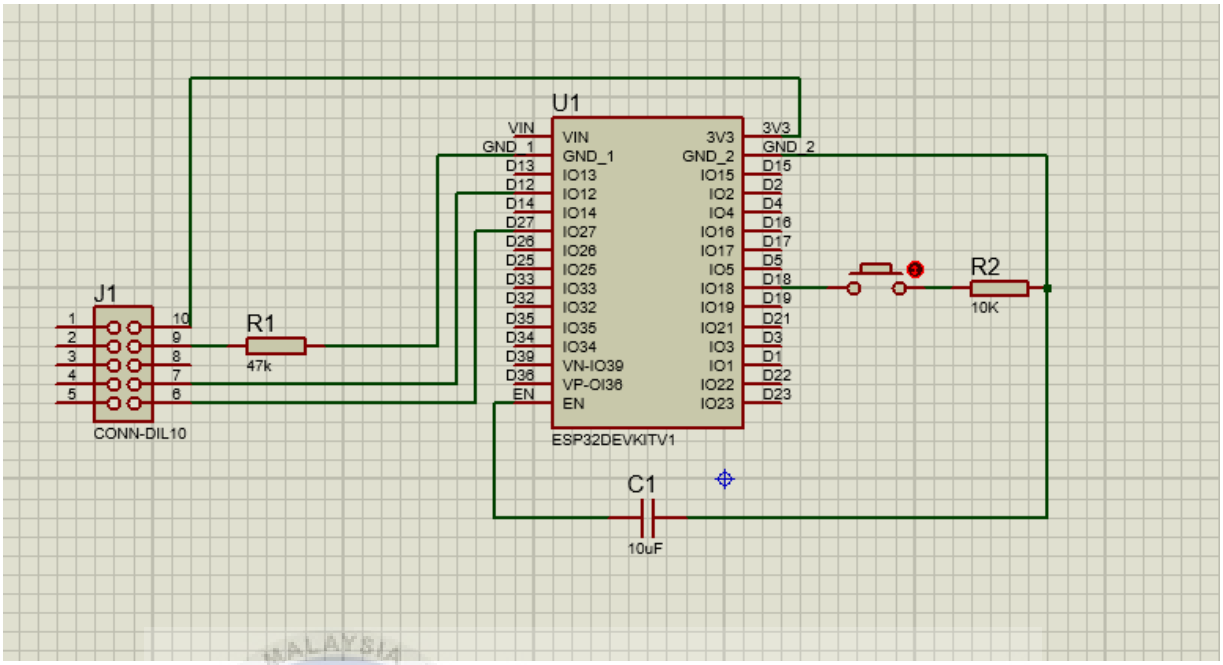


Figure 3. 3: Connection of Arduino ESP32

3.4.1 ESP32 Microcontroller

ESP32 has been selected to be used as a microcontroller to control the whole system of this project. The microcontroller has been chosen after consider the size factor. The project must be small in size, must be portable and, can perform wireless data logging. ESP32 fulfill all the requirement mentioned. Other than that, ESP32 is already integrated with the Bluetooth module so, no external Bluetooth module is required. In this project, wireless data transmitting and receiving are performed using Bluetooth function. Esp32 has been decided to be used in this project as it is small in size, portable, and foremost it is cheap cost-wise when compared with other microcontrollers. This microcontroller can exchange data between many electronic devices. The concept of machine to machine is being used in this project as this is a wireless data logging project, no manpower is required to do the data logging. Esp32 will directly send the data to Microsoft excel on our personal computer.

Figure 3.4: ESP32 Microcontroller

3.4.2 Digital Dial Gauge

A dial gauge is tool used to measure angle and small distance. Dial gauge can be classified into two categories. The first is analogue and the second is digital. In this project, digital dial gauge has been utilized. The value of the measurement is taken in binary and then the value will be converted into a readable form and will be displayed on the LCD screen of the dial gauge. Moreover, this project a dedicated to CTRM company and they are using digital dial gauge in their production and this is one of the reasons why digital dial gauge has been used in this project.

Figure 3.5: Digital Dial Gauge

3.5 Utilization of Software

Two software has been used to complete this project. Arduino ide software has been used to program the ESP32. CoolTerm software has been used to save the data transferred via Bluetooth in text format. Visual Basic Application software has been used to import the saved data text format data into Microsoft Excel

3.5.1 ESP32 System

ESP32 has been selected as the microcontroller to use in this project. This decision was made after bringing several factors into consideration. Firstly, ESP32 is a small microcontroller with high specifications. Next, the programming language of this microcontroller is easy to understand and the application Arduino IDE can be used to program the board. The ESP32 library has to be installed in order to communicate Arduino IDE with ESP32.

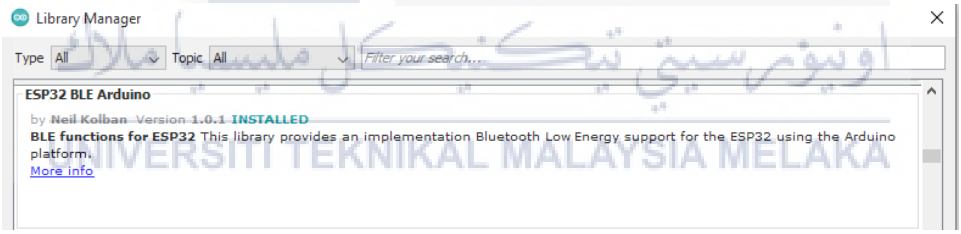


Figure 3. 6: Installation of ESP32 library in Arduino IDE

3.5.2 CoolTerm Software

CoolTerm can be used as data logging system, as it can directly transfer data as it can save data in text format. This software is very important and helpful as it will organize the data properly and the graph can be generated. The prominent factor that needs to be considered to transfer the data via Bluetooth is the settings of the baud rate and port number. The value of baud rate and port number set in the Arduino ide must be the same with setting in CoolTerm.

