Faculty of Electrical and Electronic Engineering Technology

A DEVELOPMENT OF VEHICLE DETECTION AUTOMATIC STREET LIGHT WITH SOLAR PANEL

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Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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A DEVELOPMENT OF VEHICLE DETECTION AUTOMATIC STREET LIGHT WITH SOLAR PANEL

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this project report entitled “A DEVELOPMENT OF VEHICLE DETECTION AUTOMATIC STREET LIGHT WITH SOLAR PANEL” 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 : MUHAMMAD FAIZ BIN AHMAD ZOHRI

Date : 25 JANUARI 2023

APPROVAL

I approve that this Bachelor Degree Project 1 (PSM1) report entitled "Development of Vehicle Detection Automatic Street Light with Solar Panel" is sufficient for submission.

Signature :

Supervisor Name : EN MOHD YUNOS BIN ALI

Date : 10/02/2023

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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Date : ....

DEDICATION

To my beloved mother, SUZZANA BINTI MD SAAD, and father, DR. AHMAD ZOHRI BIN ISHAK,
and to my team member, Muhammad Akhmal Syafi (Co-Sv Dr. Cong), Muhammad Syukri Suliaman, Muhamad Taufiq MD Isa and Muhammad Haziq Kharil Azri.

ABSTRACT

Tenaga National Berhad (TNB) provides a large source of electricity for the existing Automatic Street Lights. This street lighting system also only lights up when it is turned on. Furthermore, the available Automatic Street Lights only emit light regardless of how much light is used. To solve this problem, the solar system, which is a renewable energy source, has been used to replace TNB’s electricity consumption and save energy. LCD parameters are also stored in the electrical storage system to ensure that electricity consumption is always in line with the amount of energy used. The LDR sensor is also used as an on/off switch to control the light of the Automatic Street Light. The use of IR sensors to detect vehicle movement that control the brightness of the light helps reduce electricity consumption. When the car passes through the study area, the power of the light is 100%, and when the vehicle passes, the brightness is reduced stay at dim condition. The IR sensor position also will be analysis to ensure the system will operate smoothly. As a result, the efficiency of solar panels can be seen in a variety of ways, from light sources to direct current power sources. Solar panel capacity and battery capacity were also studied to accommodate the entire system to operate throughout the day. The streetlight also be monitor using smartphone based on the IoT concept. The system code will be written using Arduino software that has been learned and further simplifies the analysis process.

ABSTRAK

Tenaga National Berhad (TNB) menyediakan sumber elektrik yang besar untuk Lampu Jalan Automatik yang sedia ada dan hanya tertumpu di kawasan bandar. Sistem lampu jalan ini juga hanya menyala apabila ia dihidupkan. Tambahan pula, Lampu Jalan Automatik yang ada hanya memancarkan cahaya tanpa mengira berapa banyak cahaya yang digunakan. Untuk menyelesaikan masalah ini, sistem solar, yang merupakan sumber tenaga boleh diperbaharui, telah digunakan untuk menggantikan penggunaan elektrik TNB dan menjimatkan penggunaan elektrik yang tidak perlu. Selain itu, dengan penggunaan sistem solar dapat menyediakan lampu jalan di kawasan luar bandar. Parameter LCD juga digunakan dalam sistem penyimpanan elektrik untuk memastikan penggunaan elektrik sentiasa selaras dengan jumlah tenaga yang digunakan. Sensor LDR juga digunakan sebagai suis hidup/mati untuk mengawal cahaya Lampu Jalan Automatik. Penggunaan sensor IR untuk mengesan pergerakan kenderaan yang mengawal kecerahan cahaya membantu mengurangkan penggunaan elektrik. Apabila kereta melalui kawasan kajian, kuasa cahaya adalah 100%, dan apabila kenderaan itu lalu, kecerahan berkurangan kekal dalam keadaan malap. Kedudukan sensor IR juga akan menjadi analisis untuk memastikan sistem akan beroperasi dengan lancar. Hasilnya, kecekapan panel solar boleh dilihat dalam pelbagai cara, daripada sumber cahaya kepada sumber kuasa arus terus. Kapasiti panel solar dan kapasiti bateri turut dikaji untuk menampung keseluruhan sistem beroperasi sepanjang hari. Lampu jalan boleh dipantau menggunakan telefon pintar berdasarkan konsep IoT. Kod sistem akan ditulis menggunakan perisian Arduino yang telah dipelajari dan memudahkan lagi proses analisis.

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First and foremost, I would like to express my gratitude to my supervisor, En Mohd Yunos Bin Ali for their precious guidance, words of wisdom and patient throughout this project.

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LIST OF SYMBOLS

℃	-	Degree Celcius
I	-	Current
P	-	Power
S	-	Speed
%	-	Percentage

LIST OF ABBREVIATIONS

V	-	Voltage
TNB	-	Tenaga National Berhad
IR	-	Infrared
LDR	-	Light Dependent Resistor
Ni-Cd	-	Nickel Cadmium
UPS	-	Uninterruptible Power Supply
PWM	-	Pulse Width Modulation)
MPPT	-	Maximum Power Point Tracking
HPS	-	High Pressure Sodium Lamp
LED	-	Light-Emitting Diode
GSM	-	Global System for Mobile communication
LED	-	Light-Emitting Diode
LCD	-	Liquid crystal display
OLED	-	Organic Light-Emitting Diode
UART	-	Universal Asynchronous Receiver-Transmitter
Hz	-	Hertz
ICSP	-	In-Circuit Serial Programming
USB	-	Universal Serial Bus
PV	-	Photovoltaic
A	-	Ampere
DC	-	Direct Current
AC	-	Alternating Current
Km/h	-	Kilometer per hour

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CHAPTER 1

INTRODUCTION

1.1 Background

Malaysia's technological advancements are growing more advanced, as evidenced by the introduction of solar systems, which have been seen to have a favourable impact on the people in addition to allowing the sun's energy to be used to generate electricity. The same might be said about rural areas with only dark roads, but technical advancements and a skilled labour have transformed the situation. This rural area now has power, and the streets have begun to be lit at night with street lights.

Tenaga Nasional Berhad (TNB) is solely responsible for the operation of street lights, which are always turned on to their maximum capacity during the night to provide lighting in these rural areas. The usage of electric energy in this developing area, however, has its own set of drawbacks. With the development of technologies such as solar, an advantage in the natural generation of electric energy can be gained without changes the operation of existing street light systems, and can help to mitigate the negative effects that exist in the previous system.

The upgrading of solar-powered street lighting systems, as well as other technology connectivity such as sensors and the use of the most modern types of lighting, allows for more cost-effective, efficient, and practical operation of street lighting systems in rural areas with lower night time activity rates than in urban areas.

1.2 Problem Statement

In Malaysia, street lights are installed on almost every road to provide lighting at night. However, there are still rural regions without street lights due to a variety of circumstances, including the fact that the area is located in a hilly terrain and at the far end of the district, which limits the distribution of electricity from Tenaga Nasional Berhad (TNB).

Furthermore, the operation of street lights in rural area faces the issue of wasted electricity consumption. Because there is no adequate lighting regulation in this remote location, street lights always operate and consume the most electricity at night, despite the fact that there are no road users.

Additionally, the sort of use of fluorescent street lights that demands excessive consumption of electrical energy to light up gloomy places is still in use. This is one of the disadvantages of using ancient street lights over the various types of contemporary lights available on the market that more efficient.

As a result, the usage of solar systems is to solve the problem of supplying electrical energy from TNB. This solar system is further supplemented by a battery, which serves as a storage facility for electricity used at night. Lighting control systems are also included to determine how much lighting is required in specific regions. To combat the problem of excessive usage of electric energy, the type of street lighting used is also taken into consideration. As a result of these modifications, a more effective street lighting system will be created, as well as shared benefits for citizens living outside of the city who are affected by rapid technological advancement.

1.3 Project Objective

The purpose of this study is to give a methodical and its functional approach to advancement. The precise objectives are as follows:

1) To develop automatic street lighting with Internet of Things (IoT).
2) To provide an alternative source by using solar energy to generate electricity for the street lighting system.
3) To analyze the efficiency of the streetlight by implementing different kind of DC light.

1.4 Scope of Project

The following are the project scopes that required to be addressed and concentrated on during the completion of this project:

a) Design a small prototype of street lighting.

b) Using Arduino to build source code.

c) Find the best position for IR sensor.

d) Calculate the capacity of battery storage that want to use.

e) Comparison the performance between type of DC light

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The literature and previous research on the Auto Street Light system, as well as how the issue is addressed, are discussed in this chapter. All of these sources help and underpin the experimental design and analysis. Various techniques for improving the Auto Street Light are offered based on prior investigations. A quick review at the end of the chapter aids in defining the approaches to be used during the project.

2.2 Previous Project Research

Based on the literature review, which can be summarised as research and finding information relating to my project using current resources such as the internet, books, journals, and other sources. To begin, an understanding of the project is possible.

2.2.1 Type of Solar Power System

Solar energy is a renewable energy source that is abundant in nature. There are several ways to generate power, such as by burning fossil fuels, however all of these methods have significant environmental consequences.

This paper focuses on the several methods of solar power generating. To begin, it discusses how solar panels convert solar energy into electrical energy during their operation. P-type and n-type semiconductors are used to make solar cells.

The main three types of solar power systems that can create electricity are also discussed in this study. On-grid solar, off-grid solar, and hybrid solar are all options.[1]

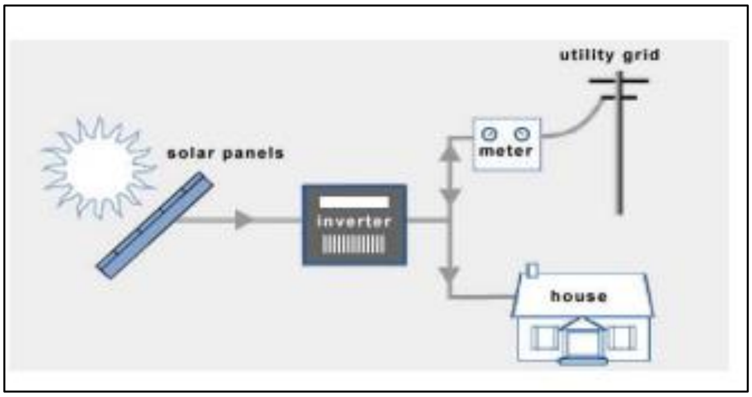


Figure 2.1 : ON- Grid Solar

ON-GRID SOLAR: An on-grid solar system, also known as grid-tie or grid feed solar, is made up of solar panels, inverters, metres, and the power/utility grid. The power generated by solar cells is direct current.

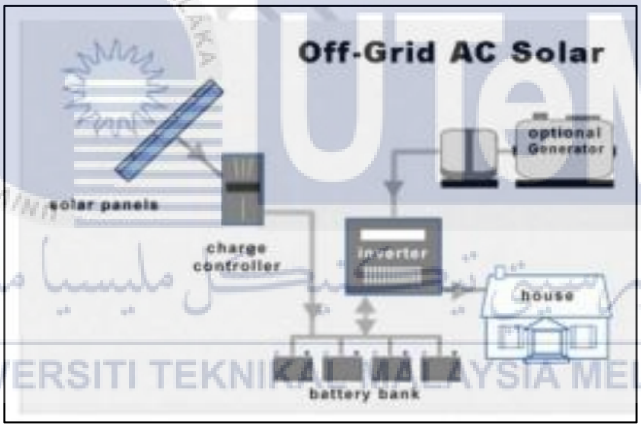


Figure 2.2 : OFF-Grid Solar

OFF-GRID SOLAR: Instead of being connected to the energy grid, off-grid solar power systems, also known as stand-alone power systems, use battery storage. Solar power that is used off the grid uses very little grid electricity. It comprises of a solar cell, an inverter, and a battery bank, with a generator as backup power if necessary. Off-grid solar power system operation: Solar cells convert sunlight into energy, which is then converted into alternating current using an inverter.

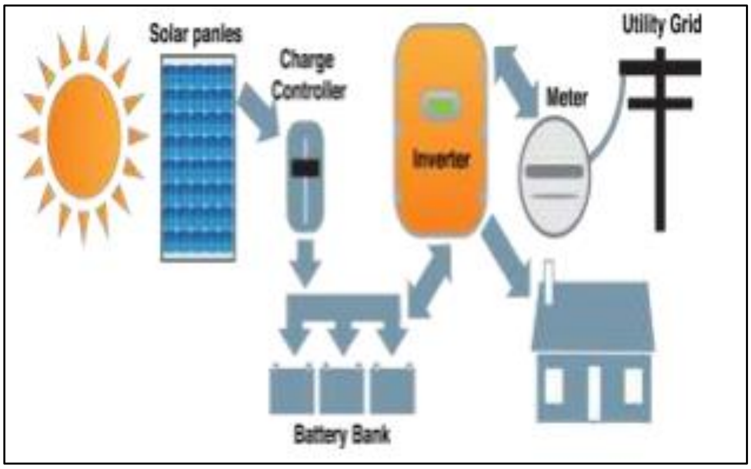


Figure 2.3 : Hybrid Solar

HYBRID SOLAR: Hybrid solar combines on-grid and off-grid solar power systems. This approach is simple to use and saves money on electricity because it stores energy in batteries for use at any time without drawing power from the grid. Excess power is fed back into the energy system in the same way that on-grid solar is. Power can be extracted from the batteries when neither solar energy nor the electricity grid are available. When the battery backup is exhausted and solar power is unavailable, an uninterrupted supply of electricity from the grid can be obtained, allowing the battery to be charged.

2.2.2 Table of comparison between the type of Solar system

Table 2.1 : Comparison between the type of Solar system

Criteria	**On-Grid Solar**	**Off-Grid Solar**	**Hybrid Solar**
Utility Grid	Connected	Independent	Connected and can work independent
Suitable place	Urban and Rural Area	Rural Area	Urban and Rural Area
Battery Storage	Not required	Depends on load requirement	Depends on load requirement
Payback Period	Short	Long	Longest
Price	Least expensive	Expensive	Very Expensive

2.2.3 Types of Solar Panels: Pros and Cons

Monocrystalline solar panels, polycrystalline solar panels, and thin-film solar panels are the three main types of commercially accessible solar panels. In this website, its discuss about each type of solar panel that has its own set of benefits and drawbacks. From the table, it show that the Monocrystalline are suitble with the project because of the efficiency of the panel about 24.4% compare the other panel.[2]

Pros and Cons of the Three Major Types of Solar Panels			
	Monocrystalline Solar Panels	Polycrystalline Solar Panels	Thin-Film Solar Panels
Material	Pure silicon	Silicon crystals melted together	A variety of materials
Efficiency	24.4%	19.9%	18.9%
Cost	Moderate	Least expensive	Most expensive
Life Span	Longest	Moderate	Shortest
Manufacturing Carbon Footprint	38.1 g CO2-eq/kWh	27.2 g CO2-eq/kWh	As little as 21.4 g CO2-eq/kWh, depending on type

Figure 2.4 : Pros and Cons of Solar Panel

2.2.4 Types of Solar Batteries

Each of these batteries has benefits and drawbacks in terms of energy storage capacity, efficiency, maintenance, cost, and durability. Solar batteries are different from regular batteries since they are designed for use in solar systems. While each battery type must fulfil certain safety and reliability standards in order to be marketed, sold, and installed in different categories, such as residential, industrial, and commercial, there is minimal standardisation of specs and features between these batteries.[3] There are four main varieties of solar storage batteries that are in use:

a) **Nickel Cadmium (Ni-Cd) Batteries**

Figure 2.5 : Ni-Cd Batteries

This battery technology has been around for almost a century, making it a tried-and-true storage option. Ni-Cd is less costly and has a greater specific energy than lead-acid batteries when compared to newer battery types. They are the most dependable alternatives for generator start-up and uninterruptible power supply. Ni-Cd batteries have been on the decrease for two reasons: they are not fully drained before being recharged, causing the battery to lose capacity, and they are exceedingly hazardous to the environment.

b) **Lead–Acid Batteries**

Figure 2.6 : Lead -Acid Batteries

Lead-acid batteries have a low energy density when compared to current rechargeable batteries. Lead-acid batteries are one of the oldest rechargeable battery technologies, with applications ranging from small-scale storage, such as UPS systems, lights, and automotive ignition power, to large/grid-scale power system storage.

c) **Lithium-Ion Solar Batteries**

Figure 2.7 : Lithium-Ion Solar Batteries

As a consequence of technological improvements, lithium-ion batteries have become one of the most widely used solar batteries in the modern era. Due to their temperature endurance and environmental safety, they are popular and in great demand among today's age.

d) **Flow Batteries**

Figure 2.8 : Flow Batteries

Flow batteries are anticipated to grow increasingly popular in the next years because they are water-based and do not contain any hazardous metals.

2.2.5 Table of comparison of each Solar battery type

Table 2.2 : Comparison of each Solar battery type

Solar Battery	Depth of Discharge	Efficiency	Lifespan	Price
Nickel Cadmium	around - 90%	70%-85%	1,000-2,000 cycles	less expensive compared to other
Lead–Acid	30%-50%	50%-85%	500-1,200 cycles	less expensive
Lithium-Ion Solar	80% to 95%	80%-90%	500-2,000 cycles	expensive
Flow Batteries	almost 100%	75-80%	unlimited cycle life	expensive

2.2.6 Solar Charge Controllers using MPPT and PWM

Figure 2.9 : PWM and MPPT Charge Controllers

The solar charge controller's primary function is to keep the amount of charge flowing into the battery bank from the solar PV module constant in order to prevent the batteries from becoming overcharged. PWM (pulse width modulation) and MPPT (maximum power point tracking) controllers are the most prevalent charge controllers presently. Both systems are widely used in the off-grid solar business and provide effective battery charging. It's used to control current and voltage when they're too high.[4]

	PWM Charge Controller	MPPT Charge Controller
Array Voltage	PV array & battery voltages should match	PV array voltage can be higher than battery voltage
Battery Voltage	Operates at battery voltage so it performs well in warm temperatures and when the battery is almost full	Operates above battery voltage so it is can provide "boost" in cold temperatures and when the battery is low.
System Size	Typically recommended for use in smaller systems where MPPT benefits are minimal	≈ 150W – 200W or higher to take advantage of MPPT benefits
Off-Grid or Grid-Tie	Must use off-grid PV modules typically with Vmp ≈ 17 to 18 Volts for every 12V nominal battery voltage	Enables the use of lower cost/grid-tie PV Modules helping bring down the overall PV system cost
Array Sizing Method	PV array sized in Amps (based on current produced when PV array is operating at battery voltage)	PV array sized in Watts (based on the Controller Max. Charging Current x Battery Voltage)

Figure 2.10 : Comparison PWM Solar Charge Controller and MPPT Solar Charge Controller

2.2.7 Lighting Technology Comparison

The varieties of street lights have now been upgraded to provide more efficient usage, thanks to quick technological advancements. The sorts of lighting utilised have been described in further depth using internet sources. [5]Below the table of comparison among those type of lamp.

