DEVELOPMENT OF LIGHTNING MONITORING AND WARNING ALERT SYSTEM USING ARDUINO

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Development of Lightning Monitoring and Warning Alert System using Arduino

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Telecommunication) with Honours.

By

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2020

DECLARATION

I hereby, declared this report entitled Development of Lightning Monitoring and Warning Alert System is the results of my own research except as cited in references.

Signature: 

Author's Name: NURALIYAH BINTI TABRI

Date: 15/01/2021

APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunication) with Honours. The member of the supervisory is as follow:

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Co-supervisor: TS AHMAD FAIRUZ BIN MUHAMMAD AMIN

ABSTRAK

Malaysia adalah negara ketiga tertinggi yang tersenarai dalam aktiviti kilat di seluruh dunia dengan purata ribut petir 180 - 260 setiap tahun. Kajian menunjukkan bahawa loji rawatan air dan air sisa, masing-masing di lokasi geografi yang berbeza, mengalami kerosakan serius pada peralatan instrumentasi dan kawalan (I&C) kerana lonjakan-aruhan yang disebabkan oleh kilat. Akibat kilat pada loji rawatan mempunyai kesan pada semua peralatan. Lonjakan voltan secara langsung akan mempengaruhi alat instrumentasi dan alat kawalan jauh serta Pengawal Logik Pembolehprogram (PLC). Dalam projek ini, sistem yang dapat memberi peringatan awal mengenai fenomena kilat dibangunkan dan digunapakai untuk mengurangkan kos kerosakan akibat kilat. Kilat dikesan dan isyarat dihantar oleh pengawal berasaskan Arduino untuk memberi amaran kepada pengendali melalui isyarat penggera dan visual. Hasilnya, pengendali boleh menutup sementara bahagian operasi yang paling berpotensi untuk terjejas.

ABSTRACT

Malaysia is the third highest country that listed in the lightning activity all over the world with the average of 180 – 260 thunderstorms per year. Studies shown that a water and wastewater treatment plant, each at a different geographical location, experienced serious damage to instrumentation and control (I&C) equipment because of lightning-induced surges. The consequences of lightning on treatment plants have repercussions on all equipment. Overvoltage will directly affect instrumentation and remote management devices as well as Programmable Logic Controllers (PLCs). In this project, a system that can give the early warning of lightning phenomena is developed and implemented in order to reduce the cost of the damage due to lightning. The lightning is detected and the signal is sent by the Arduino based controller to alert the operator via alarm and visual signals. As the result, the operator can temporarily shut down the most potentially effected operation area.

DEDICATION

This dedication is for my beloved family but mostly my parents, Tabri Bin Hussein and Norazarah Binti Asmoni as well as my close friends who encourages me, also not to forget to whom that may involve in helping me to complete my project. I also dedicate this report to my Project Principal Supervisor, Assoc. Prof. Mohd Ariff Bin Mat Hanafiah and my Co-Supervisor, Ts Ahmad Fairuz Bin Muhammad Amin who always inspires and guides me until the completion of this project. Finally, I dedicated this report to my helpful friends that provided me with supports and always teaching me to better every time.

Thank you.

ACKNOWLEDGEMENTS

In the first place, I would like to thank Allah that has given me the strength, knowledge, ability and opportunity to undertake this project and to complete it successfully. His blessings is a need for me to gain this achievement if not it would not have been possible.

I would also like to thank my parents for giving me supports especially in term of financial and moral support. Without them I will never be able to complete my final year project because this project is like a bridge between theoretical and practical. This project is dedicated to both of my parents whose dream for me to have resulted in this achievement.

I would also like to express my sincere gratitude to my Project Principal Supervisor, Assoc. Prof. Mohd Ariff Bin Mat Hanafiah and my Co-Supervisor, Ts Ahmad Fairuz Bin Muhammad Amin for giving me continuous guidances, comments and supports. They both played a very important roles in the process of completion of this project. Both of them always be there for me when I am in need of help or any assist. Most important is they always helping me regarding my project and always correcting me when I did any mistake.

I would also like to thank all my friends for the helps and information given. Without them, I can get any useful information easily that lead me to the completion of this project. Last but not least, I want to thank everyone that helps me either directly or indirectly in order for me to complete this project.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter is to discuss the overview of this project and the main reason why this project is being developed. This chapter describes the background, objective, scope of the project and the organization of this project.

1.1 Background

Nowadays, when the lightning strikes, it produces a strong electric field, differ from 10 to 30 kilovolts per meter (kV/m) in the middle of clouds and earth. Moreover, lightning strikes during the field reach above 5 kV/m but even there is no lightning strike produces, a chargeable cloud motion will make gap become possible in the middle of an end on the earth underneath the cloud. Lightning is a natural thing that happen between atmosphere and the ground which produce by two electrically charged regions that temporarily equalize and produce an electrostatic discharge. This may produce a wide range of electromagnetic radiation which lead to the occurrence during thunderstorms normally and other type of energetic weather systems.

Therefore, this project is to prevent any excessive damage occurred to the electrical devices and any electronic component especially for the wastewater treatment plan area. As you can see during a severe thunderstorm in August 1994 in Arkansas, a wastewater treatment plant been through an excessive damage which it causes the plant monitoring system to not able to operate. It is further complicated because it takes time to identified the damaged equipment only until an additional protection was added to the system.

Another one case study that focuses on the effect of lightning strikes on a wastewater treatment plant is in March 1994 take place at southeast Florida which experienced a direct lightning strike during a thunderstorm. Due to this accident, a large amount of electronic equipment in the circuit was damaged as well as senders, analysers, authorities of valve position transducers, PLC input/output (I/O) cards, surge suppressors, and path for controlling variable frequency.

Based on these two cases, can observe that the vulnerability of wastewater treatment plant monitoring system cannot equipped the high-voltages surges caused by lightning which is it cause a lot of damaged that cost of money and manpower. Receiving risk that keep on occurs during the method grounding plan that exclude the safety regarding the disappearance lightning that give energies and decreasing big difference if possible. This accident normally happened to all the monitor system or any electrical devices that exposed to have the risk receiving a direct lightning. In order to prevent this problem from occur the company will find something to protect their electrical devices from burning due to excessive voltage. Therefore, this project would like to recommend an additional of temperature sensor and voltage sensor as well as current. Voltage and current sensor function are the same which is if the voltage increase, the value of current will also increase based on the basic ohm's law formula:

$$V = 1R,$$

V = Voltage (Volt, V)

I = Current (Ampere, I)

R = Resistor (Ohm, R)

Based on this formula voltage is directly proportional to current impressed across the circuit. So, this project will use only two sensors which is voltage and temperature sensor. With the used of the two sensor is to alarmed when the value exceed and the controller can turn off the system and it can be done automatically or manually. This circuit will be using Arduino Uno to program the whole function of this project including to set the limit.

1.2 Problem Statement

Due to the damage that can be done by a lightning to all the earth living and the system that by accident receive an excessive power and can cause the electronic equipment temperature to heat up or overload which is the value of voltage and current is high. This project is to provide basic information such as the temperature and value of voltage to be display on the Liquid Crystal Display (LCD) screen and alarmed the controller.

1.3 Objective

1) The purpose of the project is to develop a Lightning Monitoring System and Warning Alert System for wastewater treatment plant.
2) To create Lightning Monitoring and Warning Alert System by using Arduino microcontroller, with the implementation of temperature and voltage, and current sensors.

1.4 Scope of the experiment

In this project, the Lightning Monitoring and Warning Alert System will be developed by the combination of the software and hardware. Development of this project is taking the input of voltage/current as the ratio to the actual lightning. As the cost for the actual system is a bit expensive. Moreover, the evolution of this project includes three types of sensor which are temperature voltage and current sensor. The sensors function is actually able detect the temperature, current and voltage. By implementing the project with the sensor to the system is to make sure that the system would not easily damage due to the excessive power that get affected by nearby lightning. The study covers no how the project is carry out, what equipment are used to build this project, the functions of this project and how those functions can prevent

the system from excessive damage and most importantly the project is built based on the objective and fulfilling the main objective itself.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The primary focus of this literature review for this project is to discuss previous research that already done by previous researchers related to the project. However, this chapter will discuss in details of this project which is divided into several parts. The first part will explain and describe about the previous research related to detection of lightning. Next, this chapter will also describe the microcontroller hardware that will be used which is Arduino Uno and the sensors. The sensor that will be used in this project is voltage and temperature sensor.

2.1 Previous Related Research

Several researchers manage to determine how to detect lightning or to protect the system from receive excessive damage by the lightning nearby. Moreover, it can be conducted by making an observation of any changes of certain parameters in the circuit. Previous studies may be referred from the various authors and also a variety of sources such as articles, journals, books, website and newspapers.

2.1.1 Introduction of Lightning

The natural machines called thunderstorm is the largest and most powerful electrical machines which exist on earth. It was guessed three hundred years ago, by the first workers on electricity. However, the great American, Benjamin Franklin who first showed in 1752 by direct experiment that thunderclouds are electrically charged. The investigators from different parts of world have builds up a thing upon Franklin's

discovery which is a whole super structure of accurate knowledge and manage to measure the quantity of electricity, rate at which it is generated, the electrical pressure or voltage produced.