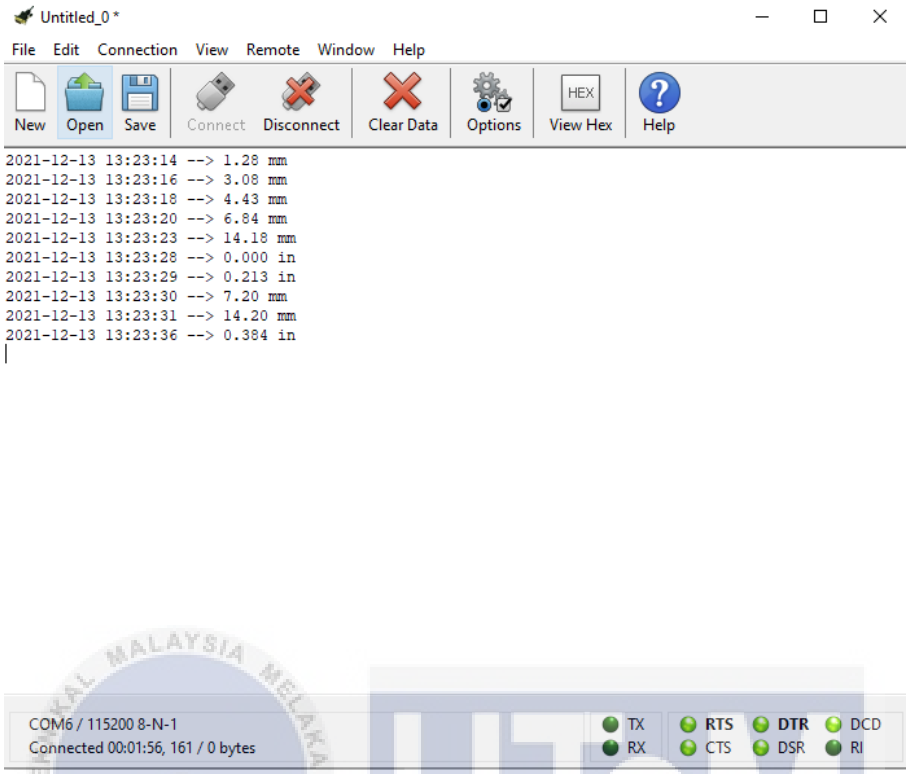


Figure 3.7: CoolTerm data retrieving system

3.6 Conclusion

This project will be very helpful to CTRM company to increase their production as the automatic data logging system is being used. Currently, they are using a manual method to record the data which leads to some problems such as data loss and inaccuracies of data logging. This project will reduce the manpower needed for measuring and data logging because by implanting this system a same worker can do the process of measuring and recording. The project is user-friendly as it is built in small in size and portable which can be carried by the worker wherever he goes. Finally, the measured data will be saved in text format and VBA is used to import the data into Microsoft Excel and can be documented in a proper way.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

The chapter of the result and discussion will discuss how the project works. The problem faced and the method that has been implemented to solve the problems also will be discussed in this chapter.

4.2 The Data Collection Process

This project prioritizes the function retrieve and transferring the data to excel wirelessly. This not only helps to reduce the worker's job scope but also helps to eliminate the error that occurs during the manual data logging process. This latest technology will help to make the data collection process to be more efficient. The survey has been given to students to get their views about wireless data collection and transmission.

The respondents occupation has been focused on this survey. This is because students and workers might have different views about this system as both of them are in different stages of life. From the analysis that has been made the number of workers who answered this survey is much higher than the number of students who answered this survey. This might be because workers might have better knowledge about this because most of the workers will be involved in the data collecting process and also they might need this latest technology to ease their work process. Based on the pie chart below it shows that 58.3% which is equivalent to 21 respondents who answered this survey are workers. Meanwhile, 41.7% which is equivalent to 15 respondents who answered this survey are students.

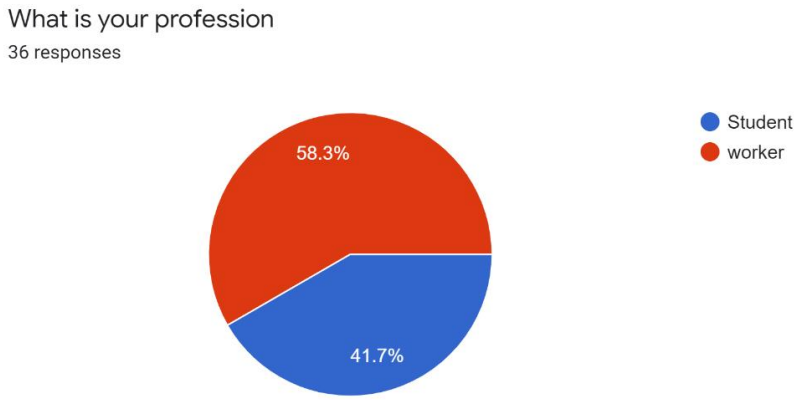


Figure 4.1: Respondents percentage

The second question for this survey is "Do you think that wireless data transfer will help you in your daily life". This question has been asked in this survey to get people's views regarding the usage of wireless data transfer in their daily life. Based on the pie chart it shows that 2 respondents which are equivalent to 80.6% answered yes to this question. meanwhile, 7 respondents which is equivalent to 19.4% answered no to this question. This proves that wireless data transfer system helps people with their daily life

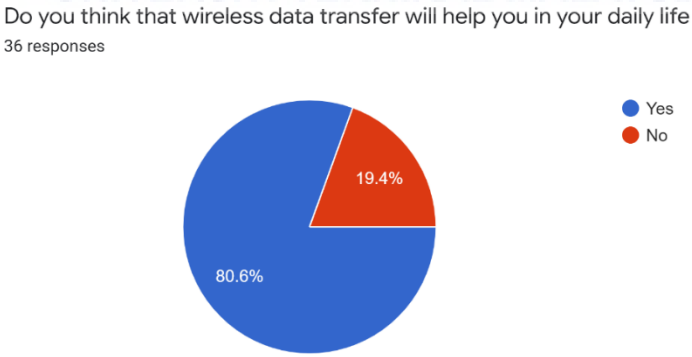


Figure 4.2: Respondents answers in term of percentage for first question

The last question is to monitor the respondent's views regarding the method that they will be used for the data collecting and logging process. Based on the analysis that has been made its shows that 86.1% which is equivalent to 31 respondents prefer to use wireless data logging systems. meanwhile,13.9% which is equivalent to 5 respondents prefer to use a manual data logging system.

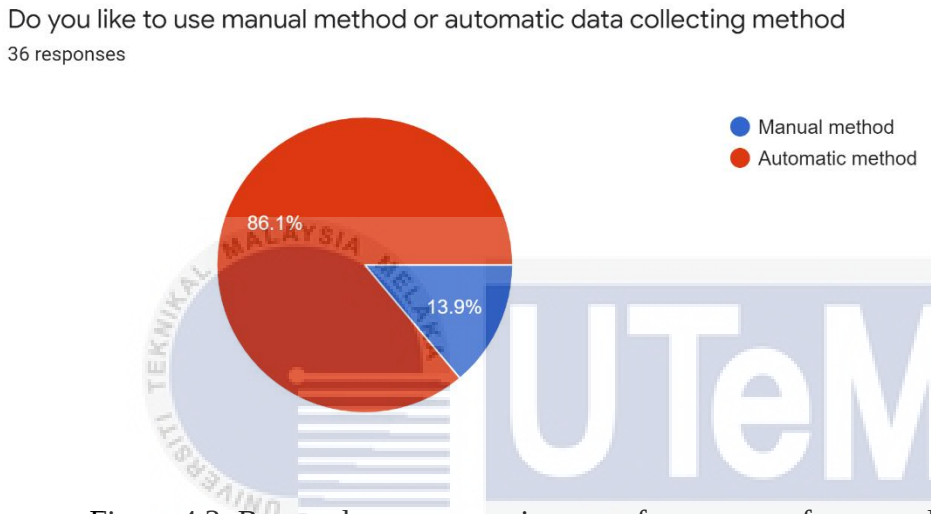


Figure 4.3: Respondents answers in term of percentage for second question

4.3 Hardware Utilized

In the development process of this project, a few hardware components have been utilized. All these components are needed to make this project works. In this part, the details about the components that have been used will be explained

4.3.1 Digital Dial Gauge

In the initial plan, the dial gauge using by CTRM company is planned to be used in this project but due to some circumstances, the dial gauge with the different brand has been used. although the brand is different the function is still the same and the difference is only in the aspect of design.

The dial gauge that is being utilized by CTRM is Mitutoyo's dial gauge but this device is costly and very hard to buy as it is not available in most places. This is the main cause for using a different dial gauge in the development process of the project. The big advantage of the dial gauge is a port that can be used for data collection has been given. This port can be used to retrieve the data of dial gauge

The first step that has been taken to this dial gauge is identifying the purpose for every pin in that output port. This process needs to be conducted in the laboratory as the help of an oscilloscope is needed but due to some obstacle, the laboratory is not available at that moment. To solve this problem research was done by surfing the internet and finding out the function of each pin.

The analysis concentrated on finding the data pin and clock pin from this dial gauge but in total this port consists of four pins which are known as supply, ground, data, and clock.