Table 2.3 : Comparison Lighting Technology Comparison

Light Technology	**Life time**	**Colour temperature**	**Dimming Control**	**Ignition time**	**Cost of operation**	**Cost of Installation**
incandescent lamp	1k-5k	2.8k	excellent	instant	Very high	Low
mercury vapor lamp	12k-24k	4k	Not possible	2 – 6 min	Moderate	Moderate
metal halide lamp	10k – 15k	3k-4.3k	Not practical	5 – 10 min	Low	High
high pressure	12k-24k	2k	Not practical	2 – 6 min	High	High

sodium lamp (HPS)						
low pressure sodium lights	10k-18k	1.8k	Not practical	2 – 5 min	High	High
fluorescent lamps	10k-20k	2.7k-6.2k	good	2 – 5 min	moderate	moderate
compact fluorescent lamp	8k – 20k	2.7k – 6.5k	Not possible	1 – 5 min	moderate	moderate
induction light	60k – 100k	2.7k – 6.5k	Not possible	instant	Very Low	High
LED light	50k – 100k	3.2k – 6.4k	excellent	instant	Very low	High

2.2.8 Street Light Control with GSM Technology

This project uses an electromagnetically driven switch to turn on and off the lights at the appropriate moments by using the saturation and cut off areas of a transistor.

GSM-based street light automation refers to the use of a GSM module to control street light automation. Its purpose is to improve street lighting's night time performance and efficiency. This module's main function is to gather or record data and transfer it to the main server.

It consists of a microprocessor that switches on/off the street light based on time delays and sends an update to the designated phone number through a phone. LEDs are also used to indicate whether street lights are on or off, and they are controlled by a timer and a sensor module with two sensors, an IR sensor and an LDR sensor, which allow the system to monitor sun light intensity, day/night conditions, road traffic, and detect item movement.[6]

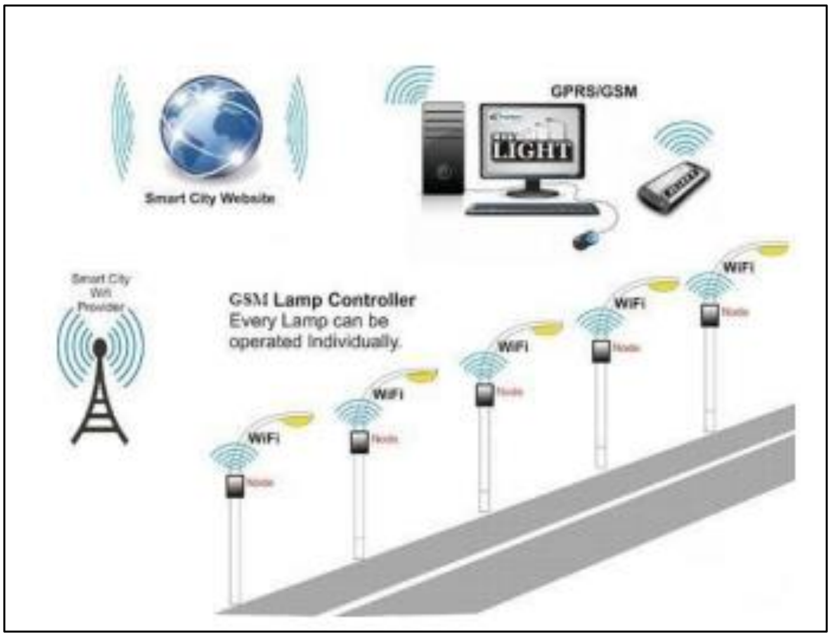


Figure 2.11 : The System of Street light controller with wireless technology

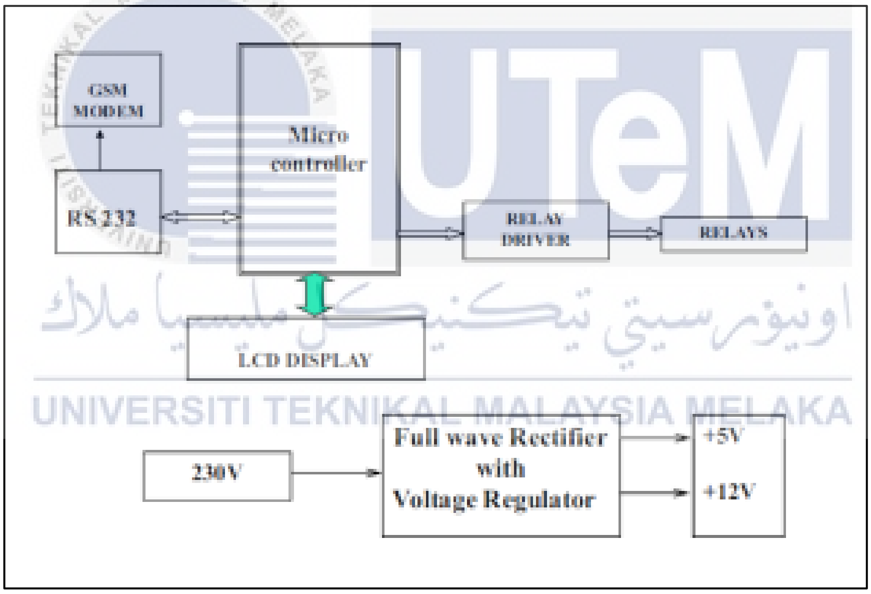


Figure 2.12 : The Block Diagram of Street light controller with wireless technology

2.2.9 Intelligent Street Light System for Smart Cities

Solar panels, are used to provide energy to the entire power in the system. The system includes an Arduino Uno that is programmed to consider both LDR and IR inputs simultaneously. One disadvantage of this approach is that the street light's ON and OFF times are fixed. During the certain time, the system switches to dimmer mode, which is inconvenient for late-night users

The movement of people and objects is detected using an infrared sensor. A dimming control circuit was created based on the IR sensor's output. The system also uses the Arduino Uno as the main controller because it easier to design and write the code. The system can be used in one of three different modes. When the LDR is exposed to sunlight, the entire system is turned off. When LDR is in the dark, the system turns on and the lights illuminate dimly. When the IR sensor detects the presence of things, the lights brighten to their maximum brightness.[7]

Mode 1: The LDR is exposed to sunshine.

This option instructs the controller to turn off all street lights.

Mode 2: LDR is in the dark, and the lights are dimly lit.

In this mode, the suggested controller turns on all of the low-intensity street lights.

Mode 3: When the IR sensor detects any things, the lights glow brightly.

In this mode, the suggested controller turns on all street lights with high intensity for those whose sensors detect a vehicle and leaves the others on low intensity.

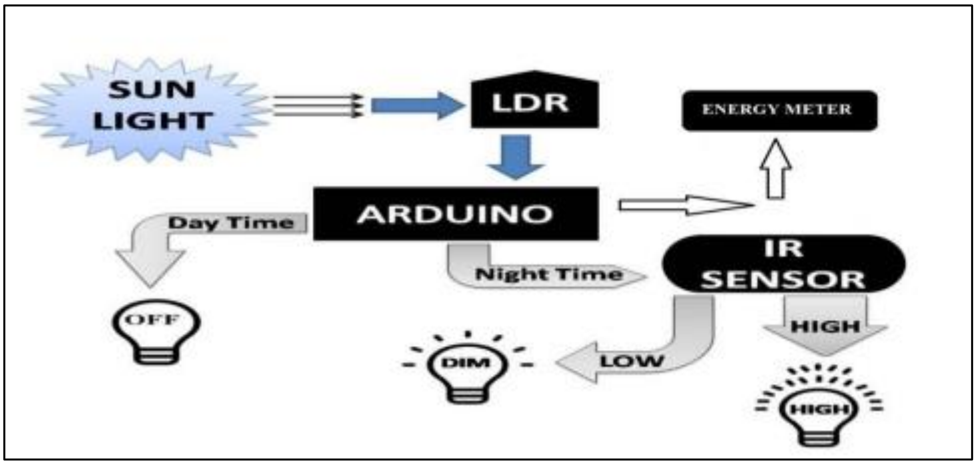


Figure 2.13 : The System design of Intelligent Street Light System for Smart Cities

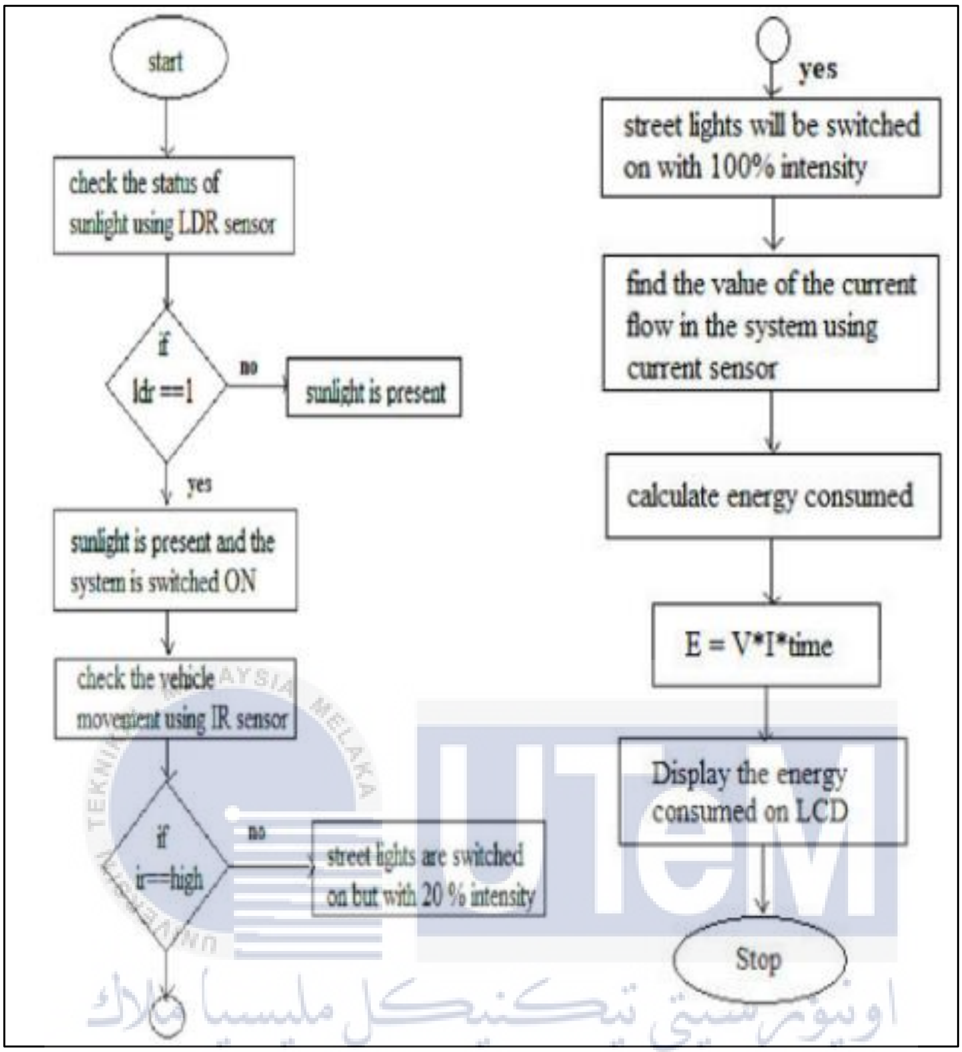


Figure 2.14 : The Flow chart of Control Method of Intelligent Street Light System for Smart Cities

2.2.10 Table of comparison between using GSM and without GSM at rural area

Table 2.4 : Comparison between using GSM and without GSM at rural area

TYPE	GSM	Without GSM
CIRCUIT	Complex	Simple
COST	Expensive	Cheap
NETWORK	Using Internet	Standalone
MAINTENANCE	Hard	Easy

2.2.11 Solar panel power calculation

Before to choose the size or the number of solar panel, the power of load need to calculate first to ensure the solar panel can generate energy based on the load needed. With the formula below, the power can be calculate manually before start construct the circuit.[8]

Power = Average load wattage x hours per day x 1.5

- Power = total power needed
- Load wattage = amount of electricity uses
- Hours per day = the amount of time want to use the solar panel

2.2.12 Battery Sizing Calculation

When employing a solar system, batteries are one of the most critical components. Calculations must be performed in order to store and use the electricity generated by the solar panels on a daily basis.[9] Below the calculation for battery capacity:

$$\text{Battery Capacity (Ah)} = \frac{\text{Total Watt-hours per day used by appliances}}{(0.85 \times 0.6 \times \text{nominal battery voltage})} \times \text{Days of autonomy}$$

Figure 2.15 : Battery Sizing Calculation

2.2.13 Speed Limit According to Road Type

According to the National Speed Limit Order of 1989, the maximum speed on highways is 110 km/h, while the limit on other routes is 90 km/h. In rural areas, the speed limit is 110 km/h on motorways or tolled routes. Depending on the type of development along the roadside of urban motorways, the speed limit might range from 90 km/h to 80 km/h. The speed limit in high-density and less-clear zones is 80 km/h.

Federal and state roads are the other categories of roadways, both of which are toll-free. Federal roads are those that connect Malaysia's states and the majority of the nation's major cities. Federal roads and state roads each have a speed restriction of 90 km/h and 80 km/h, respectively. In town, the posted speed limit is 60 km/h. The speed restriction in school zones is substantially lower, at 30 km/h. The permitted speed in residential zones is 40 or 50 km/h.[10], [11]

2.3 Summary

According to studies, Arduino is a basic key microcontroller that may be used to operate a system. Furthermore, the off-grid system is a viable option for executing this project since it can run on its own with the aid of batteries, which are used to store electricity generated by solar panels. The type of Lithium-Ion battery to be used is one of the most essential aspects in terms of the amount of electrical energy that can be gathered and has a long lifespan, according to the research.

The PWM Solar Charge Controller may also be used to control the charging of batteries. As a result, increasingly advanced lights give a technological edge in terms of creating maximum lamp light while using the least amount of electrical energy possible, so indirectly saving power.

Finally, sensors such as current sensors, voltage sensor, infrared sensors and light dependent sensors are employed in every research study since their aid allows for more precise data collecting and analysis, resulting in projects that offer the data obtained.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter explains the research methods employed in this study. This chapter details the project flow as well as the experimental organisation required for the project. The techniques for data collection, testing, retrieval, categorization, and interpretation were all well-communicated.

3.2 Methodology

The term "automatic street light control" refers to the process by which streetlights are controlled automatically (Turn on and off based on the light). By combining LDRs (Light Dependent Resistors) and LEDs (Light Emitting Diodes) with an Arduino in this project (An Arduino is used to control the amount of voltage applied to the LED based on the input from the LDR sensor). When a small amount of light is present, the light automatically glows, when a sufficient amount of light is present, the light automatically turns off. Furthermore, IR sensors are included with the Arduino to operate as an automated switch by detecting object. This all system be monitor based on the IoT system. Solar panels are also employed as a source of energy for the whole system, allowing it to run independently in rural locations. The battery is an extra tool for storing electrical energy gathered by the solar panel, and the solar charge controller is used to monitor solar panel to the battery, as well as the battery's health state.

3.3 Flow Chart of the Street Light System

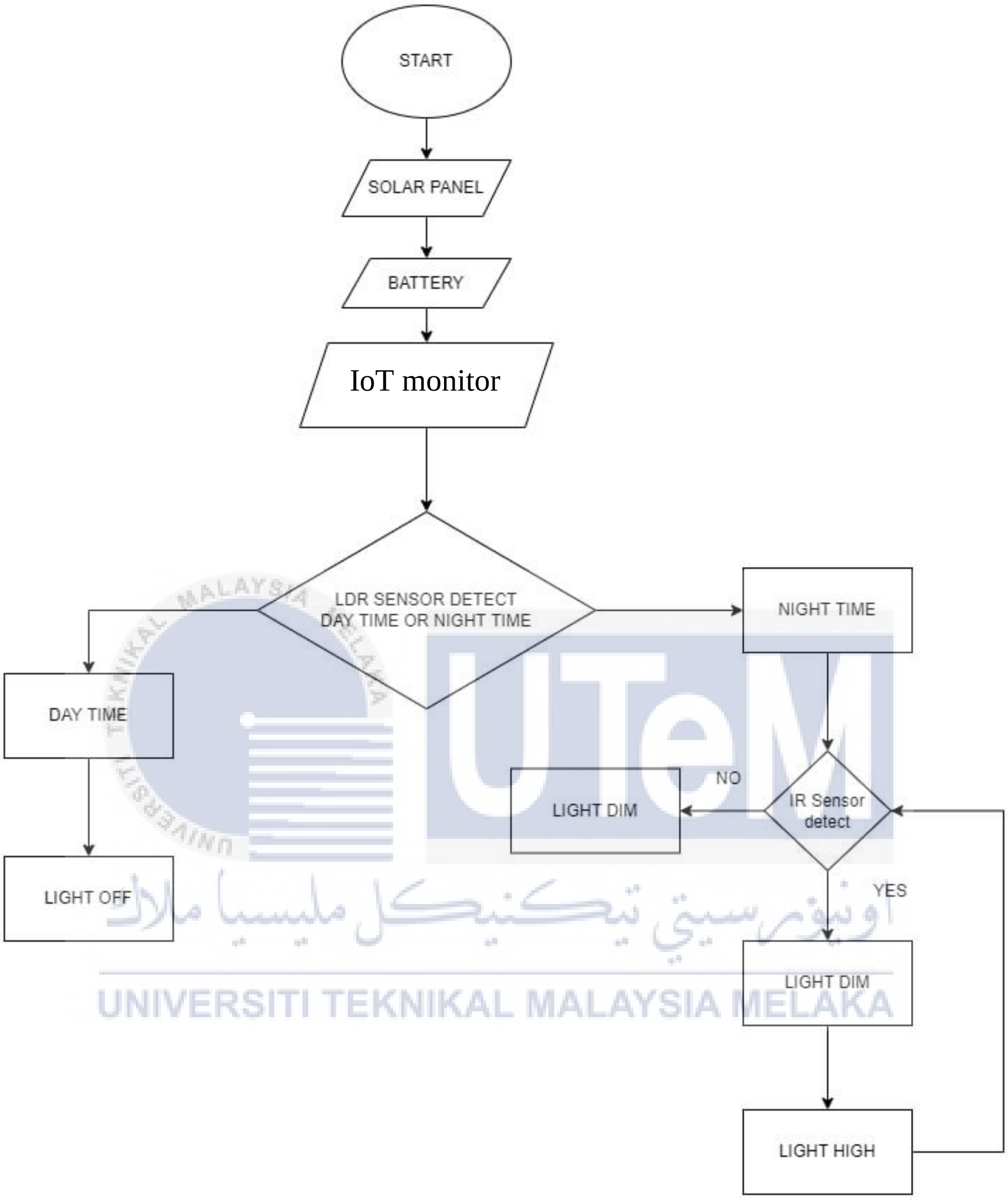


Figure 3.1 : Flow Chart of the Vechile Detection Automatic Street Light System with Solar Panel

