Faculty of Electrical Technology and Engineering

**DEVELOPMENT OF SOLAR POWERED AUTOMATED ROOF FOR A CLOTHESLINES HOME USING ARDUINO AND IOT**

**NURUL SYAHIRAH BINTI ABDUL TALIB**

**Bachelor of Electrical Engineering Technology (Industrial Power) with Honours**

**2023**

**DEVELOPMENT OF SOLAR POWERED AUTOMATED ROOF FOR A CLOTHESLINES HOME USING ARDUINO AND IOT**

**NURUL SYAHIRAH BINTI ABDUL TALIB**

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

**Faculty of Electrical Technology and Engineering**



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2023**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**
FAKULTI TEKNOLOGI DAN KEJUTERAAN ELEKTRIK

**BORANG PENGESAHAN STATUS LAPORAN**
**PROJEK SARJANA MUDA II**

Tajuk Projek : **Development Of Solar Powered Automated Roof For A Clotheslines Home Using Arduino And IoT**

Sesi Pengajian : **2023**

Saya **Nurul Syahirah Binti Abdul Talib** mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

| | | |
|---|---|---|
| ☐ | **SULIT*** | (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972) |
| ☐ | **TERHAD*** | (Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan) |
| ☑ | **TIDAK TERHAD** | |

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

Alamat Tetap: No. 48, Jalan P/I 8/9, Taman Pulai Indah, 81300, Skudai, Johor.

ADAM BIN SAMSUDIN
PENSYARAH
Fakulti Teknologi dan Kejuruteraan Elektrik
Universiti Teknikal Malaysia Melaka

Tarikh: 30 / 01 / 2024

Tarikh: 05/02/2024

*CATATAN: Jika laporan ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh laporan ini perlu dikelaskan sebagai SULIT atau TERHAD.

**DECLARATION**

I declare that this project report entitled "Development Of Solar Powered Automated Roof For A Clotheslines Home Using Arduino And IoT" 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 : **Nurul Syahirah Binti Abdul Talib**

Date : **30 / 01 / 2024**

**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 Electrical Engineering Technology (Industrial Power) with Honours.

Signature :

Supervisor Name : **Sir Adam Bin Samsudin**

Date : 05/02/2024

Signature :

Co-Supervisor Name (if any) : **Madam Nurul Kausar Binti Ab Majid**

Date : 05/02/2024

## DEDICATION

*To my beloved mother, Nur Hayati, and father, Abdul Talib, and my beloved family,*
*To my supervisor, Sir Adam Bin Samsudin,*
*Also, my co supervisor, Madam Nurul Kausar Binti Ab Majid,*
*This project is dedicated to all of you and to God Almighty who is my creator, my strong pillar, my source of inspiration, wisdom, knowledge, and comprehension. They have been a source of strength for me throughout this effort, and on His wings I have soared. They have also supported me along the way to ensure that I give it everything I must finish what I have started. God's blessings on you.*

# ABSTRACT

People increasingly spend less time at home because of corporate culture, and some rely on cutting-edge technologies for safety and other basic necessities. The shifting seasons are difficult to predict, especially when it is raining, which can impede drying and keep laundry moist. This issue happens when the consumer is not in an accessible location while it is rainy days. Other than that, Malaysia's equatorial location makes it Malaysia's equatorial location, it is difficult for users to figure out whether it will rain or be sunny on that day. These issues are addressed by smart home automation technologies. " Development Of Solar Powered Automated Roof For A Clotheslines Home Using Arduino And IoT," for example, handles such a problem. The scope of this project is which focuses on possible users, who are students and workers with busy schedule. This project's major goal is to develop and construct a climate-friendly automatic smart roof for cloth suspension, as well as to administer the automatic roof system using an ESP8266 NodeMCU and to analyze the efficacy of the roof system using a rain sensor. The design and implementation of this study allow users to use their smartphone to monitor the conditions of the laundry suspension area, design and develop a climate-friendly automatic clothes dryer, and then adjust the automatic suspension system. As expected, recommendations. hardware includes three different parts for sensing, driving, and notification systems. The ESP8266 NodeMCU controller controls the sensing and driving modules. The system can be controlled manually through the automatic roof application. The driving mechanism, similarly, found on numerous retractable roofs, is a motor. Because motors require servo mechanisms, servo motors are used as driving modules in this prototype. Moreover, unlike previous iterations, this proposal's approach appears simpler to create and more affordable to implement.

# *ABSTRAK*

Orang ramai semakin kurang menghabiskan masa di rumah akibat budaya korporat, dan sesetengahnya bergantung pada teknologi canggih untuk keselamatan dan keperluan asas yang lain. Musim peralihan sukar untuk diramalkan, terutamanya apabila hujan, yang boleh menghalang pengeringan dan mengekalkan lembapan pakaian. Isu ini berlaku apabila pengguna tidak berada di lokasi yang boleh diakses semasa hari hujan. Selain itu, lokasi khatulistiwa Malaysia menjadikannya lokasi khatulistiwa Malaysia, sukar bagi pengguna untuk mengetahui sama ada hujan atau cerah pada hari tersebut. Isu ini ditangani oleh teknologi automasi rumah pintar. "Reka bentuk dan pembangunan bumbung boleh ditarik balik automatik untuk jemuran menggunakan Arduino," sebagai contoh, menangani masalah sedemikian. Skop projek ini adalah yang memberi tumpuan kepada pengguna yang mungkin, yang merupakan pelajar dan pekerja dengan jadual yang padat. Matlamat utama projek ini adalah untuk membangunkan dan membina bumbung pintar automatik mesra iklim untuk ampaian kain, serta untuk mentadbir sistem bumbung automatik menggunakan ESP8266 NodeMCU dan untuk menganalisa keberkesanan sistem bumbung menggunakan sensor hujan. Reka bentuk dan pelaksanaan kajian ini membolehkan pengguna menggunakan telefon pintar mereka untuk memantau keadaan kawasan ampaian dobi, reka bentuk dan membangunkan pengering pakaian automatik mesra iklim, dan kemudian melaraskan sistem bumbung automatik. Seperti yang dijangkakan, cadangan perkakasan termasuk tiga bahagian berbeza untuk penderiaan, pemanduan dan sistem pemberitahuan. Pengawal ESP8266 NodeMCU mengawal modul penderiaan dan pemanduan. Sistem ini boleh dikawal secara manual melalui aplikasi bumbung automatik. Mekanisme pemanduan, begitu juga, terdapat pada banyak bumbung yang boleh ditarik balik, adalah motor. Oleh kerana motor memerlukan mekanisme servo, motor servo digunakan sebagai modul pemanduan dalam prototaip ini. Selain itu, tidak seperti lelaran sebelumnya, pendekatan cadangan ini kelihatan lebih mudah untuk dibuat dan lebih berpatutan untuk dilaksanakan.

## ACKNOWLEDGEMENTS

Firstly, I would like to express my gratitude to Allah S.W.T for granting me the chance to commence my Final Year Project and for successfully finishing this arduous and lengthy endeavour. I express my profound appreciation and gratitude to my family, friends, supervisor, and co-supervisor. I wish to convey my sincere appreciation to all individuals who have made valuable contributions to the successful culmination of this undertaking. This feat would have been unattainable without their invaluable assistance, direction, and encouragement. I am extremely grateful to my supervisor, Sir Adam Bin Samsudin, and my co-supervisor, Madam Nurul Kausar Binti Ab Majid, for their invaluable assistance, insightful input, and consistent motivation during the course of this project. Their profound knowledge and unwavering commitment have been vital in influencing the direction of my research and motivating me to achieve the highest level of performance. I am grateful to the staff members of Universiti Teknikal Malaysia Melaka for their lessons and guidance, which have enhanced my knowledge and skills, helping me to overcome the hurdles I faced along this trip.

I would like to express my sincere gratitude to my family and friends for their unwavering support and comprehension during the challenges and successes of my academic journey. Their affection and encouragement have served as a steadfast source of support, intensifying my resolve to successfully bring my endeavour to fruition. Last but not least, I want to thank me, I want to thank me for believing in me, I want to thank me for doing all this hard work, I want to thank for having no days off, I want to thank me for never quitting, I want to thank me for always being a giver and trying to give more than I receive, I want to thank me for trying to do more right than wrong, I want to thank me for just being me all time.

# TABLE OF CONTENTS

`

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF ABBREVIATIONS AND SYMBOLS

| | | |
|---|---|---|
| ° | - | Degree sign |
| GSM | - | Global System for Mobile Communication |
| UV | - | Ultraviolet |
| DC | - | Direct Current motor |
| IoT | - | Internet of Things |
| IOD | - | Indian Ocean Dipole |
| MJO | - | Madden-Julian Oscillation |
| ENSO | - | El Nino-Southern Oscillation |
| COP | - | Common Operating Picture (COP |
| RFID | - | Radio-Frequency Identification |
| WSN | - | Wireless Sensor Network |
| SEDA | - | Sustainable Energy Development Authority Malaysia |
| CO | - | Carbon Monoxide |
| $O_3$ | - | Ozone |
| $SO_2$ | - | Sulfur Dioxide |
| PM10 | - | Particulate Matter |
| $NO_2$ | - | Nitrogen Dioxide |
| PV | - | Photovoltaic |
| MBIPV | - | Malaysian Building Integrated Photovoltaic |
| CIS | - | Copper Indium Diselenide |
| TNB | - | Tenaga Nasional Berhad |

## LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

Malaysia is a country in the center of the world that is very humid and hot all year round. Malaysia experiences rare rainfall, which increases during the rainy season. From May to September, Malaysia experiences the southwest monsoon and northeast monsoon [1-2]. When a bodyof water, such as a lake, stream, river, or ocean, evaporates into the air after being heated by sunlight, precipitation is formed. Water vapor condenses and forms clouds as it rises through theair. Clouds are made up of microscopic droplets of ice or water particles that vary in size based on the height and temperature of the surrounding air. Water condenses when an excessive amountof water condenses around the particles or when the temperature drops. Water flows into rivers and lakes when rain falls on land and enters the ground. The river water eventually ends up in the sea. The cyclical process of evaporation of water from one water area to rain then continues. This is the basic rain cycle, which serves as the basis for the formation of precipitation [3-5].



Malaysians wash their clothes and hang them for drying in the suspension area, which is usually not closed and exposed to sunlight due to the constant weather throughout the year in Malaysia. Drying using a drying machine and the usual hanging of the fabric is one of the ways to dry clothes. This is a widespread practice in equatorial countries such as the Philippines, Thailand, Singapore, Indonesia including Malaysia. However, since it requires a large amount of electricity plus the machine itself is expensive, it is cheaper than washing clothes and drying things in on a clothesline. As a result, unexpected rain when drying clothes in the suspension can be a problem, especially if you are far from home. Clothes dryers and tumble dryers are another common technique of drying textiles in Western countries. Instead of using cloth suspensions common in the East, most Western homes have clothes dryers. Using a tumble dryer, on the contrary, is faster than using a fabric suspension. This is because the method of suspending clothes requires sunlight, and evaporative drying takes a long time. Another cultural difference in drying clothes is that hanging clothes is considered unattractive in the West, although it is much more effective. Because there is no need to occupy space to hang clothes when using the clothes dryer. Even so, the dryer requires more energy, but drying line uses, renewable energy, such as sunlight [6-8]. It is designed a retractable automatic roof system. The microcontroller records the data in real time and transmits it wirelessly to the user's smartphone.The application on the mobile device displays the properties of the sensor. In addition, mobile phones are used as user monitoring devices instead of laptops to track and administer the entire system. Applications for smartphones can be used to remotely monitor the system from anywhere, and commands can be communicated to the system at home in real time [9-12].



## 1.2 Societal and Global Issue Of Climate Change And Variability over Malaysia: gaps in Science and research information

Malaysia's current scientific understanding of climate change and variability. Malaysia is located on Southeast Asia's Maritime Continent in the west. Malaysia weather patterns necessitates an understanding of regional changes in climate and variability. Based on the pollution circumstances, the average ambient temperature in Malaysia could rise by 3-5°C by the final decade of the twenty-first century, according to the most current regional climate downscaling study. The average precipitation in the Northern Hemisphere is predicted to drop (increase) throughout the winter (summer). Nonetheless, future fluctuations in geographical phenomena which include the monsoon, the El Nino-Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), and the Madden-Julian Oscillation (MJO) remain unresolved. Nothing is known about the severity and frequency of further extreme occurrences (drought as well as flooding) currently. Additionally, this applies to ongoing shifts in regional waterways, particularly in the southern South China Sea. Researchers discovered that climate change information gaps remain throughout Malaysia and the bordering region.

Climate change is thought to alter atmospheric air composition, although little is known about the direct relationship between these factors, particularly in a hot tropical environment like Malaysia's. To evaluates the climate state and air quality of Peninsular Malaysia for the last 20 years (2000-2019) using selected ground-based observations of temperature, precipitation, relative humidity, wind speed, wind direction, and concentrations of PM10, $O_3$, CO, $NO_2$, and $SO_2$. To forecast the degree of change in future air quality under different warming scenarios, the Pearson correlation and canonical correlation analysis (CCA) methods are used to assess the relationship between the climate state and air quality. It was discovered that Peninsular Malaysia had heavy precipitation predominantly in the central and mountainous regions, while air pollutants were concentrated primarily in heavily populated areas. Peninsular Malaysia became warmer and drier across the research period (interannual, monthly, and diurnal time series analyses), with a substantial increase in temperature (+4.2%), drop in relative humidity (4.5%), and increased variation in precipitation amount. Pollution levels have risen over the last 20 years, with increases in PM10 (+16.4%), $O_3$ (+39.5%), and $NO_2$ (+2.1%) concentrations. However, the levels of $SO_2$ (53.6%) and CO (20.6%) were much lower. The monthly variation analysis reveals a strong bimodality of PM10 and O3 concentrations, which coincides to the monsoon changeover. All variables in this study show intense diurnal oscillations and relationships [13].

## 1.3 Problem Statement

The challenge in this project arises when the user fails to prevent rain from wetting the clothesline while they are at work or away from home. This is considering consumers have become too busy with work and other obligations to spend all their time at home. Furthermore, because Malaysia is located on the Equator line, it is difficult for users to figure out whether it will rain or be sunny on that day. Next, the manual drying procedure renders drying garments useless if it rains unexpectedly, forcing the user to wash and then dry the clothes again.

## 1.4 Project Objective

The goals of Automated Roof for a Clotheslines Home Using Arduino are to improve and construct a prototype of a mobile application that can connect to the system and receive notifications. There are three objectives as following:

a) To design and construct a climate-friendly solar powered automated roof for a clothesline using arduino.

b) To develop an IoT system of solar powered automated roof for a clothesline home using arduino.

c) To analyze the effectiveness of the solar powered automated roof for a clothesline home using arduino.