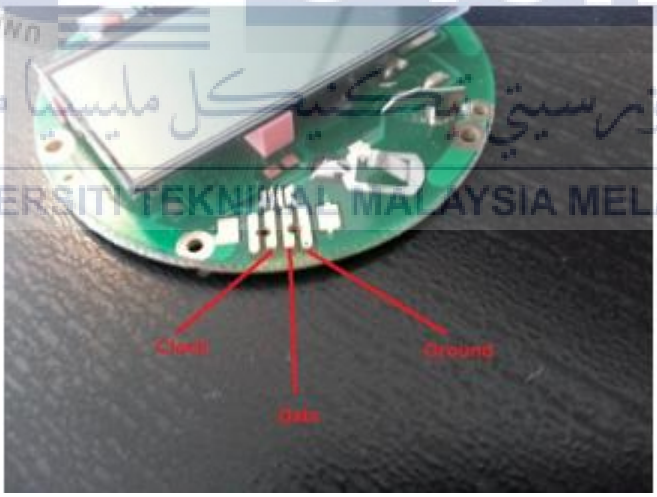


Figure 4.4: Data port of the dial gauge

4.3.2 NodeMCU ESP32

ESP32 NodeMCU was utilized as the microcontroller of this project. This ESP32 will control all the processes of the project. ESP32 is chosen to be utilized in this project because it is small in size and portable. Next, it is easy to be programmed, able to communicate with a digital dial gauge and in terms of costing the price of the microcontroller is cheaper. This microcontroller is already integrated with Bluetooth functionality which means no external Bluetooth module is needed. Arduino IDE software was utilized to program the ESP32. The Bluetooth functionality can be activated by setting up the library. The process of setting and programming this microcontroller is much easier compared to other microcontrollers. The pinout of ESP32 that has been used for this project is pin D27 which has been used for data pin. Next, is pin D12 which has been used for clock pin. Pin D18 were used as pushbutton pin. The ground pin, 3V3 pin and Enable pin also has been utilized.

4.4 Software Utilization

The planning regarding the project's development is done carefully. This is to make sure each scope of the project is achieved at the end of this project. Some software has been used in the progress of the project and each software has a prominent and individual role in making this project works accordingly. The software that has been used in conducting this project are Proteus, Arduino IDE, Microsoft Excel, CoolTerm and Visual Basic Application.

4.4.1 Development of circuit

Size plays an important role in this project to make sure the project that is developed is portable and light in weight. This means that the components have to be arranged properly so that the circuit board that developed will be small in size.

The developed design is communicating between ESP32 NodeMCU and dial gauge. This design was developed to make sure all the components are arranged properly and fit into a small casing which makes this device portable. This design consist of a terminal block, 10K ohm resistor, 47K ohm resistor, pushbutton, wires, and ESP32. The data signal, clock signal, supply, and ground from the dial gauge will be connected to the terminal block and from the terminal block it will be connected to the ESP32 microcontroller.

The components and the microcontroller were arranged properly on the donut board and soldered. This soldering is a very crucial process, a small mistake in the soldering process can cause the project to not function

4.4.2 NodeMCU ESP32 Coding

This coding section is divided into a few parts. The first one is coding for ESP32 node MCU. This code will be about the process of transforming analogue signals into digital signals and transforming it to decimal value. Next, the coding for to display the value of dial gauge on the serial monitor. The third part is code for enabling the Bluetooth functionality which will cause the data on the dial gauge will be transferred to computer to via Bluetooth. All those codes have to be completed before saving the data in text format by using the CoolTerm software. Next, this data will be transferred to Microsoft Excel by using Visual basic application. The code has been written by using visual basic application software.

```
#include "BluetoothSerial.h"
#if !defined(CONFIG_BT_ENABLED) || !defined(CONFIG_BLUEDROID_ENABLED)
#error Bluetooth is not enabled! Please run `make menuconfig` to and enable it
#endif
BluetoothSerial SerialBT;


void setup() {
SerialBT.begin("ESP32test");
```

Figure 4.5: ESP 32 code to enable Bluetooth

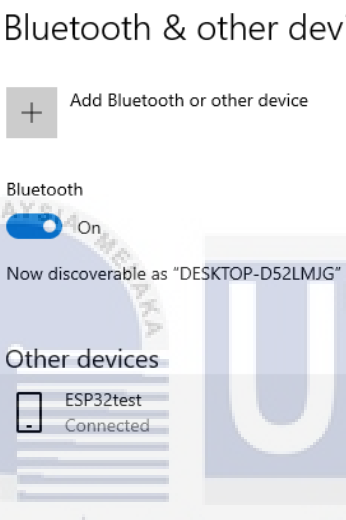


Figure 4.6: ESP 32 connected to laptop via Bluetooth

4.5 Result analysis

The data has been analysed by using two different techniques. The first technique is collecting the data manually and next technique by using wireless data logging. The data for 1minute is collected by using these techniques. This is to make sure which technique has more efficiency in the data collecting process. The result of the bar chart shown displayed above explains the difference in the total number of data collected by using two different techniques. The wireless data logging system has higher efficiency compared to the manual method. This is because the number of data collected by using wireless data logging system is 24 and the number

of data collected by using the manual method is 16. When using a wireless data logging system it requires an average time of 2.5 seconds to collect data and it requires 3.75 seconds to collect data when the manual system is utilized. This proves that more data can be collected by this project compared manual system. The difference in the total number of data collected in one 1minute by using different techniques is analysed by using the calculation method. It shows that the wireless data logging system is 50 percent faster than the manual method. This analysis shows that the manual method requires a higher time to conduct the process as it needs to be recorded manually compared to the wireless data logging system which automatically logs the data into excel.

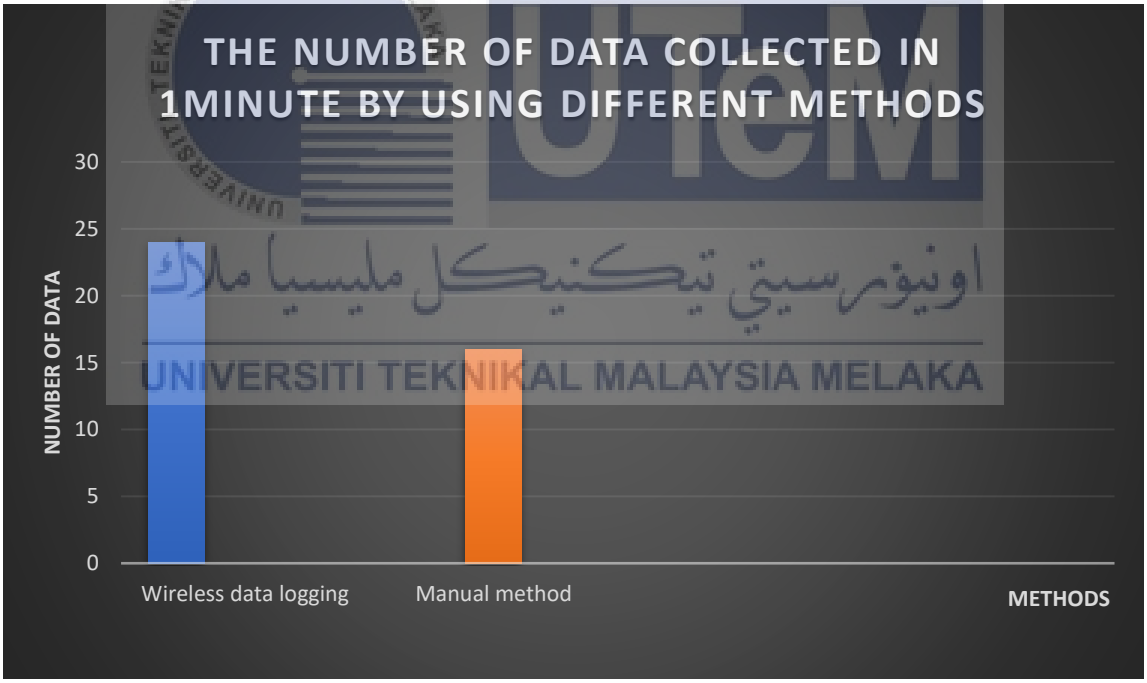


Figure 4.7: Data collected in 1 minute using two different method

4.5.1 Result of the Project

This project has been designed by considering the aspect of size and weight. This is to make sure the designed project is portable, which means the worker can carry the dial gauge while measuring the data.