3.4 Block Diagram

A block diagram displays a system in which the control subjects or actions are represented by blocks that are linked together by lines. They're popular in engineering, particularly in the design of hardware, electrical, and software, as well as process flow diagrams. The block diagram for the project is as follows:

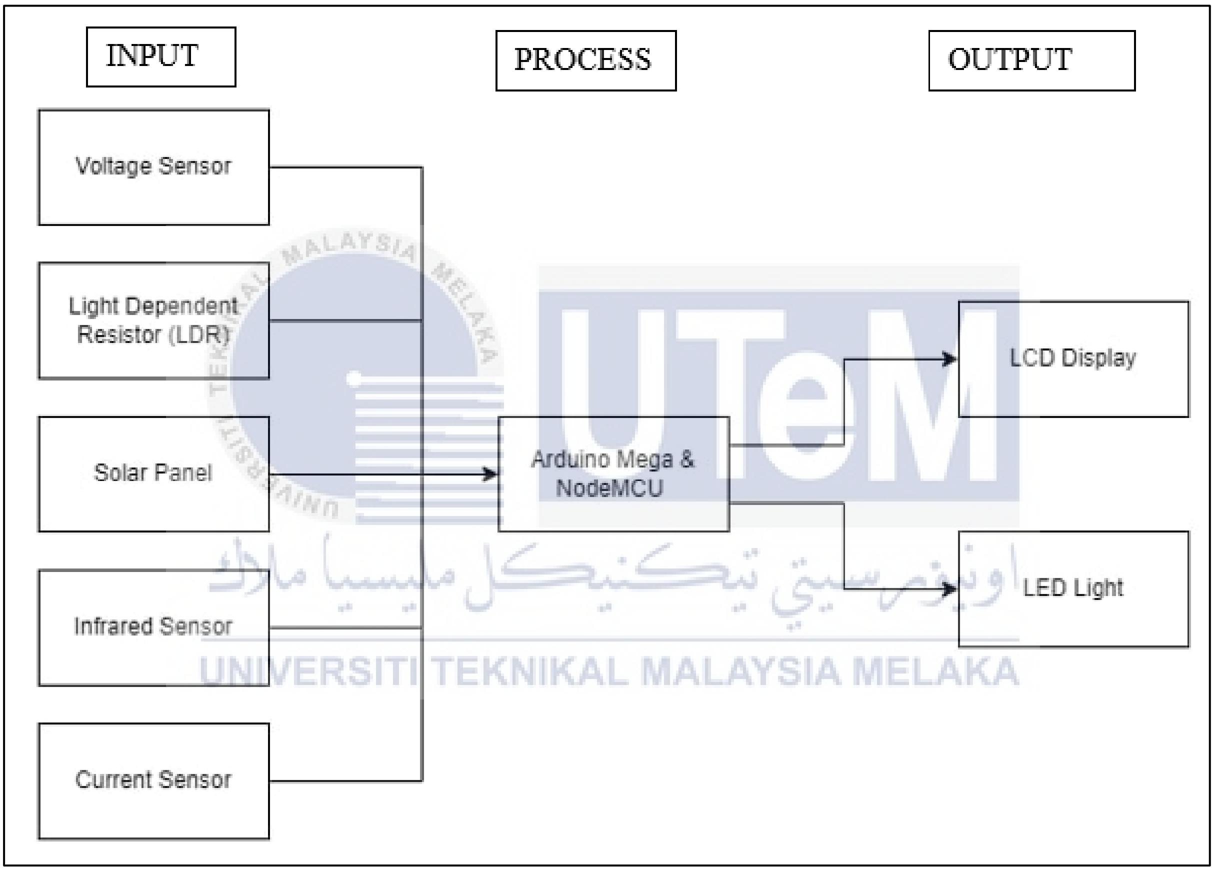


Figure 3.2 : Block diagram Vechile Detection Automatic Street Light System with Solar Panel

3.5 Experimental Setup

The data gathering procedure was carried out utilizing the equipment necessary before in this section. The equipment has been divided into two parts hardware and software.

3.5.1 Hardware Project

3.5.1.1 Arduino

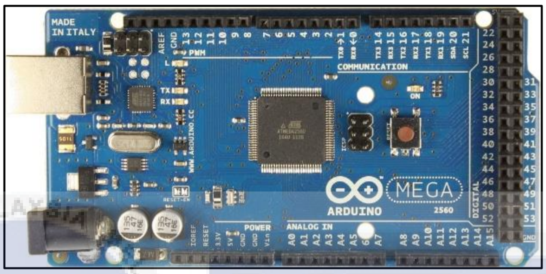


Figure 3.3 : Arduino Mega

The Arduino Mega 2560 is a microcontroller board that uses the ATmega2560-family of microcontrollers. It has 54 digital I/O pins (15 of which are PWM outputs), 16 analogue inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB port, a power connector, an ICSP header, and a reset button. It may be operated with only a USB connection to a computer, an AC-to-DC converter, or a battery. The Mega 2560 board is designed to work with the majority of Uno shield.[12]

3.5.1.2 NodeMCU ESP8266

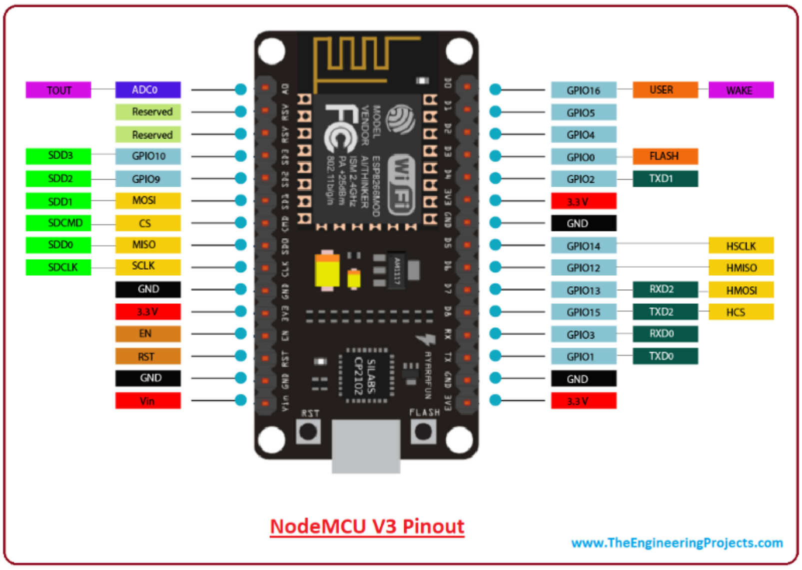


Figure 3.4 : NodeMCU ESP8266

The NodeMCU ESP8266 is a low-cost Wi-Fi microchip, that built-in TCP/IP networking software, and microcontroller capability and this NodeMCU is to make the data from the ardino to be transfer and control to smartphone. This make the system more advance and easy to monitor.

3.5.1.3 Blynk

Figure 3.5 : Blynk

Blynk is an Internet-of-Things platform for iOS or Android smartphones that allows users to remotely operate devices like Arduino and NodeMCU. Using this application, can compile and provide the right address on the various widgets to construct a graphical interface or human machine interface (HMI). This application will make the system be control by data from arduino and it will transfer using the NodeMCU device.

3.5.1.4 Light Dependent Resistor (LDR)

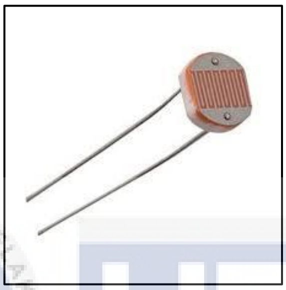


Figure 3.6 : Light Dependent Resistor

An LDR is a light-dependent resistor detects the light intensity and its changes resistance in response to the amount of light it receives. As a result, light sensor circuits may make use of them. Light-dependent resistors exist in a range of forms and sizes in electrical circuit designs. [13]

3.5.1.5 IR Sensor

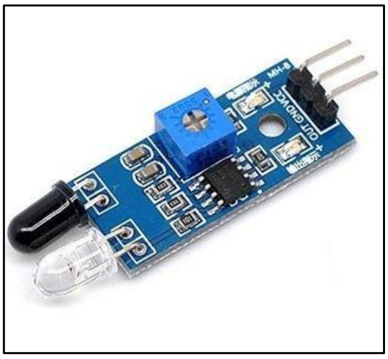


Figure 3.7 : IR Sensor

An infrared sensor is an electrical device that produces infrared light to detect specific environmental conditions. An infrared sensor can both detect motion and measure the temperature of an object. A passive infrared sensor measures rather than emits infrared light. Almost every object emits some form of infrared heat radiation.[14]

3.5.1.6 Mosfet Module

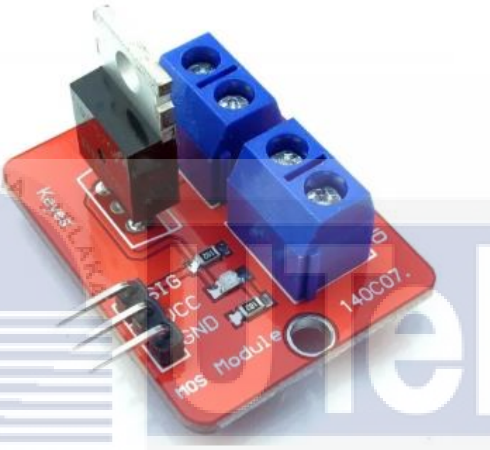


Figure 3.8 : Mosfet Module

MOSFET is one type of transistor. Their main function is to regulate conductivity, or the amount of electricity that can flow between their source and drain terminals, dependent on the voltage supplied to their gate terminal. By using the mosfet it can amplify voltages in circuits.

3.5.1.7 LED

Figure 3.9 : LED strip

A light-emitting diode (LED) emits light when current flows through it. This project utilizes only one type of LED colour, which is white because at night, white LED lights may give stronger illumination the other type of LED colour.[15]

3.5.1.8 Incandescent Light Bulb

Figure 3.10 : Incandescent Light Bulb

The traditional light bulb is an incandescent one. It generates light by heating a wire filament to a temperature where light is produced. A translucent glass bulb that is either evacuated or filled with an inert gas encloses the metal wire (a vacuum).

3.5.1.9 Lithium-Ion Solar

Figure 3.11 : Lithium-Ion Solar battery

In terms of efficiency and durability dependent on the surrounding conditions, the lithium-ion solar battery has a significant advantage over conventional batteries. Despite the somewhat higher price, the long-lasting endurance of a battery gives a benefit. This form of lithium battery, on the other hand, has a number of features that make it ideal for this project's implementation. [3]

Discharging Time=Battery Capacity*Battery Volt/Device Watt.

The battery is 10AH x 12 V/12 Watts = 10 hrs

With 90% Power efficiency for Li-ion/LiPo batteries. Then

Discharging Time=Battery Capacity * Battery Volt*0.9 / Device Watt

10Ah*12V*0.9/12W = 9 hours

3.5.1.10 Solar Panel

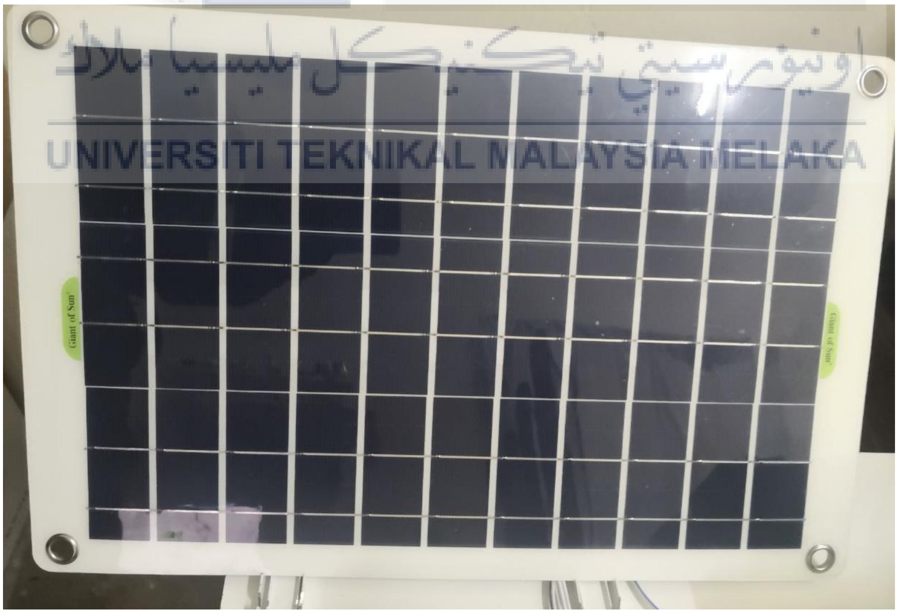


Figure 3.12 : Solar Panel

Solar panels generate electricity by turning sunlight into photovoltaic cells. Sun panels, for example, are solar collectors that may be used to heat water or air. Photovoltaic

(PV) or solar module are other terms for solar collectors. The solar panel type are Monocrystalline with size 11 inches x 16.5 inches.

3.5.1.11 PWM Charger Controller

Figure 3.13 : PWM Charger Controller

The Charger Controller is for monitor the current supply from the panel solar and directly keep the electric energy to the battery. The electric energy that store in the battery will be use at the night to turn on the light and also supply the energy to the Arduino for run the system that has be set.[4]

3.5.1.12 Mosfet Module

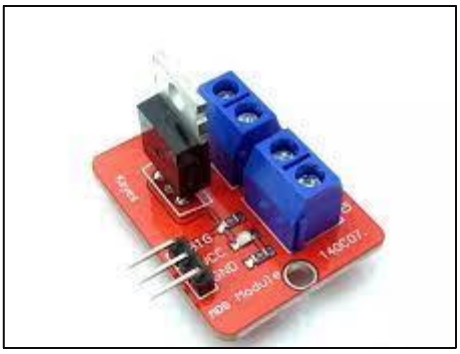


Figure 3.14 : Mosfet Module

The amount of voltage given to the gate terminal of a MOSFET (Metal Oxide Semiconductor Field Effect Transistor) controls conductivity, or to limit the electricity flow between its source and drain terminals. With the mosfet module make easy to control the electricity to dim process at night day.

3.5.1.13 Breadboard

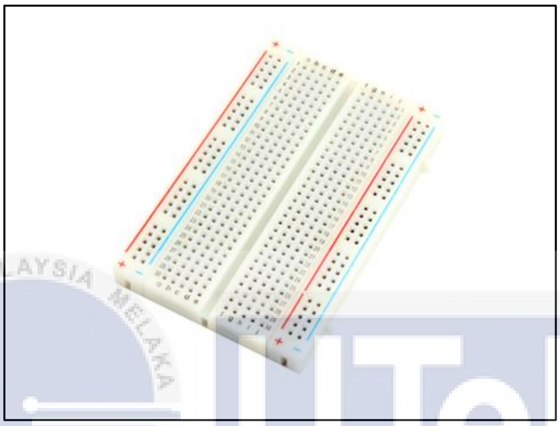


Figure 3.15 : Breadboard

The breadboard is used to quickly connect electrical components like as resistors, LEDs, diodes, dc motors, and LCDs so that the circuit may be tested.

3.5.1.14 Jumper Wire

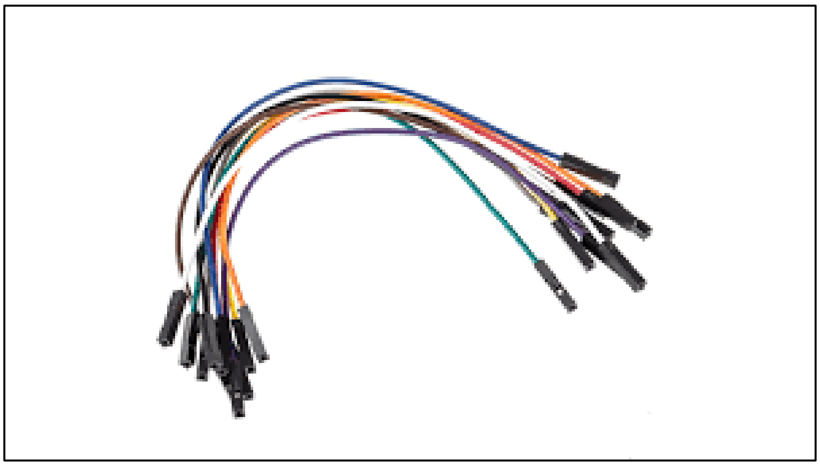


Figure 3.16 : Jumper Wire

An electrical wire, or a set of them in a cable, having a connector or pin at either end for interconnecting breadboard, dc motor, LED, and LCD components without soldering.

3.5.2 Software Project

3.5.2.1 Arduino IDE

Figure 3.17 : Arduino IDE

The Arduino IDE is a cross-platform programme developed in C and C++ functions. This application is used to write and upload Arduino programmers for usage in the project.

3.5.2.2 TinkerCad

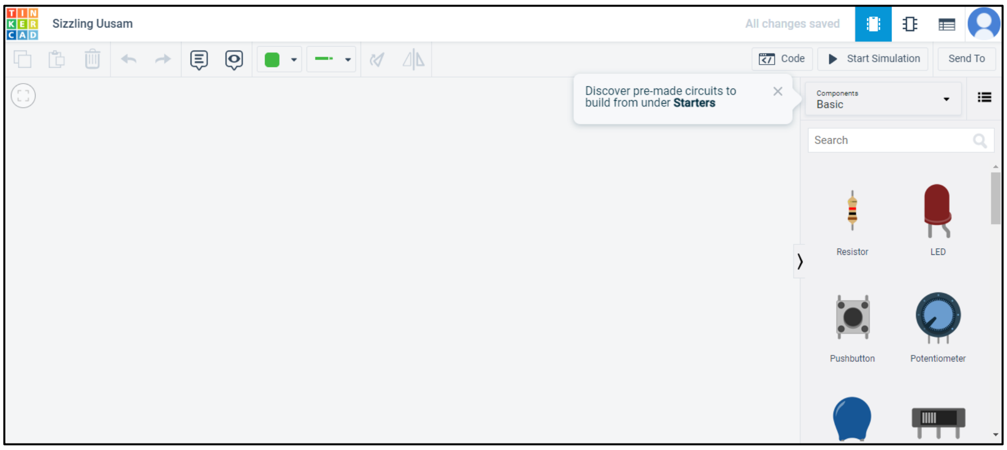


Figure 3.18 : TinkerCad

TinkerCad is a free web-based 3D modelling application that runs in a web browser and is well-known for its simplicity and ease of use. This software includes components for creating an Arduino-based automated street light with an infrared sensor, LED, and LDR sensor. It also includes a coding portion, which is used to create the system. TinkerCad was used to simulate the Auto Street Light system simulation, and it is capable of detecting and resolving issues.

