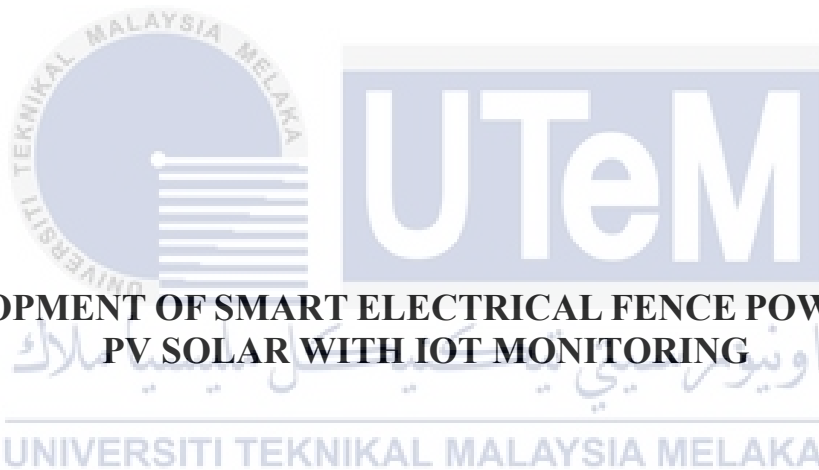




Faculty of Electrical and Electronic Engineering Technology



DEVELOPMENT OF SMART ELECTRICAL FENCE POWERED BY PV SOLAR WITH IOT MONITORING

MUHAMMAD ASHRAF BIN MOHD HASBI

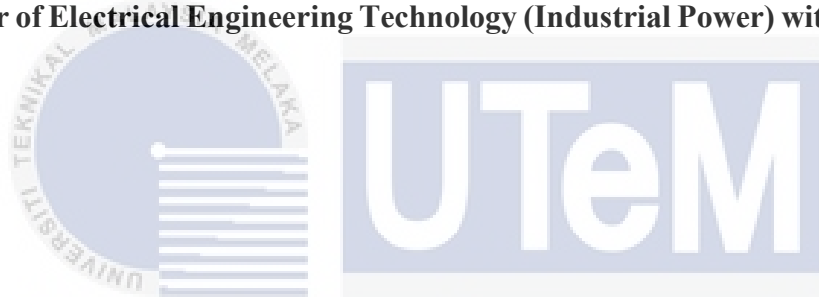
Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

2022

DEVELOPMENT OF SMART ELECTRICAL FENCE POWERED BY PV SOLAR WITH IOT MONITORING

MUHAMMAD ASHRAF BIN MOHD HASBI

**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 and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this project report entitled “DEVELOPMENT OF SMART ELECTRICAL FENCE POWERED BY PV SOLAR WITH IOT MONITORING” 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

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Student Name

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MUHAMMAD ASHRAF BIN MOHD HASBI

Date

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1/2/2023

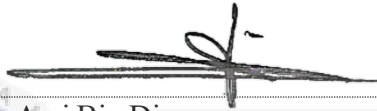


APPROVAL

I approve that this Bachelor Degree Project 2 (PSM2) report entitled “DEVELOPMENT OF SMART ELECTRICAL FENCE POWERED BY PV SOLAR WITH IOT MONITORING” is sufficient for submission.

Signature

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Supervisor Name

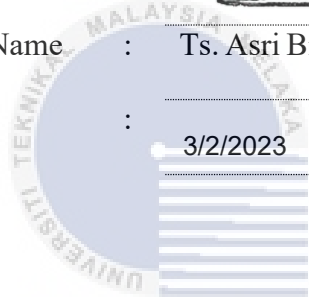
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Ts. Asri Bin Din

Date

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UTeM

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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.

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3/2/2023

Signature

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Co-Supervisor

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Name (if any)

Date

:

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.....

DEDICATION

This project is devoted to me as an engineering technology student, and it is the first of my projects that I am studying and attempting to accomplish. It is also grateful to my mother and father, who taught me that even the most difficult activity can be accomplished if completed one step at a time and with patience. Last but not least, I would like to express my heartfelt gratitude to my supervisor, Ts. Asri Bin Din as well as all my friends, for being my pillars of support throughout this journey.



ABSTRACT

There are a lot of conventional electrical fence nowadays. Hence this project was based on study of existing conventional electrical fence and intruder or wild animal that easily trespassing without any notification. This project was based on renewable energy technologies that would be main power sources. There are various types of energy in this world and solar energy is one of energy that reliable to used. In addition, to power up electrical fence and televisions and several other gadgets and appliances in the home and garden this can be one alternative for obtaining electricity by use this method. Furthermore, a panel facing the sun can collect more solar energy and use it to power the electrical fence and lamp. Then, one of the crucial problems is the pattern of energy consumption at each equipment or process. Therefore, it relates to the difficulty in power analysis especially in system operational efficiency and proactive maintenance. Animals in the fields may cause trouble to garden or farms. Therefore, the owner can defend their fields, farmhouses, and farmlands from animals by employing electric fences. The electrical shock that produce can make animals runaway and teach them to keep away from the fence. Thus, electric fences are a cost-effective and practical way to increase field production because the output of electric fencing is discrete and safe. Project goals is to develop systematic system for gardeners by using Esp32 with sensor and to analyse the efficiency of the notification system and solar battery charging. To address this issue the system is equipped with Blynk apps as a monitoring application. The Esp32 is used in this project as a microcontroller that connects to the sensor and the battery. The operation of the smart electrical fence has met it functionality and requirements. Finally, the result of analysis has shown the positive results with relate to the efficiency of IoT response time and the charging process.

ABSTRAK

Terdapat banyak pagar elektrik konvensional pada masa kini. Oleh itu projek ini adalah berdasarkan kajian terhadap pagar elektrik konvensional sedia ada dan penceroboh atau haiwan liar yang mudah menceroboh tanpa sebarang pemberitahuan. Projek ini berdasarkan teknologi tenaga boleh diperbaharui yang akan menjadi sumber kuasa utama. Terdapat pelbagai jenis tenaga di dunia ini dan tenaga solar adalah salah satu tenaga yang boleh dipercayai untuk digunakan. Di samping itu, untuk menghidupkan pagar elektrik dan televisyen dan beberapa gajet dan perkakas lain di rumah dan taman ini boleh menjadi salah satu alternatif untuk mendapatkan tenaga elektrik dengan menggunakan kaedah ini. Tambahan pula, panel yang menghadap matahari boleh mengumpul lebih banyak tenaga suria dan menggunakannya untuk menghidupkan pagar elektrik dan lampu. Kemudian, salah satu masalah penting ialah corak penggunaan tenaga pada setiap peralatan atau proses. Oleh itu, ia berkaitan dengan kesukaran dalam analisis kuasa terutamanya dalam kecekapan operasi sistem dan penyelenggaraan proaktif. Haiwan di ladang boleh menyebabkan masalah kepada kebun atau ladang. Oleh itu, pemilik boleh mempertahankan ladang, rumah ladang, dan tanah ladang mereka daripada haiwan dengan menggunakan pagar elektrik. Renjatan elektrik yang terhasil boleh membuatkan haiwan lari dan mengajar mereka menjauhi pagar. Oleh itu, pagar elektrik adalah cara yang kos efektif dan praktikal untuk meningkatkan pengeluaran lapangan kerana output pagar elektrik adalah diskret dan selamat. Matlamat projek adalah untuk membangunkan sistem sistematik untuk tukang kebun dengan menggunakan Esp32 dengan sensor dan untuk menganalisis kecekapan sistem pemberitahuan dan pengecasan bateri solar. Untuk menangani isu ini sistem dilengkapi dengan aplikasi Blynk sebagai aplikasi pemantauan. Esp32 digunakan dalam projek ini sebagai mikropengawal yang menyambung kepada sensor dan bateri. Operasi pagar elektrik pintar telah memenuhi fungsi dan keperluannya. Akhir sekali, hasil analisis telah menunjukkan keputusan positif berkaitan dengan kecekapan masa tindak balas IoT dan proses pengecasan.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Ts. Asri Bin Din for their precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) and my parents for the financial support throughout my four years of studies which enables me to accomplish the project. Not forgetting my fellow colleague for the willingness of sharing their thoughts and ideas regarding the project.

My highest appreciation goes to my parents and family members for their love and prayer during the period of my study. An honourable mention also goes to Ts. Asri Bin Din for all the motivation and understanding.

Finally, I would like to thank all the staffs at the Universiti Teknikal Malaysia Melaka (UTeM), fellow colleagues and classmates, the faculty members, as well as other individuals who are not listed here for being co-operative and helpful.

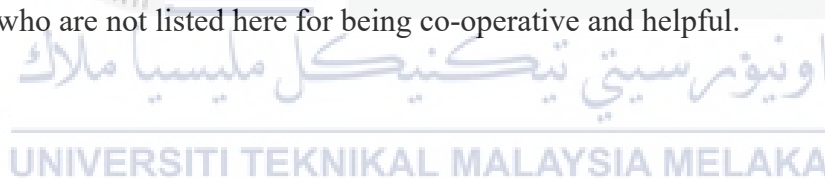


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LIST OF SYMBOLS

G	- Irradiance
C	- Celcius
n	- Solar Efficiency



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CHAPTER 1

INTRODUCTION

1.1 Background

Solar energy is an infinite source of energy that, if properly harnessed, will allow humanity to reduce its reliance on traditional energy sources. The goal of this project was to improve the efficiency of solar energy harvesting. A smart electrical fence is built using solar and Arduino. This project is powered by an Esp32 as a microcontroller, which manages the various functions of the project. A Solar Panel is used to collect solar energy. Furthermore, a panel facing the sun can collect more solar energy and use it to power the electrical fence and microcontroller.

1.2 Problem Statement

The pattern of energy consumption at each equipment or process is critical for power analysis for operational efficiency and proactive maintenance. In order to do so, some gardeners are unaware of renewable energy, and solar energy is one of the most efficient renewable energy sources. Second, this invention makes it easier for people to monitor and keep wild animals out of gardens, and gardeners who work away from home won't have to worry about their gardens because the voltage sensor would trigger it and the advantage of IoT embedded in the system could send an indicator to inform the system owner.

1.3 Project Objective

This project's main goal is to propose a systematic and effective methodology for estimating this invention system with high security. The following are the specific objectives are as follows:

- a) To generate solar renewable energy from pv solar.
- b) To develop a systematic system for gardeners by using Esp32 as a microcontroller with sensor.
- c) To analyze the efficiency of the monitoring system and solar battery charging.

1.4 Scope of Project

The scope of this project are as follows:

1. The target audience for this project is the gardener because of the viability and ease of gathering data, decided to limit the scope to the average place like garden and residential area.
2. This project was started with the intention of assisting and easing the consumer in determining which security level to increase. This typical project for any garden consists primarily of an electrical fence that runs nonstop for 24 hours. Therefore this project will duplicate the same method.
3. This project does not use conventional electricity because it uses solar energy, which is a renewable resource that can save money in the future. Furthermore, the electric fence can be monitored from a mobile phone using the Blynk app.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Everyone in today's modern society requires renewable energy efficiency. This invention makes it easier to monitor and keep wild animals out of gardens, and gardeners who work away from home won't have to worry about their gardens because our voltage sensor will trigger it and send us a warning message. Then, using Esp32 and Sensor, this project is aim want to generate solar renewable energy, develop a systematic system for gardeners, and use the energy consumed by solar to charge a battery.

The industries will benefit more if a smart electrical fence with a combination of solar and voltage sensor is designed. It has the potential to reduce the amount of electricity used by the machines and equipment in this project. It can also lead to financial gain for the gardeners. Three things are extremely important in this project: Solar panels provide renewable energy, while Esp32 provides voltage sensors and IoT, as well as an electric fence to keep wild animals at bay.