The amount of thunderstorm occurred over the whole surface of the earth is very great. The amount is around sixteen million storms per year, or forty-four thousand per day. This mean around the globe at this particular moment of time, it is approximately two thousand thunderstorms must be occurred somewhere. While this number may vary slightly every second.

2.1.2 Lightning Protection of a Smart Grid Sensor

An article (Geeth Jayendra et.al, 2007), suggest a method that is not so expensive for normal people which to give information about the risk of lightning danger in future. The system to be created is uncomplicated, productive as well and manufacture certain warnings specifically to alert the user by using a futuristic technology. By monitoring the static electric field between the earth and the cloud that produces thunderstorm will either triggers an alarm or move the beacon depends on the strength of the lightning threat using a made field mill unit. This happens with help of a neural network that was combined to the intra cloud flashes which emits radio frequency as an extra input will offer more accurate predictions.

In this article also mention about the lightning phenomenon that attack the country and cause deaths for a number of people in Si Lanka. The average number that faced injuries due to the lightning activity is around 50 and above per year. Peak season for the lightning to occur is during two inter-monsoon in the month March-April and October-November. Direct and indirect lightning cause damages and injuries to all the living and non-living, so it is important to take note on what is happening. There are also other precautionary methods to limit and avoid from doing this or that during the possibility of lightning is high at risk.

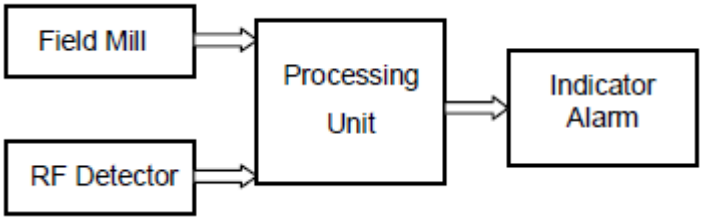

Figure 2.1: Lightning Warning System

This block diagram explains the structure of system that will be used in this paper. This system is a hybrid design that combined the sensing of static electric field with the radio frequency discharges from intra-cloud lightning release in the nearest area.

2.1.3 An Intelligent Lightning Warning System Based on Electromagnetic Field and Neural Network

According to the paper studied (Guoming Wang et. al, 2019) an intelligent Lightning Warning System (LWS) operates using based on an electromagnetic field and the artificial neural network. It was developed for improving lightning prediction accuracy. Lightning is a normal natural phenomenon which occurred within cloud-to-ground and cloud-to-cloud which, however, causes damages to electrical installations, buildings, and humans due to its large current as well as induced transient voltage. a lightning warning system (LWS) is necessary to predict and to alert the potential lightning strike. In addition, the data acquired from LWS can be used for long-term meteorological evaluation, including the analysis of thunderstorm days, lightning density distribution map, and climate change. The LWS operates based on the detection of electric field between clouds and ground, and various sensors such as electric field mill (EFM), flat-plate antenna, whip antenna, and electro-optic sensor have been developed.

Moreover, this project stated that it is necessary to develop an intelligent lightning prediction algorithm that takes the ambient temperature and humidity into consideration. Paper. Furthermore, LWS that was mainly composed Electric Field-

Mill (EFM) sensor to measure the atmospheric electric field and a pair of loop antennas to estimate the lightning location was designed.

2.1.3.1 Electric Field Mill (EFM) Sensor

The EFM sensor was used to detect the atmospheric electric field between cloud and ground. In order to provide an advanced warning before a lightning incident occurs. The configuration of the fabricated EFM sensor is shown in Figure 2. It was mainly composed of a sensing plate and a rotating plate that was grounded. Both plates were designed with 6 vanes and were made of aluminium, which is lightweight and anticorrosive. The rotating plate was driven by a Brushless Direct Current (BLDC) motor with a constant speed. Therefore, the sensing plate was exposed and shielded from the electric field periodically, resulting in the charge and discharge of the sensing plate.

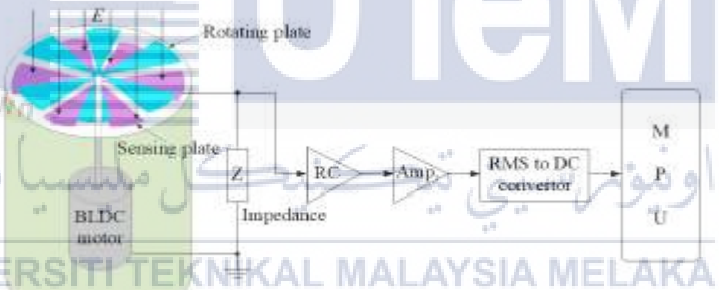

Figure 2.2: Electric Field Mill Configuration

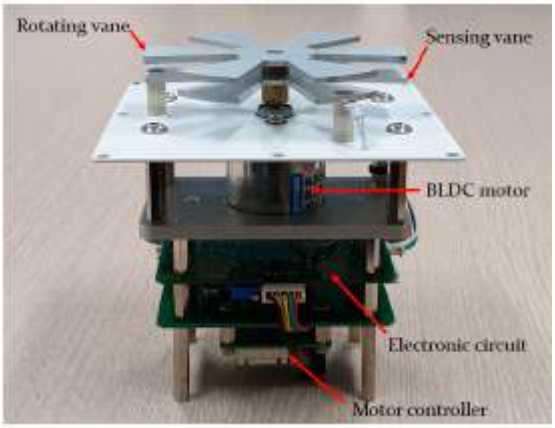

Figure 2.3: Electric Field Mill (EMF) Sensor

When the sensing plate is shielded by the rotating plate, the accumulated charges transfer from the impedance to ground and the charges will be induced. the output voltage is proportional to the electric field and, therefore, is used in this paper

3.1.2.2 Loop Antenna

A vertical and an orthogonal loop antenna were used to detect the induced magnetic field in order to estimate the location of a lightning strike. The loop antenna worked based on the principle of Maxwell's Equation. In addition, the direction of lightning was estimated by a pair of north-south (NS) and east-west (EW) oriented loop antenna, which were perpendicularly placed.

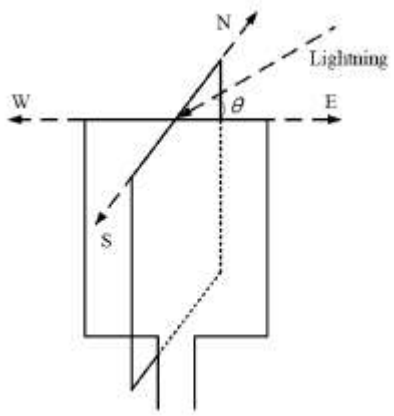

Figure 2.4: Loop antennas schematic diagram

Figure 2.5: Loop antennas and detection circuit

The function is to mainly composed of an integrating circuit, an amplifier, and a peak detection circuit. The compact configuration avoided the distortion of the magnetic signal and reduced external interference significantly, which can improve the detection accuracy. To verify the response of the designed loop antennas, it was used to detect an 8/20 μs, 500 A lightning impulse generated by a surge generator.

As for the conclusion of this paper, LWS based on the electromagnetic field and the artificial neural network was developed for improving the lightning prediction accuracy. An EFM sensor was fabricated to detect the atmospheric electric field and to provide an advanced warning before lightning occurs. The loop antennas were designed to detect the magnetic field induced by lightning for estimating the direction of the lightning strike. After training the proposed neural network, the LWS was used

to predict lightning incidents over six months by monitoring the change rate of electric field, temperature, and humidity. It was verified that the proposed system predicted lightning occurrence with an accuracy of 93.9%, which was 27.1% higher than that of the existing LWS operated with the threshold method. The proposed system was expected to be applied in outdoor areas such as farmland, golf courses, railway systems, satellite launching centers and etc. for reducing the risk level caused by lightning strikes.

2.1.4 Analysis of lightning-related damages to instrumentation and control systems for water and wastewater plants

This paper stated (P.Y. Keskar, 2015), different geographical location of water and wastewater plants experienced the same serious damage to instrumentation and control (I&C) equipment in 1994 because of lightning-induced surges. A lightning strike is high in voltage, current, and frequency phenomena capable of reaching average currents of 20 kilo-amperes (kA) to a maximum of 200 kA. It can be large, fast, rise time, surge currents to flow through an electrical system that can cause tremendous differences in potential, creating a shock hazard and damaging sensitive electronic and digital equipment not designed to withstand high-magnitude differences in potential.