3.5.2.3 Fritzing

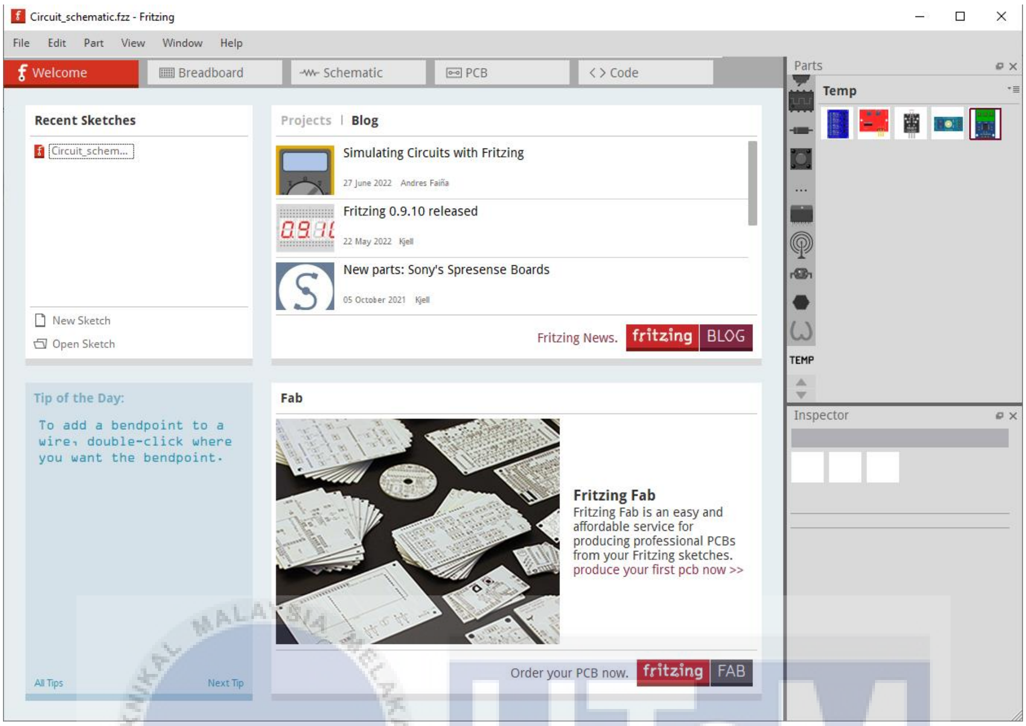


Figure 3.19 : Fritzing

This software is an open-source project to create CAD software for amateur or hobbyist designers of electronic gear, with the goal of enabling designers and artists to create more durable circuits from prototypes.The software is meaningful because easy to contruct any electronic object and it also has the arduino component in it.

3.6 Project Design

Below the 3D design of the project in TinkerCad

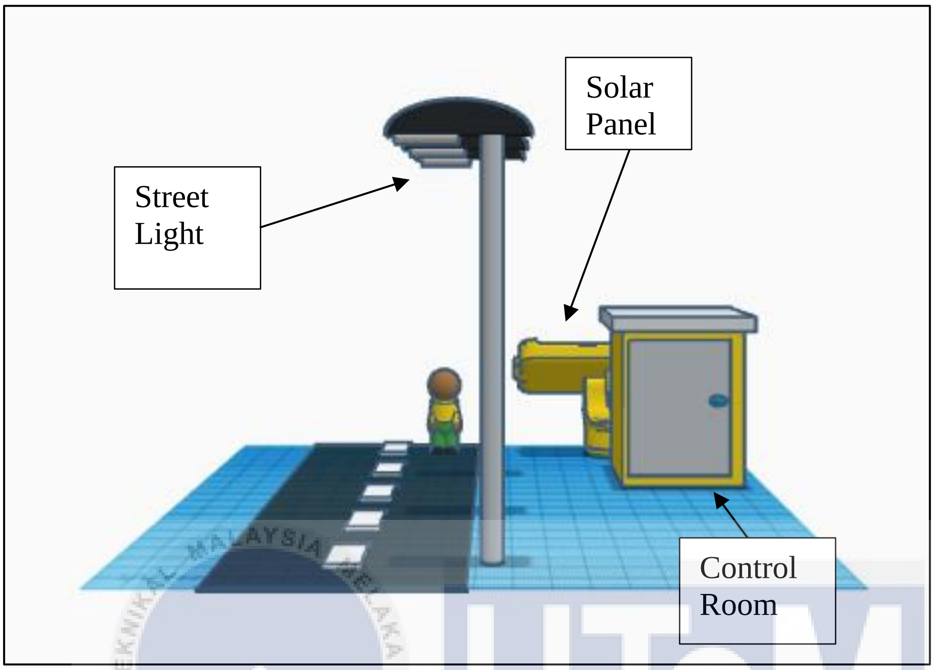


Figure 3.20 : Front View

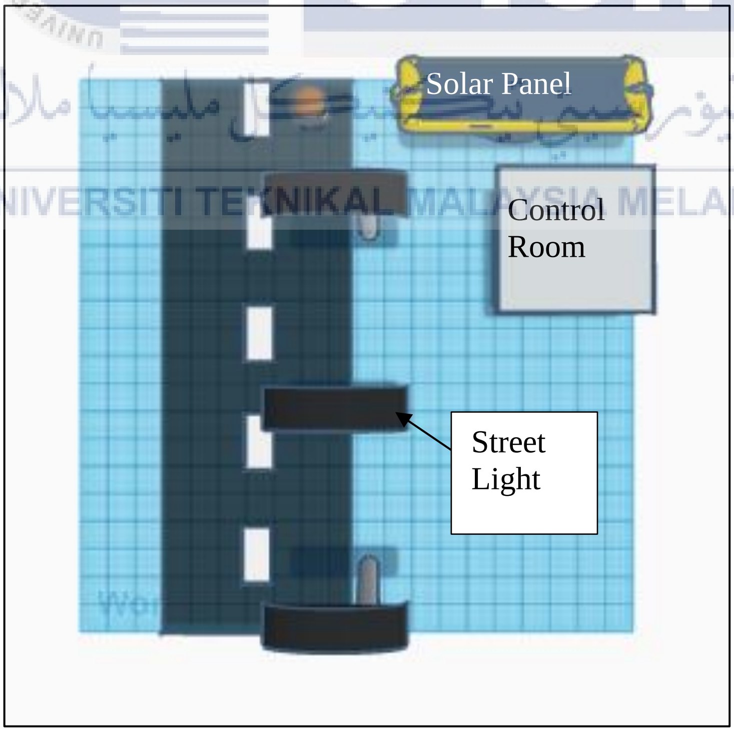


Figure 3.21 : Top View

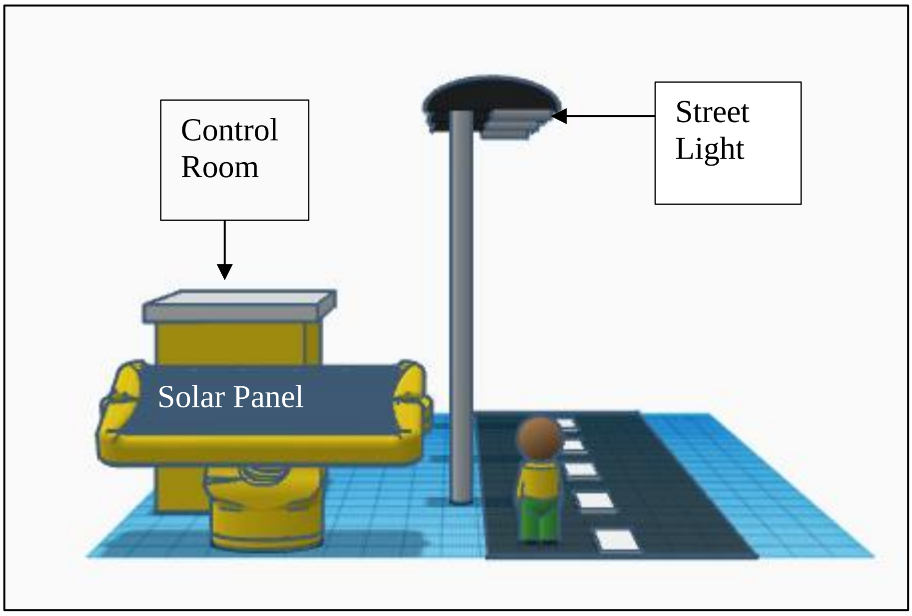


Figure 3.22 : Rear View

3.7 Project Simulation

3.7.1 LDR Sensor Circuit

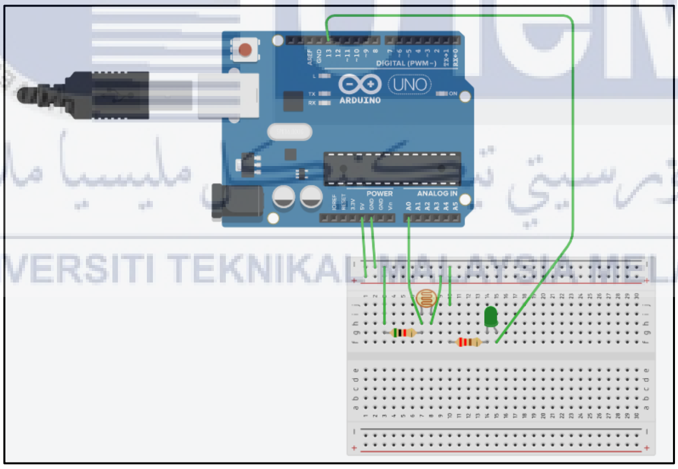


Figure 3.23 : LDR Sensor Circuit

A photoresistor (abbreviated LDR for Light Decreasing Resistance, or light-dependent resistor, or photoconductive cell) is a passive component that reduces resistance in response to the presence of luminosity (light) on its sensitive surface.

For this part, it is an LDR connection that connected with Arduino Uno and NodeMCU . The function of this simulation is it will detect the LDR sensor when in the darkness time. So that the LDR sensor will receive the signal and the LED will turn 'ON'. The LDR sensor on this simulation can be adjust when we click in the LDR component. So, we can adjust the brightness and the darkness to know when the LED's will work well. There is the step to connect the LDR sensor and LED with Arduino.

Firstly, the LDR sensor Terminal 1 are connected with resistor and plug in into A0 port. Next, for the Terminal 2 it will be connected to 5V port. Lastly for the LDR sensor connection, on the other pole for resistor it will be connected to the ground. For the LED component, the Anode are connected to port 3 while the Cathode pole will share with resistor will be connected the ground. (For the coding please refer to APPENDIX A)

3.7.2 IR Sensor Circuit

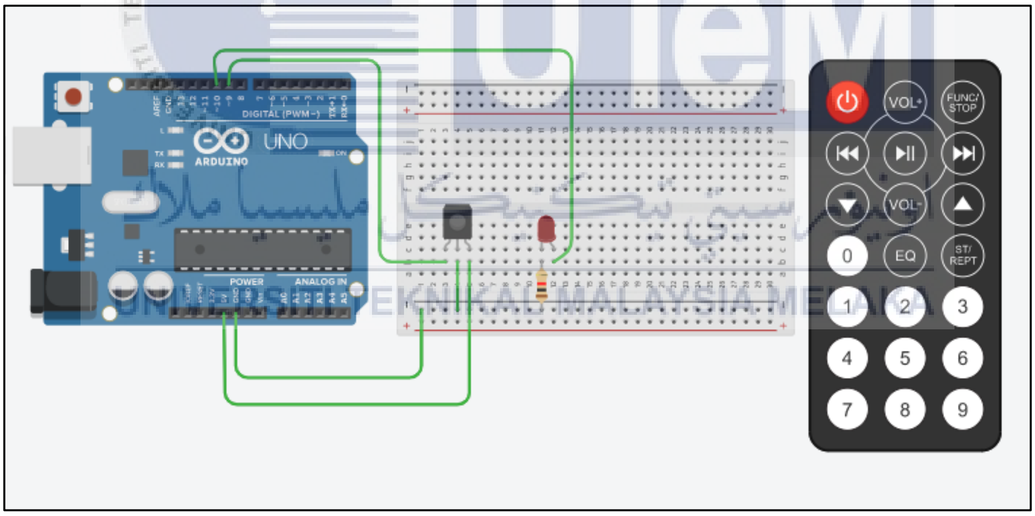


Figure 3.24 : IR Sensor Circuit

An infrared sensor is an electronic device that detects certain characteristics of its environment. This is accomplished by either emitting or detecting infrared radiation. Additionally, infrared sensors can detect movement and measure the heat generated by an object.

For this figure, we'll use an IR component for the input and an IR remote for the output, as well as an LED and a resistor. Because there is no signal to detect the IR sensor in the simulation, an IR remote was used. Thus, an IR remote control may be used to provide an option for displaying the output that was coded. In Tinkercad, the IR sensor was disabled if there was no IR remote associated with the output.

According to this figure, the sensor has three pins: power, ground, and out. The power pin will be connected to the 5V pin, the ground pin to the ground pin, and the out pin to the 9 pins. The LED's anode pole was connected to the ten-pin connector, while the cathode pole was connected to the negative terminal. (For the coding please refer to APPENDIX B)

3.7.3 LED Circuit

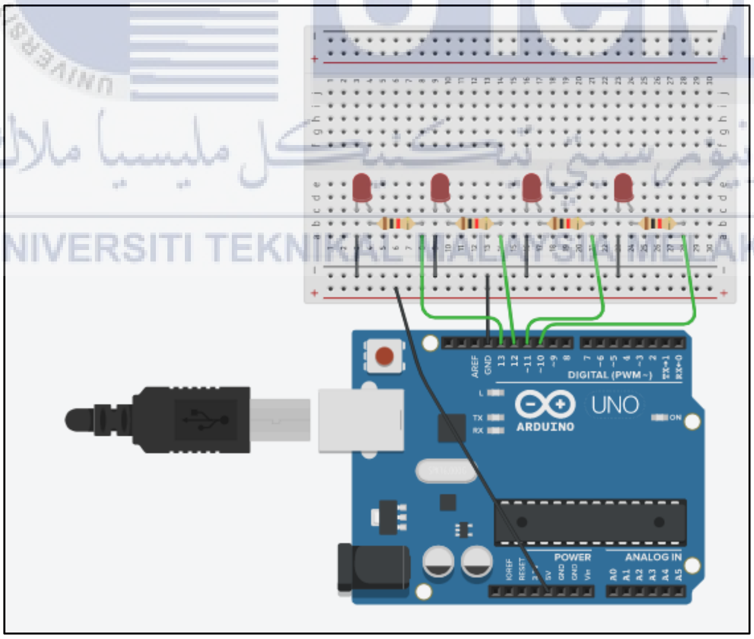


Figure 3.25 : LED Circuit

On this Figure, there is four LED that as connected in parallel circuit. The component that was used in this simulation is four LED, four resistor and an Arduino Uno. The circuit shown that the LED will turn on alternately and this is just an example for this final year project.

The working for this lamp from one place to another takes only 3 seconds. When the light is on, it is likened to a passing vehicle passing through the lamp. So it will just turn off when the vehicle was passed the lamp. (For the coding please refer to APPENDIX C)

3.8 Summary

This chapter focuses on the project methodology and methods for project implementation using the flow chart and block diagram that have been designed. In addition, the process of preparing hardware and software that should be employed to satisfy the existing objectives is covered in this chapter. Before beginning the project, each piece of equipment specified has been thoroughly examined to avoid wasting money on mistakes made during the procurement process. In addition, various simulations were run to test the tool's functionality. If software and hardware are unable to satisfy the objectives during the data collecting and analysis process, they will be replaced.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

Following the completion of the process, the project will be planned and implemented. The framework's preliminary outcome can be seen across the entire project. This section will describe the results for both software and hardware. This chapter also includes an analysis and discussion of the findings. By using a real-world prototype model to show this hardware development and the placements of all circuits. The major goal of the analysis process is to contextualise the final outcome of hardware development and to ensure that the project's objectives are satisfied.