The solar panel will energize the solar charger controller, which will store current in the battery, as expected. The battery's current will then be used to power the electric fence. Finally, we had use an electric fence to keep wild animals out of the garden, which we had detect with a voltage sensor and can be monitored from Blynk apps.

2.2 Solar energy

There are many ways to use solar energy: heating, chemical processes, and electricity production are all examples. "Solar energy" relates to the energy released by the sun. With the brilliance of the sun, our present and future energy needs are dwarfed by it. If this widely spread resource is properly used, all future energy demands may be fulfilled. With its unlimited supply and low environmental effect, solar power is likely to become a prominent renewable source in the next century. Renewable energy sources like wind and solar power are more environmentally friendly than fossil fuels like oil and gas. In spite of the low amounts of light at Earth's surface, sunlight is the most abundant energy source for the planet. It is not uncommon for radiation emitted by the Sun to spread out across a broad area. Solar radiation is absorbed and diffused by the environment by clouds, resulting in just a little amount of extra losses. There are little quantities of uv and other types of electromagnetic radiation in sunlight that reaches the Earth's surface, but the visible light spectrum makes up the majority of the energy that hits our planet.

Solar energy has the most potential of all renewable energy sources because it has many advantages over other sources and it is also the most reliable energy in malaysia. Hence ,Solar energy is a free source of energy from the sun. It is a non-polluting, naturally accessible source that emits no GHGs or air pollutants. Solar energy is either directly harvested from the sun for heating or converted into electricity using a solar panel with solar cells mounted on it. Due to its proximity to the equator, Malaysia has a lot of potential for solar energy resources in comparison to other countries. As a result, Malaysia receives an abundance of natural solar radiation throughout the year [1].

2.2.1 Photovoltaic solar energy

Direct conversion of solar radiation to electricity is how photovoltaic energy from the sun is generated. Solar cells are most typically made with silicon owing to the availability of this material on our planet, its low contamination rate, its long-term durability, and the wealth of knowledge it has gained in the microelectronics sector. Despite the fact that a variety of methods have been developed and implemented, the most often used silicone panels are monocrystalline and polycrystalline. The cylinder monocrystalline silicon bars used to make crystalline silicon cell are roasted in a special furnace before being used to make monocrystalline silicon cells. Using a sharp knife, slice the bars into long, thin strips (300 mm thick). However, despite their high manufacturing costs, they have a conversion efficiency of 15% when converting solar light to energy. Using molds, silicon blocks are melted in order to create polycrystalline silicon cells. This process does not result in the formation of a single crystal. This solar panel's conversion efficiency when exposed to the sun is 13%. Solar radiation and cell temperature are the two most essential elements that affect the results of a photovoltaic panel. As the amount of cell insulation increases, so does the temperature within the cell, reducing module efficiency [2]. As shown in Figures 2.1 and 2.2, the intensity of solar radiation and the temperature differential impact the performance of photovoltaic panels.

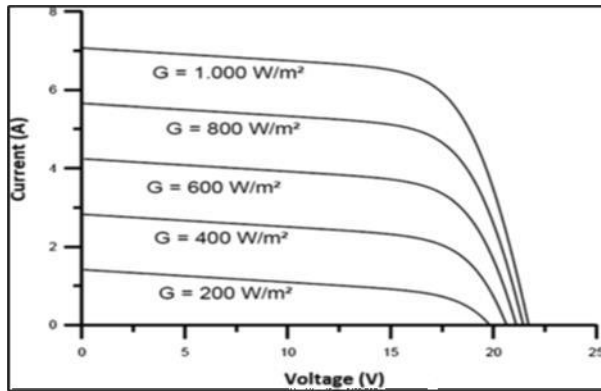


Figure 2.1 Variation in a PV system's characteristic curve due to changes in solar radiation has this effect.

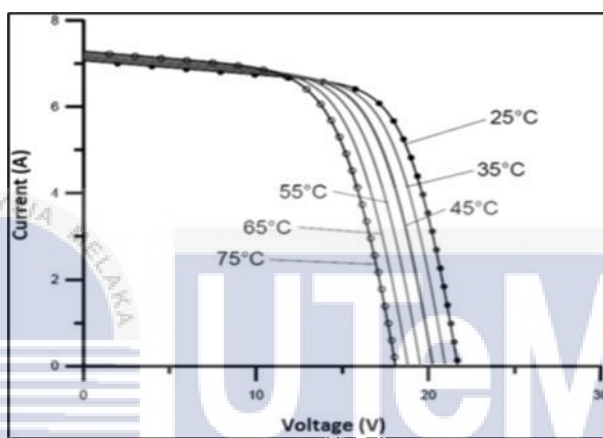


Figure 2.2 The curve of a Photovoltaic exhibits an effect induced by temperature.

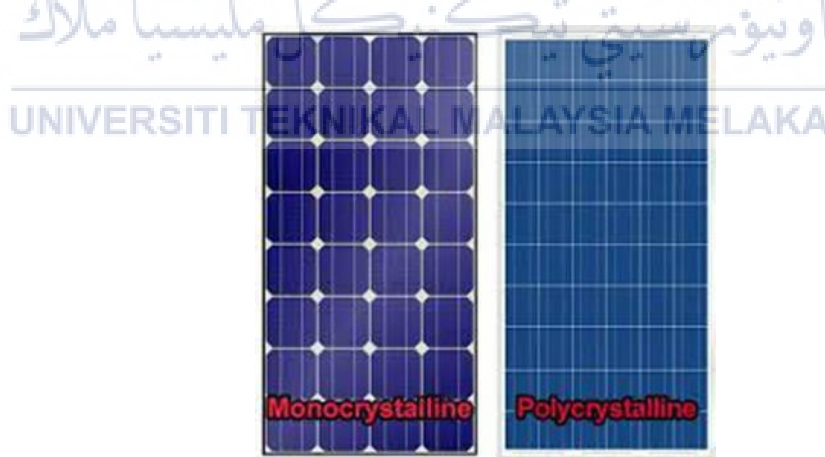


Figure 2.3 Example of Monocrystalline and polycrystalline photovoltaic panels.

2.2.2 Charger controller

To prevent the batteries from being overcharged, a charger controller, which is also called a battery regulator or a charge regulator, is used. Overcharging and overvoltage may be prevented using this solid-state circuitry. It will also lengthen the battery's life and improve its performance at the same time.

2.2.2.1 Type of controller

Stand-alone charger controllers and integrated charge controller circuits are two kinds of controllers.

2.2.2.2 Maximum Power Point Tracking (MPPT)

MPPT controllers have been critical in tracing the PPP and increasing the efficiency of photovoltaic installations. In 1968, the first photovoltaic system incorporating MPPT was developed for use in a space system. Following then, MPPT controllers improved significantly in terms of reliability, precision, tracking speed, efficiency, and simplicity. The ideal MPPT algorithm is often quick, has little oscillation around the PPP, and can keep up with rapid changes in output power. There are several MPPT control strategies that have been implemented to date. These controllers are used to monitor the maximum power point under uniform irradiation for a single MPP or to track a photovoltaic system with numerous maximum power points (MMPP). The environment has a considerable effect on the output of the photovoltaic system. As a result, the production yield varies dynamically. Solar panels cannot provide their full power output without the usage of an MPPT controller. Nowadays, every photovoltaic system installed has an MPPT controller. The primary objective of MPP trackers is to ensure that the MPP is located quickly, with

little convergence time, minimal oscillation, and high precision, in order to improve energy production [3].

2.3 Internet of Things (IoT)

The Internet of Things (IoT) has achieved significant recognition and appeal as the standard solution for limited lossy networks (LLNs) with restricted resources because to the increasing expansion of intelligent devices with high networks in this age of IR 4.0. It is a private or public network that links "things," or embedded systems with sensor. Remote control of Internet of Things (IoT) devices is possible. A network using industry-standard communication protocols is used to transfer data between devices. Things" are the term used to describe smart, internet-connected objects. From tiny wearables to massive equipment, there's something for everyone. The sensors devices are included in box. Fitness data may be tracked and analyzed using Lenovo smart sneakers, for example. Washing machines and other electrical equipment are comparable. Remote control is available for machines and freezers. Using Internet of Things (IoT), a location's security cameras may be watched from anywhere in the world. The Internet of Things (IoT) has a positive impact on society in addition to its personal benefits. You can monitor operations in hospitals, assess weather conditions and give vehicle monitoring and communication with a variety of smart devices. 'Smart gadgets' Animals may already be identified using biochips. Requirements particular to the community. The information gleaned from these. Real-time processing of devices may help enhance system efficiency. [4].

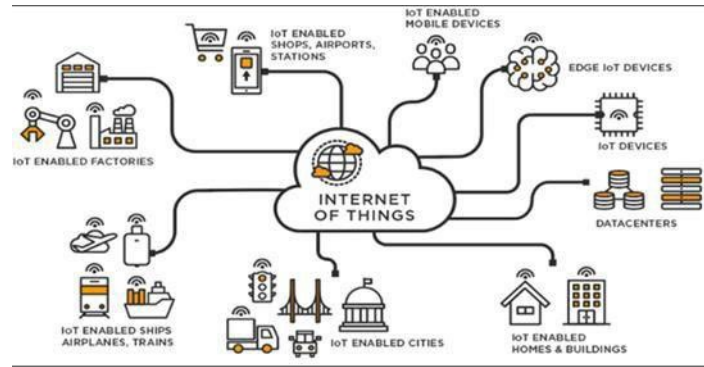


Figure 2.4 Example of process internet of things

2.3.1 Arduino mega

The objective of the Arduino Mega is to charge it by connecting it to your computer through USB or by using an AC-DC converter or battery. Most shields produced for the Arduino Duemilanove or Arduino Diecimila are compatible with the Arduino Mega2560. The Arduino Mega2560 is the most recent version, replacing the Arduino Mega.



Figure 2.5 Example of Arduino mega 2560

Arduino Mega 2560 is a precision open-source microcontroller board that replaces the Arduino Mega. It utilizes an ATmega2560 SMD chip. In addition to AREF, the Mega 2560 R3 has SDA and SCL pins. Additionally, two extra pins have been added near the RESET pin. The IOREF, for instance, allows shields to adjust to the voltage given by the board [5].

2.3.2 Arduino uno

Arduino Uno is a single-board computer based on the ATmega 328 microcontroller. This microcontroller has 14 digital I/O (six of which may be used as PWM outputs), six analogue inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. This microcontroller runs on a 5V supply and is used as a USB-to-serial converter for serial communication with a computer through the USB connection [6].



Figure 2.6 Example of Arduino Uno

2.3.3 Raspberry Pi

Single-board computer (SBC) called Raspberry Pi is a credit card-sized, powerful, but affordable, computer. For about USD35, this Raspberry Pi 3B + one of the most economical quad-core processors on the market. SBCs are already a disruptive technology for a broad variety of applications, particularly for the Internet of Things, as more SBCs become accessible.

Open-source software and the 40-pin GPIO port on SBCs make it simple to connect them to other devices and add functionality. These platforms are ideal for point of care and point of need applications because of their small size, flexibility, affordability, and mobility. A Raspberry Pi-based device can detect C-reactive protein electrochemical reaction with a detection limit (LOD) of 58 ng/mL, whereas Lin et al. used a microfluidic biosensor and Raspberry Pi to detect Salmonella with a LOD of 14 CFU/mL.

Electrochemiluminescence (ECL) is a chemiluminescence process that is induced by an electric current. The excited state of a luminophore may be produced either by utilizing a co-reactant or by using the annihilation process, which involves electrochemical creation of both the reduced and oxidized luminophore forms. Due to this, the co-reactant route is essential for water sensing since it allows ECL to operate in its potential window [7].