Grounding systems is one of the main factors because the designed can affect the differences in potential either to maximize or minimize. A ground that fulfilled the requirement for normal power application (60 Hertz, Hz) or strictly from an instrumentation and control (I&C) standpoint maybe inadequate for withstanding a lightning-induced surge. Damages that produce from the surges usually occurs when the system grounding design ignores the safeguards both for dissipating lightning surge energies and minimizing large differences in potential. Few problems were discovered due grounding inspection:

- Inadequately sized long grounding conductors.
  - Grounding conductor size which is long and small rendered the surge suppressor ineffective, which can cause dangerous common-mode overflow voltages.
  - The grounding conductors were bundled together and carried to the ground bus inside the panel.
  - Each of the surge suppressor has a ground terminal that should be connected to the system ground with the shortest adequately sized cable because the inductance of the grounding cable plays a major role in elevating the voltage of the surge suppressor ground with respect to the system ground.

Grounding conductor length (ff)	Grounding conductor size (No.)	Common-mode voltage (volts)
10	6	550
10	12	650
0	12	30

Table 1 Effect of grounding conductor length and size on common mode voltage

  - This table demonstrate the effect of grounding conductor length and size on the common-mode voltage of signal.

- Improperly grounded signal cable shields.
  - The signal cable shields at the plant area were landed on the surge suppressor ground connection, which is a poor grounding practice.
  - It is preferable for the shields to be directly landed on the panel ground and not through the surge suppressor grounds.

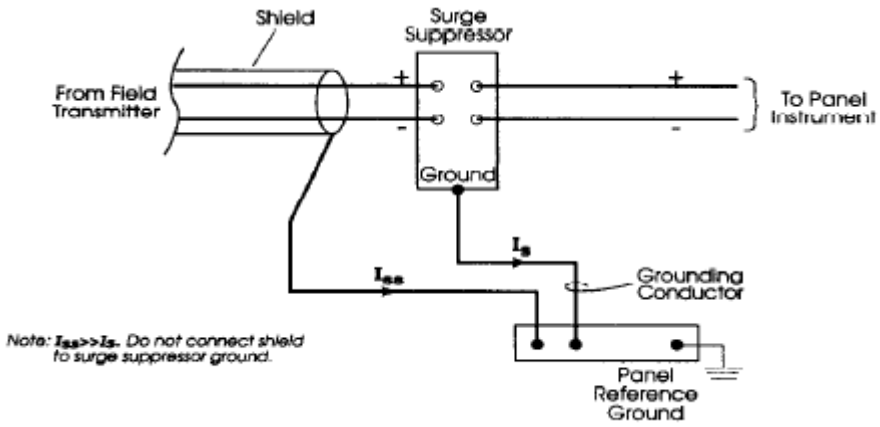

Figure 2.6: Correct method of grounding cable

- Based on Figure 2.5, I_{ss} is larger compared to I_s which is I_{ss} as the surge current in the shield circuit, and I_s as the surge current through the surge suppressor grounding conductor.

- Daisy chaining of surge suppressor grounds with grounding conductors.
  - In some control panels, the surge suppressor grounds were daisy chained using a single grounding conductor. Again, this is a poor grounding practice for reasons described earlier. Figure 6 below shows both the incorrect and correct method of grounding.

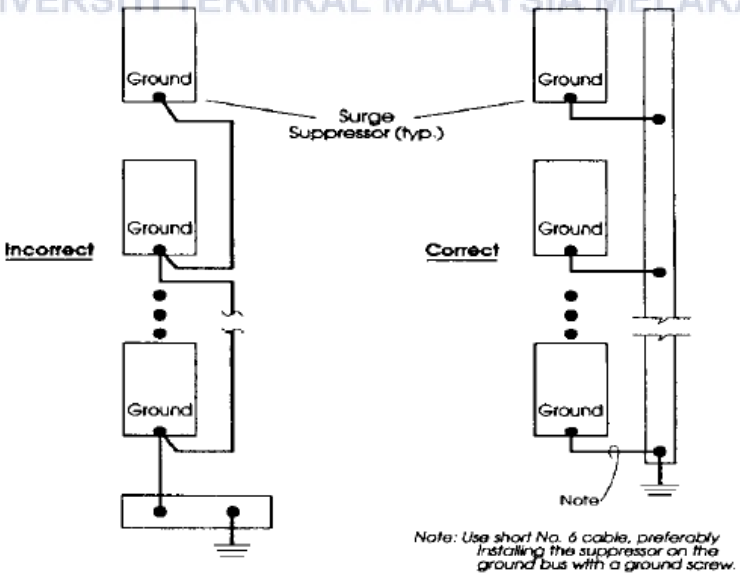

Figure 2.7: Incorrect and correct method of surge suppressor grounding

2.1.5 Electromagnetic Methods of Lightning Detection

A study done by (V.A. Rakov, 2013) stated a large amount of processes that produce electromagnetic field signatures in different regions of the spectrum produce by both cloud-to-ground and cloud lightning. A few of lightning locating techniques, which is magnetic direction finding, time-of-arrival technique, and interferometry.

Lightning is known to emit significant electromagnetic energy in the frequency range from below 1 Hz to near 300 MHz, with a peak in the frequency spectrum near 5 to 10 kHz for lightning at distances beyond 50 km or so. Moreover, any observable electromagnetic signal from a lightning source can be used to detect and locate the lightning process that produced it in form of general. In addition to electromagnetic radiation, lightning produces the acoustic radiation that can be also used for detect lightning location.

The most common electromagnetic radio-frequency-locating techniques is magnetic direction finding (MDF), time of arrival (TOA), and interferometry. Therefore, the type of locating information obtained depends on the frequency of the radiation detected. The MDF and long-baseline (hundreds of kilometers) TOA systems usually operate in the VLF/LF range and report one location per lightning event. The interferometry and shorter-baseline (tens of kilometers or less) TOA systems usually operate at VHF and provide multiple locations per lightning event (VHF images of lightning channels).

2.1.6 Lightning Protection of SCADA and Telemetry Systems

According to the paper studied by (Phillip R. Tompson, 1997) would suggests methods of protection using SCADA and telemetry system components including these characteristics to drive the need for that protection. This is to show that single building protection is not enough and need to know the importance of earth conductor impedance influences earthing design.

Most of the process control and utility industries such as electricity, gas, and water supplies need remote for controlling and monitoring. SCADA (Supervisory Control and Data Acquisition) is a term generically applied to systems which may be used to collect data and acting upon that information and control some process function. The controlling intelligence may be remotely located based on the data. SCADA essential elements is field sensors, field actuators, Remote Terminal Unit (RTU), communication system, and last one master station.

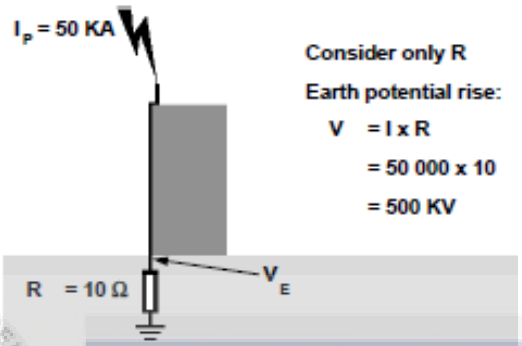

Figure 2.8: Earth potential rise

Lightning strikes, whether direct or indirect can cause damage to sensitive electronics in many parts of the system. But if the building is protected by any protection system the cost of lightning strike perhaps will be reduce to 25% and below. Imagine a lightning strike to a protected building as shown in figure 2.8 the lightning of the energy will be conducted to the earth termination and dissipate the charge into the mass of the earth. The effect of this current is that it able to increase the earth potential of the building itself. If all equipment within the building is correctly bonded and single point earthing techniques applied, there should only be small potential differences within the building and all the equipment should be safe. In addition, although the resistance of conductors is important, the inductance is important as well.

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter will discuss about the method that is applied in the progress of completing this project. This project was designed based on the literature review that had been carried out. This chapter will describe the components and software used in the experiment, flowchart of this project completion, simple circuitry of this project and the expected result of this project.

3.1 Project Flowchart

This project has been through several times discussion in making decision. The decisions that had been made after some researches through literature review. This project is created to fulfil its title that is Development of Lightning Monitoring and Warning Alert System. So, this project will be focusing on detecting rather than controlling. Functionality, stability, performance and cost are also considered. The flowchart below shows the methodology of this project.