Figure 4.8: Project prototype

4.5.2 Analysis of data measured using dial gauge

Analyzer Gage R&R technique has been utilized to make the data analysis. The R&R stands for repeatability and reproducibility. The main aim of this analysing technique is the accuracy and consistency of the project in the process of data collecting and also to find the efficiency of the measurement in the process of collecting data. This technique is being utilized by many companies that are in the field of manufacturing and are related to the measurement system. This is to conduct a differentiation in the reading of a measuring tool before the service and after the service. This is to increase the efficiency of the measuring instruments

The data analysis was conducted by collecting the data from different kinds of objects. This is to make sure whether the displayed data on the dial gauge is reliable or not. The width

of different objects has been measured. The data of three different products have been taken and each of the products has been split into three sets. The products that have been used in this process was a RFID card, printed circuit board(PCB), and memory card.

VARIABLE MSA - GAUGE R & R - DATA ENTRY

Appraiser (A

Trial\Sample	1	2	3	4	5	6	7	8	9	10	Average	
1	0.98	1	1	1	0.98	0.99	0.99	0.98	0.99	1	0.99	
2	0.99	0.99	1	1	0.98	0.99	0.99	0.98	0.99	1	0.99	
Average	0.99	1.00	1.00	1.00	0.98	0.99	0.99	0.98	0.99	1.00	Xbar(A)	0.99
Range	0.01	0.01	-	-	-	-	-	-	-	-	Rbar(A)	0.00

Appraiser (B

Trial\Sample	1	2	3	4	5	6	7	8	9	10	Average	
1	0.99	1	1	1	1	0.99	1	0.98	1	1	1.00	
2	1	0.99	1	1	0.99	0.99	0.98	0.98	1	1	0.99	
Average	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.98	1.00	1.00	Xbar(B)	0.99
Range	0.01	0.01	-	-	0.01	-	0.02	-	-	-	Rbar(B)	0.01

Appraiser (C

Trial\Sample	1	2	3	4	5	6	7	8	9	10	Average	
1	1	0.99	0.99	0.99	0.99	0.99	1	0.99	1	1	0.99	
2	1	0.99	0.99	0.99	0.98	0.99	1	0.98	1	1	0.99	
Average	1.00	0.99	0.99	0.99	0.99	0.99	1.00	0.99	1.00	1.00	Xbar(C)	0.99
Range	-	-	-	-	0.01	-	-	0.01	-	-	Rbar(C)	0.00

Part Average	0.99	0.99	1.00	1.00	0.99	0.99	0.99	0.98	1.00	1.00	$X_{doublebar}$	0.99
											$R_{doublebar}$	0.00
											R_p	0.02
											R_o	0.00

Previous step: Setup
Next step: View Results
Range of Part Averages
Range of Appraiser Averages