4.2 Results and Analysis

4.2.1 Hardware Setup

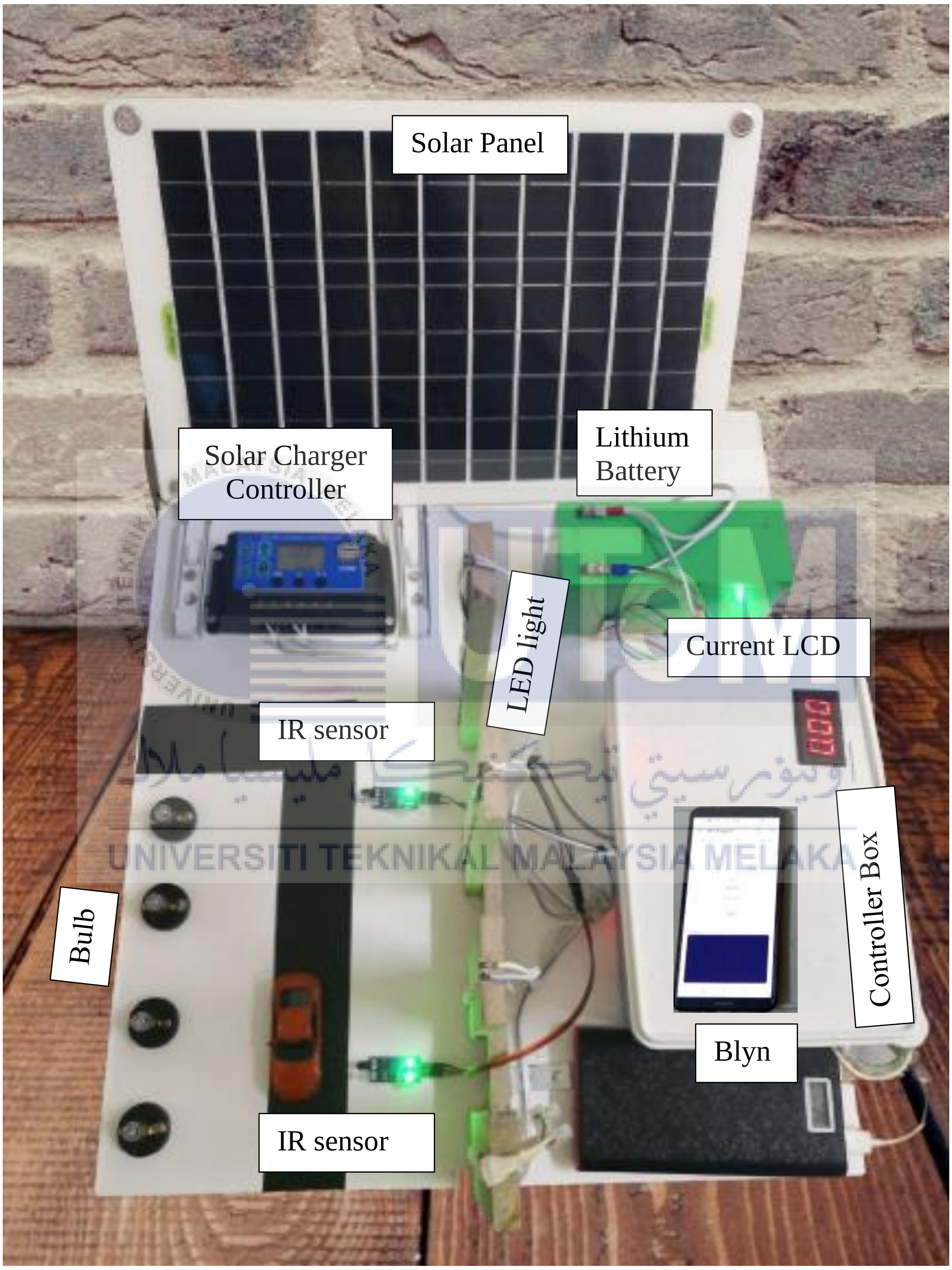


Figure 4.1 : Full Project Hardware Setup

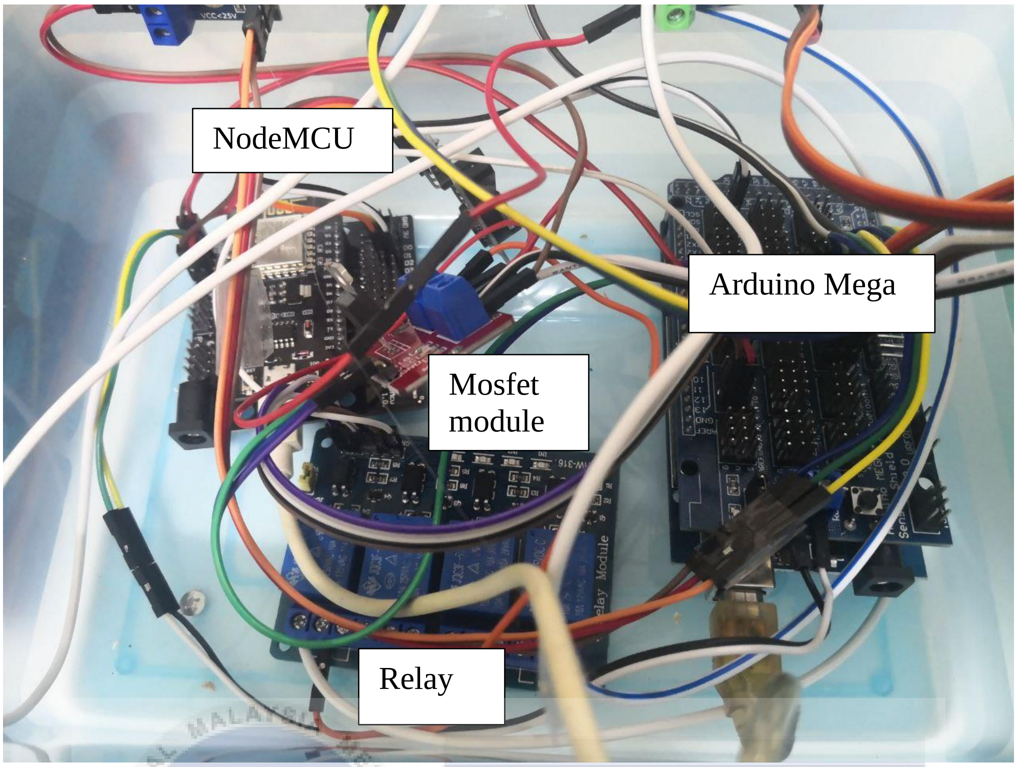


Figure 4.2 : Microcontroller System Setup

Figure 4.3 : LDR Sensor Setup

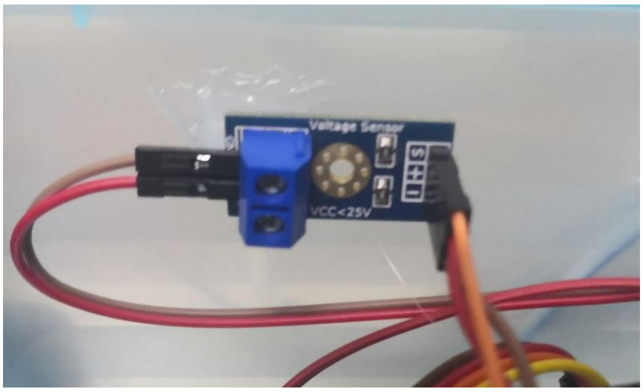


Figure 4.4 : Voltage Sensor Setup

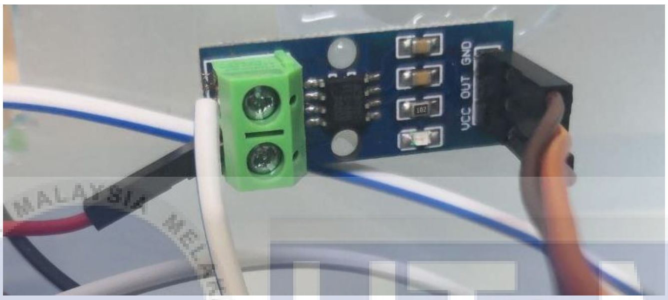


Figure 4.5 : Current Sensor

Figure 4.6 : IR Sensor Setup

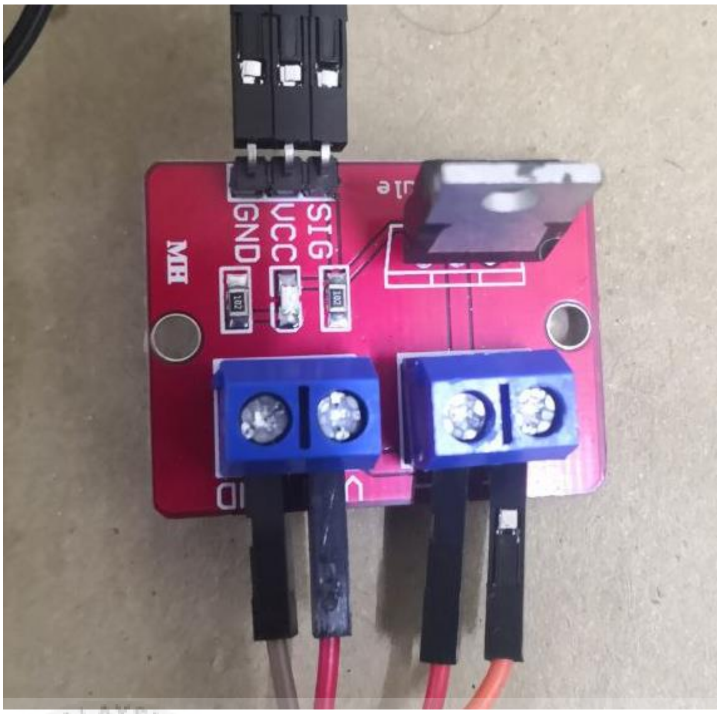


Figure 4.7 : Mosfet Module Setup

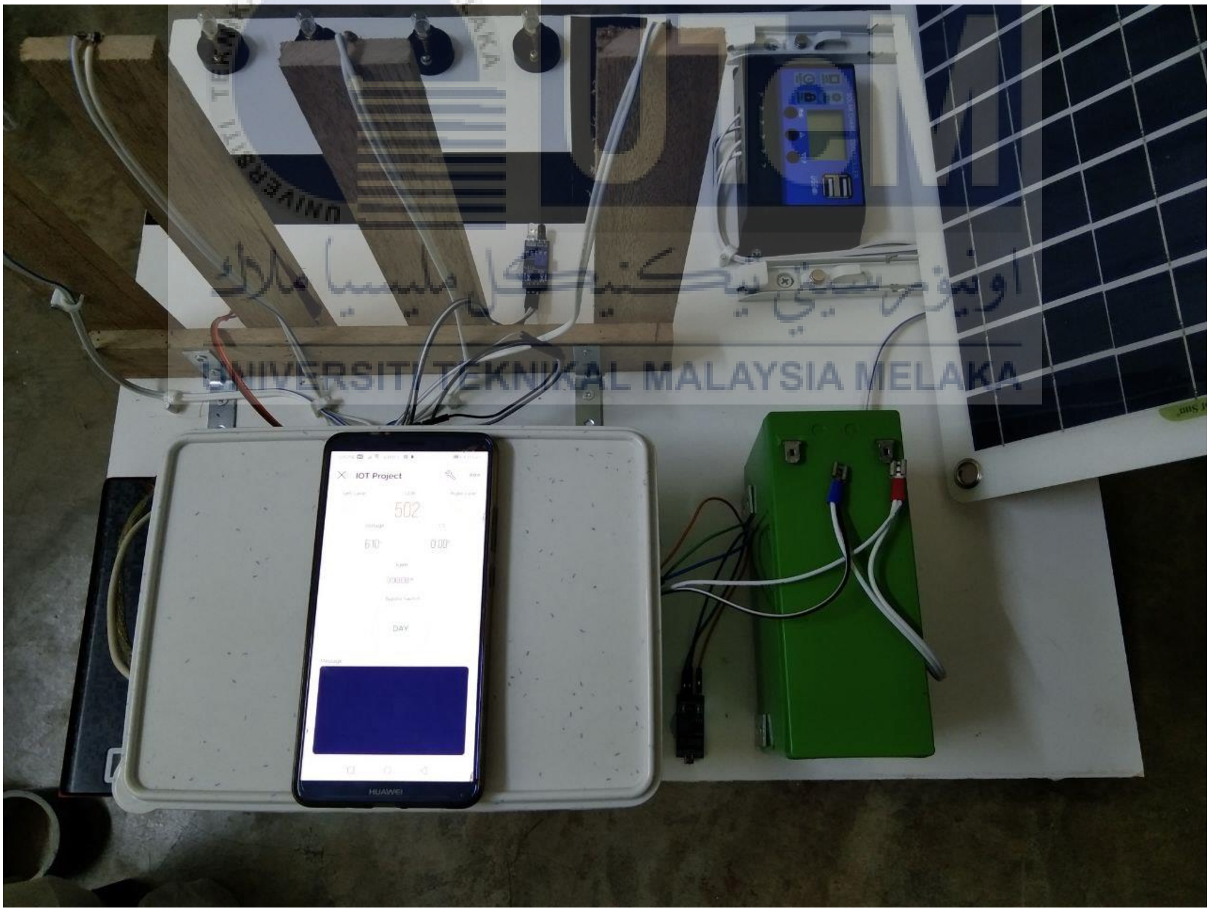


Figure 4.8 : IoT Blynk Placement Setup

4.2.2 Software Setup

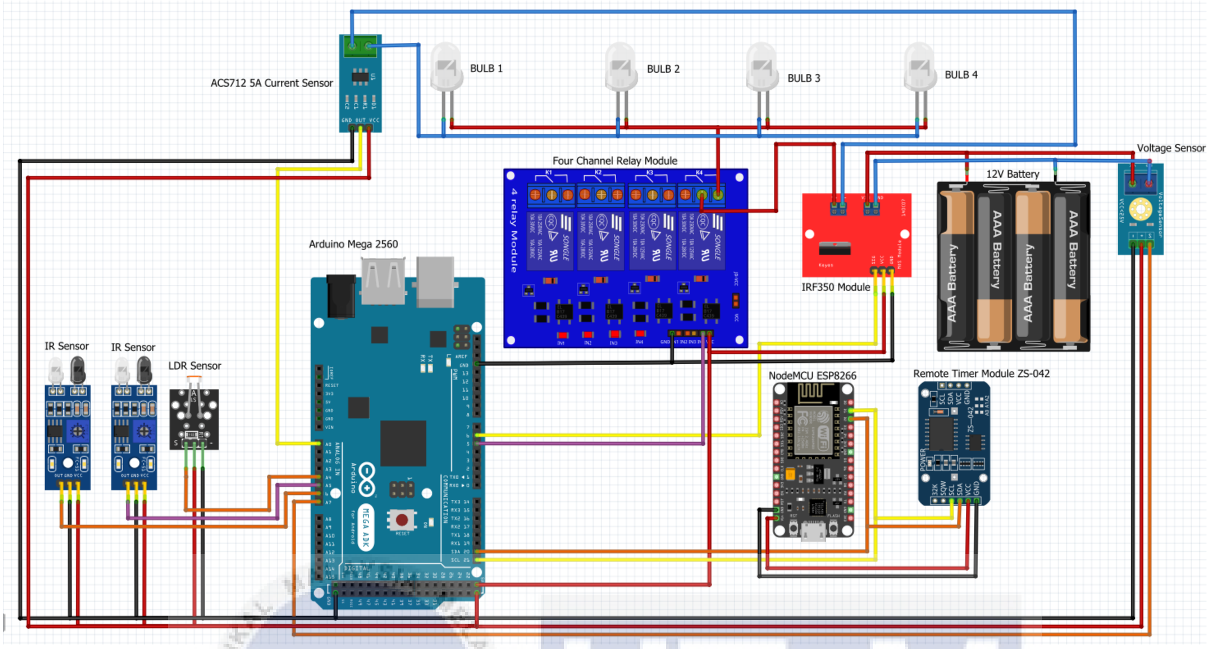


Figure 4.9 : Circuit Diagram of Microcontroller

(For the coding please refer to APPENDIX D & E)

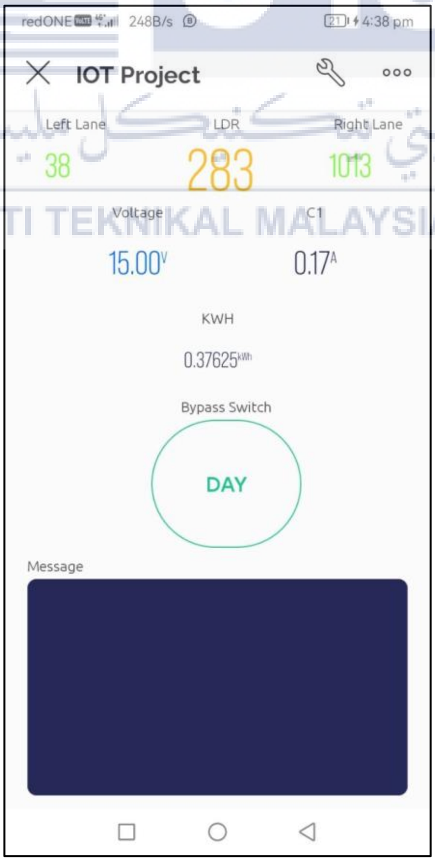


Figure 4.10 : Iot Blynk Display

4.2.3 System Operational

Figure 4.11 : Street when day-time

At day-time the LED light is turn off and IR sensor will not operate, and at this time the Solar panel will collect the energy from sunlight and change to electric energy. The electric energy is use to charges the battery and the battery storage will be use at night-time. The battery storage level will be monitor by the Solar Charge Controller and also can be monitor using the blynk that display the current and also the voltage that help to do a maintenance if see abnormal readings with the display.

Figure 4.12 : Street when night-time

At night-time, the battery storage will be use to light up the street lamp and the IR sensor will operate. In normal condition, the light will on dimmer. When the IR sensor detect a moving object like a car, the street light will automatic increase the light to 100% of it power. The street light will turn to normal condition after the moving object pass throught the area. The proses will be repeated until to day-time. At night-time also can monitor the level of battery storage that has be use to supply electric energy for operate at whole night.The IoT system also will display amout of current flow because there are the light or load has be use on the night time.

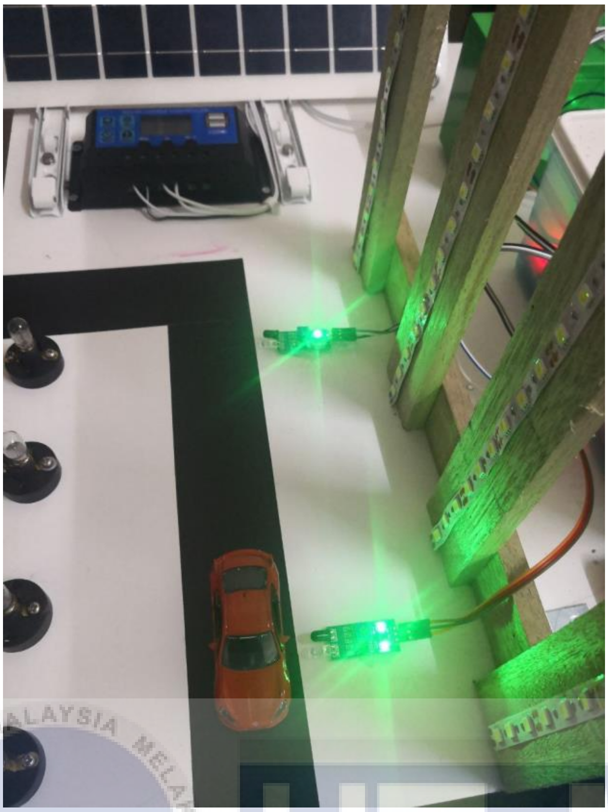


Figure 4.13 : IR Sensor located

The IR sensor will be located near the street to easy detect any movement of object along the road. The sensor also has be test the position to ensure the sensor is fully function. If the sensor located way from the street, the sensor difficult to detect any moving object and the detail of the position has be do analysis to fullfil the objective and scope above.

4.3 Analysis Data

4.3.1 Power generation of Solar Panel

4.3.1.1 Procedure of measure the solar panel

Operation

Place the solar panel angle at 45˚ to the sunlight.

(For the coding please refer to APPENDIX H)

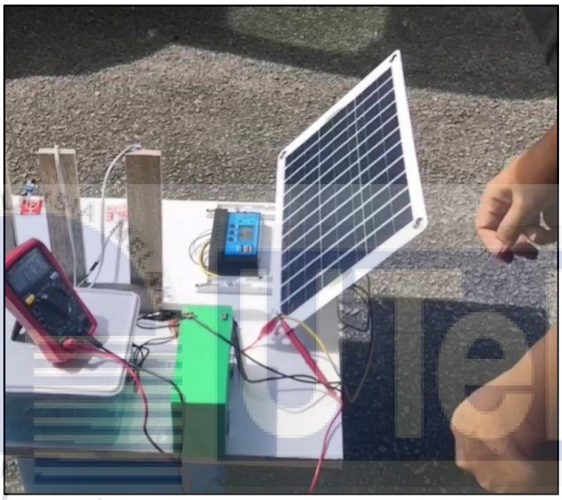


Figure 4.14 : Position angle of Solar Panel

Place the Irradiance at it position by

Aim the sensor window on the top panel of your UV metre straight at a UV source to use it. Push and hold the unit's front pushbutton switch. Aim the sensor window in the meter's top panel at the UV source. Note the LCD reading and record it if necessary.