## 1.5 Scope of Project

To create and install a system that automatically protects garments by detecting rain without the humans' supervisions. So, our concept, Automated Roof for a Clotheslines Home Using Arduino, is a little step towards comfort and saving time. The scope of this project is divided into two categories:

a) Collect average data for voltage and power from sunlight for a week in Johor Bahru, Johor in November 2023 using 5v, 250mA (1.25w) solar panel with wires.

b) Collect average data for roof and fan to open and close automatically when it rains and manually in the application.

c) Application for automated roof to control and monitor when rainy weather, data voltage and power on the day.

d) Using a Wi-Fi as a wireless connection for application.

## 1.6 Summary

Malaysia's humid climate, influenced by its location on Southeast Asia's Maritime Continent, is expected to rise by 3-5°C by the end of the 20th century. The Northern Hemisphere's average precipitation is expected to fall over winter, but future oscillations in geographical phenomena like monsoons, El Nino-Southern Oscillation, Indian Ocean Dipole, and Madden-Julian Oscillation remain unresolved. A report evaluates Peninsular Malaysia's climate and air quality over the last 20 years, revealing considerable precipitation in central and mountainous regions and increased air pollutants in densely populated areas. The project faces challenges in predicting rain and sunshine due to Malaysia's Equator location. If it rains unexpectedly, manual drying techniques render drying clothing worthless, forcing the user to wash and dry the clothes again. The goal is to design and install a system that detects rain and automatically protects clothing without the use of humans. The project's scope is divided into two parts: analysing data to determine the realistic amount of solar energy generated and optimising smart automated roof solar energy harvesting and utilisation for powering the automatic clothesline.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Seasonal variations are difficult to predict these days, especially during the wet season. It is unusual to find sun rays to dry our clothes during the rainy season, but how can we expose our garments to sun rays as soon as they are available? As a result, human interaction is essential to monitor this on a frequent basis. It is a waste of time to keep a person always on the lookout for sun rays. As a consequence, there is an electromechanical system that continuously monitors the sun's rays and the rainy season and automatically removes the garments from the sun's rays to keep them dry.



## 2.2 Sustainable Development of Renewable Energy – Solar Electricity Study on Malaysian's Perspective Towards Renewable Energy Mainly on Solar Energy

Malaysia, although being one of the world's largest suppliers of oil and natural gas, is having difficulty meeting domestic and worldwide energy demand. Due to mature reservoirs, the country's oil production has been continuously declining since hitting a peak of 862,000bbl/d in 2004. Alternative costs and maintenance are increasing year after year, while fuel supplies are diminishing, making it difficult for Malaysia to sustain its oil development. This has become a significant issue for the government to establish electricity in the most economically valuable areas to assure its long-term development. By performing a poll from this research gives an assessment of Malaysians' perspectives on renewable energy, focusing on the solar energy sector. The poll focuses on Malaysians' comprehension of renewable energy, their acceptance of solar energy, the prospects of solar energy, and their financial outlook on solar energy in Malaysia. According to research, renewable energy, particularly solar energy, is warmly welcomed by many Malaysians, and there is a desire to modify the traditional energy approach. Malaysians are likewise concerned about the environment and are ready to implement any legislation that wouldprovide a solution to the energy dilemma [14].

The research are Poul Alberg Ostergaard, Neven Duic, Younes Noorollahi, Hrvoje Mikulcic and Soteris Kalogirou provides a review of the state of research in the exploitation of renewable energy sources, with a focus on the status of technologies exploiting renewable energy sources, an assessment of the availability of renewable energy sources, and research into the types of systems that can integrate renewable energy sources. Marino et al. examined a system comprised of a solar system and power storage based on electrolyser, hydrogen storage, and a fuel cell using the energy systems simulation model HOMER. The results reveal that extensive high-pressure storage is necessary; yet, the system's economics is too poor and would have to be reduced by three quarters to compete with grid electricity, for example : Ocon and Bertheau investigated the energy transition from fossil to hybrid solar PV [15].

## 2.3 Automatic Harvested Crop Protection System with GSM and Rain Detector



This project demonstrates how the tray will open and close dependent on the sun's rays. The tray is secured to the roof and controlled. The roof-mounted tray is controlled by an 8-bit microprocessor that detects weather conditions. It can also be utilized in a crop protection system with an auto roof that covers a defined area. When it rains, the rain sensor activates, alerting the control system to shut the roof and transmitting a Short Message Service (SMS) to the farmer via the Global System for Mobile Communication (GSM). When the rain stops, the controller opens the roof automatically. Manual control mode and SMS are also included in this device [16].

### 2.3.1 Implementation of an Automated Retractable Roof for a Home Line-Dry Suspension Area Using IoT and WSN in Conjunction with ESP-Mesh.

The study's design and implementation allow users to monitor parameters at the laundry suspension place using their smartphones and prevent the laundry from becoming wet. To identify features such as humidity, UV intensity, the presence of water, and humidity, this study employs humidity sensors, an UV sensor, a rain sensor, and a temperature sensor. When it rained, information gathered by the sensors was gathered and analyzed to identify the parameters' values. During a weather prediction experiment, these variables were discovered. According to the findings of the experiments, the retractable roof opens and shuts based on the system's status. Furthermore, the device may use an Internet connection to communicate with the owner's smartphone. The Blynk mobile app keeps track of and regulates the system via an internet connection created between the app and the microcontroller. The findings will benefit non-profit organizations and may be applied to commercial applications with future advancements [13].

### 2.3.2 An Automatic Sliding Roof Using Infrared Sensor.



An autonomous sliding roof system with an infrared sensor was designed. It consists of a sensor, a control module, and an actuator unit to raise and close the roof at a public facility's entrance. The fundamental goal of this studies is to know about the operation of the automatic roof system and to comprehend the ideas involved. An additional purpose aims to create a basic circuit model that demonstrates how the system works. This work's key activities include researching how an automatic door performs, followed by producing basic replica [17].

Figure 2.1 Past research prototype of sliding roof.

### 2.4 Previous Retractable Roof System Study

Since 1930, many different types of mobile roofing systems have been employed all over the world. Large structures, most notably stadiums, have only recently began to use or build roofing systems. Regardless, movable rooftops are increasingly being employed on medium-sized structures such as apartments and businesses. As indicated by Ishii [18], Zablocki [19], and Liu et al [20], almost 25 large-span moveable rooftops were employed for stadiums around the globe during the first millennium, with Japan accounting for roughly half of the total.Though the number has risen in recent years because of major athletic events necessitating stadium building and upgrades. The Pittsburgh Civic venue was the initial facility in the UnitedStates to have a significant adjustable roof for a sports stadium. Mellon Arena, USA was then given the name [21]. A huge moveable roof can be opened and closed in a variety of ways. The approaches are easily comprehended by categorizing their motion as aligned oval or vertical, and their storage manner as overlaps, non-overlapping, or folding. Kass-abian et al. [22], Jensen [23], Korkmaz [24], and Fenci and Currie [25] have discussed the use of a mixture of these methods in addition to the prior strategy. The folding systems method is preferred for the purposes of this investigation. A research study was carried out to investigate the use of bending membranes as adjustable roofs. Fortunately, the folding roof was not completed until the mid-1980s, and it had to be rebuilt owing to wind-induced structural membrane defects. For opening and closing membrane systems, the Institute for Light Weight Structure (1972) advised the table following approach [26].

Table 2.1 Table of the type of roof movement [26].

| Type of Movement | Central | Circular | Parallel |
|---|---|---|---|
| Membrane (Stationary structural support) |  Bunching |  Bunching |  Bunching |
| | | |  Sliding |
| Supporting Membrane (moveable supporting structures) |  Folding |  Folding |  Rolling |
| | | |  Folding |
| Method Used | Despite of the linear motion and simplicity of repair, most big movable roofs are based on parallel | The technique of opening and shutting is usually connected with vertical motion, where | The panels or membranes can be stored in overlapping or folding |

| | | | |
|---|---|---|---|
| | movement. The membrane or support structure advances horizontally at the same time until it reaches one of the structure's ends. | the membranes or panels shift vertically while extending the folded or overlapped membranes. | configurations using this method of opening and closing the roof by rotating a fixed point. |

Clothes drying on a clothesline is a practice that most housewives employ. This is due to the fact that this procedure is incredibly efficient and requires little money. Still, should there is an unexpected downpour, the housewives' endeavors to dry clothes will be futile if they are ignorant of it. To determine the threshold values, the features of the sensors would be investigated by measuring the voltages across both sensors under various scenarios. The threshold values found were entered into the software in order to allow the system to estimate the intensity and accessibility of droplets in the surrounding environment [13].

## 2.5 Methods and Recommendations from Some Previous Endeavors

Table 2.2 contrasts the techniques and recommendations of the prior projects outlined above.

Table 2.2 Table of previous roof research.

| Author | Title | Method | Proposed Method |
|---|---|---|---|
| Ishii (2000) [18]. | Retractable Roof Structures | A retractable roof may be opened or shut in a variety of ways. | The sliding method is used for opening and shutting a retractable roof. |
| Madankar (2011) [27]. | Intelligent Rain Sensing using Automatic Wiper System | Using the Rain Sensor program, create an automatic wiper system. | The structure that went into action was the movable roof. The rain sensor functioned in the system like a switch. |
| Jadhavet al. (2016) [28]. | Environment Monitoring System using Raspberry-Pi | Using a Raspberry Pi, weather tracking environments with parameters including humidity, temperature, vibration, and gas changes. | The parameters that are used for monitoring and control. The variables in the current research were humidity, temperature, and UV intensity. |
| VivekBabuet al. (2017) [29]. | Weather Forecasting Using Raspberry Pi with the Internet of Things | The Raspberry Pi is solely used for weather forecasting and parameter monitoring. The hardware is a Raspberry Pi board. | The Arduino microcontroller is employed, and the Blynk program is used to monitor and operate the roof system. |

## 2.6 Similar Project

Table 2.3 compares the prior initiatives mentioned above in terms of their features, advantages, and disadvantages [16].

Table 2.3 Table of the advantages and disadvantages of past research [16].

| Project | Features | Advantages | Disadvantage |
|---|---|---|---|
| Prototype Smart Clothesline with an Arduino [30]. | It makes use of a rain sensor | Determines the exact time it is pouring | Clothes remain damp because they were previously exposed to rain. |
| | DC motor is installed | Capable of simply pulling the entire clothesline | Expensive |
| Automatic Laundry Cover [31]. | Uses a servo | Inexpensive and simple to use. | Unable to pull much clothing and is quite frail. |
| | It makes use of a rain sensor | Determines the exact time it is pouring | Clothes remain damp because they were previously exposed to rain. |
| Automatic Clothesline Retrieval System [32]. | Uses a servo | Inexpensive and simple to use. | Unable to pull much clothing and is quite frail. |
| | It makes use of a rain sensor | Determines the exact time it is pouring | Clothes remain damp because they were previously exposed to rain. |

| | | | |
|---|---|---|---|
| Rain Detector [33]. | Uses a servoJ | Inexpensive and simple to use | unable to pull much clothing and is quite frail. |
| | It makes use of a rain sensor | Determines the exact time it is pouring | Clothes remain damp because they were previously exposed to rain. |

According to Table 2.3, the rain sensor was utilised to detect rain in all of the prior projects. Although the rain sensor accurately detects when it is raining, the clothing will still become wet since they will be exposed to the rain just before being removed. Two of the concepts make use of a direct current (DC) motor, making proves more dependable but more expensive than a servo motor. Servo motors are more helpful for students and employees who want to keep money while also having a system that can make their lives easier.

## 2.7 Solar Energy In Malaysia: Current State And Prospects

Malaysia is in the Khatulistiwa line, with a monthly average solar radiation of 400-600 MJ/m2. It has the potential to create large-scale solar power projects; yet solar energy is still in its infancy due to the high cost of photovoltaic (PV) cells and solar electricity tariff rates. The Malaysian government is eager to promote solar energy as a key energy source for the country.

The 9th Malaysia Plan (9MP) includes major funding for the building of solar PV projects. A Malaysian Building Integrated Photovoltaic (MBIPV) project was begun on 25 July 2005, with a completion deadline of 2010 [34].

### 2.7.1 A practical field study of various solar cells on their performance in Malaysia

A realistic field research was conducted with the goal of analysing and comparing the performance of various types of commercially available solar panels in Malaysian conditions. For the practical field investigation, four distinct types of solar panels are used: mono-crystalline silicon, multi-crystalline silicon, amorphous silicon, and copper-indium-diselenide (CIS) solar panels. A number of performance-related characteristics were collected using a data logger over three consecutive days in the goal of providing some preliminary information on the true performance of various solar panels. The results demonstrate that monocrystalline silicon and multicrystalline silicon solar modules work better in hot sun, whereas CIS and triple junction amorphous silicon solar panels perform better in cloudy, diffused sunlight. Furthermore, it has been discovered that the efficiency of crystalline silicon solar panels decreases as temperature rises. This phenomenon does not occur in CIS or amorphous silicon solar panels, indicating that CIS and amorphous silicon solar cells perform better in terms of power conversion efficiency and total performance ratio. The first results show improved performance of thin film solar cells such as amorphous silicon and CIS, which calls attention to the selection of solar panels and may boost their use in tropical climates such as Malaysia [35].

### 2.7.2 Solar Energy in Malaysia

Malaysia has a good potential to construct solar power plants due to its equatorial location [36], high average daily solar radiation (4500 kWh/m2), and ample sunshine for approximately 10 hours each day. Table 2.4 reveals that Kota Kinabalu has the maximum solar radiation of 1900 kWh/m2, followed by Bayan Lepas (1809 kWh/m2) and Georgetown (1785 kWh/m2) in different cities in Malaysia. Table 3 depicts Malaysia's solar energy capacity from 2008 to 2017. In 2017, the solar energy capacity was raised from nine to 362 megawatts. Malaysians have reacted positively to the government's attempts to promote solar technology [37-39]. Many government agencies [40-43] such as Petronas, Tenaga Nasional Bhd, Sustainable Energy Development Authority Malaysia (SEDA), and Malaysia Energy Centre (PTM) play a significant part in determining the importance of energy development in the country.