Figure 4.9: Measured thickness value of RFID card

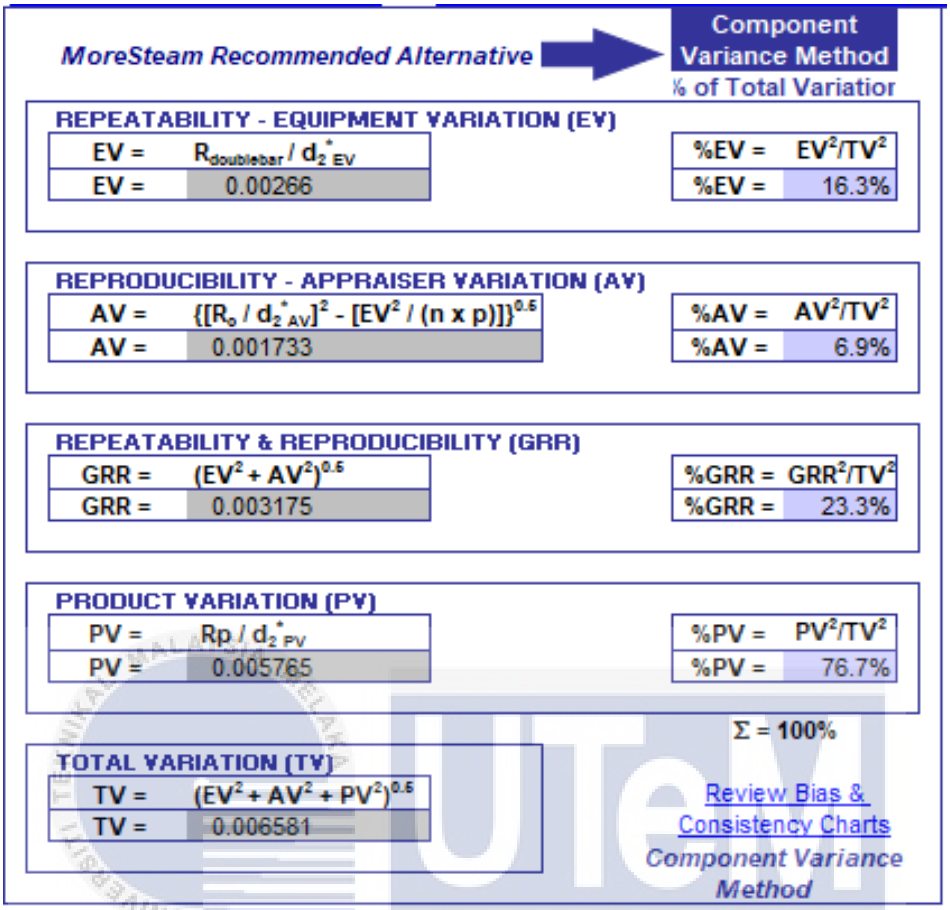


Figure 4.10: Gage R&R result for RFID card

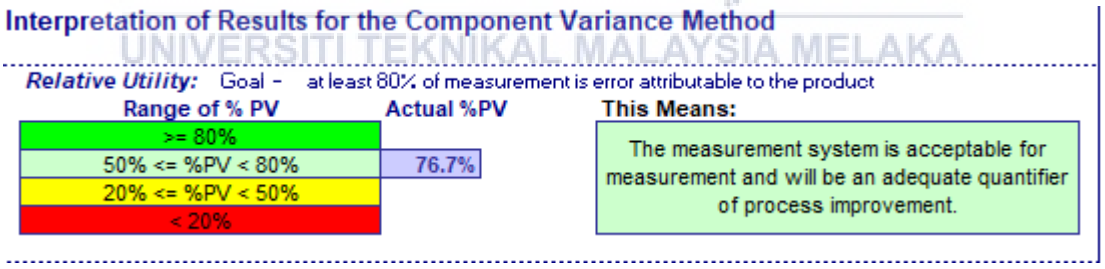


Figure 4.11: Result of the components variance method

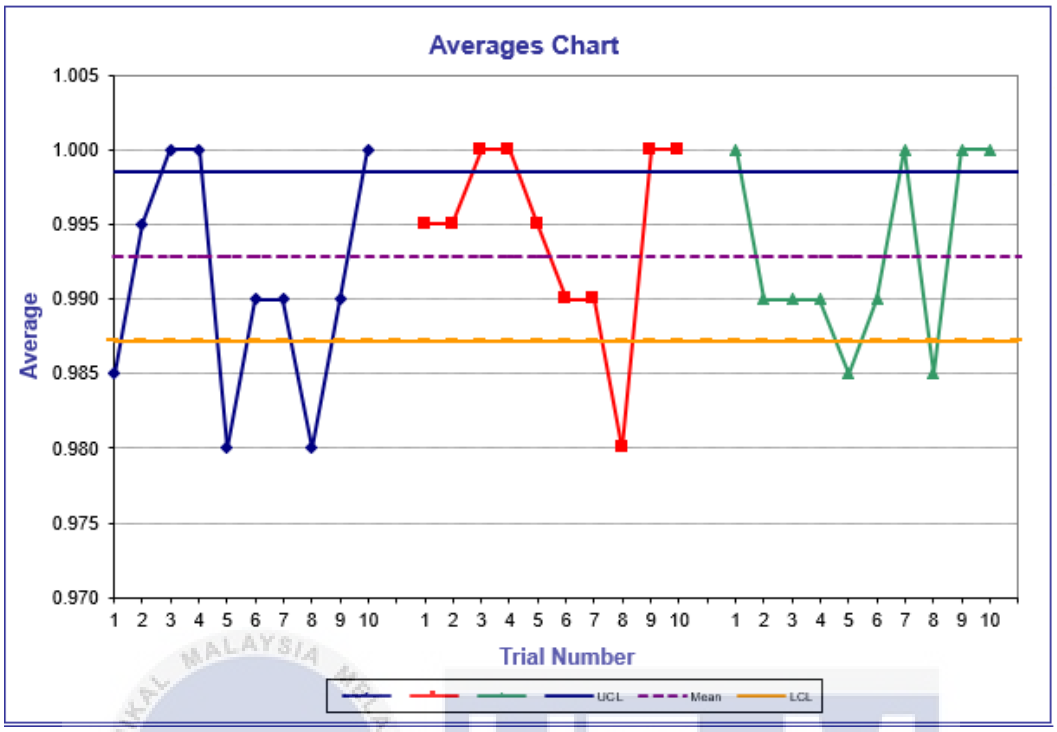


Figure 4.12: Graph of average measured thickness value of RFID card

VARIABLE MSA - GAUGE R & R - DATA ENTRY

Appraiser (A

Trial\Sample	1	2	3	4	5	6	7	8	9	10	Average	
1	0.61	0.61	0.6	0.6	0.6	0.59	0.6	0.6	0.61	0.61	0.60	
2	0.61	0.61	0.6	0.6	0.6	0.6	0.59	0.6	0.61	0.61	0.60	
Average	0.61	0.61	0.60	0.60	0.60	0.60	0.60	0.60	0.61	0.61	Xbar(A)	0.60
Range	-	-	-	-	-	0.01	0.01	-	-	-	Rbar(A)	0.00

Appraiser (B

Trial\Sample	1	2	3	4	5	6	7	8	9	10	Average	
1	0.61	0.61	0.61	0.6	0.59	0.6	0.6	0.6	0.6	0.61	0.60	
2	0.61	0.61	0.61	0.6	0.59	0.61	0.59	0.6	0.61	0.6	0.60	
Average	0.61	0.61	0.61	0.60	0.59	0.61	0.60	0.60	0.61	0.61	Xbar(B)	0.60
Range	-	-	-	-	-	0.01	0.01	-	0.01	0.01	Rbar(B)	0.00

Appraiser (C

Trial\Sample	1	2	3	4	5	6	7	8	9	10	Average	
1	0.61	0.61	0.61	0.6	0.6	0.59	0.61	0.6	0.61	0.61	0.61	
2	0.61	0.61	0.61	0.6	0.6	0.6	0.6	0.6	0.61	0.61	0.61	
Average	0.61	0.61	0.61	0.60	0.60	0.60	0.61	0.60	0.61	0.61	Xbar(C)	0.61
Range	-	-	-	-	-	0.01	0.01	-	-	-	Rbar(C)	0.00

Part Average	0.61	0.61	0.61	0.60	0.60	0.60	0.60	0.60	0.61	0.61	$X_{doublebar}$	0.60
											$R_{doublebar}$	0.00
											Range of Part Averages (R_p)	0.01
											Range of Appraiser Averages (R_o)	0.00