Figure 2.7 Example of raspberry PI

2.3.4 Thingspeak

By sharing data, an IoT system enables the simple yet powerful capacity of working with a variety of devices and applications. IoT services are in charge of disseminating messages to the platform's customers. ThingSpeak is an Internet of Things (IoT) platform for collecting and storing sensor data in the cloud, as well as developing IoT applications. The ThingSpeak IoT platform includes programmes that enable you to analyse and display data in MATLAB and then take action on it. Sensor data may be transferred to ThingSpeak through the ESP8266 Wi-Fi module on the NodeMCU [8].



Figure 2.8 Example of process flow of ThingSpeak

2.3.4.1 Thing Speak-powered ionospheric monitoring system

The Internet of Things (IoT) is a rapidly developing technology that allows digital items to be connected across a network. The Internet of Things (IoT) makes it possible to gather data from GNSS receivers linked to the internet, providing a rare chance to learn about the geographic and temporal distribution of various objects. The ionospheric monitor system is built using ThingSpeak in this post (IoT). Comparing the observed calculated TEC values to the IRI-16 (International Reference Ionosphere) model values. The observed TEC standard deviation for four GNSS stations is as follows: 17.26 TECU for Port Blair, 18.34 TECU for Ben- galuru, 16.51 TECU for KLEF-Guntur, and 14.07 TECU for Lucknow. Consequently, the online monitoring system reduces costs and provides data backup and retrieval capabilities. It enhances worldwide Internet-based productivity and collaboration. Because of this, Thing Speak and the Internet of Things are used to construct an ionospheric monitoring system. Scientific applications that involve the collection and analysis of GNSS signals in various geographic regions are of particular interest to me. The idea of moving GNSS signal processing to the cloud appeals to a broad range of applications that need high-performance computation. Thing Speak channel ID and Channel API key were used to send GNSS data to the cloud from various GNSS devices. Thing Speak (IoT) was used to determine the ionospheric signal delays, while MATLAB was used to compute the ionospheric TEC. So, the Cloud paradigm allows for the creation of complex applications that are suited for cloud-based infrastructure. A real-time space weather forecasting system with ionospheric time delay will be provided by further development of the current approach [9].

2.3.5 Blynk application

BLYNK is an application platform for mobile OS (iOS and Android) devices for controlling Internet-connected modules such as Arduino, Raspberry Pi, ESP8266, WEMOS D1, and others. This widget may be moved by dragging it. It is easy to construct and takes around five minutes. Blynk is not confined to a particular board or module. Using this application platform, we can operate anything remotely from any location on the planet. The Internet of Things (IOT) system includes constantly Internet-connected records.

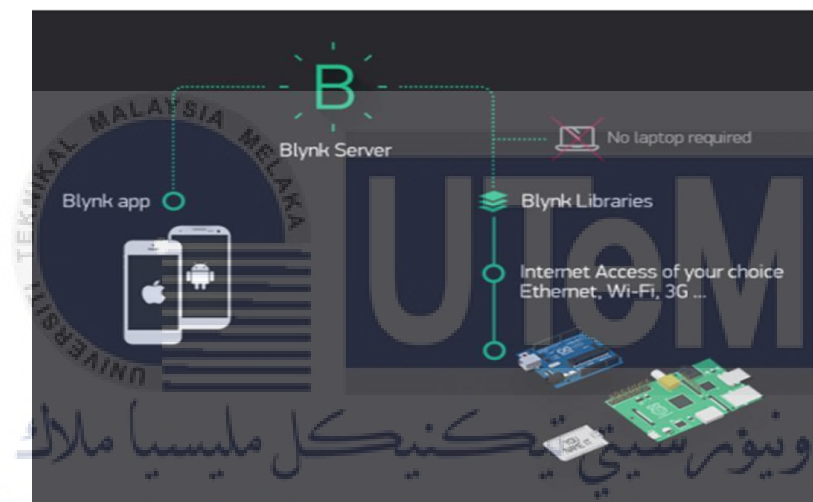


Figure 2.9 Example of Blynk app process flow diagram

The Blynk application is simple to use on a smartphone. The purpose of the Blynk programmed is to get notifications when anything like a sensor contacts the app, and the app sends a notice. When anything contacts the sensor, the Blynk app sends a notice to the user. As a result, users will be aware that something has occurred [10].

2.4 Batteries

Chemicals have a finite capacity to create a finite quantity of electrical energy per battery pack. Voltages, forms, sizes, and capacities come in a wide variety. Chemical processes will begin to happen in this little metal canister and create electrical energy for such a small equipment in this way. It consists of two separate conductors, one of which receives and the other of which increases the flow of electrons. As a result, current will flow.

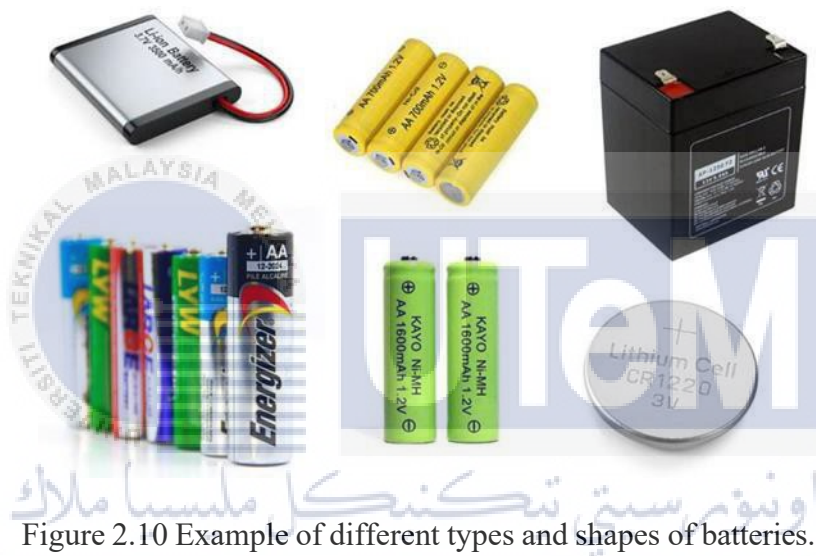


Figure 2.10 Example of different types and shapes of batteries.

Each cell in a battery generates an electric current via the chemical reactions it undergoes. An anode (the '-' side), a cathode (the '+' side), and some form of electrolyte are the three basic components of a battery (a substance that chemically reacts with the anode and cathode).

Anode and electrolyte reactions occur whenever a current battery cathode and anode are connected in series. The transport of electrons through the circuits then back into to the cathode is the outcome of this chemical process. It is no longer possible for a battery to produce electricity if indeed the cathode or anode material has been depleted or is no longer functional. The battery is termed "dead" at this point.

2.4.1 Types of batteries

Primary batteries are those that can be discarded after usage. Secondary batteries are rechargeable batteries that can be used multiple times.

2.4.1.1 Primary batteries

Primary batteries are non-rechargeable. The dry cell is a popular main battery. The dry cell is a lithium-ion battery made of zinc and carbon. Zinc may be used as a container as well as a negative electrode. The positive electrode is a carbon rod encased in a paste composed of manganese (IV) oxide, zinc chloride, ammonium chloride, carbon powder, and a trace of water.

2.4.1.2 Secondary batteries

Rechargeable secondary batteries are included. These are the battery kinds used in smartphones and electronic tablets. NiCd batteries have a nickel-plated cathode, a cadmium-plated anode, and a potassium hydroxide electrode. The positive and negative plates are rolled together and placed in the case, with the divider preventing them from shorting. This "jelly-roll" configuration enables the NiCd cell to produce far more current than a comparable-sized alkaline battery. One of the examples of secondary batteries is lithium-ion battery which is going to be used in this project.

2.4.1.3 Difference between primary and secondary batteries

Primary cells cannot be recharged and must be discarded once their useful life expires, but secondary cells must be replenished when the charge runs out. Both forms of batteries are widely employed in a variety of gadgets, and these cells vary in size and material composition.

Table 2.1 Difference between primary and secondary cell

Primary cell	Secondary cell
Have a high energy density, a modest discharge rate, and are simple to utilise	They have a reduced energy density.
Because the cells contain no fluid, they are often referred to as dry cells.	There are two types of wet cells: flooded and liquid cells, as well as molten salt cells (liquid cells with different composition)
Its internal resistance is rather substantial.	It has a low coefficient of internal resistance.
It is a chemical compound that undergoes an irreversible chemical reaction.	It undergoes a chemical process that is reversible.
Its design is more compact and lightweight.	Its design is more intricate and substantial.
It has small initial cost.	Its initial investment is substantial.

2.4.1.4 Lithium-Ion

Sony commercialised the Li-ion battery in the early 1990s. Li-ions are added and removed from the negative and positive electrodes, respectively, during charging. Additionally, when charging, Li^+ is deintercalated from the cathode oxide complex and incorporated into the anode's lattice. Cathodes have a high potential but a low Li state, while anodes have a low potential but a high Li state. During discharge, the procedure is reversed.

In comparison to other kinds of batteries, Li-ion batteries have a high energy density (due to the high output voltage), great efficiency, a long cycle life, and are

environmentally friendly. These desirable characteristics have resulted in Li-ion batteries being prevalent in portable gadgets such as smartphones and power banks [11].

2.4.1.5 Lithium-Ion Polymer

Rather of using a liquid electrolyte, the lithium-ion polymer battery utilises a high conductivity semisolid (gel) polymer electrolyte. The voltage of a battery cell is determined by the chemical composition of the electrode materials. Lithium–metal–oxide (LiCoO₂) cells have a completely discharged voltage of 2.5–2.8 V and a fully charged voltage of 4.2 V, while lithium–iron–phosphate (LiFePO₄) cells have a fully drained voltage of 1.8–2.0 V and a fully charged voltage of 3.6–3.8 V. Lithium polymer batteries have a greater specific energy than lithium-ion batteries. The polymer electrolyte provides a more stable performance for the lithium polymer battery when subjected to vibration. These two characteristics have aided in the development of lithium polymer batteries for use in electric vehicle applications [12].

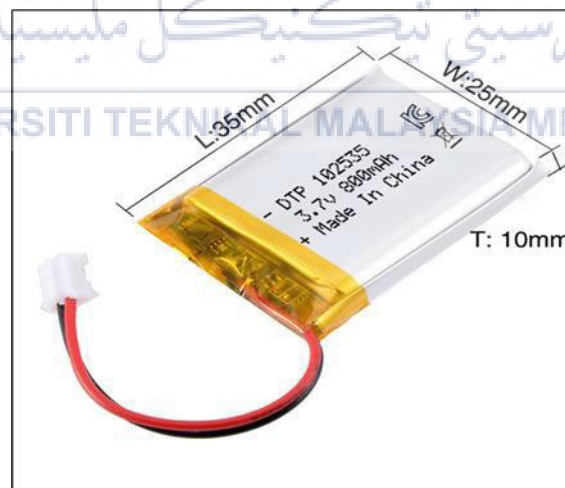


Figure 2.11 Example of lithium-ion polymer

2.4.1.6 Battery 12V

As their name suggests, 12V 7Ah batteries feature a nominal voltage of 12V and a nominal (20h) capacity of 7Ah. Most 12V 7Ah batteries are sealed, maintenance-free Absorbent Glass Mat (AGM) although there are several Gel-Cell lead-acid batteries on the market, most are lead-acid or Lithium Iron Phosphate (LiFePO₄) batteries. Most cost-effective for high-power applications when weight is unimportant [13].