Table 2.4 Table of annual solar radiations in different cities in Malaysia [43].

| **Region / Cities** | **Annual average value (kWh/$m^2$)** |
|---|---|
| Kuching | 1470 |
| Bangi | 1478 |
| Kuala Lumpur | 1571 |
| Petaling Jaya | 1571 |
| Seremban | 1572 |
| Kuantan | 1601 |
| Johor Bahru | 1625 |
| Senai | 1629 |
| Kota Bahru | 1705 |
| Ipoh | 1739 |

| | |
|---|---|
| Taiping | 1768 |
| Georgetown | 1785 |
| Bayan Lepas | 1809 |
| Kota Kinabalu | 1900 |

Table 2.5 Table of solar energy capacity in Malaysia from 2008 to 2017 [43].

| Year | Megawatts |
|---|---|
| 2008 | 9 |
| 2009 | 11 |
| 2010 | 13 |
| 2011 | 14 |
| 2012 | 32 |
| 2013 | 138 |
| 2014 | 203 |
| 2015 | 263 |
| 2016 | 340 |
| 2017 | 362 |



### 2.7.2 Current status of solar energy development

Malaysia is located near the equator. The large-scale solar project could be implemented in Malaysia since the average monthly solar radiation was 400 to 600 MJ/m2 [44]. Figure 3 depicts Malaysia's photovoltaic power potential. When compared to other cities in Malaysia, Kota Kinabalu (1900 kWh/m2), Bayan Lepas (1809 kWh/m2), George Town (1785 kWh/m2), and Taiing (1768 kWh/m2) had the most solar radiation. Several organizations, including Malaysia Energy Centre, Tenaga Nasional Berhad (TNB), and the Sustainable Energy

Development Authority Malaysia have contributed to the development of solar energy [45]. According to Table 2.6, the installed capacity of solar energy has expanded from 166 MW in 2014 to 1493 MW in 2020, suggesting that the solar market has developed greatly as a result of supportive government policies and actions at various end-user sectors.

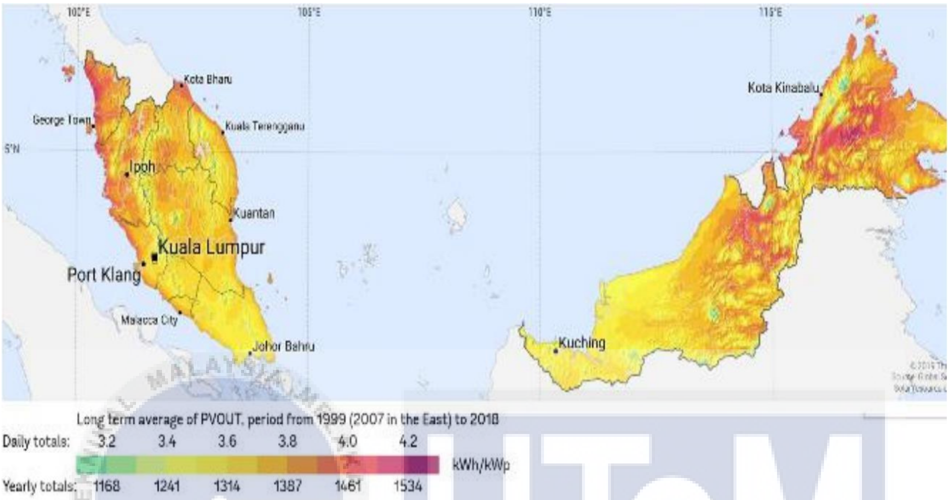



Figure 2.2 Photovoltaic power potential in Malaysia.

Table 2.6 Table of total solar energy installed capacity (megawatts) in Malaysia [43].

| **Year** | **Installed capacity (MW)** |
|---|---|
| 2014 | 166 |
| 2015 | 229 |
| 2016 | 279 |
| 2017 | 370 |
| 2018 | 536 |
| 2019 | 882 |
| 2020 | 1493 |

## 2.8 Weather Forecasting Parameters

Weather patterns and climate change have long been studied and observed around the world. Several characteristics were examined to evaluate the environmental changes that occurred. Because climate is so vital in human life, scientists are being driven to create new methods of sensing and understanding both weather and climate. Several automated platforms and environmental prediction systems have been built around the world to continuously collect data on the environment for diverse applications. Data from weather forecasting can be used in a variety of industries, including agriculture, transportation, and construction. By VivekBabu et al., the prediction of weather, despite its application, should be dependable and precise [29]. During their research, they developed an early version system that monitors changes in the weather using an Embedded System with Raspberry Pi. Among other things, the systems measured humidity, temperature, moisture in the soil, rainfall, and intensity of light. The system's data can be used in agricultural applications. The prototype system made advantage of freely available hardware, such as the Raspberry Pi and Wi-Fi. The detectors capture information from a variety of environments and communicate with the Raspberry Pi, which serves as the station's foundation. The Raspberry Pi sends statistics over Wi-Fi, and the findings are shown on the laptop. The ESP32 and ESP8266 were employed as bases and microcontrollers in this inquiry, respectively. The ESP8266 gathers data from sensors as well as the ESP-Mesh connection to which it is linked. The data was then delivered to the consumer's smartphone through Bluetooth. Furthermore, rather than monitoring and data collection, the study's goals are to create an automated roof system that the user can manage and monitor [12].

## 2.9 The Internet of Things (IoT)

The IoT is a networked computing system that encompasses anything with a unique identification and a capability to transmit info across a network autonomously lacking the involvement of human or computer interaction, Mechanical as well as digital equipment, objects, animals, and humans are examples. In other words, the Internet of Things encompasses any device that is linked to the Internet and has been switched on. This includes nearly everything imaginable, everything from cellular phones to an airplane's aircraft engine to building maintenance is covered. An ESP32 microprocessor with Wi-Fi and Bluetooth capabilities controls the retractable roofing mechanism in this work. To communicate with a consumer's smartphone, Bluetooth is necessary. We use an ESP8266 microcontroller with only a Wi-Fi function for a sensor node, which is adequate for Wi-Fi connection with the ESP-Mesh library. ESP-Mesh covered in the following section. The swift rise of devices like these in a communicating-actuating network has had an impact on the evolution of the Internet of Things. Sensors also actuators have become increasingly integrated into our surrounds in recent years. To develop a common operating picture (COP), information is exchanged across the platform. The Internet of Things has emerged from its initial stages, owing to the recent emergence of wireless technology such as RFID tags, embedded sensors, and actuators nodes, and it is poised to be the next game-changing technology in changing the Internet into an all-encompassing future Internet network [12, 46-49].

## 2.10 Wireless Sensor Network (WSN) Using ESP-Mesh

Sensors is a processing device and a communication device (RFM69). Sensing nodes capture data and send it to sink nodes via sensors. The sink node is located on the WSN's fringes. It is the sink node's responsibility to collect all data received from WSN sensor nodes and provide it to the database server. To log data to the cloud/internet, the sink node is generally linked to a more capable computer, such as a Raspberry Pi. Many such sensor nodes are deployed at regular intervals to cover a vast geographical area. They all sent data to a single receiver in a centralized data monitoring and storage system. On a regular basis, all sensor nodes communicate data (sensor values). The receiver receives data from all such nodes, stores it, and displays it for monitoring and control [12].

## 2.11 Micro Servo SG 90

One of the Servo motors that can assist the project move anything is the Micro Servo SG 90. Micro servos are frequently utilized due to their compact size and ability to rotate and hold position or angle in response to control pulses. Depending on the gear configuration, almost all servos can rotate from 0° to 180°, but they can even rotate 360° to complete a full circle. Aside from its lower cost, one of the key reasons why this project picked a servo motor over a DC motor is its ability to vary its rotation angle. It is also easy to use and program [50].

## 2.12 Rain Sensor

One of the most important components in this endeavor is a rain sensor. This can be accomplished to identify whether a component is moist or evaporate in water by measuring conductivity. The resistance raises the value of the sensor wire until it is shorted to the grounded line by a drop of water. The resulting pulse width data is entered into a microcontroller software counter to compute the number of raindrops [27, 51-52]. Using the ESP8266's digital I/O pinsor analog pins, the wiring estimates the volume of water-tempted interaction that exists among the grounded and sensor lines. Certain work is improved and innovated to make it safer and more customer friendly. A rain sensor, for instance, as part of an inventive item is designed to improve an already existing good.

The spreading disc rain sensor is one of the most prevalent types of rain sensors on the market. The rain sensor detects raindrops that fall via the active board [53]. Throughout periods of heavy rain, an electromechanical actuation mechanism uses the rain sensor to generatea circuit interruption, which momentarily disables the irrigation controller. Following the deluge, technology rapidly restored regular operation to the controller. The rain sensor provides a number of capabilities and benefits, including automated rain cutoff, which avoids overloading due to natural precipitation that occurs. Apart from this, moisture-sensing discs are applicable in a wide range of climates [12].

## 2.13 Summary

The study investigates Malaysia's view on renewable energy, with an emphasis on solar energy and the construction of an automated harvested crop security system with GSM and rain sensors. It intends to address Malaysia's energy issues, including as dwindling oil production and rising alternative costs and maintenance. The study also looks at the current status of research in renewable energy sources, such as technologies, availability, and the many sorts of systems that use renewable energy sources. The project shows how a tray may open and close dependent on the position of the sun's rays, and how it can be utilised in crop protection systems with an auto roof. The project looks into the use of IoT and WSN in conjunction with ESP-Mesh to implement an autonomous retractable roof for a house line-dry suspended area. The discoveries can help non-profit organisations and may be adapted to commercial purposes in the future as technology advances. The goal of the research is to create an autonomous sliding roof system that uses an infrared sensor to improve the efficiency and cost-effectiveness of clothing drying on a clothesline. The study evaluates the features, benefits, and drawbacks of several laundry cover system attempts, employing a prototype that employs a rain sensor to identify the precise time clothing remain damp, an Arduino, a DC motor for simple tugging, and an automatic servo for ease of use. Malaysia has a significant potential for solar energy growth due to its equatorial location, high average daily solar radiation, and 10 hours of sunshine per day. The retractable roofing mechanism is controlled by an ESP32 microprocessor with Wi-Fi and Bluetooth capabilities, as well as a Micro Servo SG 90.

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

A methodology is a method for improving and monitoring a project. The strategy for this chapter is to examine, research, and process this project. This project incorporates information, formulas, and statistics from journals, websites, research articles, and books. In this section, we will try to explain the block-level specifications as well as the technical design technique used to achieve the intended results. The mechanism is split into two halves which are hardware prototype development, and software development. The hardware construction of the project comprises making a prototype out of the materials required. The software building, on the other hand, is accomplished through the use of Arduino IDE software for circuit development and simulation.



## 3.2 Project Layout

The diagrams below illustrate the project layout for the following house design. where the solar panel is installed on the flat roof of the house, where the roof of the house that can be opened 90° is placed in the middle between the two walls of the house where the user places the clothes hanger. While the exhaust fan is positioned on the house's wall to assist in the drying of the garments while other components are kept.


Figure 3.1 View when the roof in an open state at 90º.



## 3.3 Block Diagram

The block diagram is displayed in the diagram below. The NodeMCU is an autonomous system of components with an integrated TCP/IP protocol stack that allows any microcontroller to connect to a WiFi network. NodeMCU needs to be used for the project. Because the microprocessor operates on 3 volts, the power supply stage must provide the microcontroller with controlled $3V$. As a result, the power supply stage, which comprises of a solar panel and a battery, does this function.

In this project, a rain sensor is employed. Rain sensors are sensors located on the roof that short out the probes when it rains, and the microcontroller receives input 0. Rain sensors are mounted on the house's roof. It is used to predicting whether or not it will rain. This sensor provides data to the microcontroller. The relays and tray, which work based on the contacts of the relays, are the microcontroller's outputs. The tray performs in accordance with our sensor's settings. The exhaust fan will also operate. The notification will be forwarded to the phone of the following individual.

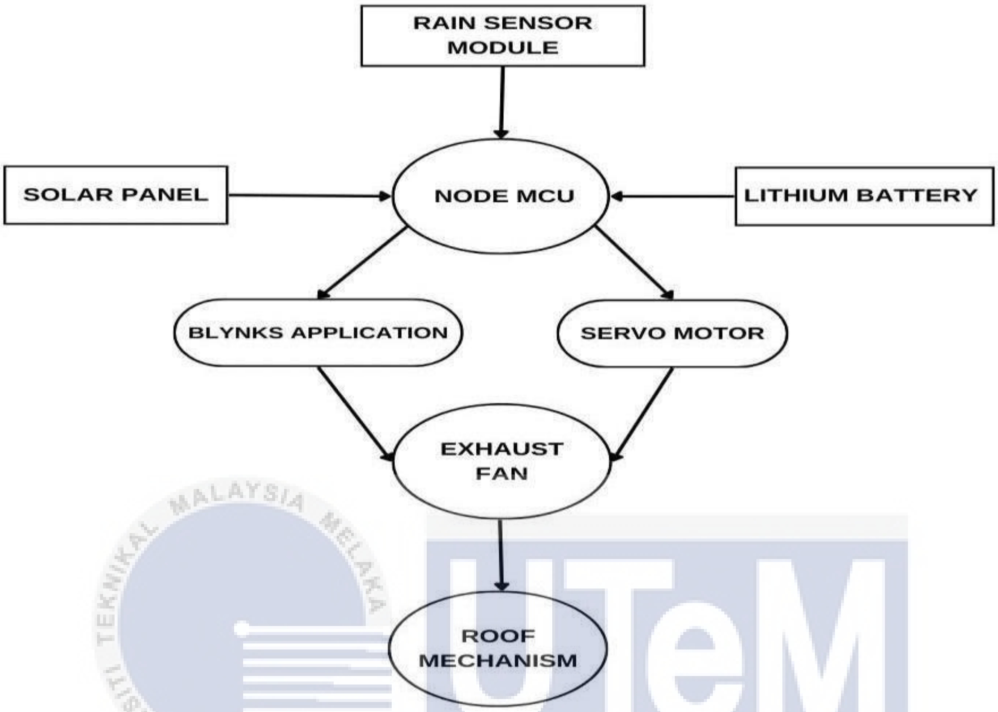



Figure 3.2 Block diagram of the project.



### 3.4 Project Flow Chart

The technique or procedure for this process begins when the user turns on the system. It is sensors begin collecting parameter metrics and will send a real-time signal to the user. As an outcome, whatever the programming language downloaded by the device, the sensors will convey the signal through the ESP8266 WiFi Module, which will perform the conditions specified when the signal from the sensors is received. The signals will then be transferred over internet connections to the IoT application.