Previous step: Setup

Next step: View Results

Figure 4.13: Measured thickness value of sim memory card

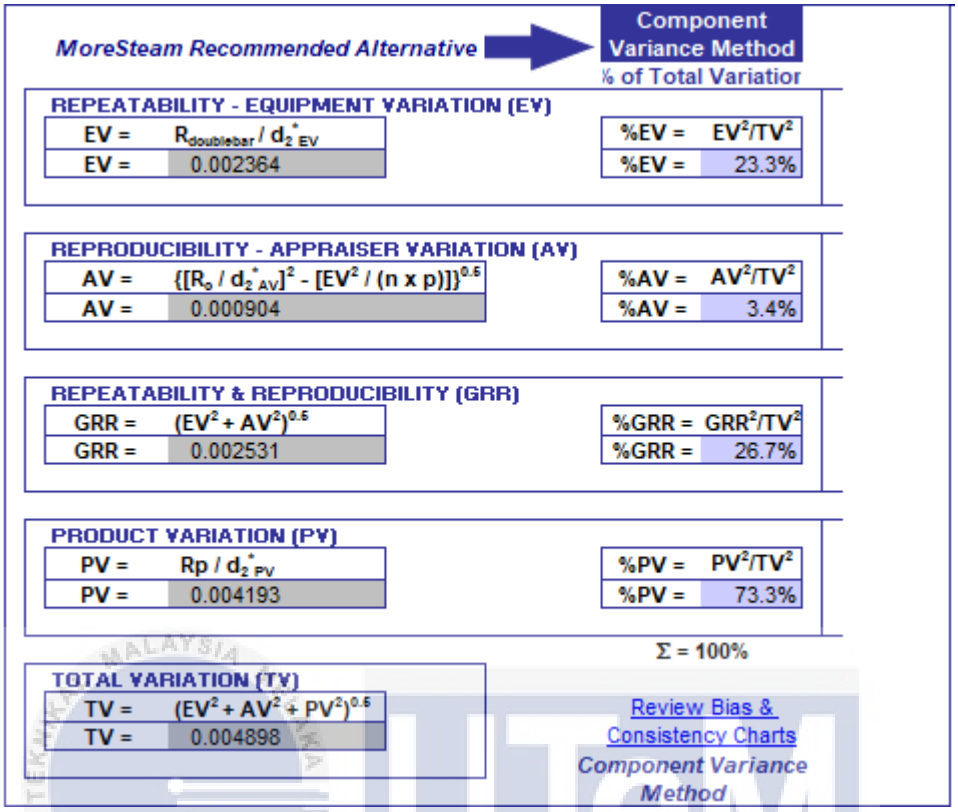


Figure 4.14: Gage R&R result for memory card

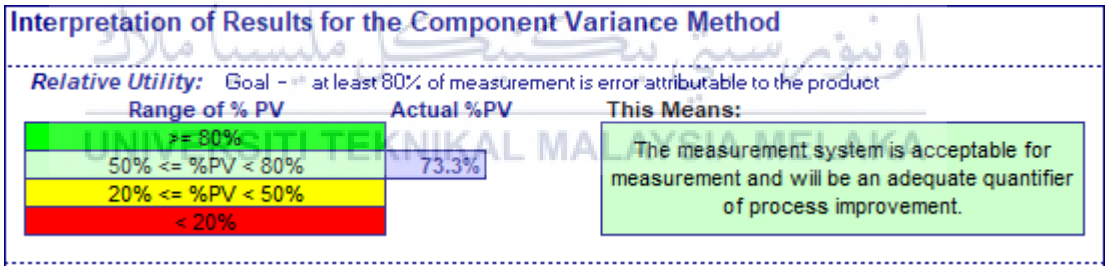


Figure 4.15: Result of the components variance method

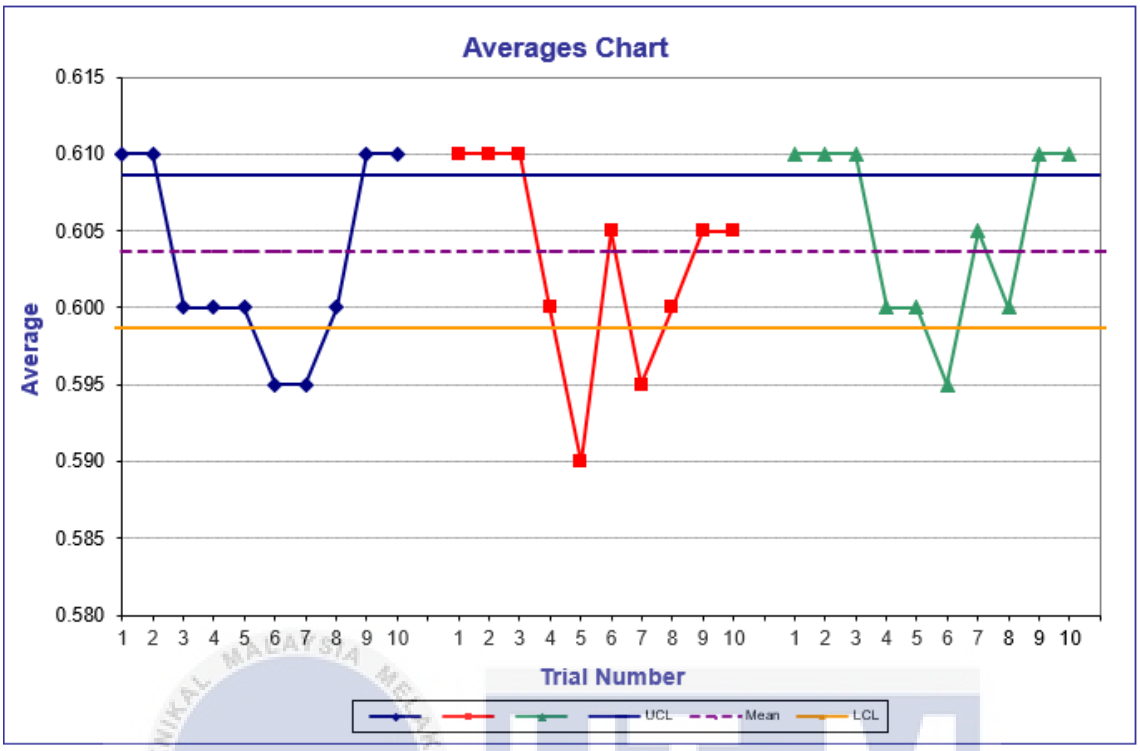


Figure 4.16: Graph of average measured thickness value of memory card

VARIABLE MSA - GAUGE R & R - DATA ENTRY

Appraiser (A

Trial\Sample	1	2	3	4	5	6	7	8	9	10	Average	
1	0.93	0.92	0.91	0.91	0.90	0.91	0.91	0.91	0.92	0.92	0.91	
2	0.92	0.92	0.91	0.91	0.91	0.90	0.91	0.90	0.92	0.92	0.91	
Average	0.93	0.92	0.91	0.91	0.91	0.91	0.91	0.91	0.92	0.92	Xbar(A)	0.91
Range	0.01	-	-	-	0.01	0.01	-	0.01	-	-	Rbar(A)	0.00

Appraiser (B

Trial\Sample	1	2	3	4	5	6	7	8	9	10	Average	
1	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.89	0.91	0.91	0.91	
2	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.91	0.91	0.90	0.91	
Average	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.90	0.91	0.91	Xbar(B)	0.91
Range	-	-	-	-	-	-	-	0.02	-	0.01	Rbar(B)	0.00

Appraiser (C

Trial\Sample	1	2	3	4	5	6	7	8	9	10	Average	
1	0.92	0.92	0.92	0.91	0.91	0.90	0.92	0.91	0.92	0.92	0.92	
2	0.92	0.92	0.92	0.90	0.91	0.91	0.91	0.91	0.92	0.92	0.91	
Average	0.92	0.92	0.92	0.91	0.91	0.91	0.92	0.91	0.92	0.92	Xbar(C)	0.91
Range	-	-	-	0.01	-	0.01	0.01	-	-	-	Rbar(C)	0.00
Part Average	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.91	0.92	0.92	$X_{doublebar}$	0.91
											$R_{doublebar}$	0.00
											R_p	0.02
											R_o	0.00

Previous step: Setup
Next step: View Results
Range of Part Averages
Range of Appraiser Averages