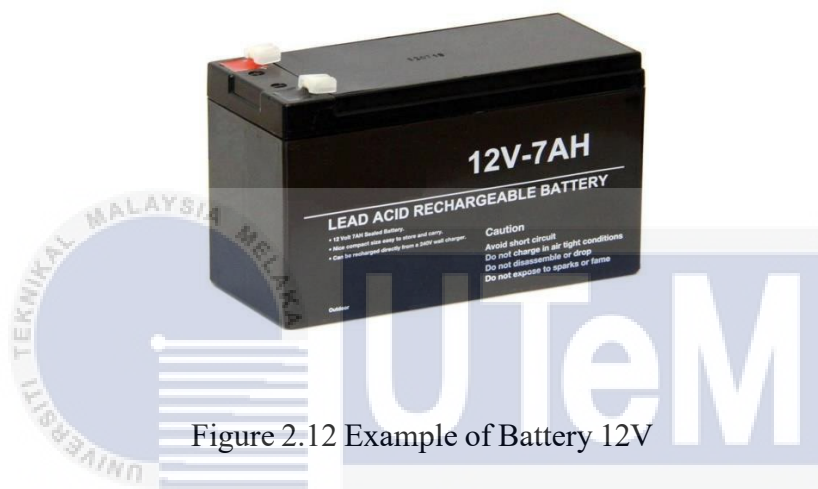


Figure 2.12 Example of Battery 12V

2.4.1.7 System charging the battery

The Sun is a big source of energy that emits electromagnetic radiation. Depending on the wavelength of the created radiations, they may be classified as light, radio waves, or other forms of radiation. In the earth's atmosphere, just a minute fraction of the sun's rays is visible. Using this visible light, solar cells make electrons. Various solar cells use distinct light wavelengths.

Solar cells, which generate energy, are composed of semiconducting materials like silicon. A stream of tiny particles known as electrons transports electricity as an electric current. When sunlight hits a solar cell, silicon captures the electrons, which then flow through the n and p layers to generate electric current before departing the cell through the metal contact.



Figure 2.13 Example of equipment that use

A solar charger circuit connects a rechargeable battery with a capacity of 2500 mAh to a solar panel. The battery will charge whenever sunshine is available. In the absence of solar charging, the device's battery life is roughly $2500 / 0.78 = 3205.12$ h or 133 days [13]. There is no need for human charging or power supply wire near the mailbox since it features recharging circuitry to charge the battery from a solar panel.

2.5 PV Solar efficiency

Efficiency is the most often used metric for comparing the performance of two solar cells. As a rule of thumb, an efficient solar cell produces more electricity than it consumes. The solar cell's efficiency is affected by the spectrum and intensity of sunlight, as well as the cell temperature. It is necessary to standardize the assessment criteria in order to compare the efficacy of various technologies. In pv solar system efficiency as followed can be calculated of as example below,

$$\eta = \frac{P_m}{(G * A_c)}$$

Maximum power, P_m in watt = (10 watt) (1)

Irradiance, $G = 1643 \text{ kW}$ (2)

(input light in watt/m²) (average value in Malaysia 1643 kWh m⁻²)

A_c = surface area of solar cell in m² (0.350 * 0.24)

Efficiency = $10 \text{ Watt} \div (1643 \text{ kwh} \times 0.001428)$ (3)

Answer = 34.537mW (4)

The efficiency of a solar cell is affected by the temperature because of the inherent characteristics of the semiconductor material. Solar panels become more efficient when the temperature is lower and less efficient when the temperature is higher because the voltage between the cells lowers at high temperatures.

2.6 Summary

In summary electrical fencing in the business sector has a significant economic effect on utilities, making its assessment, appraisal, and reduction crucial. Improving the economic effectiveness of electric power systems, such as those that employ renewable energy by using solar panels as a source of power, would benefit from the accurate estimation of electrical fences in our systems. Problematically, precise and detailed energy flow analysis for an electrical fence requires substantial equipment like inverters and load data, as well as rigorous calculating work. Next, our system utilizes a 12V battery for storage and it is rechargeable. None of the existing material conclusively establishes that IOT can be used in an electrical fence system. Consequently, utilizing the IoT and the Blynk app, we can monitor our house with ease. Our primary objective is lower utility expenses and increase security against intruders and wild animals. In addition, it is often desired that the approach be efficient, realistically feasible, resource-light, and capable of producing relatively accurate findings. Due to these issues, there is currently no system that can be monitored via IoT.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the methodologies and methods used for this project. Methodology is a set of guidelines that must be followed to finish a project. This chapter will walk you through the whole project from start to finish. This chapter will offer a detailed description of each procedural step to facilitate comprehension. To ensure the project's effective completion, the plan must be properly adhered to. In addition, this chapter would describe the project's schedule and methodology. The project plan and schedule will include the duration of each activity in addition to the necessary tasks. This is required to ensure the on-time completion of the project.



3.2 Diagram of the project methodology

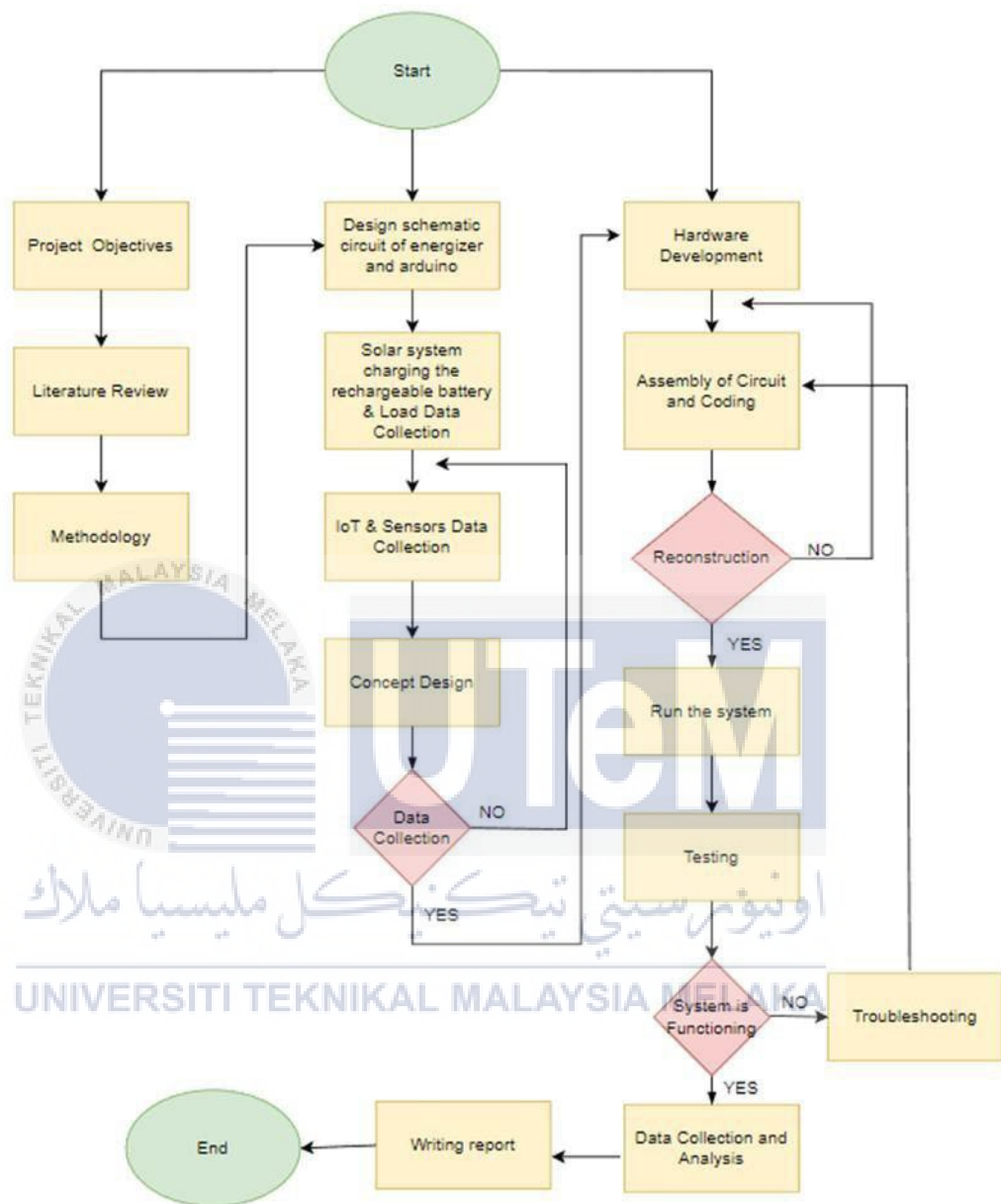


Figure 3.1 Project methodology flowchart

By referring the figure 3.1 flowchart, it is organized into many segments to help with project development, the first of which is about project documentation. This section will go through the theoretical portion of the project, which is crucial in ensuring that the project is completed correctly.

The following step is to research the associated elements and software that will be employed in this project. In this section, appropriate components, and software for completing the project were picked. In terms of software, the Arduino is used to code. The Arduino is simpler to use than other programming packages. Because it can read input signals and convert them to output signals, it may be used in situations when the sensor detects an obstruction in the path.

Proteus Software is used for circuit design, and the code is uploaded to the Arduino in Proteus Software to check for flaws or functionality. This is because, before the hardware component is completed, it must be simulated to ensure that there will be no issues. Once these sections are error-free, the hardware design process will commence. This is the most important part since it must reflect the final shape and look of the project.

AutoCAD was used to produce the design for this hardware component. It is only when all of the pieces have been finished that the project's last component, testing, may be completed. There are a number of things that this component checks, including whether or not hardware is linked to each other, whether or not code is correct, and whether or not the project is working as expected. An examination of the data output as well as the project's success will be performed if there are no issues to be discovered during the execution phase.

3.3 Project methodology

AutoCAD was used to produce the design for this hardware component. The final element of after all the elements have been finished, the project is the last step in the overall process. Here, you'll find information on how each piece of hardware is connected to each other, as well as how to troubleshoot any issues that may arise. Assuming there aren't any issues, an analysis will be performed to document the results, the project's progress, and every step along the way.