Figure 4.15 : Irradiance Meter

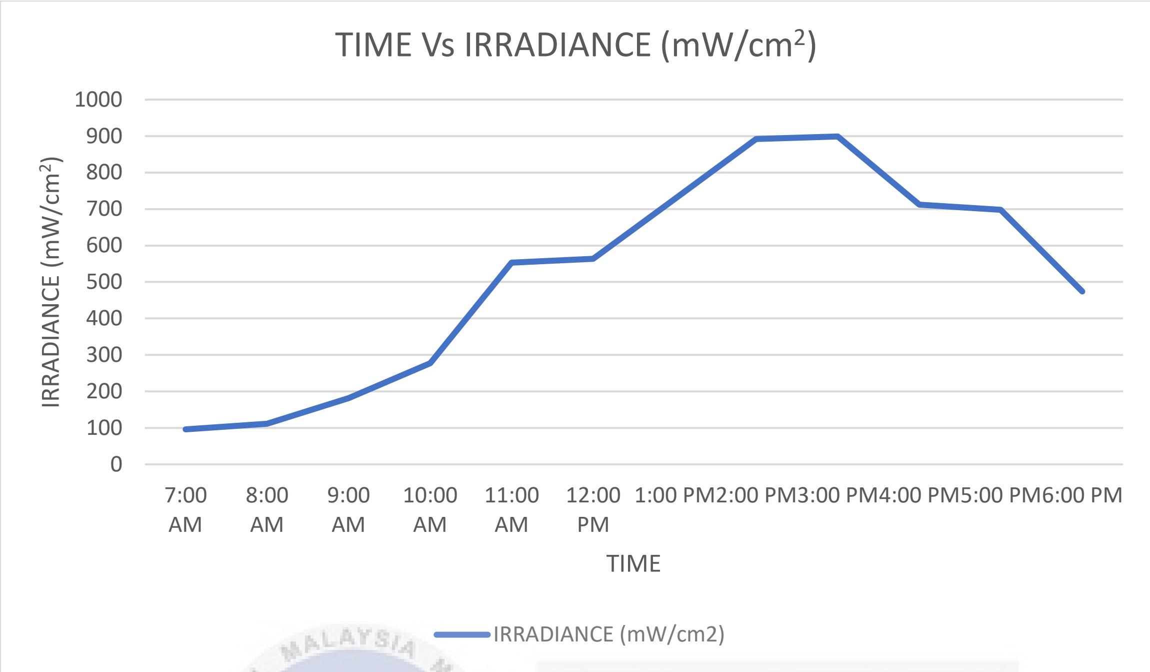
Next take the measurement of voltage and current

Fill up in the table of Solar Panel Generation Per Day

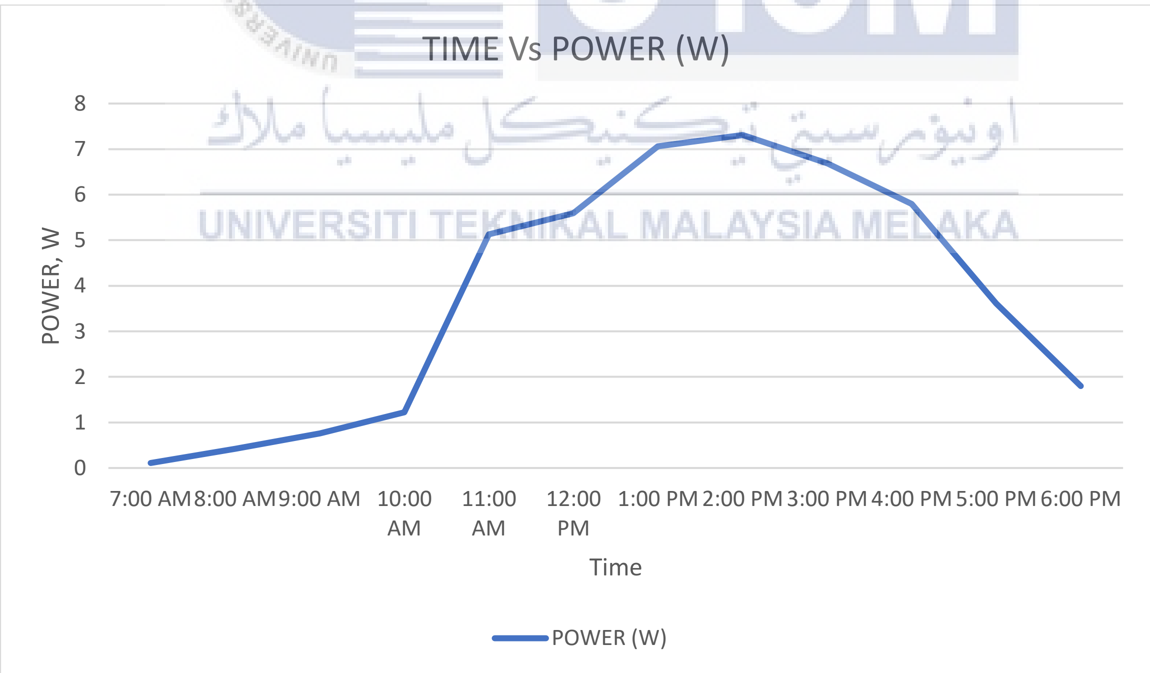
Figure 4.16 : Example of Voltage and Current Measurement

Table 4.1 : Solar Panel Generation Per Day

SOLAR PANEL POSITION: 45˚ PANEL SIZE: 11 inches x 16.5 inches					
PLACE: TAMAN TASIK UTAMA, MELAKA					
Date :23/12/2022					
MEASUREMENT DATA					
Time	IRRADIANCE (mW/cm^2)	TEMPERATURE (℃)	VOLTAGE (V)	CURRENT (A)	POWER (W)
7:00 AM	96	25	11.02	0.01	0.11
8:00 AM	111	25	14.07	0.03	0.42
9:00 AM	182	26	15.11	0.05	0.76
10:00 AM	277	26	15.2	0.08	1.22
11:00 AM	553	29	15.09	0.34	5.13
12:00 PM	564	29	15.12	0.37	5.59
1:00 PM	728	31	17.64	0.40	7.06
2:00 PM	892	31	16.61	0.44	7.31
3:00 PM	899	31	16.32	0.41	6.69
4:00 PM	712	30	15.67	0.37	5.80
5:00 PM	698	30	15.03	0.24	3.61
6:00 PM	474	29	15.01	0.12	1.80



Graph 4.1 : Time Vs Irradiance (mW/cm²)



Graph 4.2 : Time Vs Power, W

First, a 45-degree angle has been fixed so that solar panels will provide their highest average output. The weather was overcast on the day of data collection, which reduced the amount of power generated. Less than 1.50 watts of power are produced by the solar panel between the hours of 7 and 10 am, according to the two graphs above. Around 1.80W to 7.31W of power are slowly generated from 11 am to 6 pm, with the peak power produced at 2 pm. The production of power is not actually affected by the temperature; rather, it is only supported by an increase in irradiances. When the irradiance is above 400 mW/cm^2, solar electricity can be produced; when it is below 400 mW/cm^2, solar power cannot be produced. This indicates that the quantity of irradiance is crucial for producing power and recharging the battery.

4.3.2 Position of the IR sensor

4.3.2.1 Setup of IR sensor with different height

- Place the IR sensor with the different height.
- The distance between two IR sensor were neglected in this analysis.

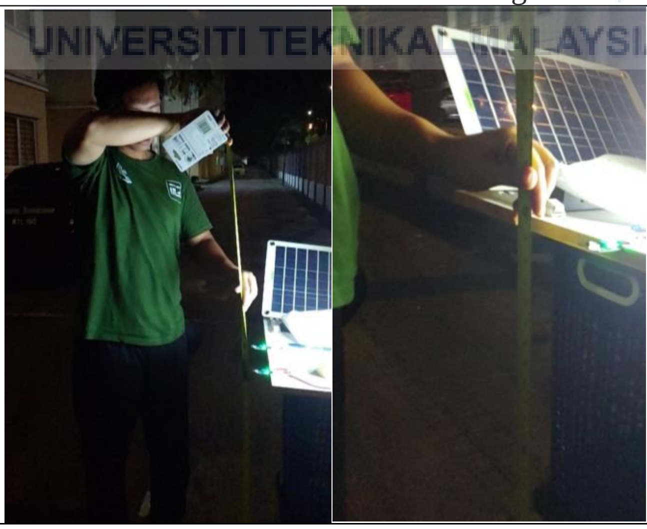


Figure 4.17 : Measure of the height of IR sensor

- Make the track for the vehicle to pass through the sensor.
- Track length from sensor = 26 cm

- (The IR sensor will not detect above than 30cm of length between the vehicle and the sensor)
- Sensor angle = 0 ̊ / 180 ̊
- Two vehicle that be use = Motorcycle - ADV150 and Car - ALZA
- Speed of vehicle = 15 km/h
- The light will be bright for 10 second and become dimmer again when IR sensor active.
- The timer will be reset when IR sensor detect another vehicle.
- All the height has 5 times of trial that to determine the sensor detection with same speed of vehicle.

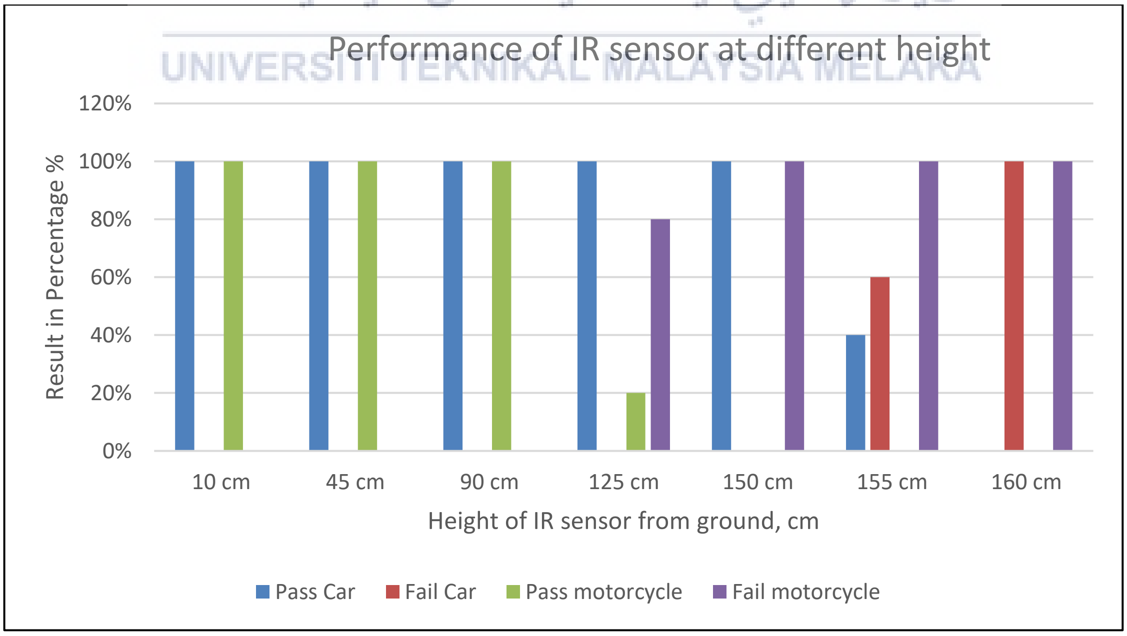
Figure 4.18 : Track for the motocycle and car speed test

Table 4.2 : The successful data of the IR sensor at different height by Motorcycle

Number of Motorcycle Trial	Height of Sensor from ground						
	10 cm	45cm	90cm	125cm	150cm	155cm	160cm
1st Trial	YES	YES	YES	NO	NO	NO	NO
2nd Trial	YES	YES	YES	NO	NO	NO	NO
3rd Trial	YES	YES	YES	YES	NO	NO	NO
4th Trial	YES	YES	YES	NO	NO	NO	NO
5th Trial	YES	YES	YES	NO	NO	NO	NO

Table 4.3 : The successful data of the IR sensor at different height by Car

Number of Car Trial	Height of Sensor from ground						
	10 cm	45cm	90cm	125cm	150cm	155cm	160cm
1st Trial	YES	YES	YES	YES	YES	NO	NO
2nd Trial	YES	YES	YES	YES	YES	YES	NO
3rd Trial	YES	YES	YES	YES	YES	YES	NO
4th Trial	YES	YES	YES	YES	YES	NO	NO
5th Trial	YES	YES	YES	YES	YES	NO	NO



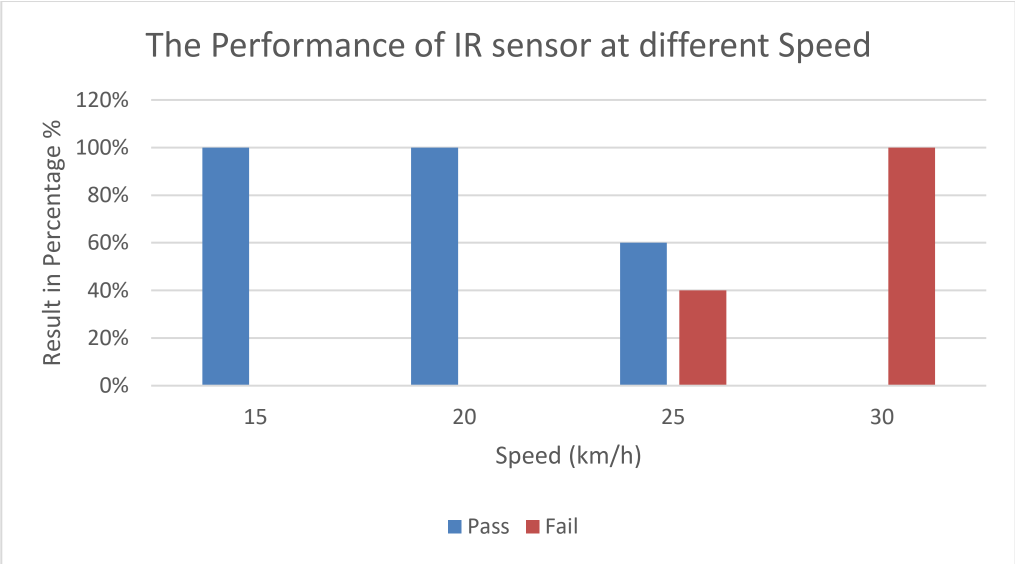
Graph 4.3 : Height of IR sensor from road Vs Result in Percentages

This study examines how the IR sensor reacts to changes in height and will make five attempts at each height. According to the findings, all heights between 10 cm and 90 cm are 100% successful for both vehicle but at 125cm from the ground, the moytorcycle results is 80% failure and 100% failure at 150 cm above the ground. The IR sensor start to miss detect the car at height 155cm and above. At height of 10 cm from the road, the sensor is placed at the wheel of a vehicle for the motorcycle and the car. This level of issue arises from the sensor's complete exposure to the wet road when it rains as well as the sensor's increased risk of being struck by a car and motorcycle because the driver is not aware of the sensor's presence. The ideal position is between 45 and 90 cm for the motorcycle and 45cm to 150cm is for the car. Finally, the height above 90 cm for motorcycle and 150 cm for car will result in a higher failure rate, making the sensor unsuitable for placement, although it is recommended to utilise this height to detect larger and higher vehicles, such as trucks, buses, or other vehicles that are higher than the average road user.

4.3.3 Performance of IR Sensor

Table 4.4 : Speed Performance of IR sensor

Speed (km/h)	Number of Trial				
	1st Trail	2nd Trail	3rd Trail	4th Trial	5th Trial
10	YES	YES	YES	YES	YES
15	YES	YES	YES	YES	YES
20	YES	YES	YES	YES	YES
25	YES	YES	NO	YES	NO
30	NO	YES	NO	NO	NO



Graph 4.4 : Speed (km/h) Vs Result in Percentage

In order to examine the best location for the sensor to be placed, this experiment was designed to ascertain the true speed of a vehicle that may be detected using an IR sensor. The ADV 150 motorcycle will used in this experiment to test the speed range of 15 to 30 km/h, with the height of the sensor being installed 90 cm from the road and zero angle position. The findings indicate that the sensor can function optimally at speeds between 0 to 20 km/h. The sensor is not advised to be used at speeds of 25 km/h or faster because only 60% of passes will result in the system operating improperly. At 30 km/h, only 100% of failure will occur. With this outcome, we can infer that the maximum speed is less than 25 km/h and is appropriate for implementation in rural areas because the maximum speed that is gazetted in traffic law is less than 30 km/h and only causes issues for vehicles that travel at a speed higher than 25 km/h.