Figure 4.17: Measured thickness value of PCB

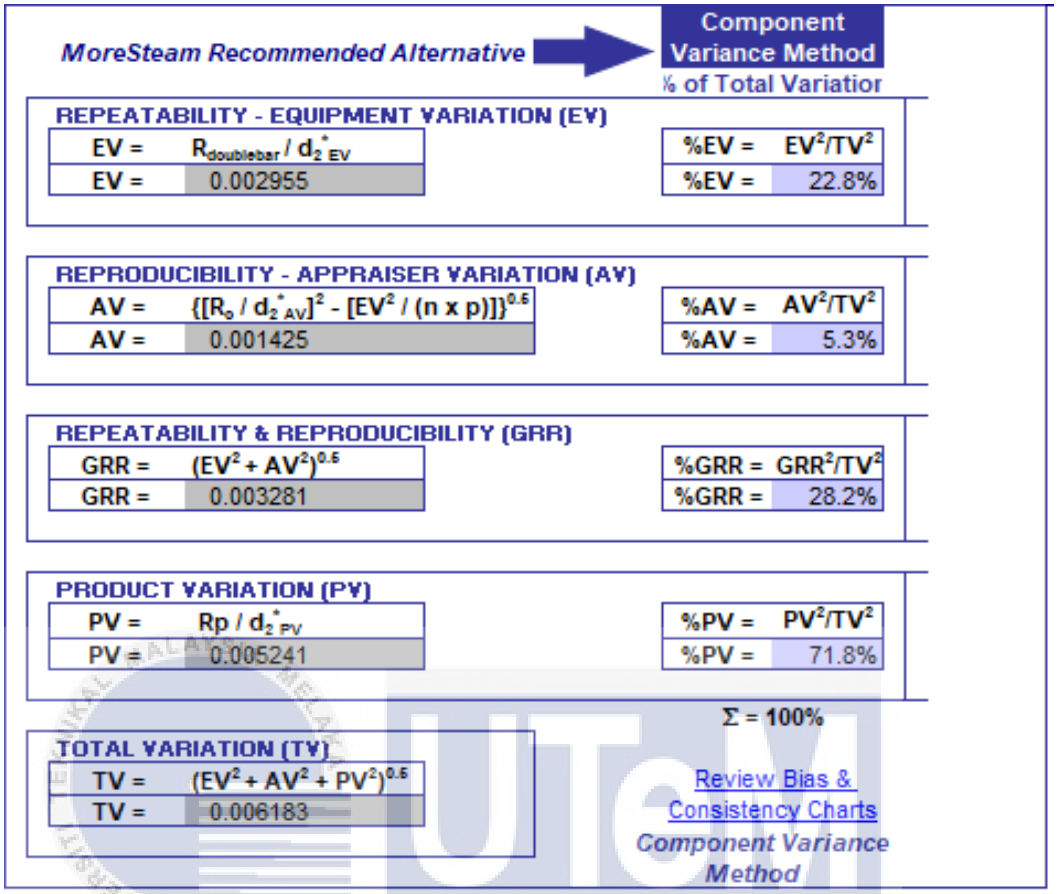


Figure 4.18: Gage R&R result for PCB

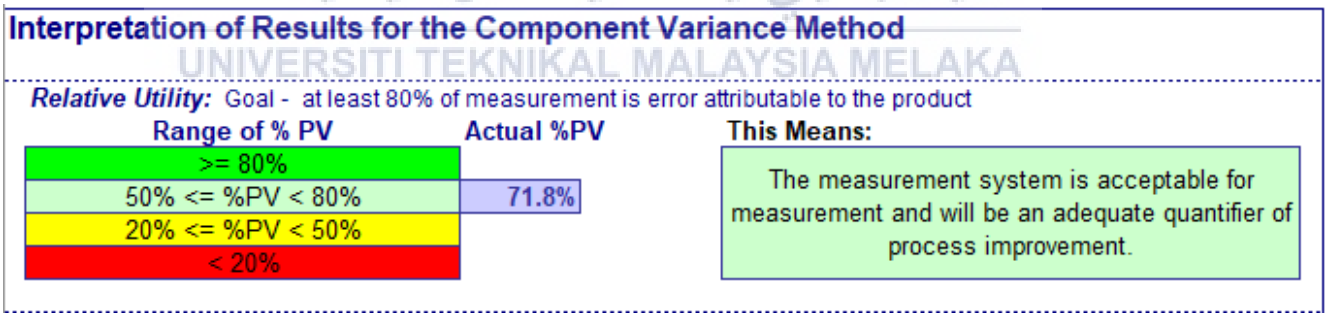


Figure 4.19: Result of the components variance method

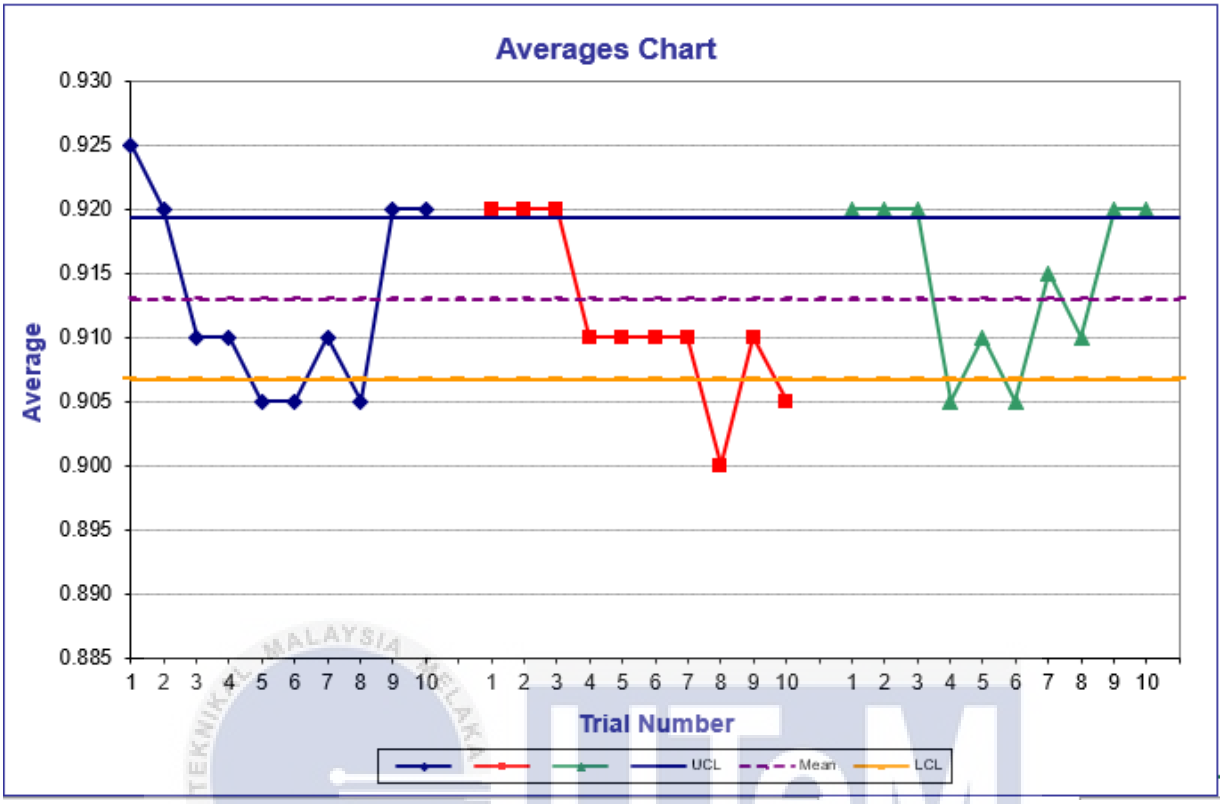


Figure 4.20: Graph of average measured thickness value of PCB

The gage R&R analysis conducted shows that the data produced by this dial gauge is reliable. This is because the thickness of three different materials was taken. Based on that data the value of the product variant of those three materials was above 50 percent. The measurement system is acceptable and the data measured in that system is reliable if the value of the product variant is more than 50 percent. Based on the analysis conducted the product variant value of 76.7%. The product variant value of sim card is 73.3 percent and for PCB is 71.8 percent

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This project is developed to transfer the data measured in dial gauge wirelessly to Microsoft Excel. This project is conducted because still many industries are using hand-operated methods to perform a measurement and to record the data. This problem is faced by CTRM company and it gives a big impact on the production rate of the company. Next, when the data is recorded manually, there are high chances of inaccuracies in data logging due to human error. Moreover, the data that has been taken and recorded manually has many possibilities to miss or get deleted. The objective of this project is to enhance the existing dial gauge to perform automated wireless data logging and recording data. Next, to eliminate inaccuracies in data logging with automated data transfer and finally is to store data in Microsoft excel which decreases the probability of data loss. The development of this project will be very helpful to everyone who works in the field of using the dial gauge. Much new knowledge regarding the latest technology is learned when a study is made to analysed past research which is related to my project.

In this project, ESP32 has been utilized as the microcontroller which will retrieve the output data from the dial gauge, the data retrieved will be in binary form and the data will be converted into digital form. The data is transferred Bluetooth protocol. The digital data will be saved in terms of text format by using CoolTerm software. This data can be imported to Excel by using Visual Basic Application. In this initial development of this project, the dial gauge is

bought and soldered the wire onto the data port of the dial gauge. The circuit of this project has been drawn using Proteus software. The circuit has been converted into hardware and then utilized the Arduino IDE software to program the ESP32 microcontroller so that the microcontroller can transfer the data from the dial gauge using Bluetooth. The data has been imported to Excel to make sure that the data visualization to be more organized and clear.