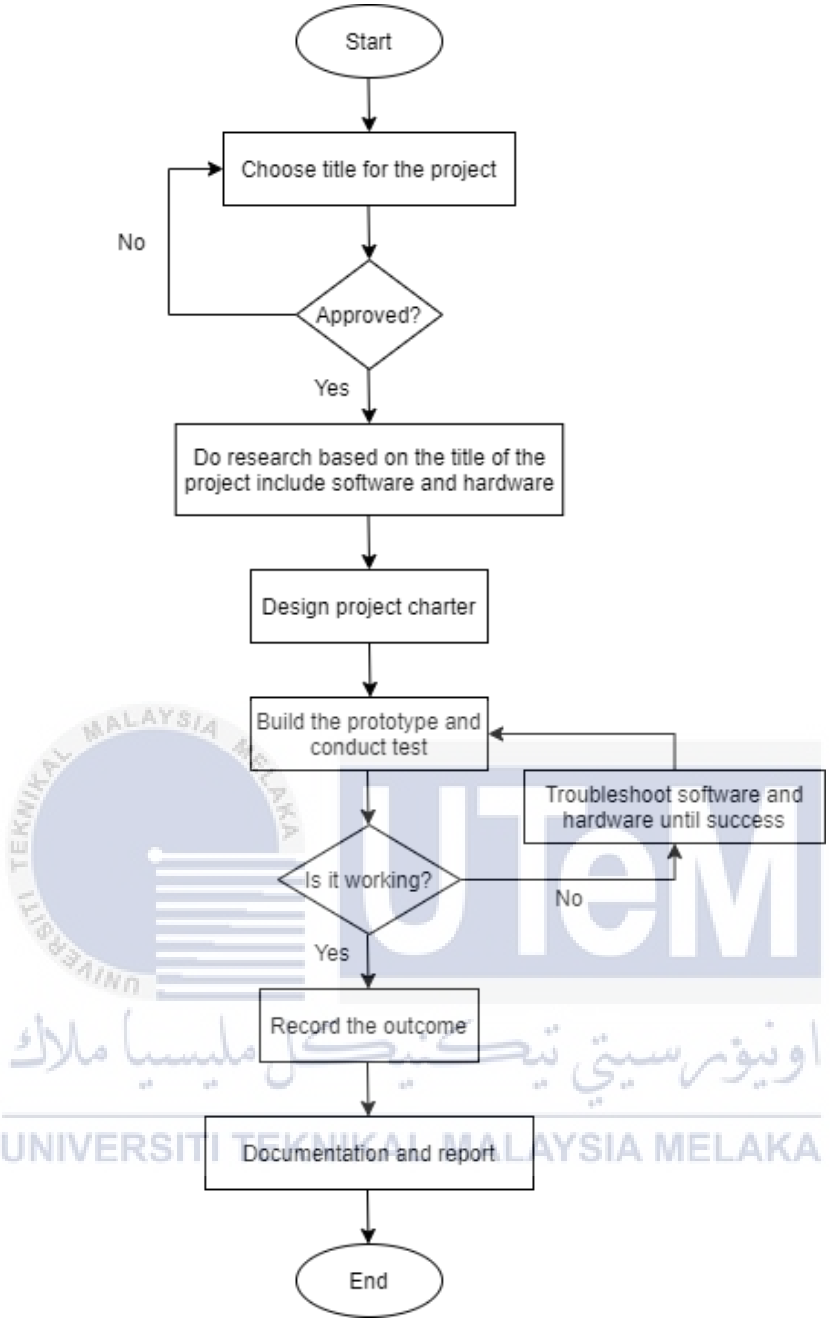

Figure 3.1: Flowchart of Project Methodology

First of all, the sensor was chosen based on how to detect the lightning based on the criteria of the lightning. Therefore, there are a lot of method to detect the lightning. The type of the sensor that will be used in this project is temperature sensor which is LM35, current sensor ACS712 and voltage sensor which is B25. The sensor is use as the detection tools or an input for this warning alarm system. It is also known as fully monitored system that was chosen as the type of the monitor. Between the type

of microcontroller (MCU) given, Arduino Uno is chosen because of its extra features for this project. This project which act as only the smaller scale of the real project also chose to use only in the mode of short range in order to give the output as an input to the control system. Figure below shows the flowchart for the project

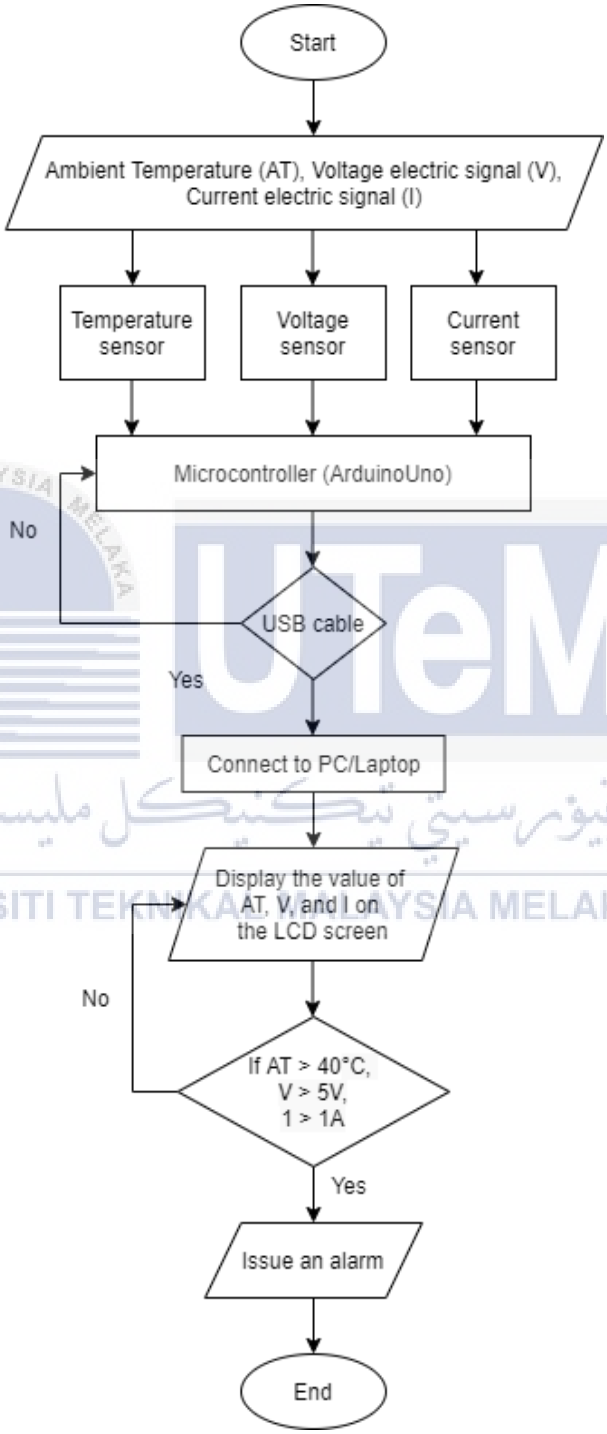

Figure 3.2: System Flowchart

Based on the flowchart above, when the system is turned on, all the sensors will start to work. There are 3 sensors which are temperature sensors, voltage sensors and current sensors. Each of the sensors will display each of their condition respectively on the LCD. But when it has reached the limit, it will send warning to the user. This flowchart is the expected result for this project as a reference before proceed to the next step which is to build the prototype.

3.2 Components and Software

The combinational of electronic components and devices and software are used in this project in order to make the designing work easier. Sensors are connected to the Arduino Uno to detect the conditions as the input for the lightning detection system. Both the Arduino Uno software and hardware are used to complete this project.

3.2.1 Arduino Uno

This project used Arduino IDE (Integrated Development Environment) via a type B USB cable. As for the hardware, to be detail is Arduino Uno R3 which is a single board microcontroller. The board is equipped of digital and analogue input/output (I/O) pins that may be interfaced to various expansion boards and other circuits. In addition, for the source It can be powered by using USB cable or by an external 9-volt battery, therefore it accepts voltages between 7 until 20 volts. Below will be shown the Arduino Uno R3 in hardware that will be used for this project.

Figure 3.3: Arduino Uno Hardware

3.2.2 Temperature Sensor (LM35)

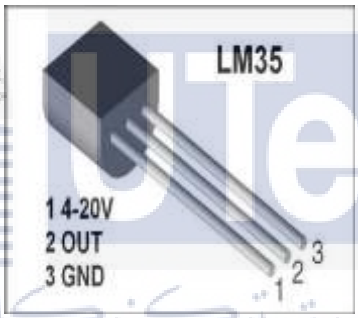

Figure 3.4: Temperature Sensor LM35 and the pin

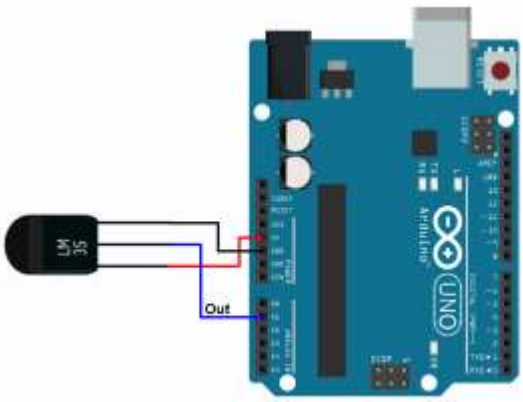

Figure 3.5: Connection between Arduino Uno and LM35

This temperature sensor is a measuring device having an analogue output voltage proportional to the temperature of its environment. The data can be used to record, monitor, or signal temperature changes. There are many types of temperature sensor but somehow LM35 was chosen based on its function and performance. This is also known as the semiconductor sensors. This sensor offered high linearity and high accuracy over an operating range of about 55°C to +150°C. The sensor AD590 is similar to this sensor. Both sensors are the most popular temperature sensor.