4.3.4 Type of Light Bulb

4.3.5.1 Incandescent DC Bulb Vs LED Light Bulb

Table 4.5 : Type of Bulb Specifications

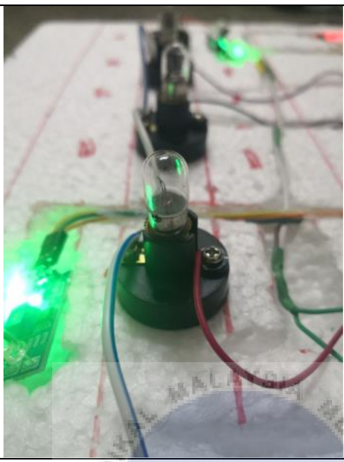
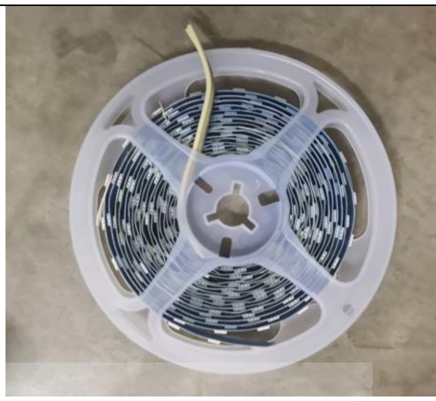
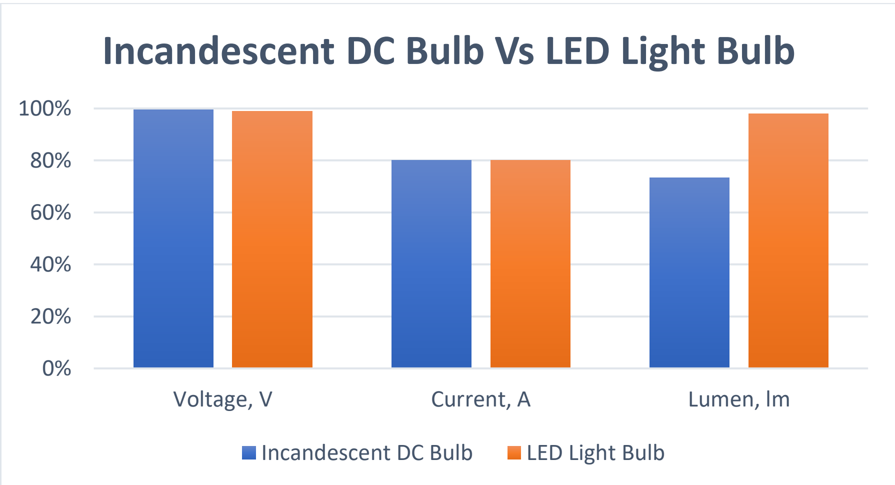
Incandescent DC Bulb	LED Light Bulb
	
Specifications • Rated Voltage 12V • Rated Power 3 W • 45 Lumen	Specifications • Rated Voltage 12V • Rated Power 3 W • 250 Lumen

Table 4.6 : Measurement of DC light

Type of Light	Voltage (Measured)	Current (Measured)	Lumen (Measured)
Incandescent DC Bulb	11.95V	0.2A	33 lm
LED Light Bulb	11.88V	0.2A	245 lm

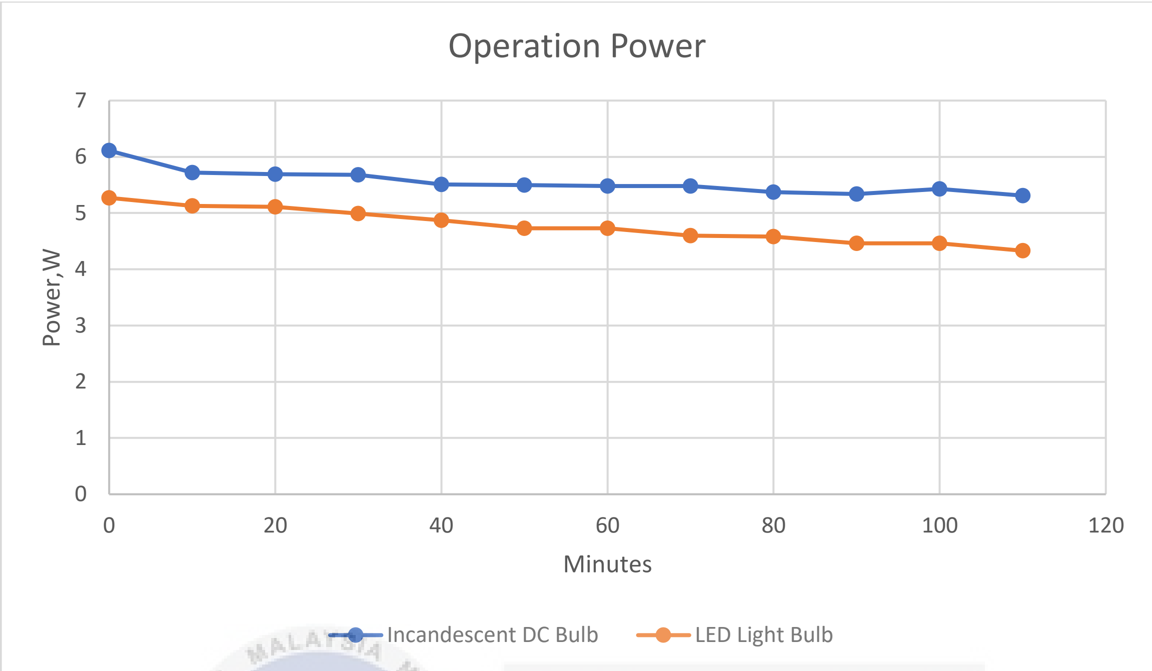


Graph 4.5 : Incandescent DC Bulb Vs LED Light Bulb

4.3.5.2 Performance Type of DC Light Data Analysis

Table 4.7 : Performance Type of DC Light Data Analysis

TIME (MINUTES)	VOLTAGE,V (MEASURED)		CURRENT,A (MEASURED)		POWER, W (MEASURED)		PERCENTAGE OF POWER SAVING BETWEEN TYPE OF DC LIGHT (%)
	Incandescent DC Bulb	LED Light Bulb	Incandescent DC Bulb	LED Light Bulb	Incandescent DC Bulb	LED Light Bulb	
0	10.91	11.46	0.56	0.46	6.11	5.27	7.00
10	10.40	11.40	0.55	0.45	5.72	5.13	4.92
20	10.35	11.34	0.55	0.45	5.69	5.11	4.83
30	10.32	11.34	0.55	0.44	5.68	4.99	5.75
40	10.20	11.32	0.54	0.43	5.51	4.87	5.33
50	10.18	11.27	0.54	0.42	5.50	4.73	6.42
60	10.15	11.25	0.54	0.42	5.48	4.73	6.25
70	10.15	11.22	0.54	0.41	5.48	4.60	7.33
80	10.13	11.18	0.53	0.41	5.37	4.58	6.58
90	10.08	11.16	0.53	0.40	5.34	4.46	7.33
100	10.05	11.15	0.54	0.40	5.43	4.46	8.08
110	10.01	11.11	0.53	0.39	5.31	4.33	8.17



Graph 4.6 : Time Vs Power,W

According to the graph, 110 minutes at the same power level were used to evaluate both types of DC lights. The experiment shows that LED lights utilise less electricity than incandescent dc lighting. Based on this, an LED light will supposedly conserve between 4.83% and 8.17% more energy than an incandescent dc light. We can also see from the graph that the power of both dc lights has drastically dropped because the experiment only used a battery as its power source. The battery can preserve power and stay longer to supply energy for a longer period of time with lower power consumption. From the result we can conclude that the LED light is better than the incandescent dc bulb because the less of power consumption and higher lumen from the LED light.

4.3.5 Full Load System Analysis

- Rated power specification for Incandescent DC light and LED = 12 Watt
- Maximum load power for incandescent DC light = 6.11 Watt
- Maximum load power for LED light bulb = 5.27 Watt

Battery Capacity for full power 12 hours operating time =

(Discharging Time*Device Watt) / Battery Volt* Power efficiency for Li-ion battery.

- Specification

  (12 hours x 12 Watt) / (12 x 0.9) = 13.33 Ah

- Incandescent Dc light

  (12 hours x 6.11 Watt) / (12 x 0.9) = 6.79 Ah

- LED light

  (12 hours x 5.27 Watt) / (12 x 0.9) = 5.86 Ah

Battery Capacity for Saving Mode at 50% 12 hours operating time =

(Discharging Time*Device Watt* 0.5) / Battery Volt* Power efficiency for Li-ion battery.

- Specification

  (12 hours x 12-Watt x 50%) / (12 x 0.9) = 6.67 Ah

- Incandescent Dc light

  (12 hours x 6.11-Watt x 50%) / (12 x 0.9) = 3.40 Ah

- LED light

  (12 hours x 5.27-Watt x 50%) / (12 x 0.9) = 2.93 Ah

Battery Capacity for Full power 4 hour and Saving Mode at 50% 8 hours operating time =

Full power (4hours) + Saving mode (8hours) = Total Battery Capacity needed

- Specification

  (4 hours x 12-Watt) / (12 x 0.9) = 4.44 Ah

  (8 hours x 12-Watt x 50%) / (12 x 0.9) = 4.44 Ah

  Total = 8.88 Ah

- Incandescent Dc light

  (4 hours x 6.11-Watt) / (12 x 0.9) = 2.26 Ah

  (8 hours x 6.11-Watt x 50%) / (12 x 0.9) = 2.26 Ah

  Total = 4.52 Ah

- LED light

  (4 hours x 5.27-Watt) / (12 x 0.9) = 1.95 Ah

  (8 hours x 5.27-Watt x 50%) / (12 x 0.9) = 1.95 Ah

  Total = 3.9 Ah

Battery Charging

Given,

Battery charging time =

Battery capacity (Ah) / highest current supplied from the solar (A)

Battery capacity = 12 Ah

Based from table 4.1 : Solar Panel Generation Per Day, The highest current supplied from the sytem = 0.44 A

The Discharge Time for 12 Ah battery

= 12 Ah / 0.44 A

= 27.27 Hour

From the calculation above, rated maximum full load system it consumes 12Watt that only need 13.33 Ah of battery capacity to operate for 12 hours within 7pm to 7am but for maximum actual full load for incandescent dc light and LED light about 6.11Watt and 5.27Watt that need battery capacity above than 7Ah. If the power consumption is operated at saving mode 50% only consume 6.67Ah of battery power for the load rated value and the actual battery capacity consumption between 3.40Ah to 2.93Ah for both light incandescent and LED light. With the two-operation full mode system and saving mode system, the power for rated and actual load in the system will be cut off 50% of power consumption. The system be set up for combination of the full mode system and the saving mode system. This combination is for light the street during peak hour and saving the power consumption during the off-peak hour at mid-night above which is 11pm until 7am. Total battery power of this combination system only consumes 8.88Ah compared to the full mode system about 13.33

Ah and the system operation will save 4.45Ah of battery capacity for the rated calculation. For the actual battery power consumption is 4.53 Ah for incandescent light and 3.9 Ah for LED light, both capacity of battery will be saving between 2.27 Ah to 1.96 Ah. Lastly, with the 12V battery and based on the maximum current generate on that day, the battery needs 27.27 hours to complete charging the battery. The solar panel takes a very long time to fully charge the battery. The solar panel needs to be changed to a larger size so that it can provide a greater current and charge the battery more quickly, leading to a shorter charge period for the battery.

4.4 Summary

End of this chapter, a solar panel is use together with the solar charger controller to make sure the current from the solar panel can be charges the battery properly with any fault happen due to the return current from the battery to solar panel. The use of larger panels allows for the collection of a vast amount of solar panel current, allowing for faster battery charging. To guarantee that the light can illuminate the entire night, the battery storage needs to be properly calculated. The LDR sensor serves as a switch to turn on or off all lighting systems because it has the ability to identify activity in the immediate environment while it is dark outside, such as at night. The system will be supported by an IR sensor at night to keep the system's light on dimly or fully when an object passes by the sensor. To ensure that the IR sensor can use its sensor function to its greatest potential, the location position is crucial. To evaluate the usage of solar energy, the solar charge controller's LCD shows the battery storage level and the lcd also will display the current for the load in the system. To test performance in terms of light consumption and to achieve the required objective, LED lights and incandescent light are also utilised. Lastly, all the voltage, current and the sensor can be monitor through the smartphone using the IoT technology.

CHAPTER 5 CONCLUSION

5.1 Introduction

This chapter will discuss future recommendations and summarize the findings of this study. There are several enhancements that can be made to this project in the future. The justification for each objective will be discussed in greater detail, regardless of whether it was accomplished successfully or no.

5.2 Conclusion

In this project, we studied and implemented a fully functional model using an Arduino and NodeMCU that can monitor using IoT system. The purpose of this work is to develop a street light that can operate by solar energy supply and the functional of the electronic device with the different level position. The type of dc light also be consider to identify the power consumption that effect the energy saving in the system.

From the analysis result, solar panels can generate a large amount of electricity when the position of the panels is placed at the right angle based on the operating area of this system. In addition, the generation of solar energy is affected by the irradiance from sunlight and the temperature of sunlight does not affect the generation of electricity from solar panels. The solar panel is angled at a 45-degree angle for the analysis because this will result in the most electricity being produced. The ideal angle is between 30 and 45 degrees. When the solar panel's irradiance reaches 400 mW/cm2 or greater, it begins to produce energy. The more the solar panel's irradiance increase, the more energy is produced.

IR sensor is a sophisticated sensor to detect any object. Through research, the height of this sensor is one of the important factors in the construction of streetlights that provide maximum use. In the results that have been made, we can see that the height of the sensor placed at a certain height has its own advantages and disadvantages. At a height of 10cm to 90cm is a suitable height to detect vehicles but a height of 10cm has a slight problem which is exposed to damage as a result of stagnant rainwater or being hit by vehicles due to factors that cannot be seen while driving. At a height of 125cm and above, the IR sensor lacks the ability to detect the presence of general vehicles such as motorcycles and cars, but with such a height it is easier to detect larger vehicles such as buses or lorries. As a result, the height of 45cm to 90cm is the ideal height for the IR sensor because this level is the height of the vehicle body which increases the high detection percentage.

To determine the speed that the Ir sensor can detect, speed analysis is also performed on the sensor. According to analysis, the IR sensor can only detect moving objects moving at less than 25 km/h. Because of this, IR sensors cannot be used in rural areas, such as at schools road , where the top speed restriction is less than 30 km/h. However, this system can be used in places where the top speed limit is less than 25 km/h.

The construction of street lights also needs to emphasize the use of types of lights that have an impact on the use of power which results in waste of electricity. Two types of dc light namely LED light and Incandescent bulb are studied to ensure the energy consumption from two types of dc light. A comparison of these two types of dc light shows a significant difference in energy consumption. In comparison to incandescent bulbs, LED lights are more energy-efficient since they consume less energy and output more lumens for the same amount of power. The LED light is the greatest light to use in the streetlight system since it can produce more lumens while using less power, and save electricity.

Lastly, from all the analysis that be made, the solar panel is the best renewable energy that can use to generate electric for the system and the uses of IR sensor not compatible to implementing in the streetlight because of the sensor only has minimum speed to detect vehicle and only suitable for certain range of height. However, the uses of LED light more suitable because of less power consumption compare to other dc light.

5.3 Future Works

For future improvements, the reliability and efficiency of the street light can be improve such as the recomemendation as stated below:

i) Upgrade to a more dependable controller system before implementing it such as PLC programming.

ii) Change the detection sensor using either camera, radar, ultrasonic or Lidar based on the place operation.

iii) Use larger battery capacity to maintain the system operate more than a 1 week to backup if no power be generate by solar panel.

iv) Add more voltage and current sensor to monitor every load in the system for maintenance purpose.

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APPENDICES

Appendix A Source code simulation in TinkerCad of LDR Sensor

```
// C++ code
//
const int ledPin = 13;
const int ldrPin = A0;
void setup() {
Serial.begin(9600);
pinMode(ledPin, OUTPUT);
pinMode(ldrPin, INPUT);
}
void loop() {
int ldrStatus = analogRead(ldrPin);
if (ldrStatus <= 200) {
digitalWrite(ledPin, HIGH);
Serial.print("Its DARK, Turn on the LED : ");
Serial.println(ldrStatus);
} else {
digitalWrite(ledPin, LOW);
Serial.print("Its BRIGHT, Turn off the LED : ");
Serial.println(ldrStatus);
}
}
```

Appendix B Source code simulation in TinkerCad of IR Sensor

```
// C++ code

//

#include <IRremote.h>

#define LEDPIN 10

#define IRPIN  9

#define BUTTON1 0xFD08F7

#define BUTTON2 0xFD8877

IRrecv irrecv(IRPIN);

decode_results results ;

void setup()

{

 pinMode(LEDPIN, OUTPUT);

   Serial.begin(9600);

   irrecv.enableIRIn ();

 }

void loop()

{

  if(irrecv.decode(&results))

 {

      Serial.println(results.value, HEX) ;

       irrecv.resume();

     if(results.value == BUTTON1)

    {

     analogWrite(LEDPIN,50);
```

```
    }
   else if (results.value == BUTTON2)
   {
     digitalWrite(LEDPIN,LOW);


   }
   }


}
```

Appendix C   Source code simulation in TinkerCad of LED Light

```
// C++ code
//
int led = 13;
int led1 = 12;
int led2 = 11;
int led3 = 10;
void setup() {
   pinMode(led, OUTPUT);
}
void loop() {
  digitalWrite(led, HIGH);
  digitalWrite(led1, HIGH);
  digitalWrite(led2, HIGH);
  digitalWrite(led3, HIGH);
  delay(3000);
```

```
digitalWrite(led, LOW);

digitalWrite(led1, LOW);

digitalWrite(led2, LOW);

digitalWrite(led3, LOW);

delay(3000);

}
```

Appendix D Source code full system in Arduino Mega

```
#include <Wire.h>

#define LDR_sensor A4
#define IR_sensor1 A5
#define IR_sensor2 A6
#define bulb1 2
#define bulb2 3
#define bulb3 4
#define bulb4 5
#define regulator 6
#define voltage_sensor A7

const int current_sensor [] = {A0, A1, A2,A3};
double current_noise [4] = {550, 554, 544, 543};
double current_offset [4] = {0.4, 0.435, 0.355, 0.685};
//double current_actual [4] = {0.095, 0.095, 0.095, 0.095};
double current_value [4] = {0,0,0,0};
double previous_current_value [4] = {0,0,0,0};

int IR_input1 = 0, IR_input2 = 0;
int LDR_input = 0;
int c;

char LDR[18], IR1[18], IR2[18];
char C1[18], C2[18], C3[18], C4[18], Volt[18];
char data[18];

boolean virtual_bypass = false;
int safe_power_mode = 0, previous_safe_power_mode = 0;

double voltage = 0,previous_voltage= 0, noise_int = 0, noise_double = 0;
double Pvoltage = 0;
int count = 0;

unsigned long currentMillis = 0, previousMillis=0;

boolean car_detected = false, start_counting = false;

void setup() {
  Wire.begin(8);
  Wire.onReceive(receiveEvent); /* register receive event */
  Wire.onRequest(requestEvent); /* register request event */
```

```
  Serial.begin(115200);

  for (int a=0; a<4; a++){
    pinMode(current_sensor[a], INPUT);
  }

  pinMode(IR_sensor1, INPUT);
  pinMode(IR_sensor2, INPUT);
  pinMode(LDR_sensor, INPUT);
  pinMode(voltage_sensor, INPUT);

  pinMode(bulb1, OUTPUT);
  pinMode(bulb2, OUTPUT);
  pinMode(bulb3, OUTPUT);
  pinMode(bulb4, OUTPUT);
  pinMode(regulator, OUTPUT);
}

void loop() {

  LDR_input = analogRead(LDR_sensor);
  IR_input1 = analogRead(IR_sensor1);
  IR_input2 = analogRead(IR_sensor2);

  if (LDR_input > 650 || virtual_bypass == true){
    if (IR_input1 < 500 ||IR_input2 < 500){
      car_detected = true;
      safe_power_mode = 2;
    }else if (IR_input1 > 500 && IR_input2 > 500){
      safe_power_mode = 1;
    }
  }else if (LDR_input <=650 && virtual_bypass == false){
    safe_power_mode = 0;
  }

  previous_safe_power_mode = safe_power_mode;
```

```
  control_bulb();
  get_current_value();
  get_voltage();


  print_sensors_value();
}

// function that executes whenever data is received from master
void receiveEvent(int howMany) {
 while (0 <Wire.available()) {
    c = Wire.read();      /* receive byte as a character */
//    Serial.print(c);           /* print the character */
  }
// Serial.println();             /* to newline */

 if (c == 1){
  virtual_bypass = true;
 }else if (c == 0){
  virtual_bypass = false;
 }
}

// function that executes whenever data is requested from master
void requestEvent() {
//  int iLDR, iIR1, iIR2;
//  char cLDR[1], cIR1[1], cIR2[1];

  dtoa(LDR_input, LDR, 0);

  if (LDR_input<1000 && LDR_input>=100){
    rotate(LDR,18, 4, 1);
  }else if (LDR_input<100 && LDR_input >= 10){
    rotate(LDR,18, 4, 2);
  }else if (LDR_input<10){
    rotate(LDR,18, 4, 3);
  }

  dtoa(IR_input1, IR1, 0);

  if (IR_input1<1000 && IR_input1 >= 100){
    rotate(IR1,18, 4, 1);
  }else if (IR_input1<100 && IR_input1 >= 10){
    rotate(IR1,18, 4, 2);
```

```
  }else if (IR_input1<10){
    rotate(IR1,18, 4, 3);
  }

  dtoa(IR_input2, IR2, 0);

  if (IR_input2<1000 && IR_input2 >= 100){
    rotate(IR2,18, 4, 1);
  }else if (IR_input2<100 && IR_input2 >= 10){
    rotate(IR2,18, 4, 2);
  }else if (IR_input2<10){
    rotate(IR2,18, 4, 3);
  }

  dtoa(current_value[0]*100, C1, 0);
  if ((current_value[0]*100)<10){
    rotate(C1,18, 2, 1);
  }

  dtoa(voltage*100, Volt, 0);
  if ((voltage*100)<1000 && (voltage*100)>=100){
    rotate(Volt,18, 4, 1);
  }else if ((voltage*100)<100 && (voltage*100)>=10){
    rotate(Volt,18, 4, 2);
  }else if ((voltage*100)<10){
    rotate(Volt,18, 4, 3);
  }

  strcpy(data, LDR);
  strcat(data, IR1);
  strcat(data, IR2);
  strcat(data, C1);
  strcat(data, Volt);

//  Serial.print(LDR_input);
//  Serial.print(", ");
// Serial.println(data);

  Wire.write(data);
}

void rotate(char a[],size_t tsize, size_t asize, size_t rot)
```

```
{
  if (rot == 0) return;

  char c [tsize];

  strcpy(c, a);

 for(int i=0 ; i < tsize ; i++){
   if (i+rot < asize){
     a[i+rot] = c[i];
   }
   if (i<rot){
     a[i] = '0';
   }
 }
}