3.3.1 Project development process flow

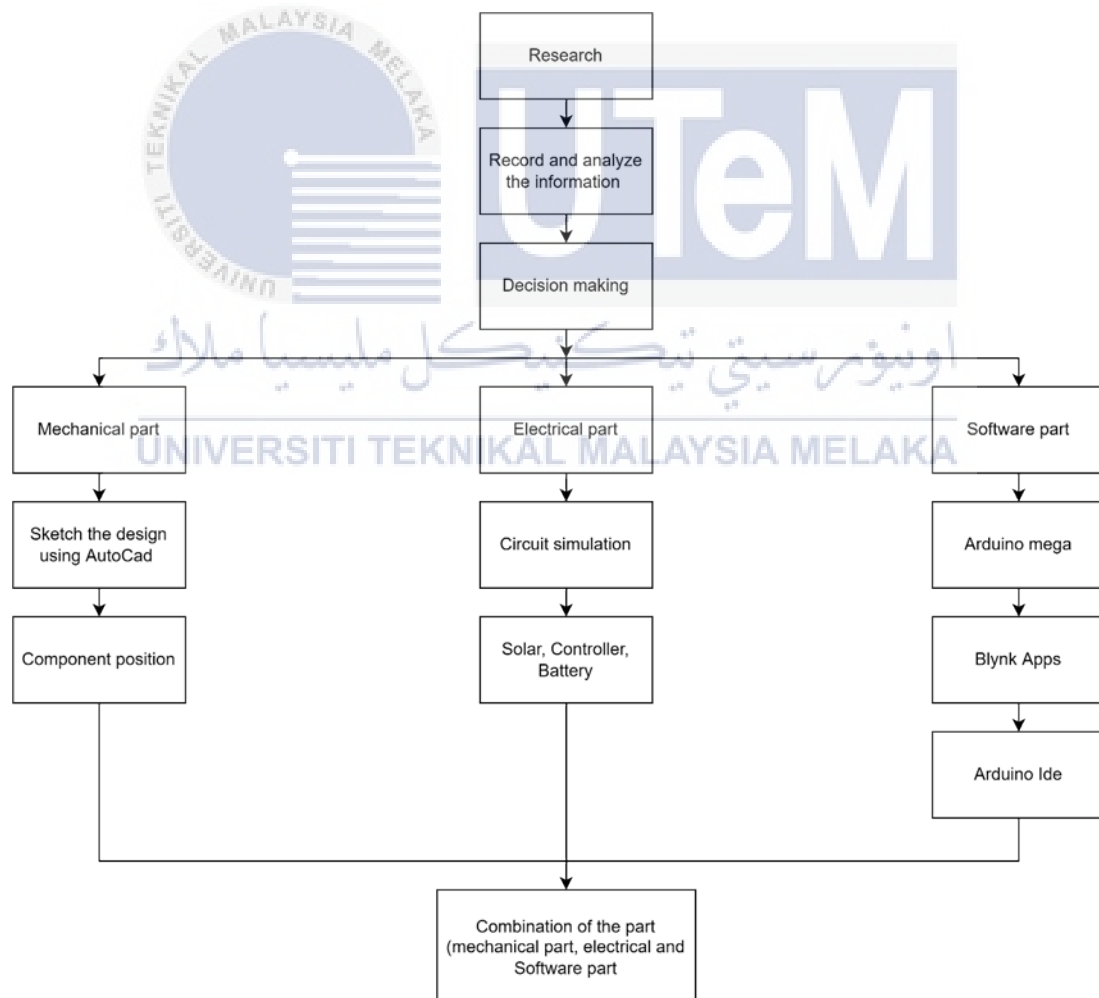


Figure 3.2 Process flow of project

3.4 Stage 1: Project Research Planning

On this stage, the element that needs to be to solve the problem indicated in the problem statement by designing a smart systematic system for gardeners for increase high security level with less energy consumption.

3.5 Stage 2: Development of the Project System Operation

General system functionality has been figured out at this point, consisting of a charger controller and a rechargeable battery. This charger controller will be placed between the solar panel and the battery to provide the electrical energy. The Esp32 microcontroller is used to monitor and sense our smart electrical fence in this project as well.

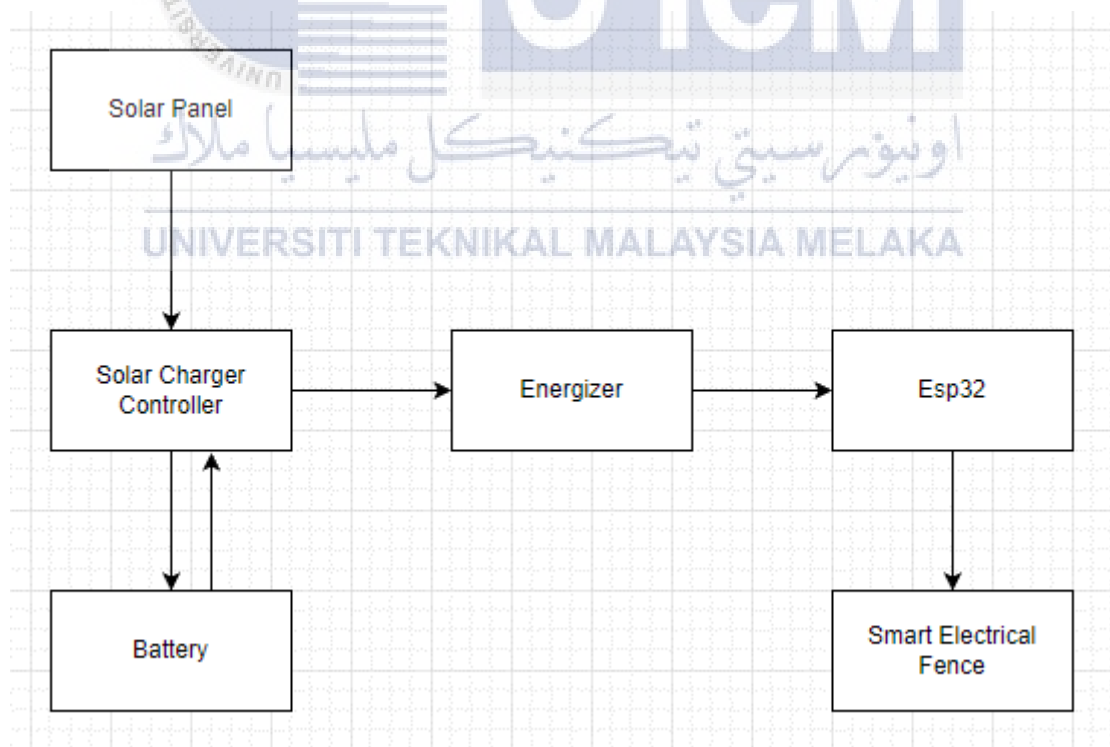


Figure 3.3 Block diagram of project

3.6 Stage 3: Project Determination

This stage is where the appropriate component, program coding, hardware, and mechanical design to be apply in this project prototype. This project consist of three section which is designing the mechanical part like the smart electrical fence structure, electrical system and software design.

3.7 Electronic Design

Electrical design is the process of putting into action the simulated circuits and item type selected for the project. The Proteus software and the Arduino are used to create or design the project circuit for simulation and programming.

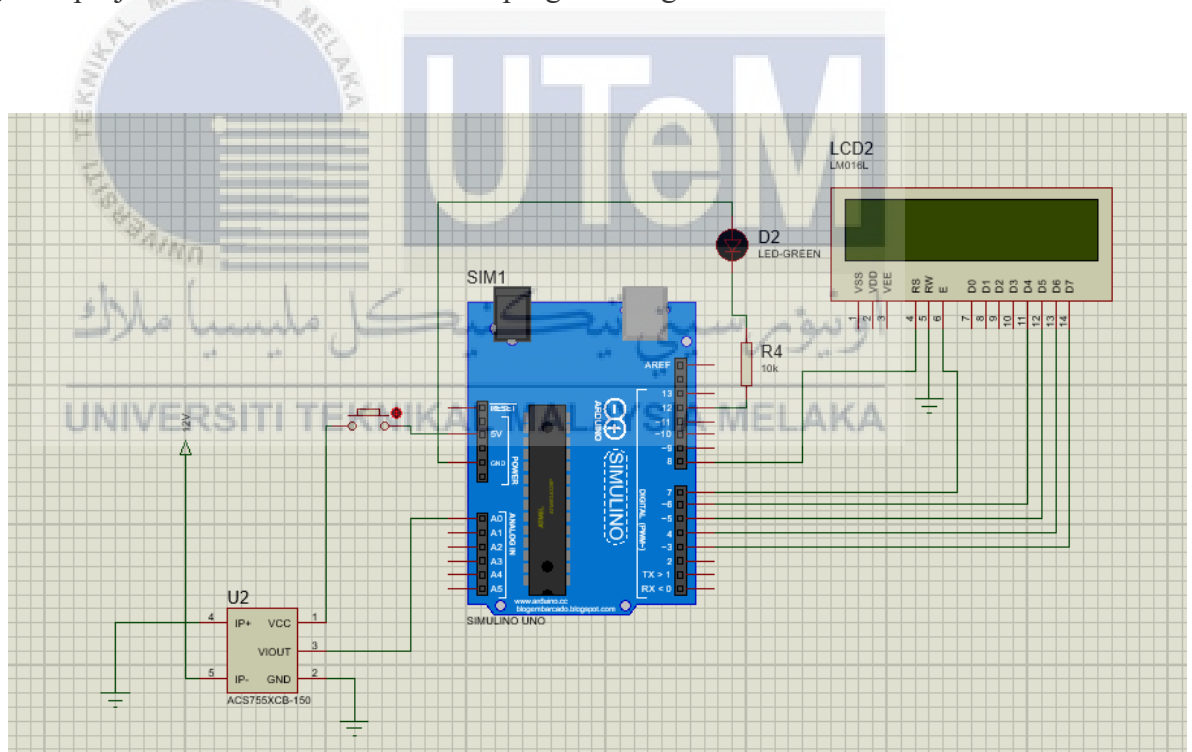


Figure 3.4 Arduino circuit of project

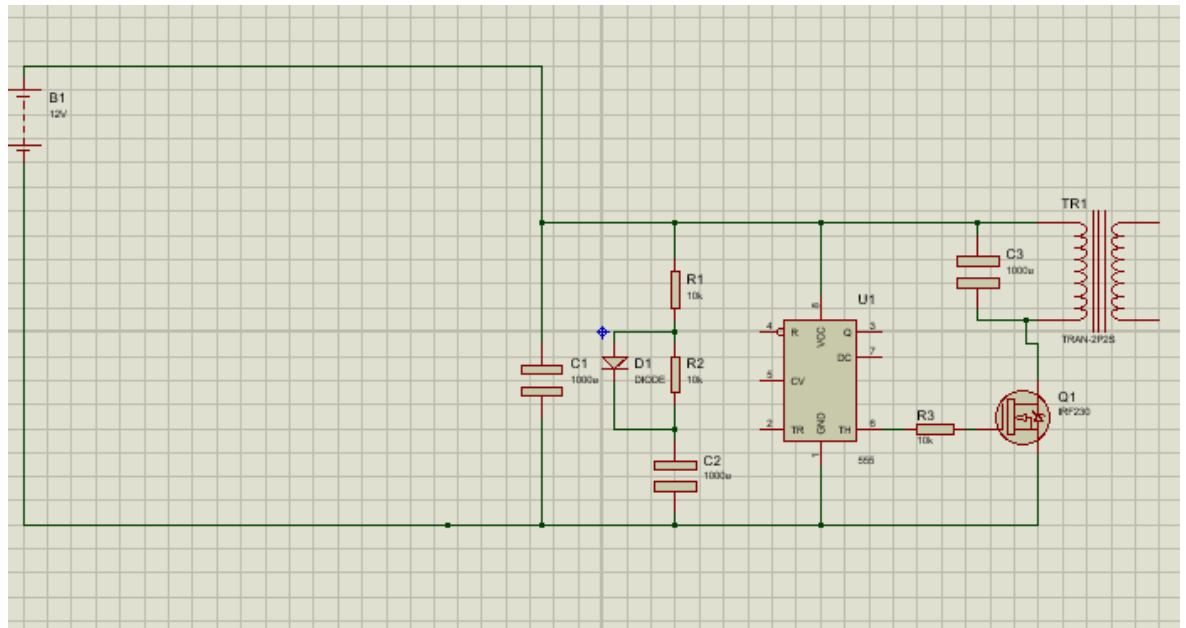


Figure 3.5 Schematic circuit for energizer

```

File Edit Sketch Tools Help
ESP32 Dev Module

sketch_dec18a.ino
1 #include <LiquidCrystal_I2C.h>
2 #define ANALOG_IN_PIN 32
3
4 #define BLYNK_PRINT Serial
5
6 //define BLYNK_TEMPLATE_ID "TMPLnAqE9Sg"
7 //define BLYNK_DEVICE_NAME "Quickstart Device"
8 //define BLYNK_AUTH_TOKEN "qcqqg0mix76hf_yGAI3VyoxvPTDy69NV"
9 #define BLYNK_TEMPLATE_ID "TMPLaangbpNL"
10 #define BLYNK_DEVICE_NAME "Quickstart Device"
11 #define BLYNK_AUTH_TOKEN "ThmtSz2LynKtM62aUBfCbFkMKPX-V6Fs"
12
13
14
15
16 #include <WiFi.h>
17 #include <WiFiClient.h>
18 #include <BlynkSimpleEsp32.h>
19
20 char auth[] = BLYNK_AUTH_TOKEN;
21
22 // Your WiFi credentials.
23 // Set password to "" for open networks.
24 char ssid[] = "ASH666";
25 char pass[] = "Ashraf12";
26
27 WidgetLED led1(V1);
28
29 BlynkTimer timer;A
30
31 int lcdColumns = 16;
32 int lcdRows = 4;
33
34 int relay1 = 18;
35 int relay2 = 19;
36 int gate = 34;
37
38 float adc_voltage = 0.0;
39 float in_voltage = 0.0;
40
41 float R1 = 30000.0;
42 float R2 = 7500.0;
43
44 float ref_voltage = 5.0;
45

```

Figure 3.6 Example coding

3.8 Stage 4 Complete Project Integrations

After the mechanical design, electrical design, and software design stages for the Smart electrical fence monitored and sensing system, the creation of comprehensive project integration begins. An actual project prototype will be used in the project's performance, with all the components and program code built and implanted in it. To achieve the project's objectives, every project will be constantly tested and reworked throughout this period.