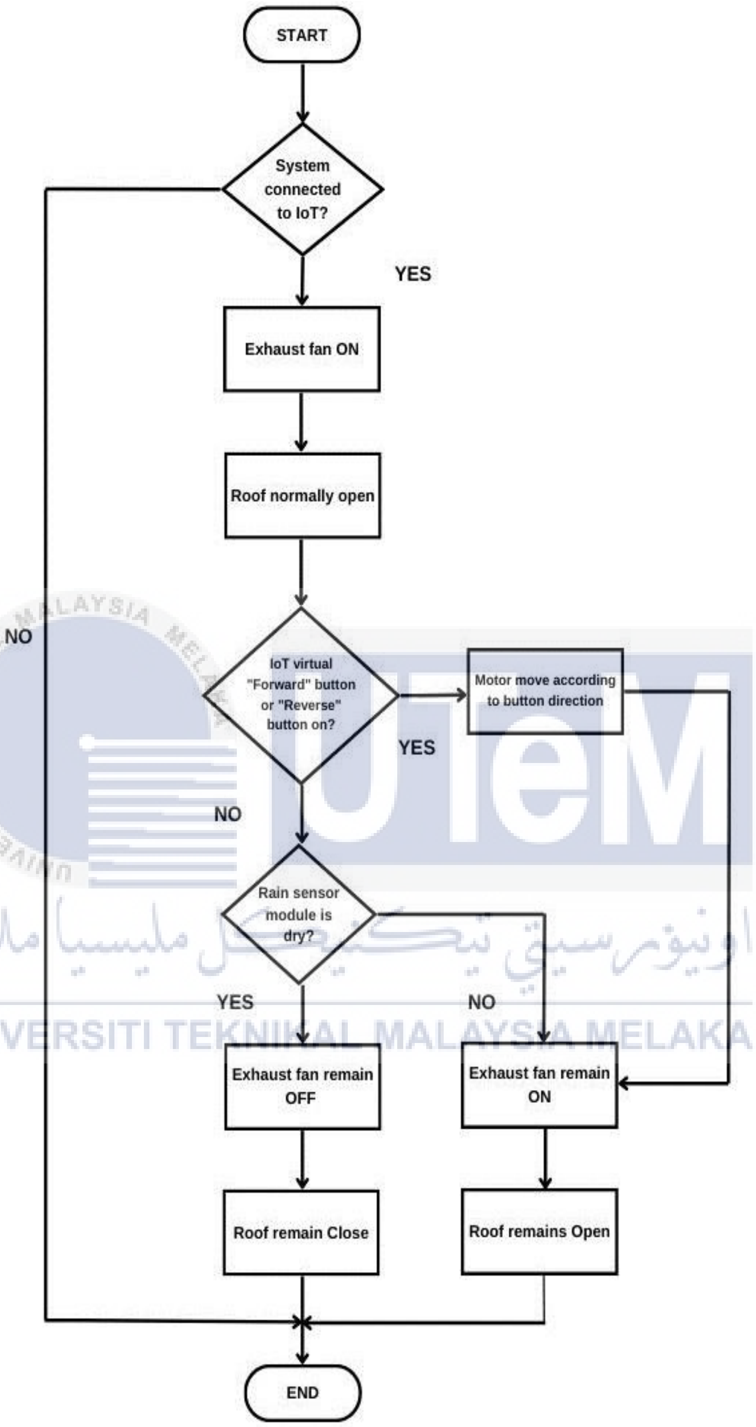



Figure 3.3 Program flowchart for this project.

## 3.5 Materials and Components

### A. <u>Hardware Prerequisite</u>

### 3.5.1 Servo Motor

Servo motors, as opposed to DC motors, can precisely position themselves at an angle by controlling the motor shaft with a control signal. As a result of this, this basic servo motor is employed in a variety of purposes. The size and torque of servo motors varies. The Arduino energy source is typically used to power mini-servo motors that operate at low voltages. The MG995 servo has been suggested for the ARRC system concept due to its shock-proof double ball bearing structure.

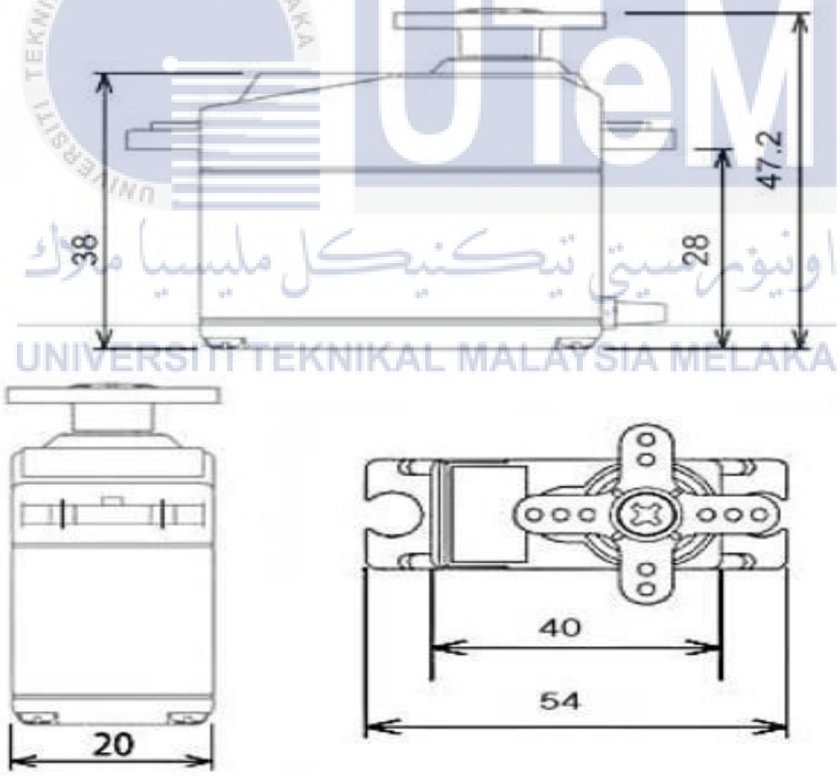




Figure 3.4 Structure of servo motor.

### 3.5.2 Raindrop Sensor Module

It bases itself on a theory of resistance. The Rain Sensor module assesses moisture using analog output pins and generates a digital output once a moisture criterion is exceeded. The sensor is a resistive dipole the fact that resists less when wet and more when dry. When there are no droplets on board, the Resistance increases, leading to a high voltage computed by V= I x R. Water is an electrical conductor, and the presence of water joins nickel lines in parallel, lowering resistance and voltage drop across it. The material is RF-04 double-sided high-quality. On one side, the nickel plate is 5cm x 4cm. Anti-oxidation and anti-conductivity properties, as well as a long useful life. The comparator output signal is clean and has a driving capacity more than 15mA. The potentiometer controls the sensitivity.

Figure 3.5 Raindrop sensor module.

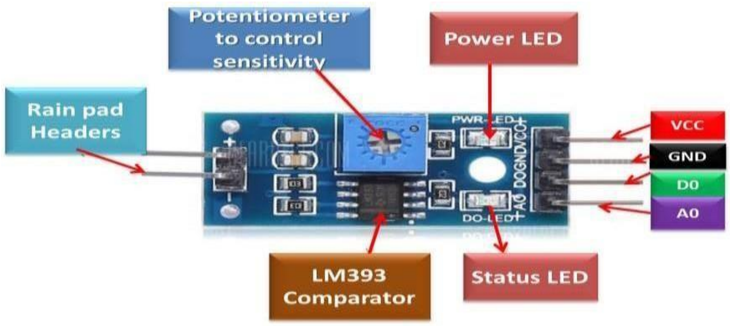



Figure 3.6 Rain sensor detection board image.

### 3.5.3 1 Channel 5V Relay Module

A relay operates by passing an electric current between both contacts of a switch. When the coil is energized, a coil attracts and pulls the contacts of a switch together, while a spring pushes them apart when the coil is not energized. This method has two distinct advantages: The amount of current necessary for triggering the relay is considerably smaller than the current capacity of switching relay contacts, while the coil and contacts are galvanically detached which means there is no electrical connection between them. This implies that the relay could change the mains current using a low-voltage isolated digital system like a microcontroller.

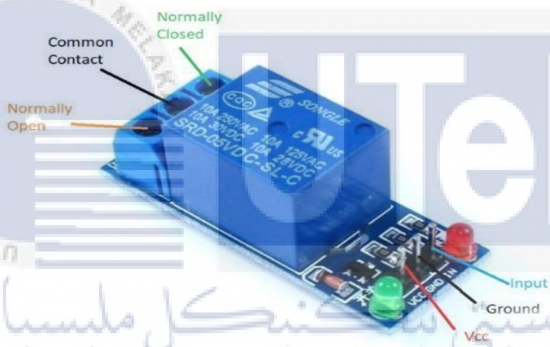



Figure 3.7 1 Channel 5V Relay Module detection board image.



**B. <u>Software Prerequisite</u>**

### 3.5.4 An IoT platform

An IoT platform offers iOS and Android devices that uses the Internet to controlArduino, Raspberry Pi, and NodeMCU. This software is used to gather and supply the required coordinates on all of the accessible widgets in order to create a graphical interface or human-machine interface (HMI). It may remotely manage equipment, display sensor data, save data, visualize it, and perform a rangeof other exciting tasks.


Figure 3.8 Logo for IoT applications used.

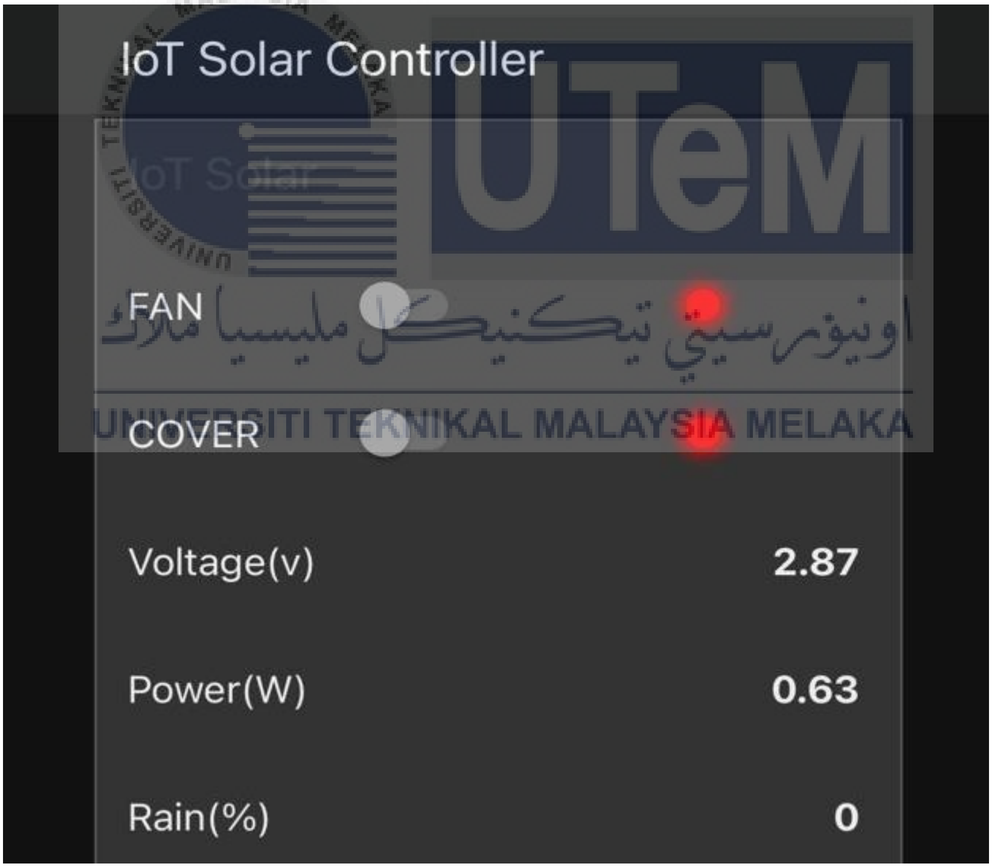





Figure 3.9 Buttons for cover and fan next values for volatge, power and rain percentage.

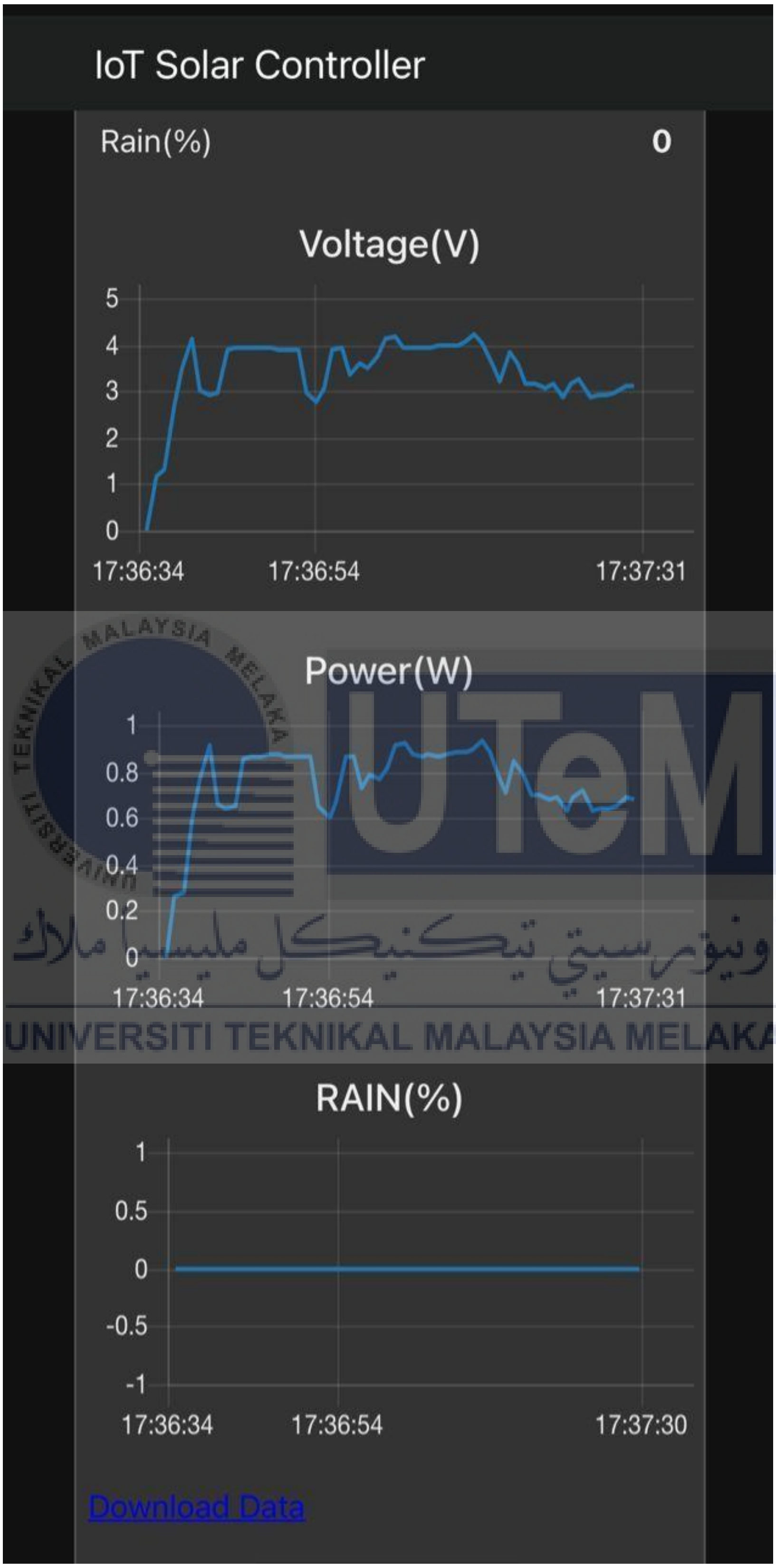



Figure 3.10 Graph data for voltage, power and percentage of rain that can be downloaded to the user's mobile phone.