3.2.3 Voltage Sensor (B25)

Figure 3.6: Voltage Sensor

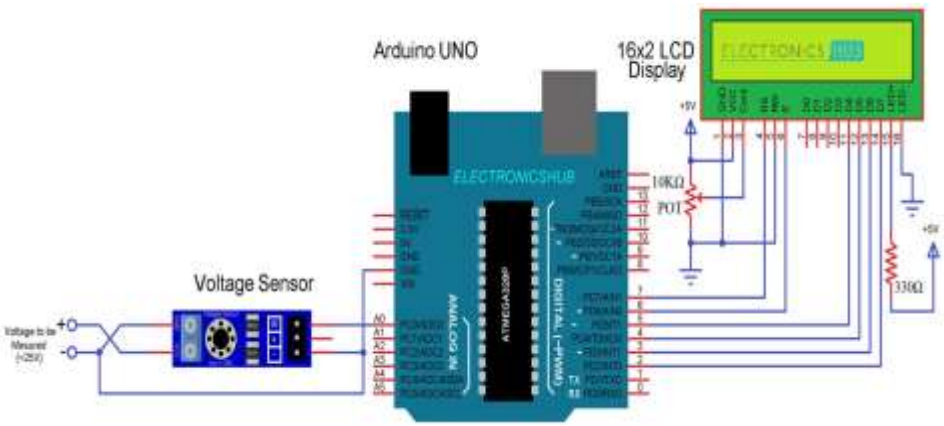

Figure 3.7: Connection between Arduino Uno and B25

First of all, this sensor is an electrical device that is used to monitor, calculate and especially the ability to determine the amount of voltage in an object. It can detect the voltage either in AC or DC voltage supply. Input and output were included for this sensor. For the input side it mainly consists of two pins which is positive and negative pins. The pins of the device for the connection to the positive & negative pins of the sensor. This sensor's output mainly includes supply voltage (Vcc), ground (GND), analogue o/p data.

3.2.4 Current Sensor (ACS712)

Figure 3.8: Current Sensor

Figure 3.9: Connection between Arduino Uno and ACS712

The current sensor, ACS712 can functioned by using both supply AC and DC. 5V is the most suitable amount of power supply to produces an

analogue voltage output of the sensor that is proportional to the amount of current been measured. This sensor used a Hall Effect to produces an output in voltage while the input is in current. Therefore, it plays an important role in the device which is power calculation management applications.

3.2.5 Buzzer (Piezo Speaker)

Figure 3.10: Buzzer

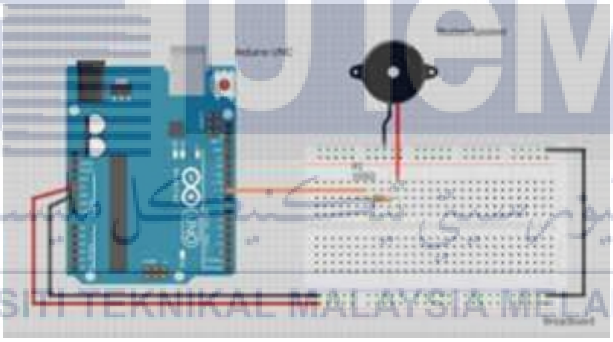

Figure 3.11: Connection between Arduino Uno and Buzzer

A buzzer also known as a beeper is an audio signalling device. It can also be either mechanical, electromechanical, or piezoelectric. Normally, it is applied in alarm devices, timers, and confirmation of user input such as a mouse click or keystroke. piezo buzzers. A piezo buzzer is a device powered using piezoelectricity which is created using material that produces an electric charge when placed under mechanical pressure. Based on the buzzer function, it is one of the most suitable electronic equipment to give warning to the user.

3.2.6 LED (generic)

Figure 3.12: LED (generic)

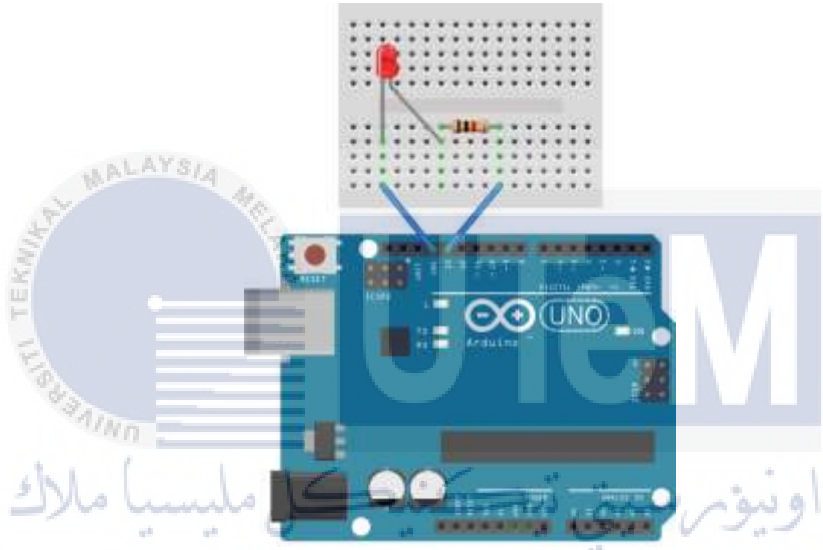

Figure 3.13: Connection between Arduino Uno and LED

LED stands for Light Emitting Diode which is a semiconductor light source that produce light when current pass through it. Colours that generate is corresponding to the energy of the photons that is determined by the band gap of the semiconductor that required energy for the electrons to go through them. This LED is used in this project to send warning instead of using buzzer only.

3.2.7 Liquid Crystal Display (LCD) 16×2 screen

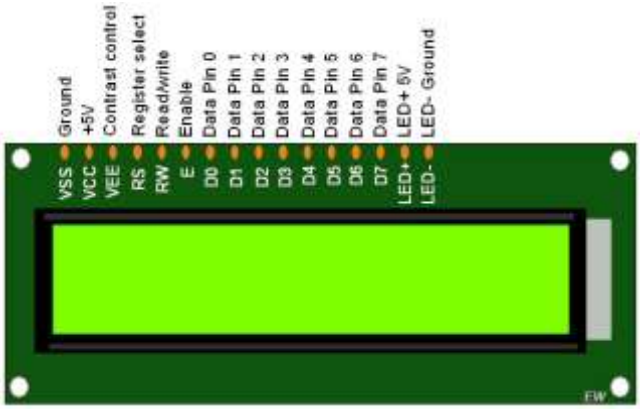

Figure 3. 14: LCD screen 16×2 with label of the pin

Figure 3.13:

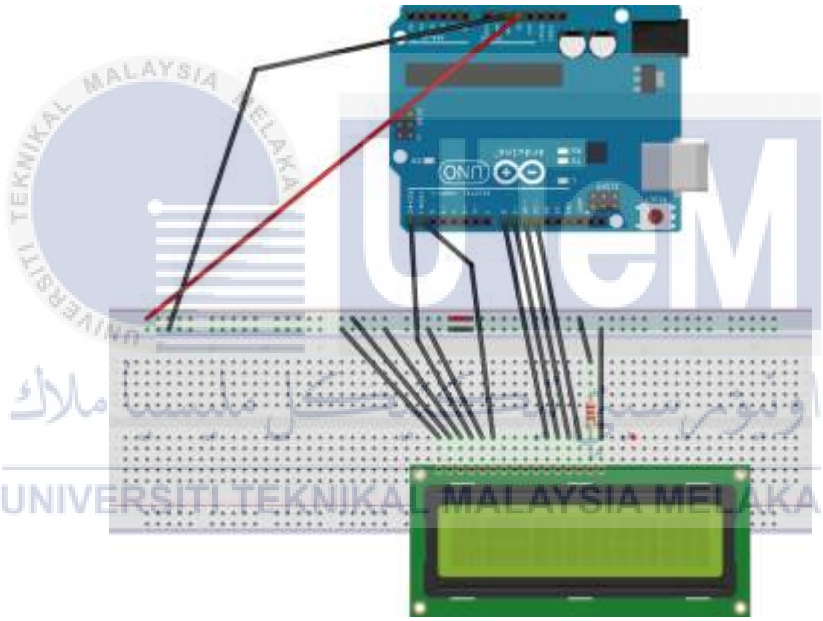

Figure 3.15: Connection between Arduino Uno and LCD 16×2 screen

An LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16×2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD, each character is displayed in a 5×7 pixel matrix. Moreover, it consists of two registers which is command register and data register. The main for command register is to stores the command instructions that has given to the LCD.

A command can be defined as an instruction in term of coding given to the LCD as an input to a predefined task for example the command to clear the screen, to initializing and many more. Therefore, second type of register is the data register which stores the data to be displayed on the LCD, it can be from any input such as sensor which supply data. The data will be in ASCII value of the character to be displayed on the LCD. Whenever, the data is sent to the LCD, it goes to the data register and is processed there. The register that has been select will be used to switch from one register to another. Whereas, RS=1 means the data register is selected while RS=0 for command register.

3.3 Design Overview

Figure 3.16: Design Overview

The figure above shows the plan of the prototype for this project. That is the expected outcome for this project based on the block diagram in the figure. This figure shows all the components that has been used as the outputs and the inputs of this project. Plus, it also explained the flow of the project on monitoring and warning.