3.8.1 Component list

3.8.1.1 Solar panel



Figure 3.7 Example of solar panel

Solar panels collect sunlight and convert it into electricity, which may then be used to power electrical loads. Each solar cell consists of layers of silicon, phosphorous (which imparts a negative charge), and boron. Solar panels are comprised of a number of solar cells (which provides the positive charge). Solar panels collect photons and convert them into an electric current.

When photons contact the surface of a solar panel, the resulting energy pushes electrons out of their atomic orbits and into the electric field generated by the solar cells, which then draws these freed electrons into a directed current.

3.8.1.2 Solar charger controller



Figure 3.8 Example solar charger controller

The charge controller is designed to prevent any 12-volt Gels or Flooded batteries from being overcharged by solar panels. There's also a built-in safeguard to prevent a reverse battery hookup. This controller displays the recharging rate or battery voltage on the LCD metre. The charge controller is built to endure a long time and save money on electricity costs. There is a constant change in the over-discharge voltage due to the battery draining rate curve.

3.8.1.3 Battery 12v 7Ah



Figure 3.9 Example of Battery 12v 7Ah

A common 12-volt battery seen in cable systems and home security systems, the 12v 7Ah is a high-capacity 12-volt battery. A number of choices, such as safety and backup power systems, may benefit from its tiny size. The external shell is made of ABS plastic to minimize spills and leaks. When needed, the battery can provide powerful currents and has a long lifespan thanks to its construction using Absorption Glass Mat Technology. This battery may be fully recharged in as little as four hours using the proper solar charging technique, and it will last for far over three years.

3.8.1.4 Esp 32 Microcontroller

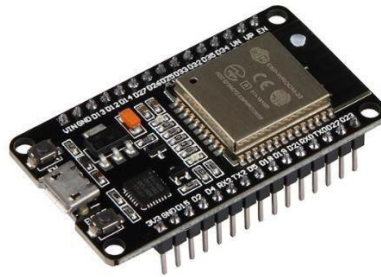


Figure 3.10 Example of Esp32

IoT, smart electrical fence and embedded technologies are all fast evolving at the moment. This has a lot to do with the evolution of hardware modules and CPUs. On development boards, a communication interface, and peripherals, as well as the main CPU processor, are incorporated. The ESP32 chip is getting increasingly popular, and there are already several hardware modifications and software development streams for it. A large community of developers, as well as researchers, are working on using the ESP32 chip as the successor to the ESP8266 microcontroller. A microcontroller may be used with a variety of environmental monitoring sensors, whether they are used to monitor air pollution or to directly detect LPG leaks. Smart home applications, automation, wearables, audio applications, cloud based IoT applications, and more may all benefit from ESP32 prototype boards. A specific development kit or a custom embedded system based on the ESP32 microcontroller can be created. The Arduino platform is the simplest method to get started writing code for the ESP32 platform. The ESP32 is a low-cost, low-power system-on-a-chip microcontroller that has built-in Wi Fi and dual-mode Bluetooth. The ESP32 series contains built-in antenna switches, RF baluns, power amplifiers, low-noise receive amplifiers, filters, and power-management modules, as well as a Tensilica Xtensa LX6 CPU in dual-core and single-core versions. Furthermore, with all the element provide esp32 can monitored all the function of smart electrical fence thru online by Blynks apps.

3.8.1.5 Energizer AC and DC



Figure 3.11 Example of Energizer

The Energizer for electrical fence and it can be power up by Alternating current (AC) or Direct Current (DC). The energizer can control the pulse duration control (0.75S ~ 1.30S). Voltage Indicator also has been displayed. It is Suitable for 3-4 arce farm use with 3 lines of wire. Solar energy is compatible for the energizer. Hence, it can electrify your fence with solar power by connecting solar panels to battery that powering Energizer. The solar panels charge the battery and provide sustainable livestock control. Specifications Input Voltage 12 V / 100 - 240 V KE A05 Distance powers (Max): 5 km Distance powers (Max): 3 Hectare Output Voltage: 8KV ~ 12KV *Using Galvanize / Aluminium Alloy wire. Maximum stored energy 0.8 J Maximum output energy 0.5 J.

3.8.1.6 Lcd Display

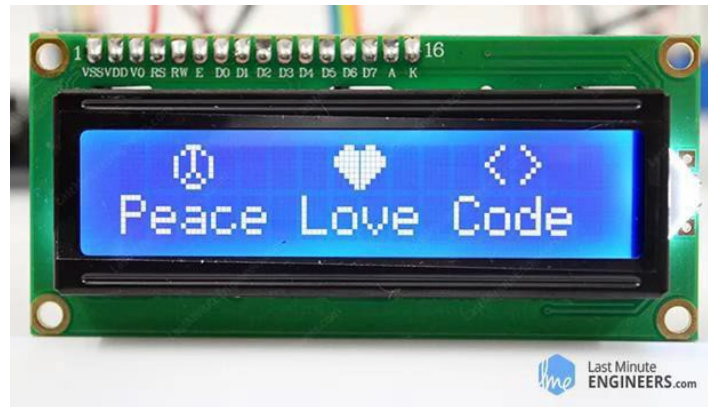


Figure 3.12 Example of LCD display

The Liquid Crystal library enables the manipulation of LCD screens compatible with the Hitachi HD44780 driver. There are plenty available, and you can often identify them by their 16-pin interface. LCD 16x2 is a 16-pin device with two rows of 16-character capacity each. LCD 16x2 may operate in either 4-bit or 8-bit mode. Additionally, it is possible to generate unique characters. It includes eight data lines and three control lines for control purposes.

3.8.1.7 Step down Dc to Dc



Figure 3.13 Example of Step down

DC-DC step-down converters essentially take a higher input voltage and convert it to a lower output voltage by rapidly switching the output power transistor on and off so that the output basically looks like a square wave, and then using an LC filter to smooth it back into a DC voltage on the output.

3.8.1.8 Voltage sensor



Figure 3.14 Example of voltage sensor

A voltage sensor is a device that measures and computes an object's voltage. Voltage sensors can distinguish between AC and DC voltage. Input to the sensor is voltage, and outputs are switches, analogue voltage signal, current signal, or audio signal. Sensors are electronic or optical devices capable of detecting, identifying, and reacting to certain electrical or optical signals. Voltage sensor and current sensor approaches have shown to be a superior alternative to conventional ways of measuring voltage and current.

3.8.1.9 Basic component

Table 3.1 List of Basic Component

No	Component	Function
1.	Resistor	Just enough biasing is supplied to critical active components, such as transistors and ICs, so that the current is restricted.
2.	Capacitor	Electrostatic energy storage in an electric field and supply to the circuit whenever possible.
3	Photocoupler	A photocoupler is a gadget that combines a photodetector and a light-emitting diode (LED) into one unit. Light is not emitted outside of the container, in contrast to other optical devices. The exterior resembles that of solid state relays and non-isolators. A photocoupler is an optical device, however it deals with electrical impulses rather than light.
4.	Diode	A diode is a device that only permits current to flow in one direction.
5.	Push Buttons	Tactile buttons may be accessed by opening the tactile buttons. When pressed, a circuit is activated or a connection is made. Whenever it is pressed, the circuit is connected and disconnected. The SCR is activated by pressing the button on the gate terminal.
6.	12V-24VDC Relay	The relay's primary job is to balance the supply and turn off battery power. The EV-Relay stops a capacitor, motor, or harness from failing instantly from a short circuit. Additionally, when an instant rapid stop happens, it safeguards against reverse regen current.

3.9 Software

The software that will be used in developing this project is Blynk for monitoring and controlling purposes and AUTOCAD to demonstrate the model of smart electrical fence prototype.

3.9.1 Blynk

This project will use Blynk App since it is used to produce a graphical user interface (GUI) or human machine interface (HMI) by compiling and providing the relevant widget address. It can remotely control hardware, display sensor data, save data, and render it visually. Blynk is compatible with several platforms, including IOS and Android, making it perfect for this project since users can remotely operate and monitor the prototype using their mobile devices.



Figure 3.15 Blynk App

3.9.2 Arduino Ide



Figure 3.16 Arduino Ide

The Arduino IDE is a free and open-source software platform for creating and uploading code to Arduino boards. The IDE developed may be useful to users of Microsoft, Os X, and Linux. The C and C++ programming languages are supported. An Development Environment (IDE) is what the term IDE stands for in this context.



CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Introduction

Improving the electrical fence with a monitoring system's performance. The project is completed successfully after being designed, created, and integrated. Several times during the day, the system is monitored, and only a few fence breaches are attempted. The performance is evaluated in accordance with maximum productivity using solar charging and system accuracy.

4.2 Hardware design for Smart Electrical Fence

The mechanical design is the project's design. This Smart Electrical Fence project requires a well-designed layout. The size dimension of this mailbox is 36cm L x 29cm W x 22cm H and for the junction box the size dimension is 16cm L x 9cm W x 20cm H and for the solar panel size dimension 37cm L x 24cm W. Figure 4.1 show smart electrical fence, 4.2 show battery box and 4.3 show junction box.



Figure 4.1 Smart Electrical Fence



Figure 4.2 Battery and Energizer Box

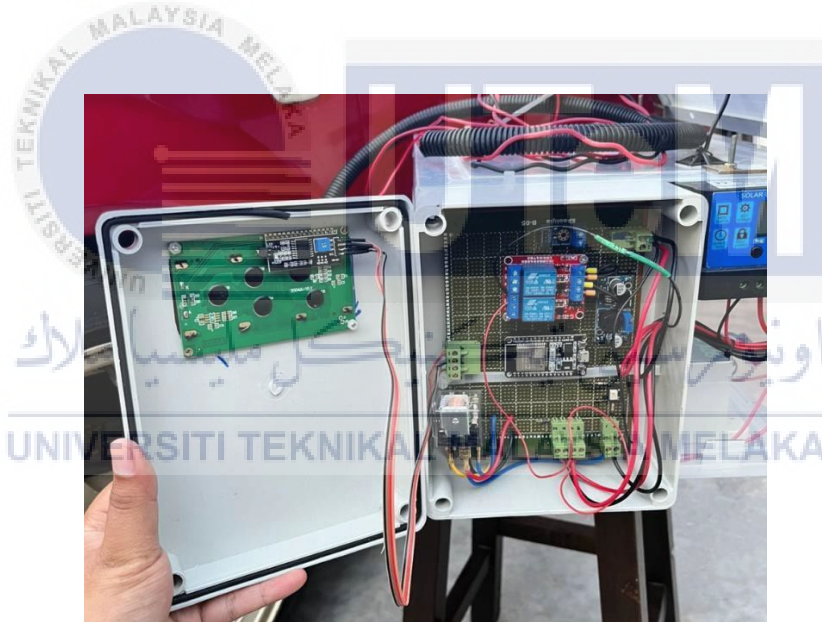


Figure 4.3 PN Junction Box

4.3 Software design

The smart electrical fence designed for this project consists mainly of Microcontroller ESP32, voltage sensor, and stepdown dc to dc. The coding and program are uploaded to NodeMcu Esp32 via usb cable from Arduino IDE. Besides, The ESP32 WIFI Module acts as wireless connectivity between the smart electrical fence and the system.