5.2 Recommendation

This part will discuss what are enhancements can be done to this project in the future. This is the future planned as it will be much easier to transfer the data to Microsoft Excel. As an enhancement, the mobile application also can be created or store the data in online storage such as cloud or google drive, this will give access to monitor the data from anywhere at any time. Next, the wifi protocol can be used to transfer data because the data can be transferred for a long distance. The circuit of the project can be integrated with a dial gauge so it will be more convenient and easy to carry. The component arrangement on the stripboard can be arranged more closely so that the size of the project will become smaller and easier to carry. The components need to be soldered wisely in order to get the correct reading from the dial gauge, a small mistake while solder could cause mistakes in the data collecting process. The column and row code on the visual basic application has to be written correctly so that the data is entered in the correct order or else the data on Excel will be not arranged. Moreover, a form can be created at Microsoft Excel using VBA and all the data that will be impoted will be located inside that form. This helps to make the visualization of the data to be more organized. A channel can be created at Telegram or Whatsapp and the data will be transmitted to that application, this will ease the process of data monitoring by superior or manager as they can monitor it all the time.

REFERENCES

Chi, J. *et al.* (2015) "Machine vision based automatic detection method of indicating values of a pointer gauge," *Mathematical problems in engineering*, 2015, pp. 1–19. doi: 10.1155/2015/283629.

Gandra, M., Seabra, R. and Lima, F. P. (2015) "A low-cost, versatile data logging system for ecological applications: Low-cost logging system," *Limnol. Oceanogr. Methods*, 13(3).

Neethu, N. *et al.* (2018) "DIGITAL DIAL GAUGE USING POTENTIOMETER."

Omre, A. H. (2010) "Bluetooth low energy: wireless connectivity for medical monitoring," *Journal of diabetes science and technology*, 4(2), pp. 457–463. doi: 10.1177/193229681000400227.

Pawar, J. P. *et al.* (2016) "Real time energy measurement using smart meter," in *2016 Online International Conference on Green Engineering and Technologies (IC-GET)*. IEEE.

Ransing, R. S. and Rajput, M. (2015) "Smart home for elderly care, based on Wireless Sensor Network," in *2015 International Conference on Nascent Technologies in the Engineering Field (ICNTE)*. IEEE.

Sreenivas Rao, M. V. and Shivakumar, M. (2020) "PLX-DAQ-based wireless battery monitoring system for obstacle avoidance robot," in *Control Instrumentation Systems*. Singapore: Springer Singapore, pp. 133–140.

Sugandi, B. *et al.* (2020) "Low cost wireless ECG patch using esp32," *Jurnal integrasi*, 12(1), pp. 31–35. doi: 10.30871/ji.v12i1.1764.

Walkowiak, M. and Nehring, A. (2016) "Using ChemDuino, excel, and PowerPoint as tools for real-time measurement representation in class," *Journal of chemical education*, 93(4), pp. 778–780. doi: 10.1021/acs.jchemed.5b00923.

Willig, A., Matheus, K. and Wolisz, A. (2005) "Wireless technology in industrial networks, " Proc," *Proc. IEEE Inst. Electr. Electron. Eng*, 93(6), pp. 1130–1151.

APPENDICES

Appendix A NodeMCU ESP32 code

```
int bit_array[24];
unsigned long time_now;
int CLOCK_PIN = 12;
int DATA_PIN = 27;
const int buttonPin = 18;
int buttonState = 0;
#include "BluetoothSerial.h"
#if !defined(CONFIG_BT_ENABLED) || !defined(CONFIG_BLUEDROID_ENABLED)
#error Bluetooth is not enabled! Please run `make menuconfig` to and enable it
#endif
BluetoothSerial SerialBT;


void setup() {
SerialBT.begin("ESP32test");
Serial.begin(115200);
pinMode(CLOCK_PIN, INPUT);
pinMode(DATA_PIN, INPUT);

}
void loop() {
while (digitalRead(CLOCK_PIN) == LOW) {}
time_now = micros();
while (digitalRead(CLOCK_PIN) == HIGH) {}
if ((micros() - time_now) > 500)
{
decode();
buttonState = digitalRead(buttonPin);
}
}
```

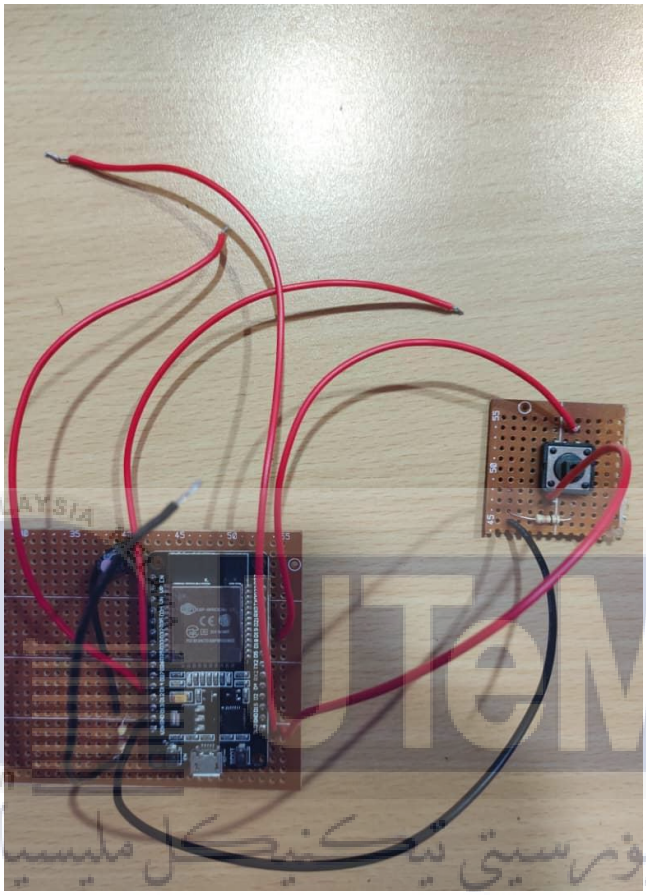
```
void decode() {
int sign = 1;
int i = 0;
float value = 0.0;
float result = 0.0;
bit_array[i] = digitalRead(DATA_PIN);
while (digitalRead(CLOCK_PIN) == HIGH) {};
for (i = 1; i <= 24; i++) {
while (digitalRead(CLOCK_PIN) == LOW) { }
bit_array[i] = digitalRead(DATA_PIN);
while (digitalRead(CLOCK_PIN) == HIGH) {}

if (buttonState == HIGH)
for (i =1 ; i <=20; i++)
{
value = value + (pow(2, i-1) * bit_array[i]);
}
if (bit_array[21] == 1) sign = -1;
if (bit_array[24] == 1)
{
result = (value*sign) / 2000.00;
Serial.print(result,3);
Serial.println(" in");
SerialBT.print(result,3);
SerialBT.println(" in");
}
else {
result = (value*sign) / 100.00;
Serial.print(result,2);
Serial.println(" mm");
SerialBT.print(result,2);
SerialBT.println(" mm");
}
}
```

Appendix B Visual Basic Application code

```
Sub Import_TxtFile()
Dim X As Double
Dim TXT As String
Open "C:\Users\Thinesh\Desktop\dialgauge.txt" For Input As #1
X = 1
Do While Not EOF(1)
Line Input #1, TXT
Cells(1, 1).Offset(X, 0) = TXT
X = X + 1
Loop
Close #1
End Sub
```

Appendix C Designed circuit



Appendix D Gannt chart