### 3.5.5 Arduino Integrated Development Environment (IDE)

The Arduino Integrated Development Environment (IDE), sometimes known as the Arduino Software (IDE), has a code editor, a message area, a text console, a toolbar with buttons for basic functions, and a series of menus. It communicates with and uploads programmes to the Arduino hardware.

Sketches are programmes created with the Arduino Software (IDE). These sketches are created in a text editor and saved with the.ino file extension. The editor has functions for cutting/pasting and searching/replacing text. The message section indicates faults and provides feedback while storing and exporting. The terminal displays text output from the Arduino Software (IDE), including error warnings and other data. The configured board and serial port are shown in the bottom right corner of the window. You can use the toolbar buttons to validate and upload programmes, create, open, and save sketches, and launch the serial monitor.



Figure 3.11 Software used for coding for the project.

### 3.5.6 Proteus Design Suite

The Proteus Design Suite combines simplicity with a robust feature set to allow for the rapid design, testing, and layout of professional printed circuit boards. Proteus is divided into three parts. The first is PCB Design, which combines schematic capture and PCB layout to give a powerful, integrated, and simple-to-use suite of tools for professional PCB design. Proteus Circuit Simulation will then be used to design, test, and debug full embedded systems within schematic capture before ordering a physical prototype. VSM introduces AGILE development to embedded workflows. Last but not least, there's Proteus IoT Builder. A comprehensive approach for designing Arduino or Raspberry Pi appliances and remotely operating them through phone or browser. Using the MQTT protocol, you can create multi-appliance systems. Proteus may be used to design, simulate, and deploy immediately.



Figure 3.12 Software used for simulation of project.

## 3.6 Circuit Diagram

In circuit simulation, the installation of an LCD to display whether or not the condition is raining. The addition of two LEDs, red and green, indicates whether the DC motor as exhaust fan and servo motor to move the retractable roof are turned on or off. While the logic state display determines whether the rain sensor detects droplets on the surface or not.


Figure 3.13 Hardware circuit diagram.

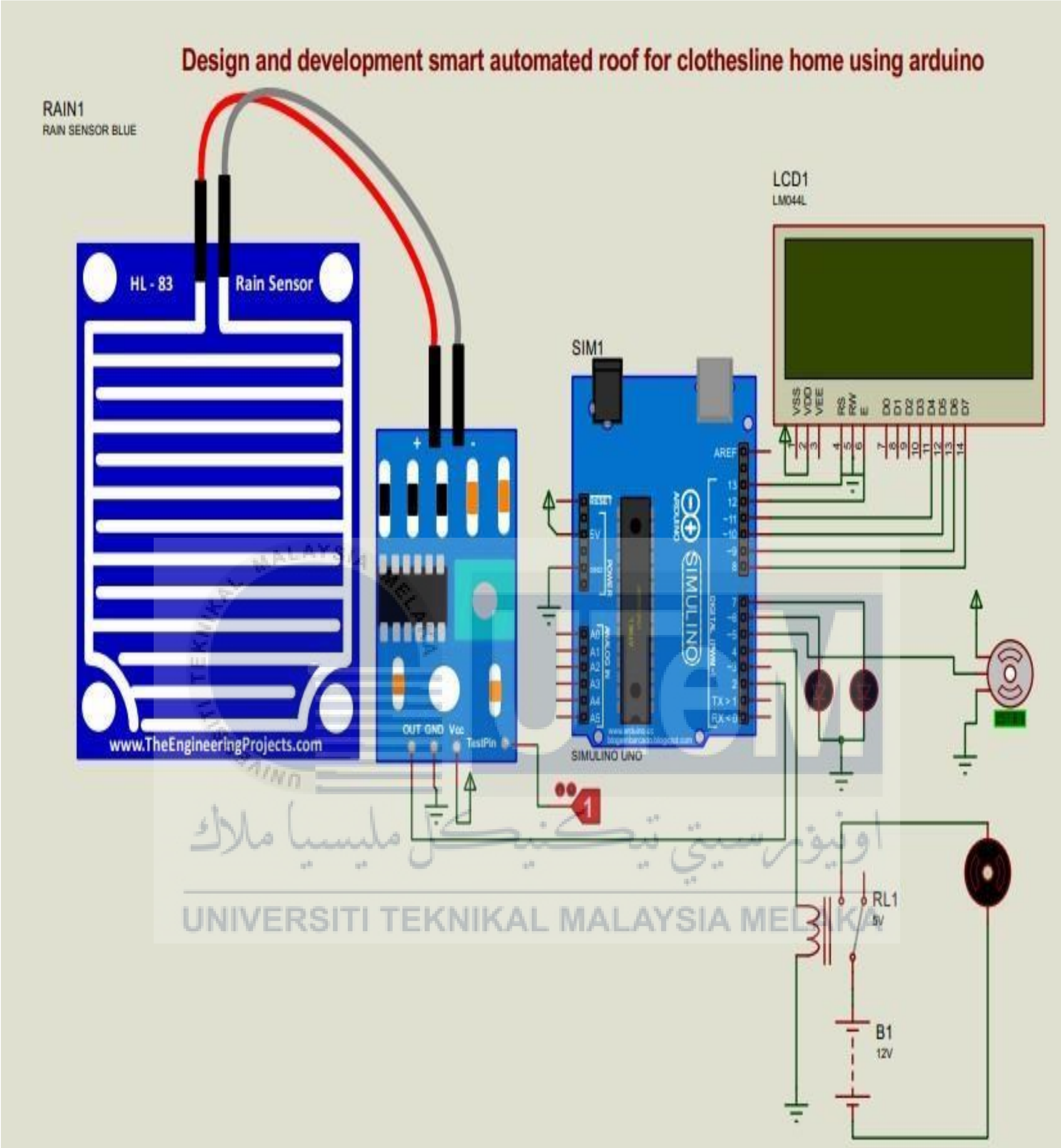




Figure 3.14 Circuit Diagram in proteus.

Table 3.1 Table of the result for open and close state in simulation.

| No. | Figure | Result |
|---|---|---|
| 1. | Close state of the Proteus simulation | • Logic state represents a rain sensor that when it detects rainwater, logic state is in state "0".<br>• The LED light will turn GREEN color.<br>• LCD will display "NO RAIN".<br>• Servo motor represents the roof will move in the close state by 90º.<br>• The dc motor representing the exhaust fan will be off. |
| 2. | Open state of the Proteus simulation | • Logic state represents a rain sensor that when it detects rainwater, logic state is in state "1".<br>• The LED light will turn RED color.<br>• LCD will display "RAIN DETECTED".<br>• Servo motor represents the roof will move in the open state by 90º.<br>• The dc motor representing the exhaust fan will be on. |

## 3.7 Summary

This chapter discusses a methodology for improving and monitoring a project, which involves examining, researching, and processing the project using information from various sources. The methodology is divided into two halves: hardware prototype development and software development. The project layout includes a solar panel on the flat roof of a house, a clothes hanger, and an exhaust fan to help dry garments. The NodeMCU is used for the project, which operates on 3 volts and requires a power supply stage with a solar panel and battery. A rain sensor is used to predict rain and provides data to the microcontroller. The sensors are connected to relays and trays, which work according to the sensor's settings. The project flow chart begins when the user turns on the system, collecting parameter metrics and sending real-time signals to the user. The sensors then convey the signal through the ESP8266 WiFi Module, which performs the conditions specified when the signal is received. The signals are then transferred over internet connections to the IoT application.



Materials and components include a servo motor, a raindrop sensor module, a 1 Channel 5V relay module, and an IoT platform. The Arduino IDE software is used for circuit development and simulation, while the IoT platform allows for remote management, display of sensor data, saving, visualization, and other tasks. The terminal displays text output from the IDE, including error warnings and other data. The Proteus Design Suite is a comprehensive tool for designing, testing, and layout of professional printed circuit boards. It is divided into three parts: PCB Design, Proteus Circuit Simulation, and Proteus IoT Builder. The coding used for the project is still in progress. In the circuit simulation, an LCD displays the condition of raining, and two LEDs indicate the operation of the DC motor and servo motor. The results show that the rain sensor detects rainwater, and the servo motor moves in the closed state.

# CHAPTER 4

# RESULT AND DISCUSSION

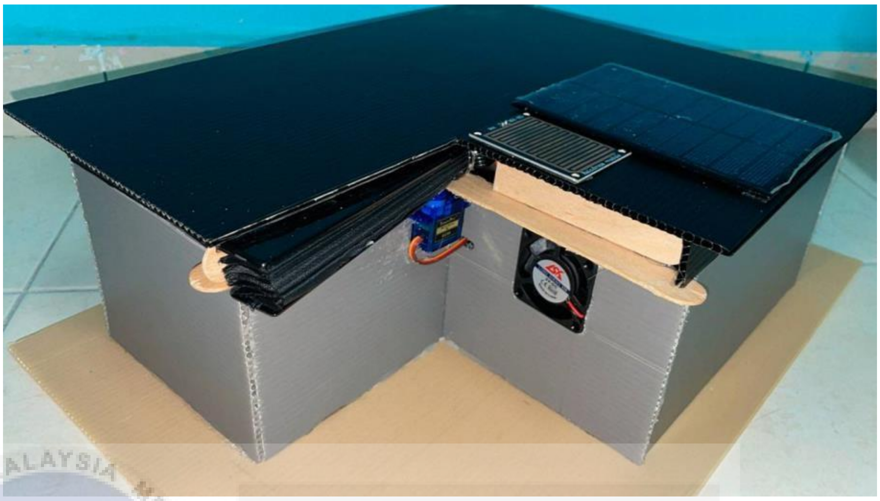
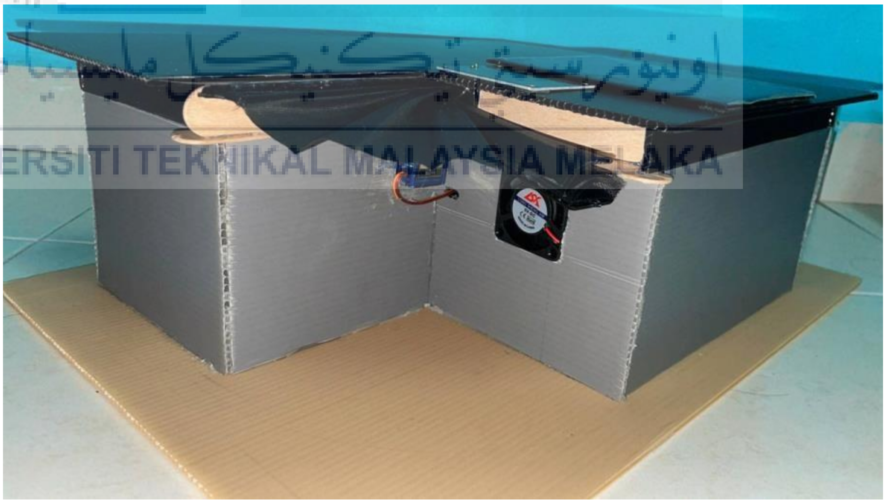
## 4.1 Introduction

The outcomes for the design and development of smart automatic roof for a clothesline home using Arduino are presented in this chapter. The purpose of this project is to devise a method to assist customers in drying their garments without consuming a lot of electricity. The initial step in the technique is to configure the input and output system to control the moving roof. Next, integrate the hardware and software tools that have been analyzed and arranged to fulfill the project's principal concept.

## 4.2 Prototype

The table below shows an overview of the condition of the roof of the house and the exhaust fan that is in an open and closed state according to current weather conditions.

Table 4.1 Table of the overview of various scenarios.

| No. | Type of conditions |
|---|---|
| 1. | Close condition  |
| 2. | Open conditions  |

## 4.3 Average power data analysis within a week

Data analysis for the value of power in Watts taken within a week that is 7 days. The data is taken within every half hour. From the average data for a week, it was found that solar panels only absorb sunlight from 8 am to 5 pm only. This was due to the intense heat and sunlight at the time. From the data below, found that power can be absorbed more at 4 pm to 5 pm. This may be due to the position of the solar panels vertically facing to the sun. The data can be collected through IoT applications that use the user's mobile phone.

Table 4.2 Table of power data analysis within a week.

| **Time** | **Average power (W)** |
|---|---|
| 08:00 GMT+0800 (Malaysia Time) | 25.32 |
| 08:31 GMT+0800 (Malaysia Time) | 24.25 |
| 09:01 GMT+0800 (Malaysia Time) | 24.45 |
| 09:31 GMT+0800 (Malaysia Time) | 24.67 |
| 10:01 GMT+0800 (Malaysia Time) | 25.01 |
| 10:31 GMT+0800 (Malaysia Time) | 24.50 |
| 11:01 GMT+0800 (Malaysia Time) | 25.63 |
| 11:31 GMT+0800 (Malaysia Time) | 26.20 |
| 12:01 GMT+0800 (Malaysia Time) | 25.98 |
| 12:31 GMT+0800 (Malaysia Time) | 26.22 |
| 13:01 GMT+0800 (Malaysia Time) | 26.41 |
| 13:31 GMT+0800 (Malaysia Time) | 26.50 |
| 14:01 GMT+0800 (Malaysia Time) | 26.74 |
| 14:31 GMT+0800 (Malaysia Time) | 26.80 |

| | |
|---|---|
| 15:01 GMT+0800 (Malaysia Time) | 26.09 |
| 15:31 GMT+0800 (Malaysia Time) | 27.22 |
| 16:01 GMT+0800 (Malaysia Time) | 27.72 |
| 16:31 GMT+0800 (Malaysia Time) | 27.93 |
| **Total** | **467.64** |

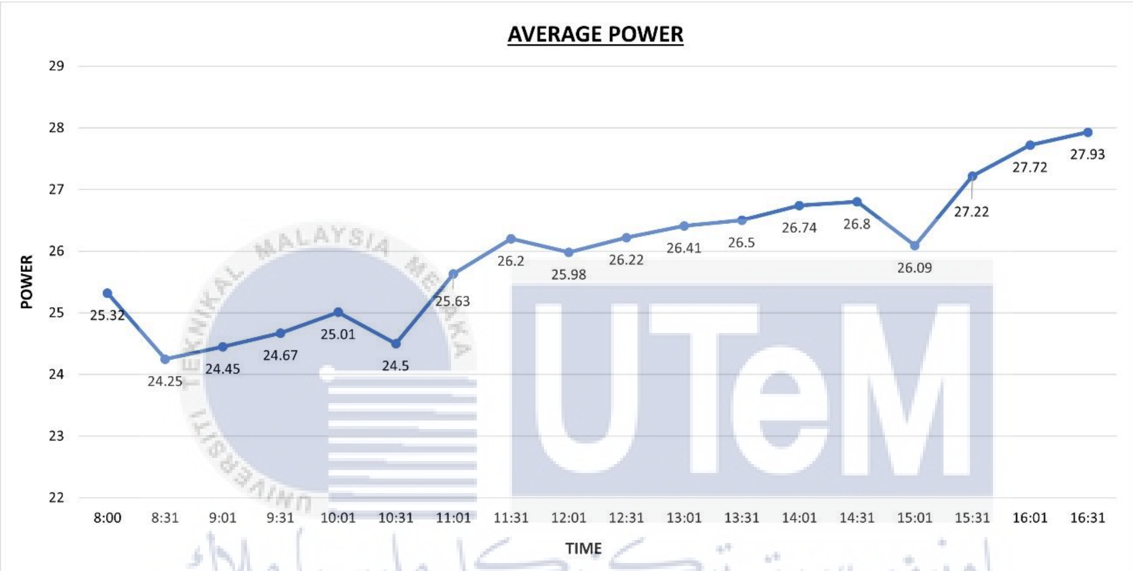



Figure 4.1 Graph for data power analysis.