4.3.1 Arduino Instructions Programming

This project made use of the Arduino IDE software. In general, the Arduino IDE software is an open source, C and C++ based programming language that is available in most operating systems. Understanding a C++-based language is essential to modify programming instruction. An Esp32 is used as the system microcontroller in this project.

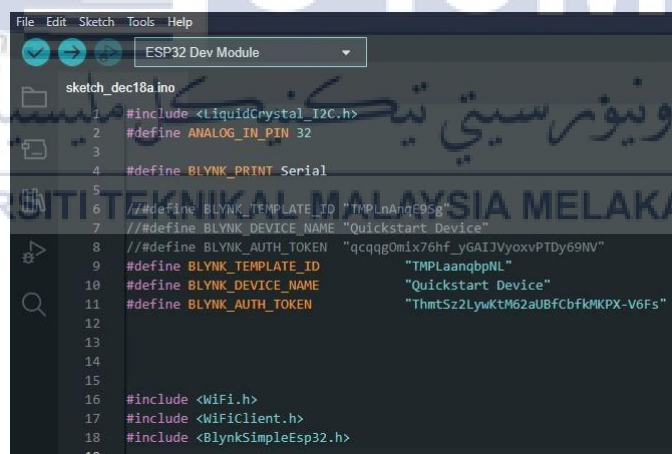


Figure 4.4 List Of Libraries

4.3.2 Arduino Instructions Programming for Esp32 connected to WIFI

```
13
14
15
16 #include <WiFi.h>
17 #include <WiFiClient.h>
18 #include <BlynkSimpleEsp32.h>
19
20 char auth[] = BLYNK_AUTH_TOKEN;
21
22 // Your WiFi credentials.
23 // Set password to "" for open networks.
24 char ssid[] = "ASH666";
25 char pass[] = "Ashraf12";
26
```

Figure 4.5 Program for connecting Wi-Fi

Figure above show the Wi-Fi connection setup for Esp32. After turn on the Esp32 to the supply it will automatically connect to the Wi-Fi because the password and the username of the Wi-Fi already been added to the program.

4.3.3 Blynk Application

In this project, the data and notifications can be monitored from the smart electrical fence with the Blynk application. This smartphone app displays all the monitoring system as shown figure 4.5.

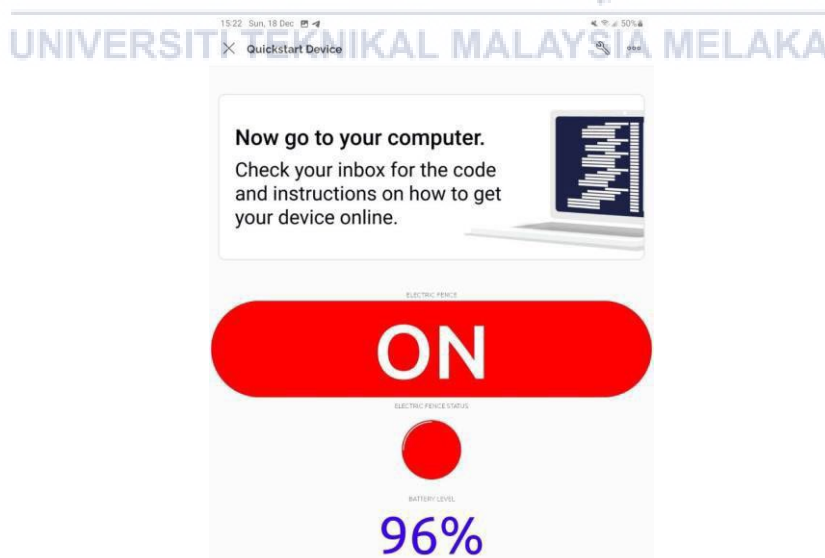


Figure 4.6 Monitoring system by Blynk application

4.4 Table collecting Data

To achieve the target that have been set in the objectives, an observation table 4.1 and 4.2 have been formed to investigate the performance of smart electrical fence. The table will determine the and gives the actual result in comparing the usage of smart electrical fence by using conventional (AC) between solar charging (DC). The manipulating variable would be the duration of smart electrical fence breach (SEC).

4.5 Result

In development of smart electrical fence, a data is required to investigate and determine the solar efficiency can apply into the concept of system. Hence, can perform as expected in conserving the usage of battery. A raw input data is recorded to evaluate the power of solar to optimize the usage of battery in practicing of smart electrical fence at farm. The result for the field test will be improved due to inefficient in data management and disturbance occurred during the field test. Figure 4.7 shows the variety of the attempt by owner and unfamiliar person achieved.



Figure 4.7 Attempt by owner and unfamiliar person

4.5.1 Monitoring System Efficiency Result

The scanning accuracy for Blynk app was tested by doing 5 scan attempts. Every time the Smart electrical fence has been breach an indicator would change the colour which is meant that electrical fence has been breach. The test was done by the owner of the smart electrical fence as well as an outsider not familiar with the concept. The results can be seen in the table below. Some of the failure which is because of the poor internet connection and miss grounding.

Table 4.1 Data obtained for monitoring system

Number Of Attempt	Response Time of Monitoring System Testing By Owner (s)		Comment	Response Time of Monitoring System Testing By Unfamiliar Person (s)		Comment
	Online	Offline		Online	Offline	
1.	2.30	3.10	Success	1.88	2.00	Success
2.	1.68	N/A	Error due miss grounding	1.94	2.15	Success
3.	1.98	2.20	Success	N/A	2.00	Lost connection due to poor internet
4.	1.56	1.98	Success	1.79	1.98	Success
5.	N/A	2.01	Lost connection due to poor internet	2.23	N/A	Error due miss grounding

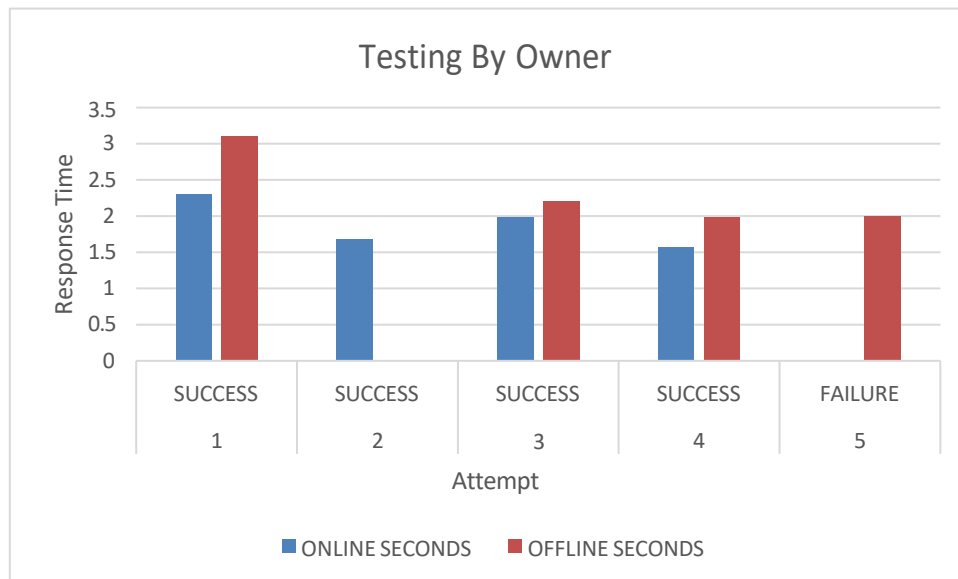


Figure 4.8 Graph for attempt by owner

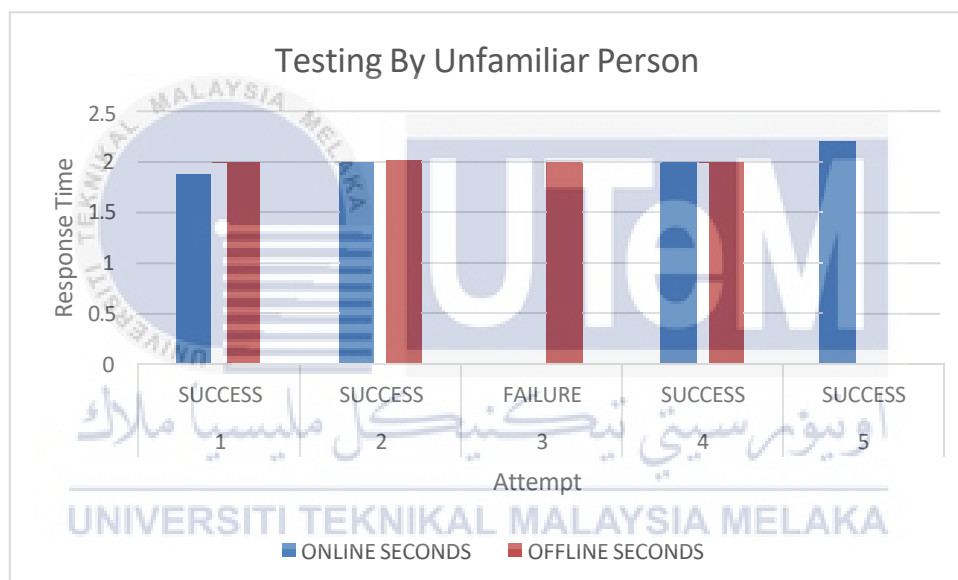


Figure 4.9 Graph for attempt by unfamiliar person

The results shown above were reached after multiple attempts by both the project's owner and a stranger. Both able to complete cutting the fence in order to receive the output from the monitoring system. Based on these findings, it can be concluded that the Blynks App's monitoring system efficiency ratios are superior to those of conventional systems. The monitoring system can operate both online and offline, so if the online session fails, it can still be observed using hardware that is offline. Additionally, it proves that an electrical fence can use a monitoring system.

4.5.2 Solar Efficiency Result

Table 4.2 Data obtained for solar efficiency

SOLAR PANEL POSITION : 75°					
PLACE : Taman Tasik Utama, Melaka					
DATE :23/12/2022					
CONDITION: Cloudy					
MEASUREMENT DATA					
TIME	RADIANCE (kwh)	TEMPERATURE (° C)	VOLTAGE (V)	CURRENT (A)	POWER (W)
8.00 a.m.	111	25	14.60	0.03	0.438
9.00 a.m.	182	25	15.10	0.04	0.604
10.00 a.m.	279	26	15.40	0.03	0.462
11.00 a.m.	550	29	15.70	0.03	0.471
12.00 p.m.	550	29	15.70	0.40	6.28
1.00 p.m.	725	30	15.90	0.46	7.014
2.00 p.m.	914	31	15.20	0.47	7.144
3.00 p.m.	899	31	15.20	0.43	6.536
4.00 p.m.	715	30	14.80	0.07	1.036
5.00 p.m.	700	30	14.75	0.05	0.738
6.00 p.m.	490	29	15.28	0.03	0.458

STEP 1: Calculate the maximum power

Maximum power, P_m in watt = (10wh)

STEP 2: Calculate the surface area of solar cell in m²

Length \times Height \times Width = Surface Area

$$0.350 \times 0.24 \times 0.017 = 0.001428$$

STEP 3: Calculate the solar efficiency

$$\text{Formula Solar Efficiency} = \text{Efficiency} = \frac{\text{Maximum power}}{\text{Irradiance} \times \text{Surface area of solar}}$$

$$n = \frac{10}{1643 \times 0.001428}$$

Answer = 5.45 %

Based on the calculation above, it is recommended to use solar as renewable energy because suit with the system and could also reduce some energy usage in using a battery as the power supply. Due to that the usage of battery can be rechargeable by solar. Table 4.2 shows that the irradiance reached 914 kwh which is the highest value obtained during the testing. However, research states that the average irradiance value that can be measured in Malaysia is 1647 kwh which is high compared to the measurement. This is due to the rainy and cloudy weather nowadays that affected the measured irradiance value to be lower.