3.4 Circuit Design

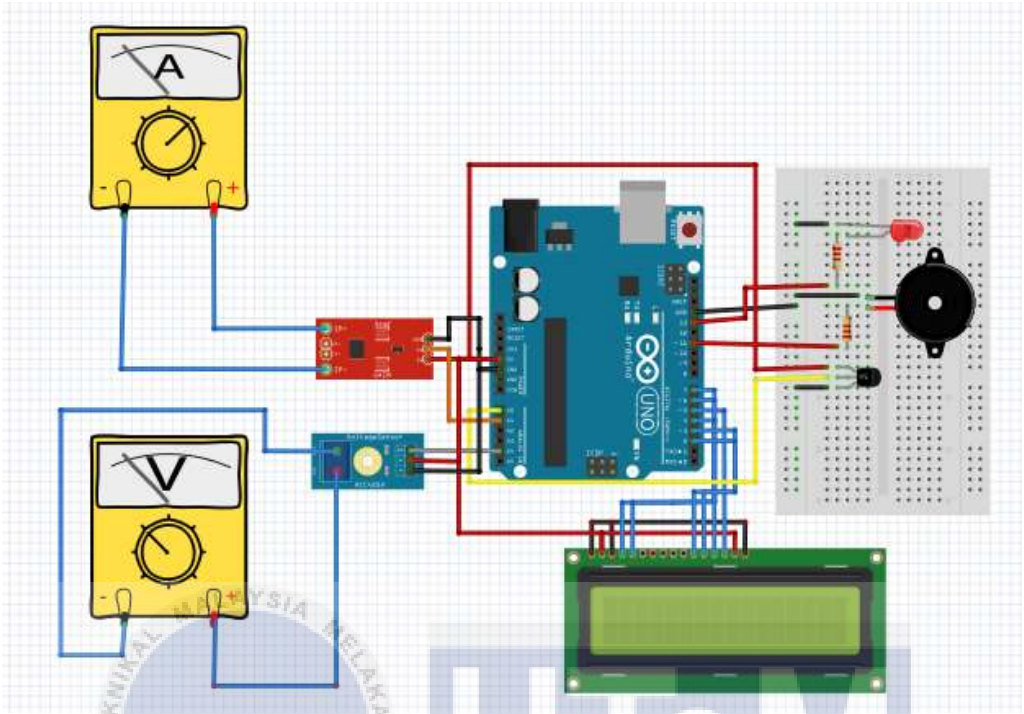

Figure 3.17: Circuit Diagram

The figure above, shows an expected result for circuit which is circuit diagram that consist all the input and output that has been figured. This circuit will be tested in the simulation before the hardware development will be started. The drawing is constructed in Fritzing software but it also can be constructed in Proteus software actually. This initiative to first constructed the circuit in software before doing the hardware is as precaution step and it make things easier to directly construct the hardware with this simulation drawing in advanced as reference.

CHAPTER 4

RESULT AND DISCUSSION

4.0 Introduction

This chapter shows the outcomes of this whole project which consist of results and analysis of this project. It will also consist of two section which are software and hardware parts. All of this result will be discussed in this chapter.

4.1 Software Configuration

This part briefly explained the configuration of the circuit that has been constructed in the software. The circuit already shown previously in Figure 3.16. It is designed in the software first because the circuit need to be configured before applied in the hardware. Arduino Uno is first need to configure and evaluate to check if the simulation can run accordingly or not as a monitor system and waring alert system.

4.1.1 Connection between Arduino Uno Rev 3, Voltage Sensor B25, Current Sensor ACS712, Temperature Sensor LM35, LED Red, LCD Display 16×2, Piezoelectric Buzzer

The circuit diagram for this project has shown previously in Figure 3.16. The circuit diagram consists of Arduino Uno Rev 3 board, Voltage Sensor B25, Current Sensor ACS712, Temperature Sensor LM35, LED Red, LCD Display 16×2, Piezoelectric Buzzer. Figure below 4.1 shows the schematic diagram of the circuit diagram in 3.16.

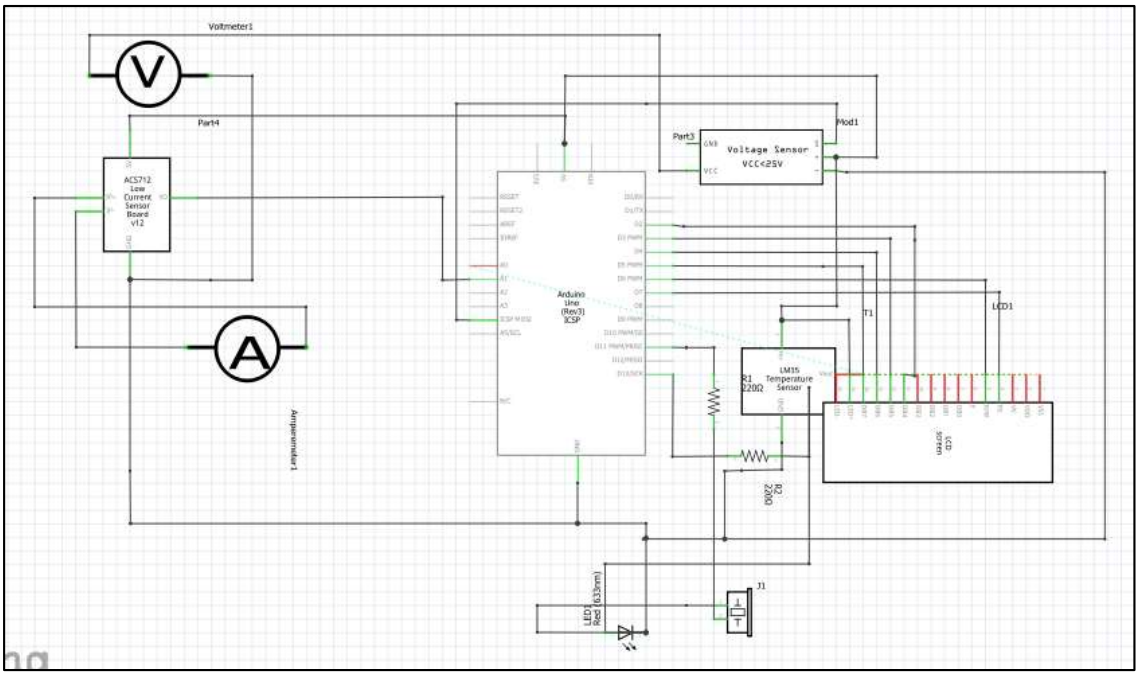

Figure 4.1: Schematic Diagram

4.1.2 Pin Configuration of the Project

This part will show the connection in the simulation of software that may also applied in the hardware. The table below will clearly present the pin configuration between Arduino Uno Rev 3 board, Voltage Sensor B25, Current Sensor ACS712, Temperature Sensor LM35, LED Red, LCD Display 16×2, Piezoelectric Buzzer.

Table 4.1: Pin Connection between Arduino Uno Rev 3 and LM35

Arduino Uno Rev 3	**LM 35**
5V	Vcc
A0	Vout
Gnd	Gnd

Table 4.2: Pin Connection between Arduino Uno Rev 3 and LED

Arduino Uno Rev 3	**LED Red**
Pin 13	Anode (+)
Gnd	Cathode (-)

Table 4.3: Pin Connection between Arduino Uno Rev 3 and Buzzer

Arduino Uno Rev 3	**Buzzer**
Pin 11	Positive
Gnd	Negative

Table 4.4: Pin Connection between Arduino Uno Rev 3 and ACS712

Arduino Uno Rev 3	**ACS712**
5V	5V
A1	Vo
Gnd	Gnd
(To measure the voltage)	IP+
(To measure the voltage)	IP-

Table 4.5: Pin Connection between Arduino Uno Rev 3 and B25

Arduino Uno Rev 3	**B25**
Pin 11	+
Gnd	-
A4	S
(To measure the voltage)	Vcc
(To measure the voltage)	Gnd

Table 4.6: Pin Connection between Arduino Uno Rev 3 and LCD

Arduino Uno Rev 3	**LCD**
Gnd	Vss
5V	V_{DD}
Pin 6	VO
Pin 12	RS
Gnd	RW
Pin 10	E

Pin 2	D4
Pin 3	D5
Pin 4	D6
Pin 5	D7
5V	A
Gnd	K

4.2 Hardware Configuration

This project is created especially for a place that become the attention for lightning such as wastewater treatment plant that always experienced serious damage to the instrumentation and control (I&C) equipment because of lightning-induced surges. This project is basically a smaller scale of the real lightning detector and that means it cannot detect the real lightning. This project design is based on the objectives that has been verified. Here, the project that has been constructed will be shown in figure below.