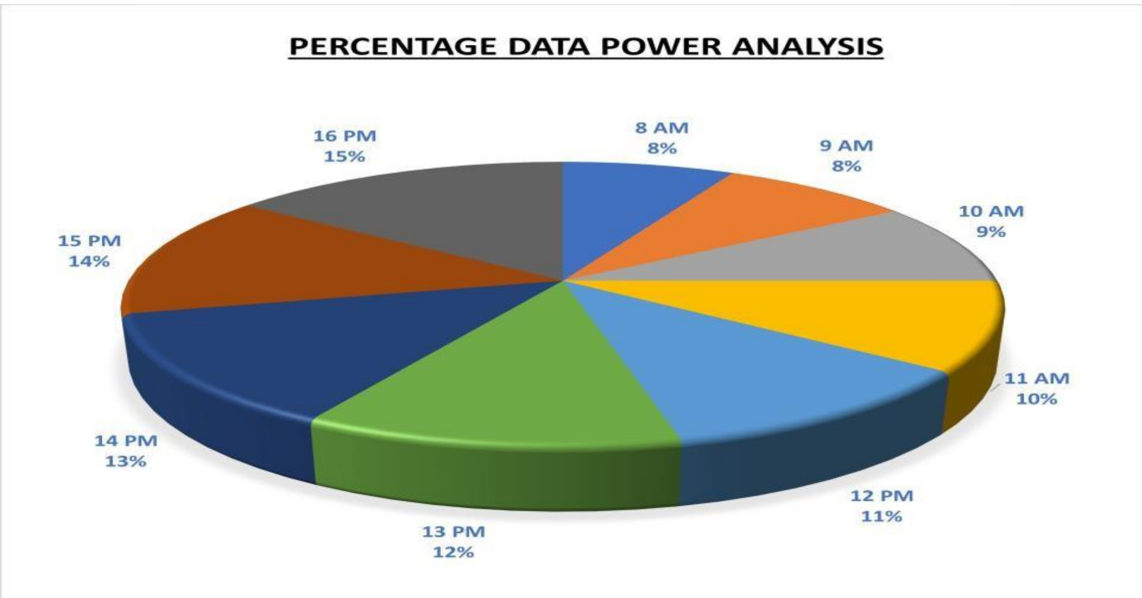



Figure 4.2 Pie chart of percentage data power analysis.

## 4.4 Average voltage data analysis within a week

Data analysis for voltage values in Volts taken within a week that is 7 days. The data is taken within every half hour. From the average data for a week, it was found that solar panels only absorb sunlight from 8 am to 5 pm only. From the data below, found that voltage can be absorbed more at 4 pm to 5 pm. This may be due to the position of the solar panels. This was due to the intense heat and sunlight at the time. The data can be collected through IoT applications that use the user's mobile phone.

Table 4.3 Table of data analysis voltage within a week.

| Time | Average voltage (V) |
|---|---|
| 08:00 GMT+0800 (Malaysia Time) | 114.90 |
| 08:31 GMT+0800 (Malaysia Time) | 109.95 |
| 09:01 GMT+0800 (Malaysia Time) | 110.79 |
| 09:31 GMT+0800 (Malaysia Time) | 112.03 |
| 10:01 GMT+0800 (Malaysia Time) | 113.73 |
| 10:31 GMT+0800 (Malaysia Time) | 111.32 |
| 11:01 GMT+0800 (Malaysia Time) | 116.47 |
| 11:31 GMT+0800 (Malaysia Time) | 119.15 |
| 12:01 GMT+0800 (Malaysia Time) | 118.37 |
| 12:31 GMT+0800 (Malaysia Time) | 119.11 |
| 13:01 GMT+0800 (Malaysia Time) | 120.07 |
| 13:31 GMT+0800 (Malaysia Time) | 120.50 |
| 14:01 GMT+0800 (Malaysia Time) | 121.71 |

| | |
|---|---|
| 14:31 GMT+0800 (Malaysia Time) | 122.05 |
| 15:01 GMT+0800 (Malaysia Time) | 118.65 |
| 15:31 GMT+0800 (Malaysia Time) | 123.81 |
| 16:01 GMT+0800 (Malaysia Time) | 125.98 |
| 16:31 GMT+0800 (Malaysia Time) | 131.40 |
| **Total** | **2129.99** |

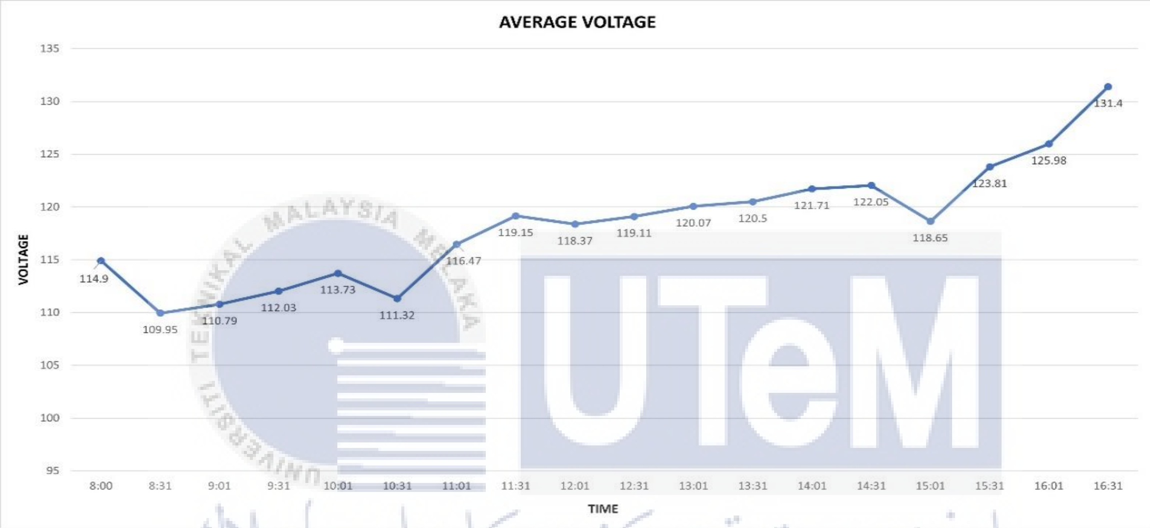



Figure 4.3 Graph for data voltage analysis.



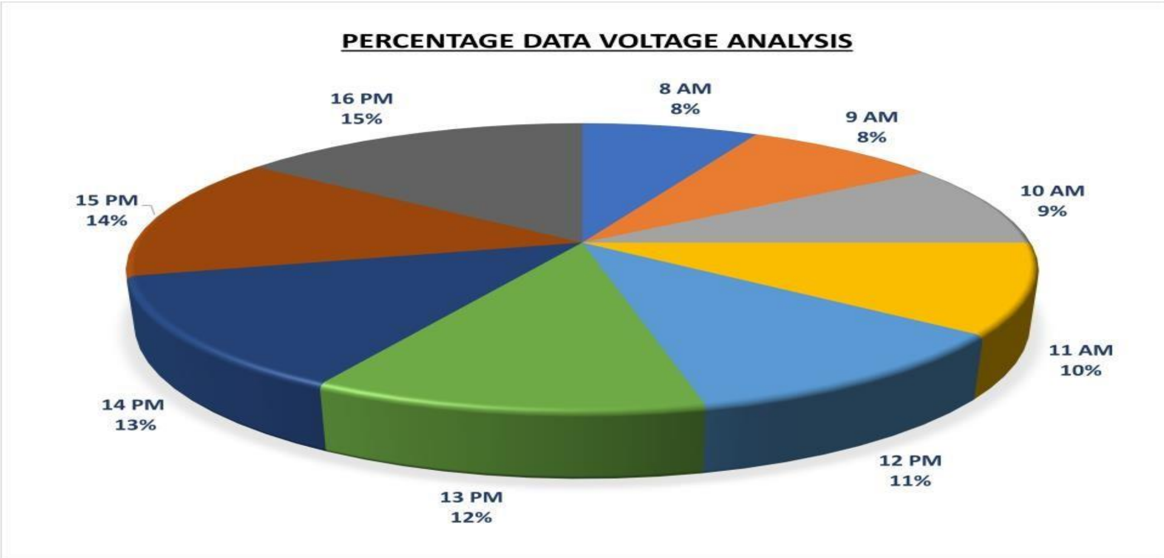



Figure 4.4 Pie chart of percentage data voltage analysis.

## 4.5 Data Analysis for Roof and Fan

The data was retrieved 10 times to get more accurate values for manually opened fans and roofs that were detected when it was raining that day. The delay occurs when the fan and roof are opened due to the sensitivity of the rain sensor to detect rainwater. Similarly, the delay between the fan and the roof is closed again because the sensitivity rain sensor detects the absence of rainwater.

Table 4.4 Table of data analysis manually opened and closed for roof and fan.

| No. | Roof and fan closed manually (s) | Roof and fan opened manually (s) |
|---|---|---|
| **Average** | 0.244s | 0.43s |

Table 4.5 Table of data analysis automatically opened and closed for roof and fan.

| No. | Roof and fan closed automatically (s) | Roof and fan opened automatically (s) |
|---|---|---|
| **Average** | 1.24s | 1.47s |

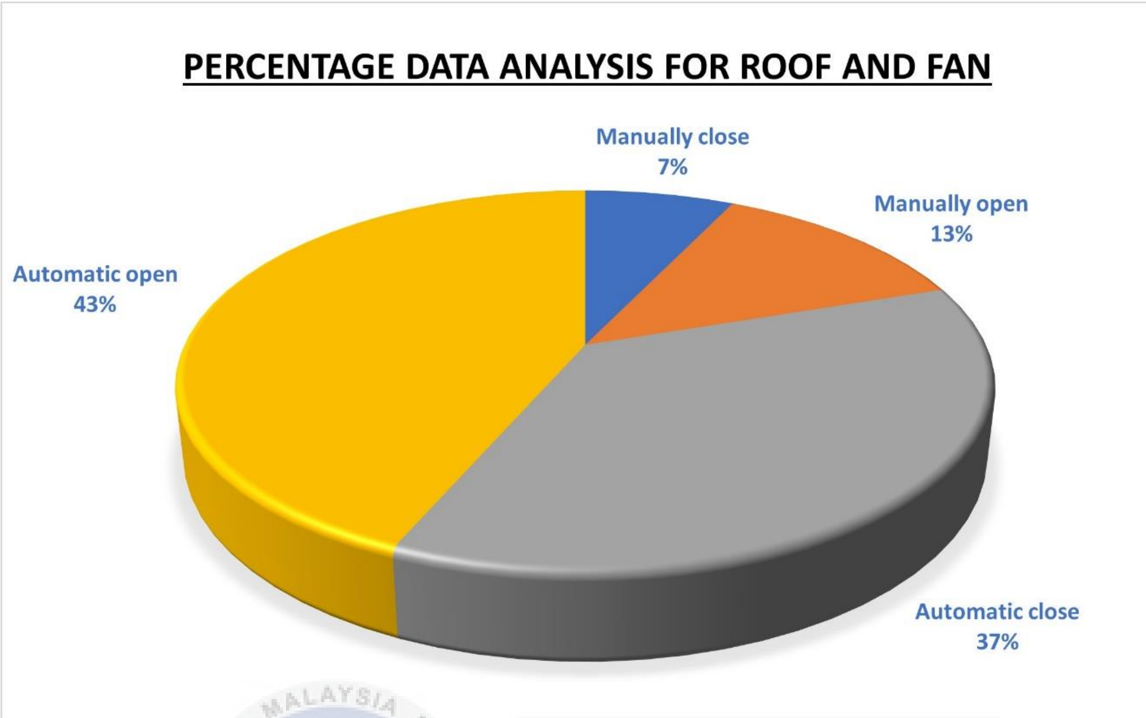



Figure 4.5 Pie chart of percentage data analysis for roof and fan.



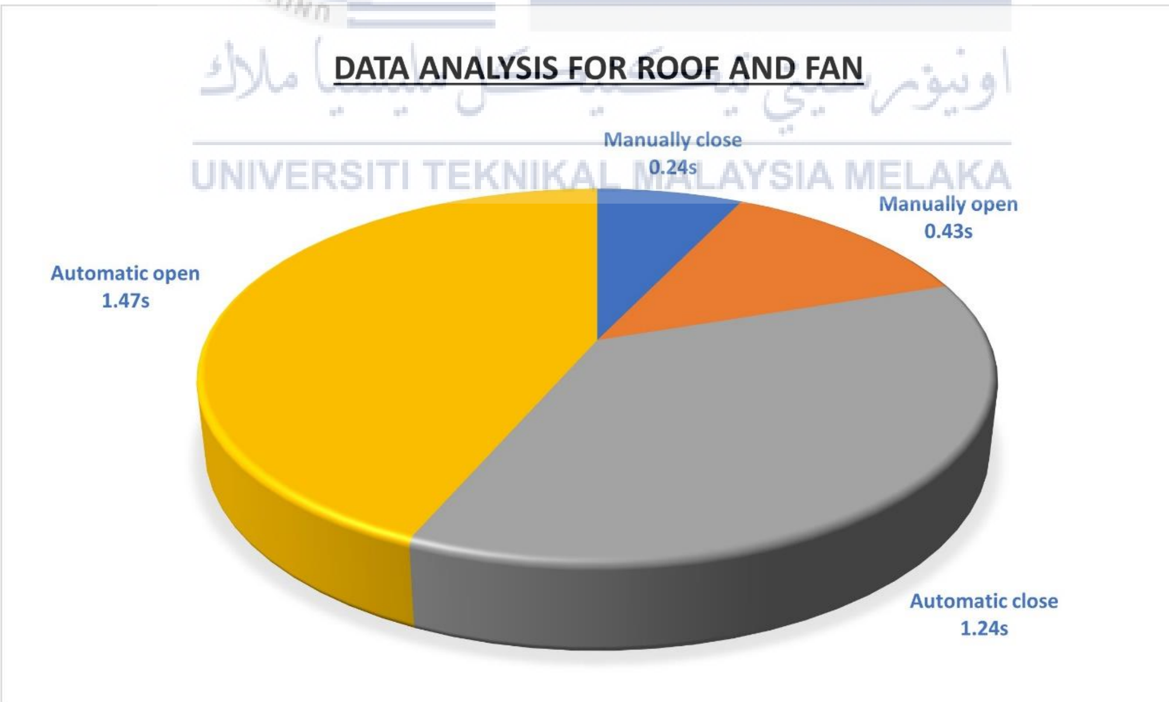



Figure 4.6 Pie chart of data analysis for roof and fan.