```

Appendix E Source code full system in NodeMCU

```
#include <Wire.h>
#include "RTClib.h"

RTC_DS3231 rtc;

// Fill-in information from your Blynk Template here
#define BLYNK_TEMPLATE_ID "TMPLgTsQGJJi"
#define BLYNK_DEVICE_NAME "IOT Project"

#define BLYNK_FIRMWARE_VERSION        "0.1.0"

#define BLYNK_PRINT Serial
//#define BLYNK_DEBUG

//#define APP_DEBUG

// Uncomment your board, or configure a custom board in Settings.h
//#define USE_SPARKFUN_BLYNK_BOARD
#define USE_NODE_MCU_BOARD
//#define USE_WITTY_CLOUD_BOARD

#include "BlynkEdgent.h"

boolean virtualBypass = false, previous_virtualBypass = false;

int count = 0;

char data[24];
char LDR[24], IR1[24], IR2[24], C1[24], C2[24], C3[24], C4[24], VOLT[24];

double ldr, ir1, ir2, c1, c2, c3, c4, volt, kwh;
double previousc1=0, previousc2=0, previousc3=0, previousc4=0;
int this_month=0, today=0;
int previous_month=0, previous_day=0, previous_hour=0, previous_second=0;

double wattseconds = 0;
double kilowatthours = 0;

WidgetTerminal terminal(V9);

BLYNK_WRITE(V0)
{
  int data = param.asInt();
```

```
  if (data == HIGH)
    virtualBypass = true;
  else
    virtualBypass = false;


  if (virtualBypass == true && previous_virtualBypass == false){
    Wire.beginTransmission(8);
    Wire.write(1); // one must mean something to the mega,
    Wire.endTransmission();
//    Serial.println("Onz");
    terminal.clear();
    terminal.println("Bypass mode on");
    terminal.flush();
  }else if (virtualBypass == false && previous_virtualBypass == true){
    Wire.beginTransmission(8);
    Wire.write(0); // one must mean something to the mega,
    Wire.endTransmission();
//    Serial.println("X Onz");
    terminal.clear();
    terminal.println("Bypass mode off");
    terminal.flush();
  }

  previous_virtualBypass = virtualBypass;
  delay(5);
}

void setup() {
  Serial.begin(115200);
  delay(100);

  Wire.begin();

  BlynkEdgent.begin();

  terminal.clear();

  terminal.println("IOT Project By Seng");
  terminal.flush();

  #ifndef ESP8266
    while (!Serial); // wait for serial port to connect. Needed for native USB
```

```
  #endif

  if (! rtc.begin()) {
    Serial.println("Couldn't find RTC");
    Serial.flush();
    while (1) delay(10);
  }

  if (rtc.lostPower()) {
    Serial.println("RTC lost power, let's set the time!");
    // When time needs to be set on a new device, or after a power loss, the
    // following line sets the RTC to the date & time this sketch was compiled
    rtc.adjust(DateTime(F(__DATE__), F(__TIME__)));
    // This line sets the RTC with an explicit date & time, for example to set
    // January 21, 2014 at 3am you would call:
    // rtc.adjust(DateTime(2014, 1, 21, 3, 0, 0));
  }

  rtc.adjust(DateTime(F(__DATE__), F(__TIME__)));

}

void loop() {
  BlynkEdgent.run();
  DateTime now = rtc.now();

  Wire.requestFrom(8, 19);    // request 6 bytes from slave device #8

  if (Wire.available()==19) { // slave may send less than requested
    for (int a=0; a<19; a++){
      data[a] = Wire.read(); // receive a byte as character
    }
    Serial.println(data);          // print the character
  }

  count++;

    for(int a=0; a<4; a++){
      LDR[a] = data[a];
    }
    ldr = atofn (LDR, 4);
    Blynk.virtualWrite(V1, ldr);
```

```
    for(int a=4; a<8; a++){
      IR1[a-4] = data[a];
    }
    ir1 = atofn (IR1, 4);
    Blynk.virtualWrite(V2, ir1);

    for(int a=8; a<12; a++){
      IR2[a-8] = data[a];
    }
    ir2 = atofn (IR2, 4);
    Blynk.virtualWrite(V3, ir2);

    for(int a=12; a<15; a++){
      C1[a-12] = data[a];
    }
    c1 = atofn (C1, 2)/100;
    if (c1 != 0.01){
      Blynk.virtualWrite(V4, c1);
    }

    if (c1 == 0){
      Blynk.setProperty(V4, "color", "red");
    }else{
      Blynk.setProperty(V4, "color", "black");
    }

    for(int a=15; a<19; a++){
      VOLT[a-15] = data[a];
    }

    volt = atofn (VOLT, 4)/100;
    if (ldr > 650 || virtualBypass == true){
      if (volt > 3){
        Blynk.virtualWrite(V8, volt);
      }
    }else if (ldr < 650 && virtualBypass == false){
      Blynk.virtualWrite(V8, volt);
    }

    if (volt>0){
      if (c1==0 && previousc1==0){
        if (virtualBypass == true || ldr > 650){
```

```
          terminal.clear();
          terminal.println("Lamp fault detected!");
          terminal.flush();
        }
      }else{

      }
    }
    previousc1=c1;

    kwh = getkwh();
    Blynk.virtualWrite(V10, kwh);

    print_sensors_value();
}



double atofn (char *src, int n) {  //char to double convertor
  char tmp[50]; // big enough to fit any double

  strncpy (tmp, src, n);
  tmp[n] = 0;
  return atof(tmp);
}
```

Appendix F Grant Chart

YEAR		2022														
WEEK		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
NO	TASK															
1	Title Submission															
2	Data Collection for Proposal															
3	Proposal Presentation															
4	Finding Research/Journal															
5	Writing Literature Review															
6	System source code testing															
7	Report Writing (Chapter 1,2,3)															
8	Report 1 Submission															
9	Presentation															
10	Revised Report 1 Submission															

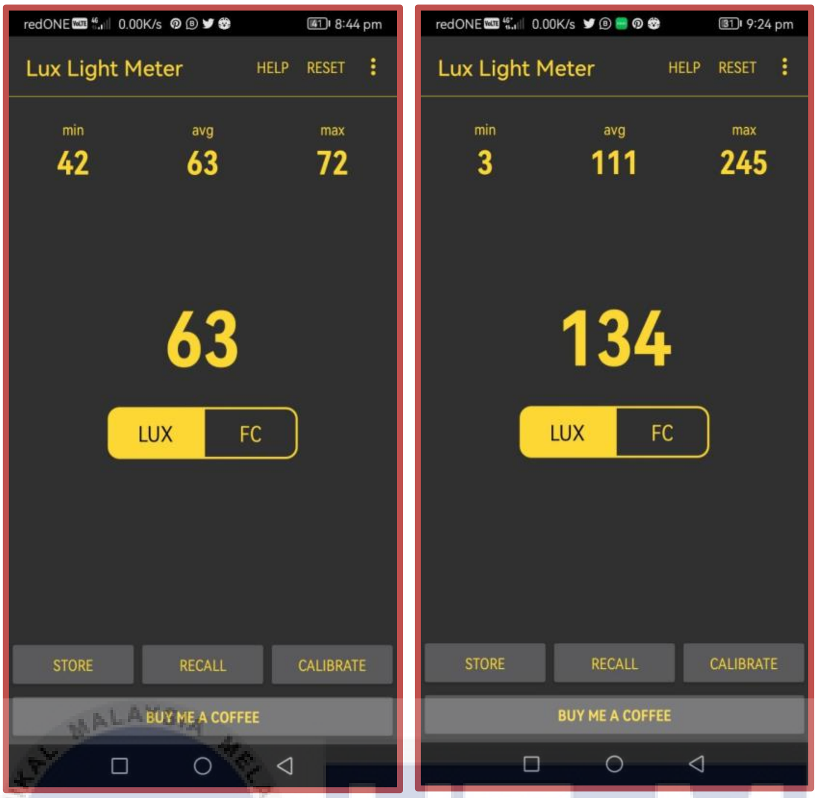
YEAR		2022 - 2023														
WEEK		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
NO	TASK															
1	Hardware Setup															
2	Software Setup															
3	Analysis Data Collection															
4	Draft Report Submission															
5	Writing Analysis															
6	Report Writing															
7	Logbook Submission															
8	Turnitin Report															
9	BDP Presentation															
10	Final Report Submission															

Appendix G Equipment & Measurement Device

Multimeter

Measure Tape

Blynk monitor



Lux Light Meter Apps

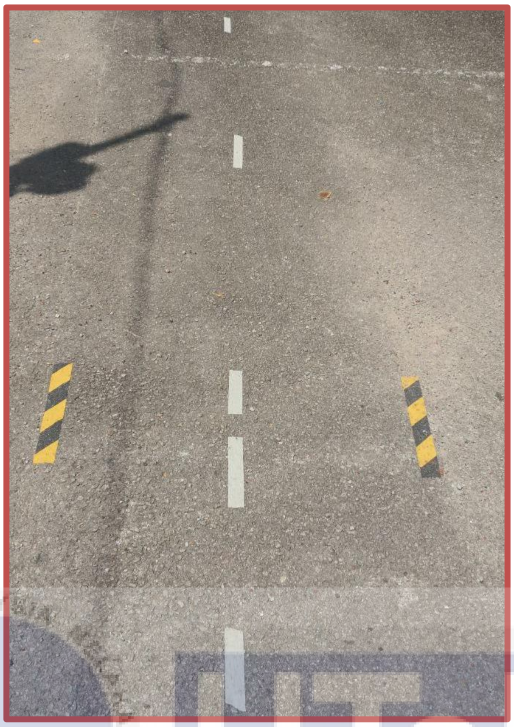
Appendix H Measurement for Solar Panel

Voltage Measurement

Solar Panel angle at 45°

Current Measurement

Appendix I   Setup the height and speed for IR sensor test

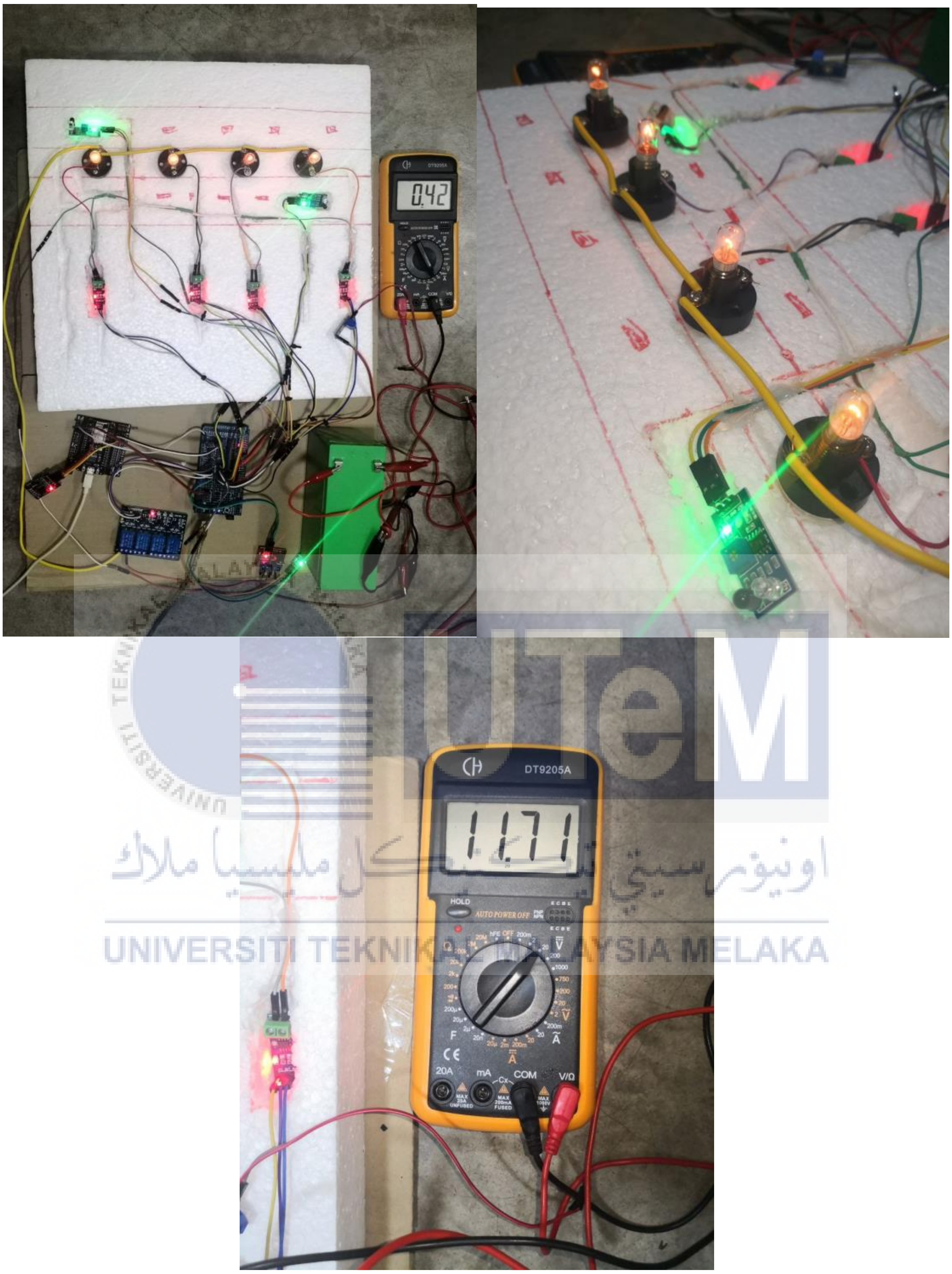


Motorcycle Track

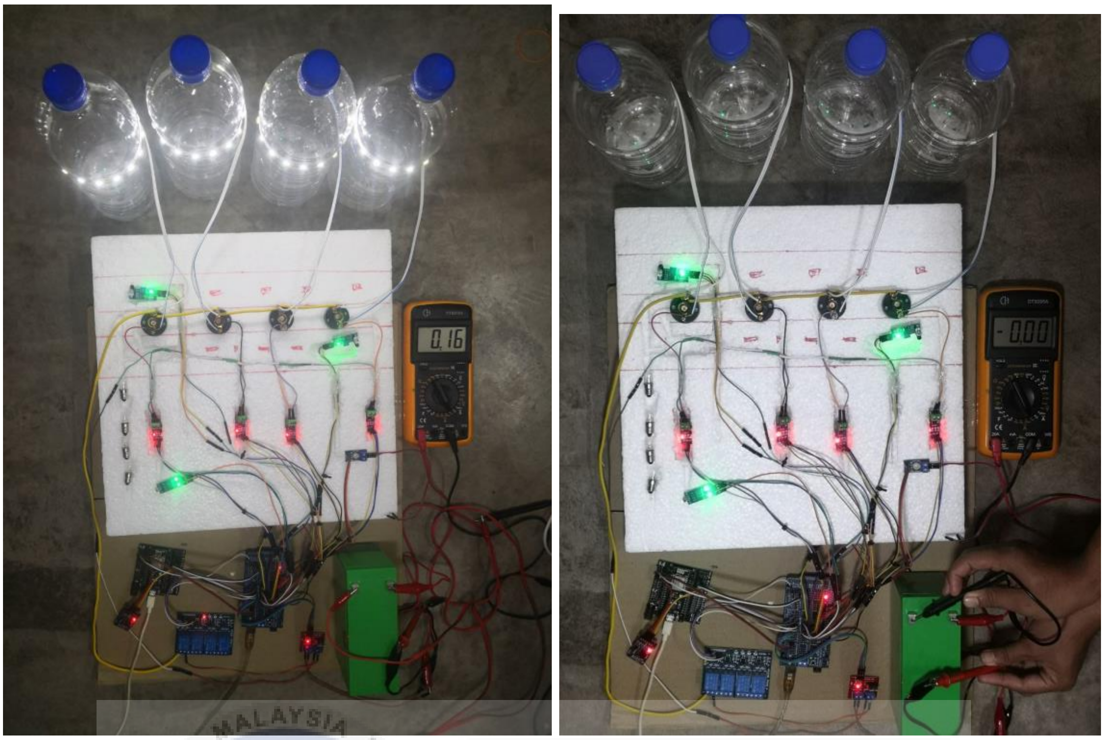
Measure the height of the sensor

ADV150 Motorcycle to set the speed(km/h)

Appendix J Measurement for Dc Light



Incandescent DC Bulb



LED Light