Figure 4. 2: Hardware Setup (overall view)

Figure 4.3: Arduino Uno Setup

Figure 4.4: Current Sensor and Voltage Sensor Setup

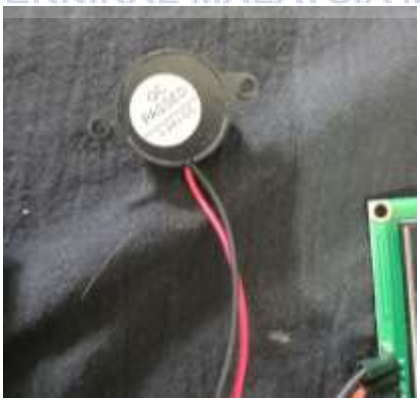

Figure 4.5: Buzzer Setup

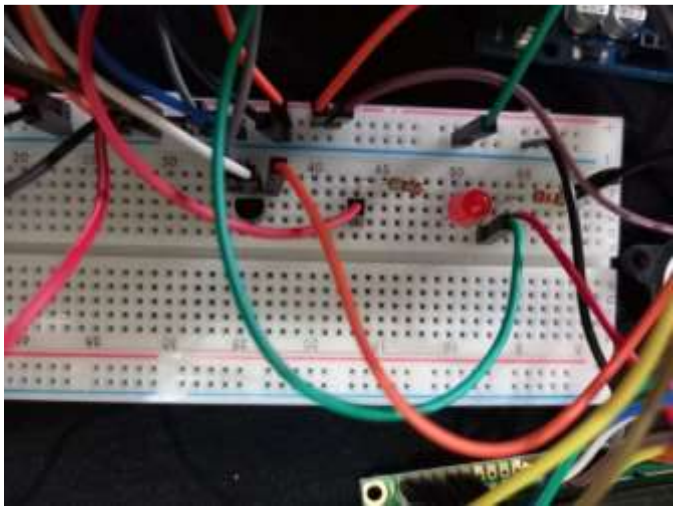

Figure 4.6: LED and LM35 Setup

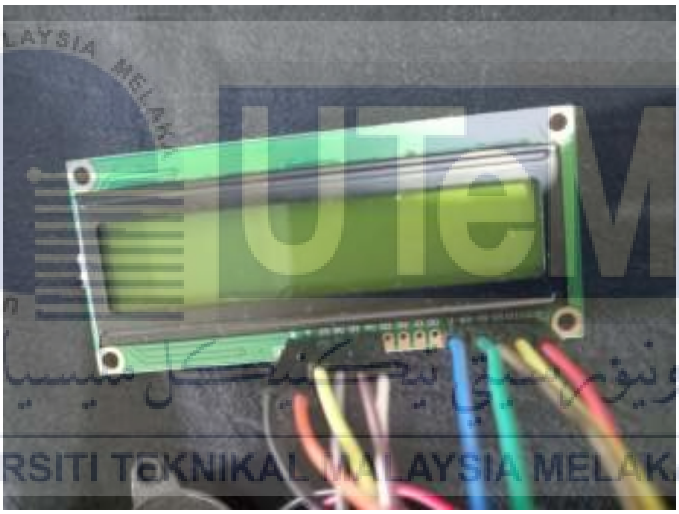

Figure 4.7: LCD Display Setup

4.3 Data Analysis

In this part of the experiment setup, monitoring the parameters which is voltage, current, and temperature have been implemented using the B25 voltage sensor, ACS712 current sensor, and LM35 temperature sensor respectively.

4.3.1 Voltage Sensor Output

The graph below can be conclude as the hypothesis between voltage and temperature changes from time to time. The hypothesis is the higher the voltage, the higher the temperature.

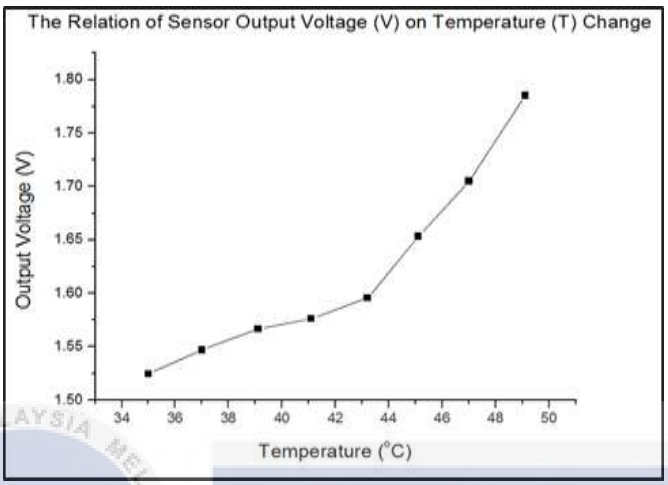

Figure 4.8: Graph of Output Voltage(V) vs Temperature(C)

4.3.2 Current Sensor Output

Based on the figure below, shows the graph of voltage vs current. The observation that has been made to this graph is the higher the voltage output, the higher the current. Current and voltage has also been stated in the ohm's law with the main formula V=IR, and the most basic knowledge in electric and electronic it should be. As mention in the formula, voltage is directly proportional to current which means when the voltage increase, the current will increase as well and inversely.

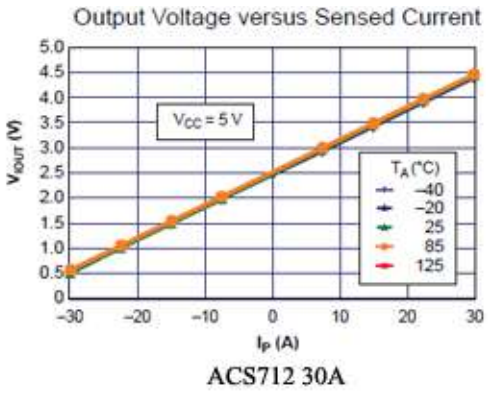

Figure 4.9: Graph of Output Voltage(V) vs Output Current(A)

4.3.3 Temperature Sensor Output

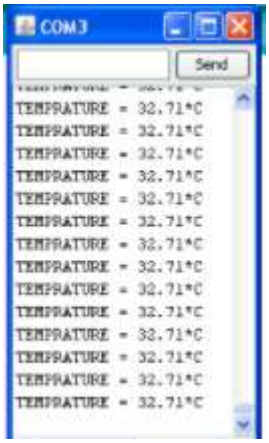

Figure 4.10: Data from LM35

This data was recorded from serial monitor through LM35 temperature sensor and the data recorded the ambient temperature. LM35 cannot detect temperature above than 150°C and less than -55°C. That is the limit for this sensor and the temperature that has been set is 40°C means whenever the temperature reach 40°C, the alarm will start.

CHAPTER 5

CONCLUSION AND FUTURE WORK

5.0 Introduction

In this chapter, conclusion of this whole project will be discussed and several improvements for the future implementation and development of the project will be suggested. This chapter will conclude the overall flow of this project from the beginning of the procedure and the result finding in this project. The recommendation and limitation will be added for this project in order to propose some suggestion on the improvement of this project and paperwork in the future.

5.1 Conclusion

This project is about monitoring the wastewater treatment plant based on some basic condition that are very important to prevent an excessive power that give damage to the earth living. Other than give damage to the earth living, it also can cause damage to the whole system due to high voltage of lightning. Therefore, this project is the sample in a smaller scale of the real version that have the ability to observe and monitor the lightning from afar by showing the condition from the LCD screen that display the actual value of current, voltage and temperature since this three is the input to this project.

Moreover, the system is also to give warning which is issuing an alarm whenever the sensors reach their limit. To be specific this alarm is a pre-alarm which warned the user that the value of current, voltage and temperature is going higher in an intermediate time. Basically, the user of this system will take precaution step before the earth living and the system will go through excessive damage and this is a bit costly to fix the all damage. Rather than fixing, it is better to preventing and that is why there is a saying mentioned preventing is better than cure.

This system is highly demanded by most of the industries nowadays especially the industries that located near to the lightning area. This system will help the user easy to monitor all the parameter chosen. With this system, industries do not have to waste money in order to fix the same repetitive damage and provide the correct data and warn the worker itself. In the century of technology, the usage of IoT technology is surely a really useful technology for the mankind. The cost of the implementation of this system is quite expensive but the cost will keep falling due to the high demands on the growth of this technology.

5.2 Justification of Objectives

As mentioned in the introduction, the purpose of this study is to develop a Lightning Monitoring and Warning Alert System using Arduino that can monitor based on the parameters and able to warn and alert the user based on the condition. The system is using Arduino microcontroller, with the implementation of temperature, voltage, and current sensors. This project was produced with a Microcontroller (MCU) which is Arduino Uno. The objectives have been achieved successfully.

5.3 Review of Method

Based on the circuit design, the construction and the connection of the components, software that were used in this project and the final design of this project, this study shows the procedures step by step from the beginning until the project was completely produced and functions very well as expected in the objectives.

5.4 Review of significant

The most significant finding that emerges from this study is that the project is successfully design and the Arduino Uno is programmed to monitor the parameter from time to time and give the warning alert when the value of the parameter reached the limit.