## 4.6 Result

This part will go through how the automated roof for a clothesline home should work in various scenarios in real life. Table 4.1 below shows the outcome based on a variety of conditions.

Table 4.6 Table of the outcome of various scenarios.

| No. | Scenarios | Result |
|---|---|---|
| 1. | When it rains and there is power from solar panels. | The rain sensor detects raindrops and communicates with NodeMCU to open the roof and switch on the exhaust fan. |

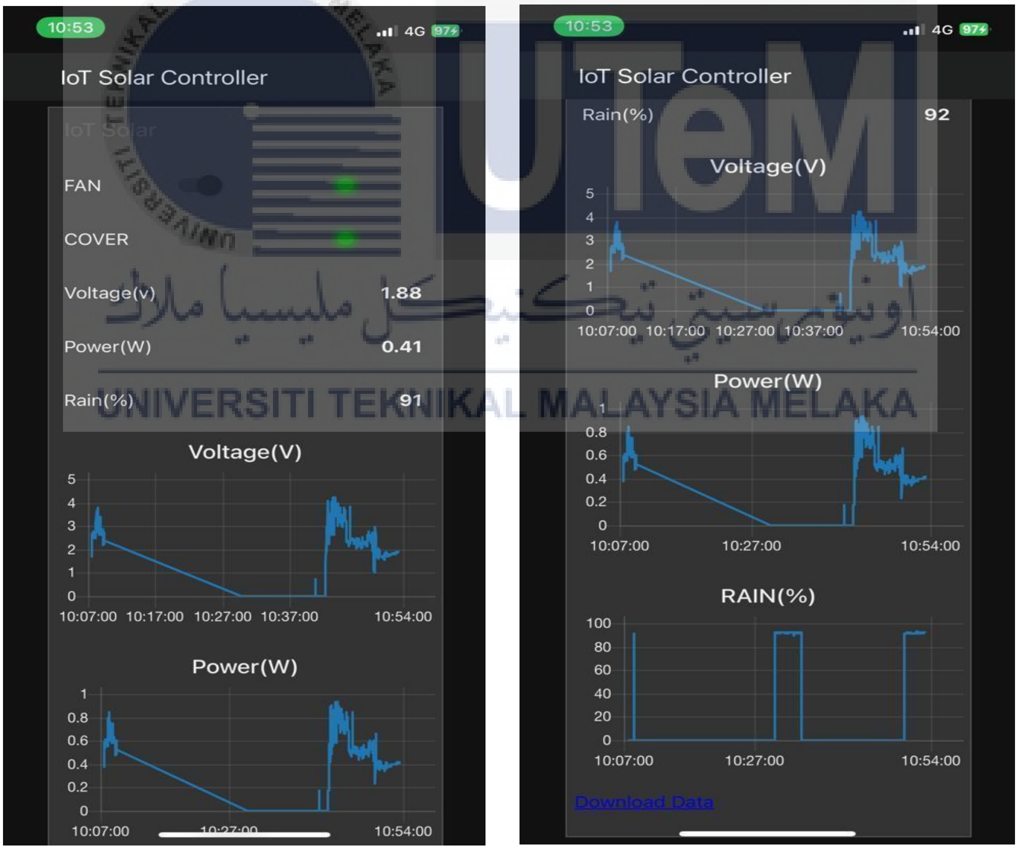



Figure 4.7 Power supply from solar panels and a rainy day at 10.54 am.

| | | |
|---|---|---|
| 2. | When the rain ceases and there is an electrical source from solar panels. | When there are no raindrop, the rain sensor signals the NodeMCU to seal the roof and exhaust fan again. |

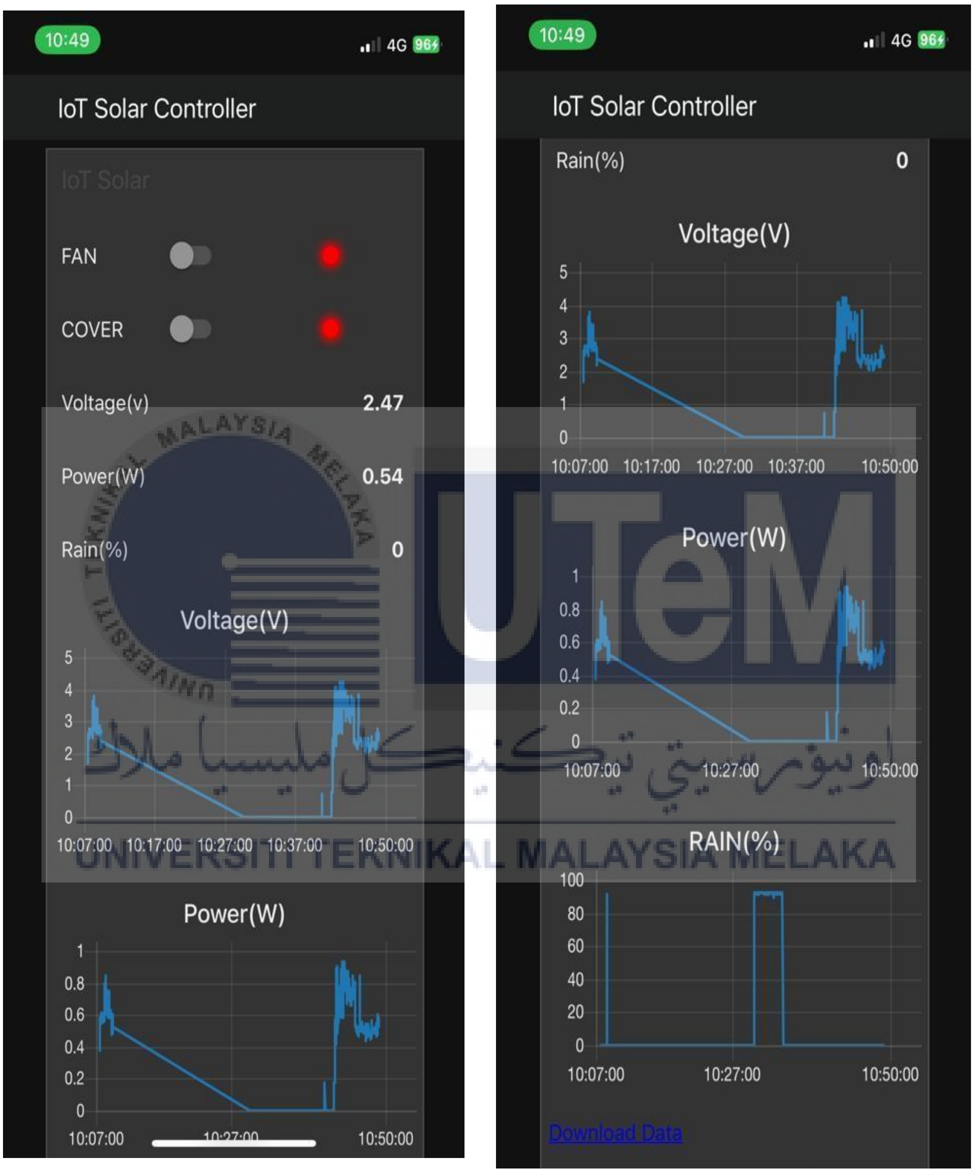



Figure 4.8 Power supply from solar panels and a non-rainy day at 10.50 am.

| | | |
|---|---|---|
| 3. | There is no electricity from solar panels on rainy days, but there is energy from a rechargeable battery. | The rain sensor detects raindrops and communicates with NodeMCU to open the roof and switch on the exhaust fan. |


Figure 4.9 No power supply from solar panels and rainy day at 10.34am.

| | | |
|---|---|---|
| 4. | Whenever the rain stops and there is no power from the solar panel, but there is power from the rechargeable battery. | When there are no raindrop, the rain sensor signals the NodeMCU to seal the roof and exhaust fan again. |

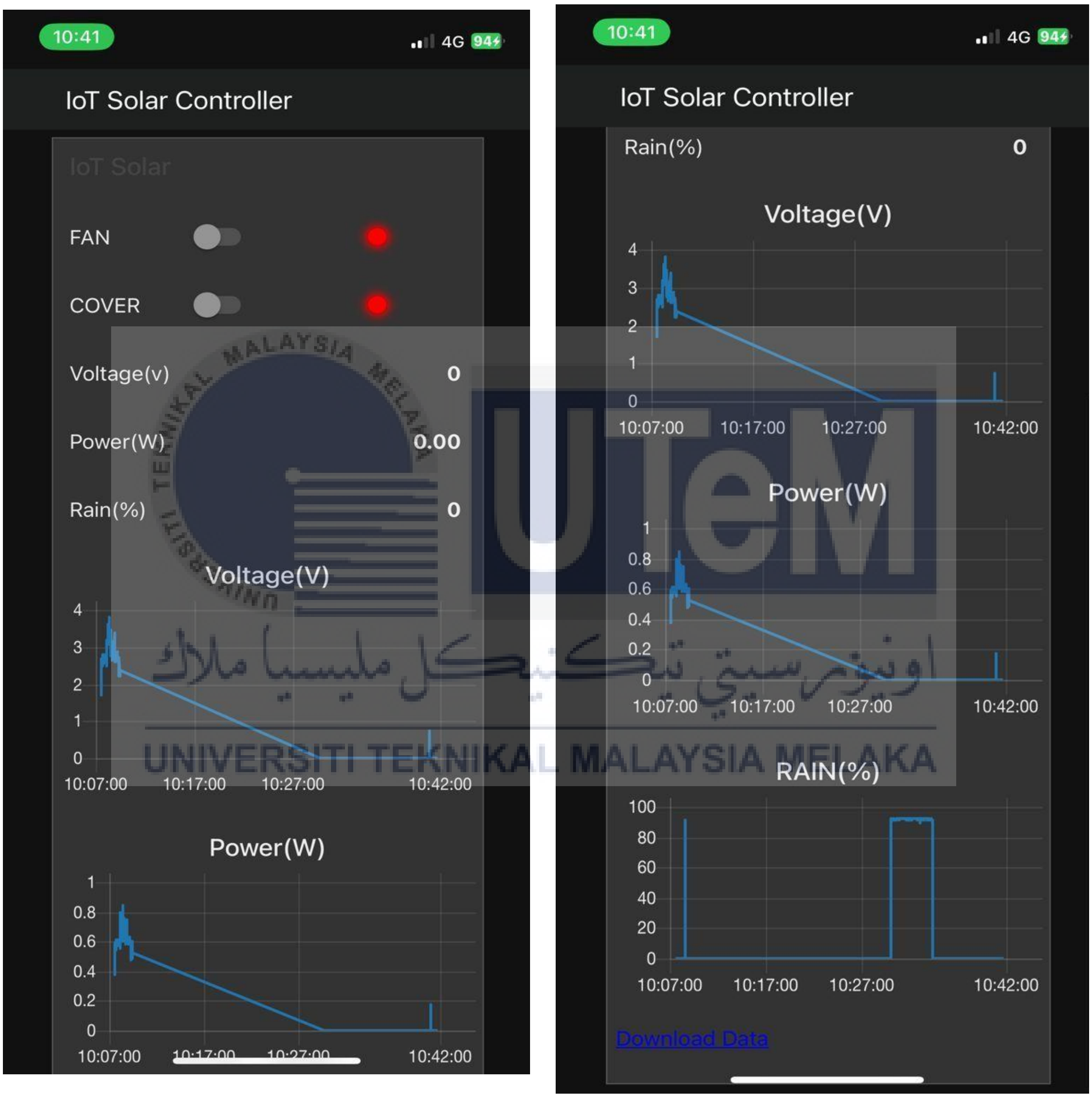




Figure 4.10 No power supply from solar panels and non - rainy day at 10.42 am.

| | | |
|---|---|---|
| 5. | Any circumstances. | Whether it is raining or not, the roof and exhaust fan can be manually opened and closed by clicking the button on the iOt application on the user's mobile phone. |


Figure 4.11 manually control on the fan and cover button for example it will open at 10.08 am on rainy days and and close again at 10.09 am on non-rainy days.

## 4.7 Summary

This chapter describes the design and development of an Arduino-based smart automated roof for a clothesline home. The idea is to let clients dry their clothes without using a lot of electricity. The first step is to configure the input and output system to manage the moving roof, followed by the integration of hardware and software tools to realise the project's main concept. Due to the extreme heat and sunlight, average power data analysis was performed within a week, with solar panels only absorbing sunlight from 8 a.m. to 5 p.m. Data can be gathered utilising IoT applications and the user's mobile phone. Data for roof and fan analysis was downloaded three times in order to obtain more precise estimates for manually opened fans and roofs discovered on rainy days. The delay occurs when the fan and roof are opened and closed due to the rain sensor's sensitivity to detect moisture. The automated roof for a clothesline home should function in a variety of real-world conditions. The results show that, regardless of the weather, the roof and exhaust fan may be manually opened and closed by hitting the button on the iOt application on the user's mobile phone. The table below provides an overview of the roof and exhaust fan in an open and closed state based on current weather conditions. The conditions are classified as open, which are the most common, and closed, which are the least common.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATION

## 5.1 Conclusion

Upon completion of the project, aims to be able to build an automatic retractable roof system for clothesline with a controllable system is designed that can answer the problem of a better idea to dry wet clothes, especially during the rainy season. If clothes are left exposed to rainwater, drying attempts will be futile, resulting in a waste of the user's time and energy. This will cause clothes or other wet items to grow damp and smell bad when the user is at home or outside the area. The accessibility of this system can help avoid the issues mentioned above and provide good results. This project will pave the way for such new technologies. The work involved shows how to automatically protect clothing throughout the rainy season without the need for human intervention. As a result, it may offer comfort, minimize human effort, and save time. It can be easily used From Home, Office, and Anywhere users need. As a result, future generations will have an easier time and save energy.

## 5.2 Recommendations

Recommendations for future research and improvements can be focused on ;

1. A humidity sensor has been added to measure humidity and air temperature. The Sensor measures the relative humidity of the environment in which it is placed.
2. A water sensor detects rain action. A dual-role device, such as a switch and intensity measurement device, is suitable for this purpose.
3. Ultraviolet (UV) sensors capable of measuring UV intensity both indoors and outdoors. It uses an inbuilt amplifier to transform the light current or voltage based on the UV intensity.
4. Include a notification mechanism in the user interface to alert the user of weather conditions in the IoT application.
5. Install a retractable automation system to collect the laundry suspension line.

## REFERENCE

[1] F.T. Tangang, J. Liew, E. Salimun, S. KwanMeng, L. LohJui, H. Muhamad, "Climatechange and variability over Malaysia: gaps in science and research information." SainsMalaysiana 41 (11), 1355 – 1366, 2012.