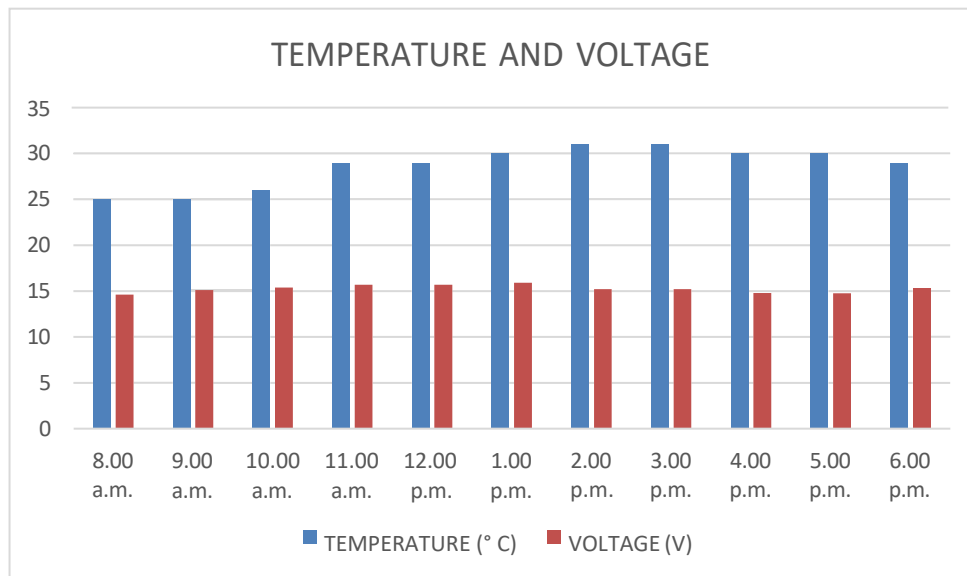


Figure 4.10 Graph for voltage (V)

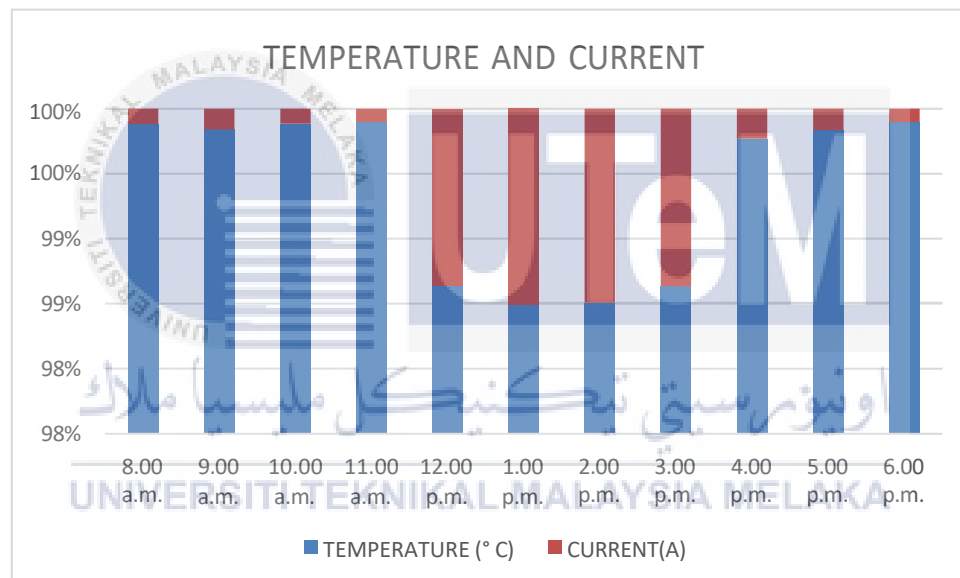


Figure 4.11 Graph for Ampere (A)

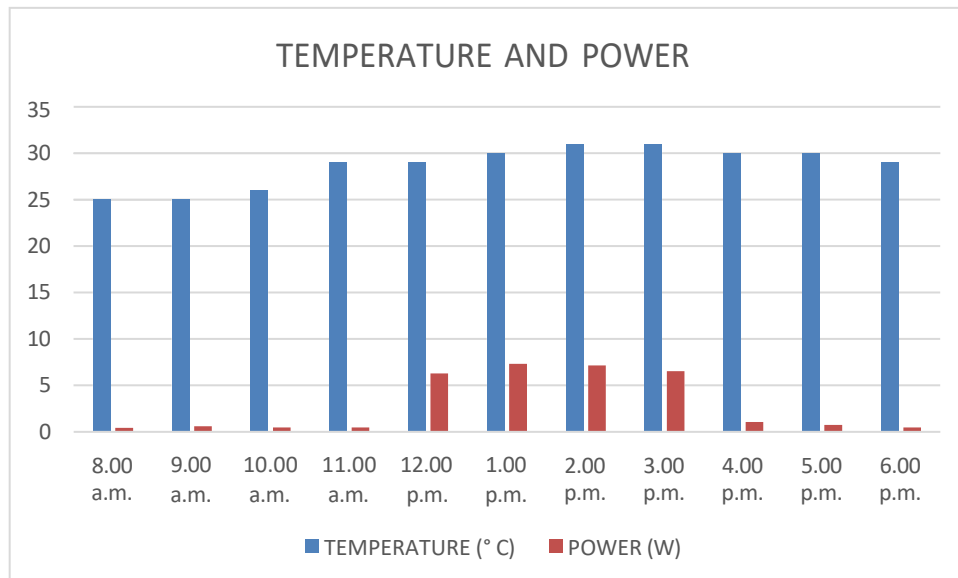


Figure 4.12 Graph for Power

Based on the overall results from the graph above, it is proved that the solar system method is capable to reduce the usage of electricity in performing electrical fence at farm. In table 4.2, the amount of wattage that manage to be conserved from using electricity.

4.6 Summary

The purposes of the project were accomplished, the methodology proposed was applied successfully with the proteus simulation. Hence, because of the production project still in process there is no analysis that have been made plus in the terms of built a coding, there is a part for considered at least the project can operate.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

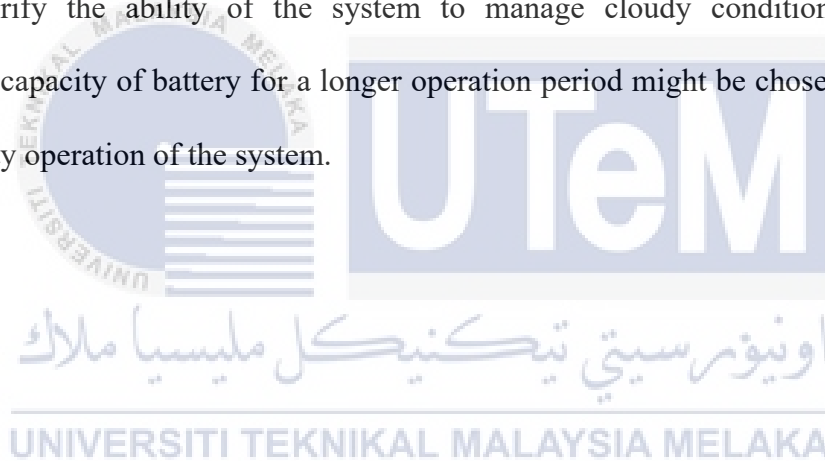
5.1 CONCLUSION

As a conclusion, this project has been successfully developing a smart electrical fence that have a systematic monitoring system features that allows the user to easily monitored thru online and offline which considered suitable to install in the farm area. The combination of electrical and electronic components allows the framework to work as expected and a few adjustments have been made to improve the structure of the smart electrical fence. The medium and compact size will give the opportunity for the user to set it up by using as minimum as one manpower. A simple assembling process requires only less than five minutes for a full assembly process. The process of dismantle is required only less than eight minutes as it is equipped with detachable component.

Next, the development of the smart electrical fence has given a significant impact in security of farm. It is observed that the system can be successfully monitored through online by Blynks app. Based on the objectives that have been set which is to analyze the efficiency of the monitoring system and solar battery charging are successfully done by obtaining various type of data during the test. The results proved that the average of voltage and current capable to charge the battery to ensure the system continuously function. Furthermore, the system is equipped by two-way real time communication which is the owner of smart electrical fence can turn on and turn off the system through IoT application. This shows that by implementing monitoring system can increase the security level rather than using conventional method which is only power up the electrical fence without any support system.

5.2 FUTURE RECOMMENDATION

The smart electrical fence is still uncommon, as they believe that using conventional AC is easier than solar PV. Hence, the result shows that the performance can be greatly improved by using solar. Besides that, with the low-cost PV panel, this work have successful achieved its objectives. However, in a commercial basis, cost effectiveness and proposed device reliability could be explored and further analyzed in future. Therefore, for this intended model, higher grade poly crystalline material-based PV panel can also be used, and a material-based analysis can be made between all systems. Observation for a long-term field service may help to estimate the efficiency of the device. There is also a need to verify the ability of the system to manage cloudy conditions. Lastly, the appropriate capacity of battery for a longer operation period might be chosen to ensure the sustainability operation of the system.



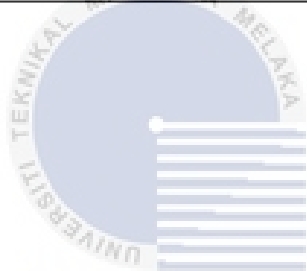
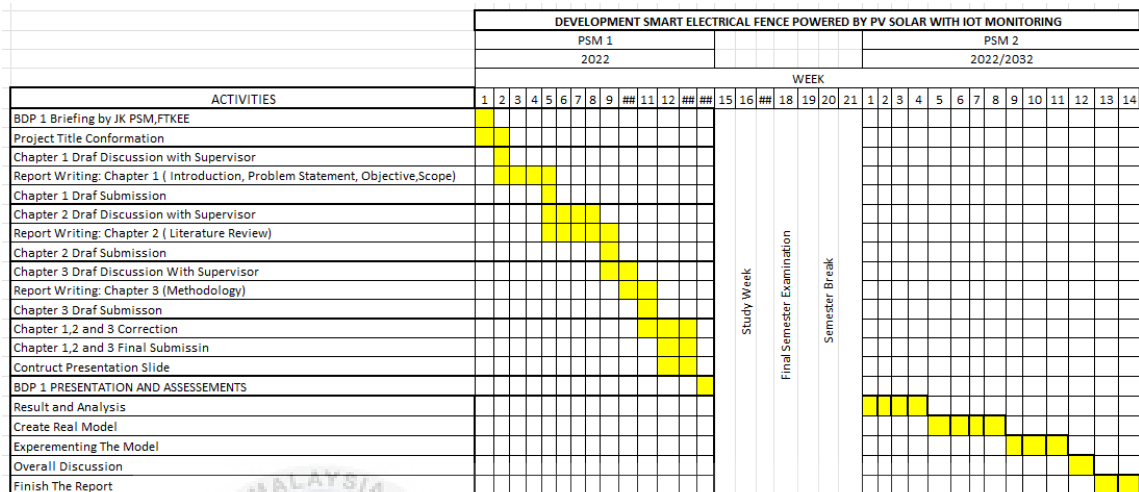
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APPENDICES

Appendix A Gantt Chart



UTeM

اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Appendix B Measuring Equipment