5.5 Limitation

When it comes to pros and cons, almost every product has even in its lowest percentage. This project will get a bit sensitive when the lightning that occur is too near and the system and the data provided is not stable. Certain part of the circuit also may burn due to the large amount of voltage that own by the lightning. It might happen due to the carelessness of the user that did not alert when the alarm has been triggered. Therefore, this project this project main problem is the sensitivity due to high amount of voltage can lead to damage of the system.

5.6 Recommendation

Due to this project limitation, as mention in 5.6 above, in 5.7 will be discussed an innovation that can be made to this project to improve this project in future. The aim is to prevent the system from excessive damage that can increase the cost due repairing the system. The stability of the sensors can be increased using a better quality of the sensors and other component which are more expensive in the market. The coding can also be modified in order to create a better and more stable data.

It is recommended the system has been set to straight close the system whenever the voltage, temperature, and current reach its limit that has been set in the coding. This method is highly recommended to prevent execution error which is categorised under human error that has been done unintentionally. Moreover, this may use more power to control the system and probably in real life with a view to maintain the system in a long term the maintenance that need to be done from time to time.

Based on this project the circuit of this system can be upgraded using etched PCB Board which is tidier, simple, light and more systematic instead of using PCB board. It is also recommended that for the LCD to use the 20×4 Line LCD Display to make it easier to display the parameters. Lastly, other than using Arduino Uno as the only microcontroller, SCADA is another option that able to control the system as a microcontroller as well.

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APPENDICES

Coding of the system

ARDUINO_B25V_ACS712_LCD1602 | Arduino 1.8.12

File Edit Sketch Tools Help

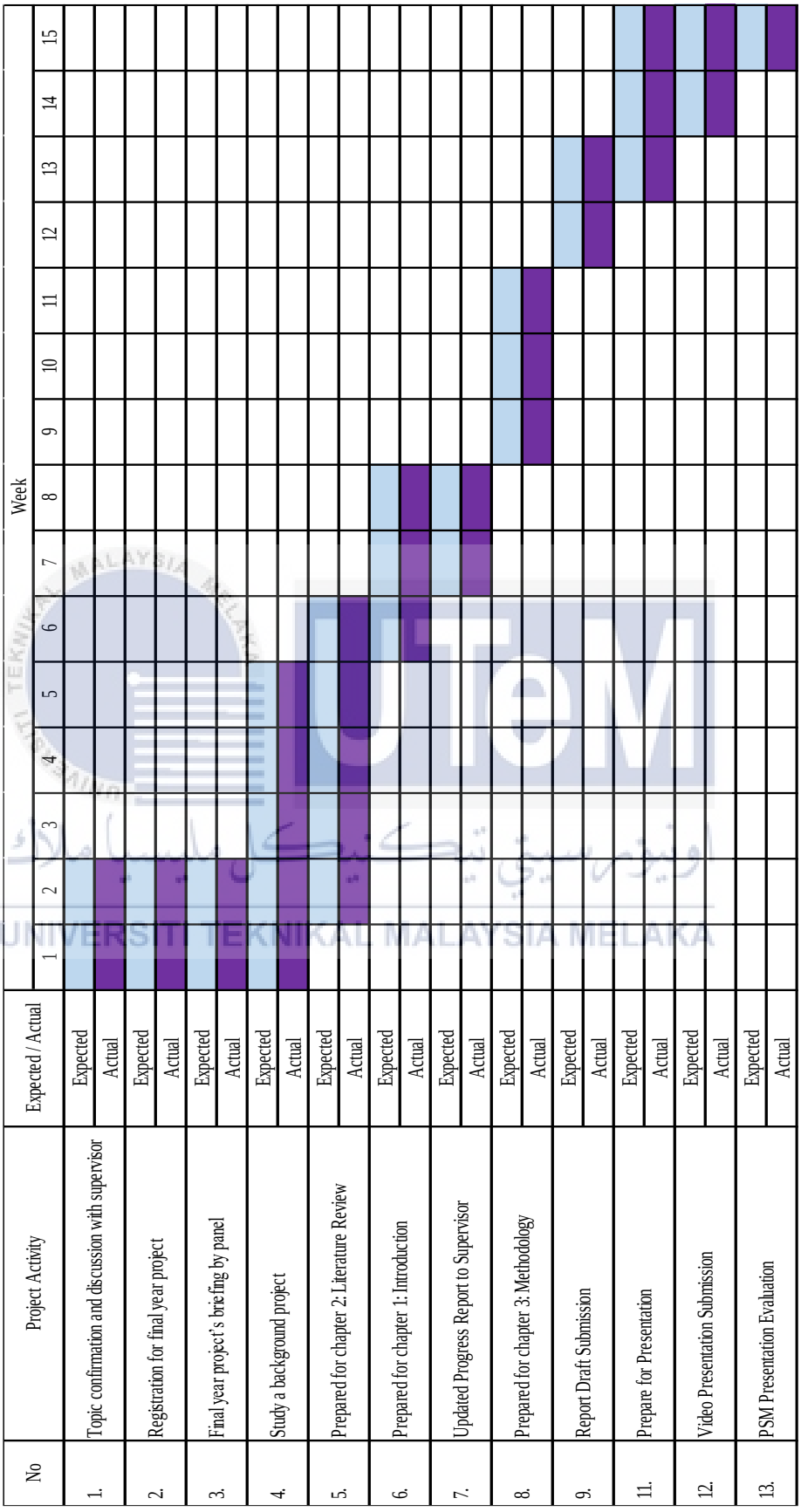
ARDUINO_B25V_ACS712_LCD1602 §

```
#include "LiquidCrystal.h"

// lm35 SENSOR
const int sensor=A0; // Assigning analog pin A5 to variable 'sensor'
float tempc; //variable to store temperature in degree Celsius
float tempf; //variable to store temperature in Fahreinheit
float vout; //temporary variable to hold sensor reading

//buzzer
int buzzer = 11;

//acs712 current sensor
const int currentPin = A1;
int sensitivity = 66;
int adcValue= 0;
int offsetVoltage = 2500;
double adcVoltage = 0;
double currentValue = 0;

// led red indication alarm
int led_red = 13;

///b25 voltage sensor
const int voltageSensor = A4;
float vOUT = 0.0;
float vIN = 0.0;
float R1 = 30000.0;
float R2 = 7500.0;
int value = 0;

// lcd part code does do here guys :
LiquidCrystal lcd(7, 6, 5, 4, 3, 2); // RS, E, D4, D5, D6, D7

void setup() {
pinMode(sensor,INPUT); // Configuring sensor pin as input
pinMode(buzzer, OUTPUT); // make buzzer as output of arduino part
pinMode(led_red, OUTPUT); //make led as output to make alarm part
lcd.begin(16,2);
lcd.print(" Measure > 25V  ");
Serial.begin(9600); // begin serial communication
}
```

```
void loop() {

vout=analogRead(sensor); //Reading the value from sensor
vout=(vout*500)/1023;
tempc=vout; // Storing value in Degree Celsius
tempf=(vout*1.8)+32; // Converting to Fahrenheit
Serial.print("in DegreeC=");
Serial.print("\t");
Serial.print(tempc);
Serial.print(" ");
Serial.print("in Fahrenheit=");
Serial.print("\t");
Serial.print(tempf);
Serial.println();

delay(1000);

adcValue = analogRead(currentPin);
adcVoltage = (adcValue / 1024.0) * 5000;
currentValue = ((adcVoltage - offsetVoltage) / sensitivity);

Serial.print("Raw Sensor Value = " );
Serial.print(adcValue);

delay(1000); //Delay of 1 second for ease of viewing

Serial.print("\t Current = ");
Serial.println(currentValue,3);

delay(1000);

value = analogRead(voltageSensor);
vOUT = (value * 5.0) / 1024.0;
vIN = vOUT / (R2/(R1+R2));
Serial.print("Input = ");
Serial.println(vIN);

delay(1000);


// control and alarm part

// voltage alarm - using b25 voltage sensor
// set 7 volt as trigger, can change according value
//if (vIN > 5)
{
  // no warning or alert, voltage just doing it fine

  digitalWrite(led_red,  LOW);
  digitalWrite(buzzer, LOW);
{
if else
```

```
}
  // alert them when voltage is dropped below 7 volt
  digitalWrite(led_red,  HIGH);
  digitalWrite(buzzer, HIGH);
}
}
```

Gantt Chart Final Year Project 1



No	Project Activity	Expected / Actual	Week														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Topic confirmation and discussion with supervisor	Expected															
		Actual															
2.	Registration for final year project	Expected															
		Actual															
3.	Final year project's briefing by panel	Expected															
		Actual															
4.	Study a background project	Expected															
		Actual															
5.	Prepared for chapter 2: Literature Review	Expected															
		Actual															
6.	Prepared for chapter 1: Introduction	Expected															
		Actual															
7.	Updated Progress Report to Supervisor	Expected															
		Actual															
8.	Prepared for chapter 3: Methodology	Expected															
		Actual															
9.	Report Draft Submission	Expected															
		Actual															
11.	Prepare for Presentation	Expected															
		Actual															
12.	Video Presentation Submission	Expected															
		Actual															
13.	PSM Presentation Evaluation	Expected															
		Actual															