[2] N.S Mei, C.W. Wai, R. Ahamad, "Environmental awareness and behaviour index for Malaysia." Proc. – Soc. Behav. Sci. 222 , 668 – 675, 2016.

[3] M. Hamlin, "The significance of rainfall in the study of hydrological processes at basin scale." J. Hydrol. 65 (1), 73 – 94, 1983.

[4] M.A. Hasan, S.M. Pradhanang, "Estimation of ow regime for a spatially varied Himalayanwatershed using improved multi-site calibration of the soil and water assessment tool (swat)model." Environ. Earth Sci. 76 (23), 787, 2017.

[5] T.E. Adams III, "The use of central tendency measures from an operational short lead-timehydrologic ensemble forecast system for real-time forecasts." Ph.D. thesis, Virginia Tech, 2018.

[6] S. Pink, K.L. Mackley, R. Moro ş anu, "Hanging out at home: laundry as a thread and textureof everyday life." Int. J. Cult. Stud. 18 (2), 209 – 224, 2015.

[7] L. Yates, D. Evans, "Dirtying linen: re-evaluating the sustainability of domestic laundry.Environ. Poli." Gov. 26 (2), 101 – 115, 2016.

[8] D. Madgwick, H. Wood, "The problem of clothes drying in new homes in the UK. Struct.Surv." 34 (4/5), 320 – 330, 2016.

[9] Y. Chunjiang, "Development of a smart home control system based on mobile internet technology. Int. J. Smart Home" 10 (3), 293 – 300, 2016.

[10] B.L.R. Stojkoska, K.V. Trivodaliev, "A review of internet of things for smart

home:challenges and solutions." J. Clean. Prod. 140 , 1454 – 1464, 2017.

[11] X. Mao, K. Li, Z. Zhang, J. Liang, "Design and implementation of a new smart home control system based on Internet of Things." In: 2017 International Smart Cities Conference(ISC2), pp. 1 – 5, 2017.

[12] Siti Nor Zawani Ahmmad, Muhammad Abdul Ghaffar Eswendy, Farkhana Muchtar & Pradeep Kumar Singh, "Implementation of Automated Retractable Roof for Home Line-Dry Suspension Area Using IoT and WSN", 2020.

[13] F. T. Tangang, Juneng Liew, E. Salimun, Sei KwanMeng, Le LohJui, Halimatun Muhamad, "Climate change and variability over Malaysia: gaps in science and research information." Sains Malaysiana, 2012.

[14] N. Gomesh, I. Daut, M. Irwanto, Y.M. Irwan, M. Fitra, "Study on Malaysian's Perspective Towards Renewable Energy Mainly on Solar Energy", Energy Procedia, Pages 303-312, Volume 36, 2013.

[15] Poul Alberg Ostergaard, Neven Duic, Younes Noorollahi, Hrvoje Mikulcic, Soteris Kalogirou, "Sustainable development using renewable energy technology", Renewable Energy, Pages 2430-2437, Volume 146, 2020.

[16] Sathvik, V Rane Vishal, Abubakkar Siddiq, Jaison D?Souza, M. Prathibha, "Automatic Harvested Crop Protection System with GSM and Rain Detector", 2019.

[17] Prof. Abhijit G Kalbande Assistant Professor, EXTC Department, PRMCEAM, Badnera, Amravati, "SMART AUTOMATION SYSTEM USING ARDUINO AND RAIN DROP SENSOR", 2017.

[18] K. Ishii, "Structural design of retractable roof structures. Computational Mechanics", 2000.

[19] W. Zablocki, “Mobility in sport architecture. In: International Symposium on Lightweight Structures in Civil Engineering”, pp. 99-106. Jan B Obrebski, Warsaw., 2002.

[20] M. Liu, Q.S. Li, S.H. Huang, F. Shi, F. Chen, “Evaluation of wind effects on a large span retractable roof stadium by wind tunnel experiment and numerical simulation”, J. Wind Eng.Ind. Aerodyn.179, 39–57, 2018.

[21] A. Mahovič, “Typology of retractable roof structures in stadiums and sports halls”, IGRAUSTVARJALNOSTI (IU)/CREATIVITY GAME (CG) Theor. Pract. Spat. Plann.3,90–99, 2015.

[22] P. Kassabian, Z. You, S. Pellegrino, “Retractable roof structures”, Proc. Inst. Civil Eng.-Struct. Build.134(1), 45–56, 1999.

[23] F.V Jensen, “Concepts for retractable roof structures”, Ph.D. thesis, University of Cambridge, 2005.

[24] S. Korkmaz, “A review of active structural control: challenges for engineering informatics. Comput. Struct”, 89(23), 21132132, 2011

[25] G.E. Fenci, N.G. Currie, “Deployable structures classification”,a review. Int. J. Space Struct.32(2), 112–130, 2017.

[26] F. Otto, B. Burkhardt, IL Five: Convertible Roofs. Information of the Institute for Lightweight Structures Series. George Wittenborn Incorporated, 1972.

[27] S.B. Madankar, D.M.M. Khanapurkar, “Intelligent rain sensing using automatic wiper system”, In: 2nd National Conference on Information and Communication Technology(NCICT), pp. 27–29, 2011.

[28] G. Jadhav,, K. Jadhav, K. Vadlamani, " Environment monitoring system using raspberry-pi", Int. Res. J. Eng. Technology, (IRJET) 3(04), 1168–1172, 2016.

[29] K. VivekBabu, K.A. Reddy, C. Vidhyapathi, B. Karthikeyan, “Weather forecasting using Raspberry pi with internet of things (IoT)”, ARPN J. Eng. Appl. Sci. 12, 5129 – 5134, 2017.

[30] B. Susi Susanti, " Prototype Automatic Clothesline Based on Arduino Uno," ProjectHubs, 16 May 2019.

[31] M. Syahadi, " Automatic Laundry Cover - Digital Project - Politeknik Negeri Bandung," Youtube, 16 June 2017.

[32] J. Fernando, " Automatic Clothesline Retrieval System. Retrieved from ProjectHub," ProjectHub, Retrieved on 4 September 2018.

[33] Suandanwar, "Rain Detector," Cytro9n Technologies Tutorial, [Online]. 20 September 2018.

[34] S. Mekhilef, A. Safari, W.E.S. Mustaffa, R. Saidur, R. Omar, M.A.A. Younis, “Solar energy in Malaysia: Current state and prospects”, Renewable and Sustainable Energy Reviews, Pages 386-396, Volume 16, Issue 1,2012.

[35] Nowshad Amin, Chin Wen Lung, Kamaruzzaman Sopian, "A practical field study of various solar cells on their performance in Malaysia", Energy Procedia, Pages 303-312, Volume 36, 2013.

[36] M. Saad, A. Safari, W. Mustaffa, M. Younis, S. Rahman, and O. Rosli, “Solar energy in Malaysia: Current state and prospects”, Renewable and Sustainable Energy Reviews, vol. 16, pp. 386-396, 2012.

[37] N. Gomesh, I. Daut, M. Irwanto, Y.M. Irwan, and M. Fitra, “Study on Malaysian’s perspective towards renewable energy mainly on solar energy,” Energy Procedia, vol. 36, pp. 303-312, 2013.

[38] M.A. Alghoul, F.Y. Hammadi, N. Amin, and N. Asim, “The role of existing infrastructure of fuel stations in deploying solar charging systems, electric vehicles and

solar energy: a preliminary analysis," Technological Forecasting and Social Change, vol. 137, pp. 317-326, 2018.

[39] A.N. Syafawati, I. Daut, M. Irwanto, Z. Farhana, N. Razliana, Z. Arizadayana, and S.S. Shema, "Potential of solar energy harvesting in Ulu Pauh, Perlis, Malaysia using solar radiation-analysis studies," Energy Procedia, vol. 14, pp. 1503-1508, 2012.

[40] N. Izadyar, H.C. Ong, W.T. Chong, J.C. Mojumder, and K.Y. Leong, "Investigation of potential hybrid renewable energy at various rural areas in Malaysia," Journal of Cleaner production, vol. 139, p. 61-73, 2016.

[41] R. Haiges, Y.D. Wang, A. Ghoshray, and A.P. Roskilly, "Optimization of Malaysia power generation mix to meet the electricity demand by 2015," Energy Procedia, vol. 142, pp. 2844-2851, 2017.

[42] K.C. Goh, H.H. Goh, A. Yap, M. Masrom, and S. Mohamed, "Barriers and drivers of Malaysian BIPV application: Perspective of developers," Procedia Engineering, vol. 180, p. 1585-1595, 2017.



[43] Ho Soonmin, Abraham Lomi, Edmund C Okoroigwe, Leonardo Rodriguez Urrego, "Investigation of Solar Energy: The Case Study in Malaysia, Indonesia, Colombia and Nigeria", INTERNATIONAL JOURNAL of RENEWABLE ENERGY RESEARCH Soonmin H. et al., Vol.9, No.1 March 2019.

[44] Ho, S.M., Lomi, A., Edmund, C., Urrego R., "Investigation of Solar Energy: The Case Study in Malaysia, Indonesia, Colombia and Nigeria," International Journal of renewable Energy Research, vol. 9, pp. 86-95, 2019.

[45] Ho, S.M., Edmund, C., Adewale, G., Hammed, B., Ahmed Y, "Advanced Research in solar energy: Malaysia, UAE and Nigeria," Eurasian Journal of Analytical Chemistry, vol. 13, pp. 312-331, 2018.

[46] J. Gubbi, R. Buyya, S. Marusic, M. Palaniswami, “Internet of Things (IoT)”, a vision, architectural elements, and future directions. Future Gen. Comput. Syst.29(7), 1645–1660, 2013.

[47] A. Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari, M. Ayyash, “Internet of Things”, a survey on enabling technologies, protocols, and applications. IEEE Commun. Surv. Tutorials 17(4), 2347–2376, 2015.

[48] S. Vashi, J. Ram, J. Modi, S. Verma, C. Prakash, “Internet of Things (IoT)”, a vision, architectural elements, and security issues. In: 2017 International Conference on I-SMAC(IoT in Social, Mobile, Analytics and Cloud)(I-SMAC), pp. 492–496. IEEE, 2017.

[49] I. Lee, K. Lee, “The internet of Things (IoT): applications, investments, and challenges for enterprises”, Bus. Horiz. 58(4), 431–440, 2015.

[50] Siti Nur Aisyah Abdul Hei, Effa Nadzirah Nazri, Nurin Faqihah Mohamed Rafik, Mazniha Berahim, “Automatic Clothesline Retrieval Prototype with Humidity Alert System to Aid Clothesline Drawbacks for Reducing Laundry Worries”, Multidisciplinary Applied Research and Innovation, 401–410, Vol. 2 No. 1, 2021

[51] B. Lai, Z. Deng, X. Wan, J. Yan, “A kind of rainfall sensor design without mechanical structure”, In: International Conference on Education, Management, Computer and Society.Atlantis Press, 2016.

[52]J.C. Chacon-Hurtado, L. Alfonso, D.P. Solomatine," Rainfall and streamow sensor networkdesign", a review of applications, classification, and a proposed framework. Hydrol. EarthSyst. Sci.21(6), 3071–3091, 2017.

[53] J. Gubbi, R. Buyya, S. Marusic, M. Palaniswami, “Internet of Things (IoT)”, a vision, architectural elements, and future directions. Future Gen. Comput. Syst.29(7), 1645–1660, 2013.

## APPENDICES

### Appendix A Example of Appendix Coding

```
#define RAIN 35
#define FAN 22
#define ANALOG_IN_PIN 34
#include <ESP32Servo.h>
#include <PubSubClient.h>
#include <WiFi.h>

const char* mqtt_server = "broker.hivemq.com";
WiFiClient espClient;
PubSubClient client(espClient);
long lastMsg = 0;
char msg[50];
int value = 0;

char ssid[] = "syora";    //wifi ssid
char pass[] = "dddddddd"; //wifi passwd

//String dataMessage;
Servo myservo;
int rainval = 0;
int pos = 0;
int servoPin = 32;
int adc_value = 0;

float adc_voltage = 0.0;
float in_voltage1 = 0.0;
float in_voltage = 0.0;
float ref_voltage = 3.3;
float R1 = 30000.0;
float R2 = 7300.0;

void initWiFi() {
  WiFi.mode(WIFI_STA);
  WiFi.begin(ssid, pass);
  Serial.print("Connecting to WiFi ..");
  while (WiFi.status() != WL_CONNECTED) {
    Serial.print('.');
    delay(1000);
  }
  Serial.println(WiFi.localIP());
}
```

```
void setup() {
  Serial.begin(115200);
  pinMode(RAIN, INPUT);
  pinMode(FAN, OUTPUT);
  ESP32PWM::allocateTimer(0);
  ESP32PWM::allocateTimer(1);
  ESP32PWM::allocateTimer(2);
  ESP32PWM::allocateTimer(3);
  myservo.setPeriodHertz(50);
  myservo.attach(servoPin, 500, 2400);

  digitalWrite(FAN, HIGH);
  myservo.write(0);

  initWiFi();
  client.setServer(mqtt_server, 1883);
  client.setCallback(callback);
}

void reconnect() {
  // Loop until we're reconnected
  while (!client.connected()) {
    Serial.print("Attempting MQTT connection...");
    // Attempt to connect
    if (client.connect("")) {
      Serial.println("connected");
      // Subscribe
     client.subscribe("intellesys/iotturbine/fan");
    } else {
      Serial.print("failed, rc=");
      Serial.print(client.state());
      Serial.println(" try again in 5 seconds");
      // Wait 5 seconds before retrying
      delay(500);
    }
  }
}
void callback(char* topic, byte* message, unsigned int length) {
  Serial.print("Message arrived on topic: ");
```

**Appendix B Example of Appendix Costing Component**

| No. | Component | Supplier | Unit | Price per Unit (RM) | Price (RM) |
|---|---|---|---|---|---|
| 1 | Solar cell | Cytron | 1 | RM 16.50 | RM 16.50 |
| 2 | LiPo rechargeable battery | Cytron | 1 | RM 18.50 | RM 18.50 |
| 3 | 90º servo motor | Shopee | 1 | RM 6.90 | RM 6.90 |
| 4 | Rain sensor module | Shopee | 1 | RM 3.70 | RM 3.70 |
| 5 | ESP32 NodeMCU | Shopee | 1 | RM 40.00 | RM 40.00 |
| 6 | Jumper wire | Shopee | 3 | RM 1.10 | RM 3.30 |
| 7 | DC fan blower 2pin | Shopee | 1 | RM 3.90 | RM 3.90 |
| 8 | Voltage sensor | Shopee | 1 | RM 3.00 | RM 3.00 |
| 9 | DC – DC boost step up converter | Shopee | 1 | RM 3.00 | RM 3.00 |
| **Total cost** | | | | | **RM 98.80** |