UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Electrical Engineering and Technology

BLINDSPOT DETECTOR AND INFORMER EQUIPPED WITH SOLAR ENERGY SYSTEM FOR HEAVY VEHICLE

MUHAMAD YAZID BIN BADEROL HISAM

Bachelor of Electrical Engineering Technology with Honours

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BLINDSPOT DETECTOR AND INFORMER EQUIPPED WITH SOLAR ENERGY SYSTEM FOR HEAVY VEHICLE

MUHAMAD YAZID BIN BADEROL HISAM

A project report submitted
in partial fulfillment of the requirements for the degree of
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FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

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I declare that this project report entitled “Blindspot detector & informer equipped with solar energy system for heavy vehicle” 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.

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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 with Honours.

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DEDICATION

This study is wholeheartedly dedicated to my beloved parents, Baderol Hisam bin Mohd Ismail and Norwati binti Tasmin who have been my source of inspiration and gave me strength when myself thought of giving up, who continually provide their moral, spiritual, emotional, and financial support.

To my brothers, sisters, relatives, mentor, friends, and classmates who shared their words of advice and encouragement to finish this study.

And lastly, I dedicated this book to the Almighty God ALLAH SWT, thank you for the guidance,

strength, power of mind, protection and skills and for giving me a healthy life.

Alhamdulillah.

ABSTRACT

The Blind Spot Detectors and Informer project aims to mitigate the rising global road accident toll, particularly involving heavy vehicles, responsible for 1.3 million annual fatalities according to WHO statistics. To enhance road safety, the project reviews prior studies, emphasizing the identification of three critical ranges for road users near heavy vehicles: safe, caution, and danger ranges. Following the study, key components crucial to the project's success are determined, recognizing their impact on the circuit's functionality. The methodology outlines the planned approach for achieving project objectives, ensuring each completed task contributes valuable insights for future endeavors. Critical to the project's success is a comprehensive testing phase. Solar stability tests assess energy production factors, such as speed and weather, crucial for the solar-powered system. The ultrasonic sensor undergoes distance tests, simulating various conditions to determine its detection capabilities at maximum and minimum distances. The entire circuit, from solar input to output on LCD, LED, and buzzer, undergoes functionality tests. Results and data from these tests are recorded and evaluated, guiding improvements and preventing issues in the integration of all components into a unified system.The project emphasizes utilizing knowledge, analysis, and experiences gained to generate impactful results for the community. By addressing the negligence-related blind spot accidents, the project aims to contribute significantly to the broader objective of reducing global road accidents and fostering a safer road environment.

ABSTRAK

Projek Pengesan Titik Buta dan Pemberitahu bertujuan untuk mengurangkan peningkatan kadar kemalangan jalan raya global, terutamanya melibatkan kenderaan berat, yang bertanggungjawab terhadap 1.3 juta kematian tahunan mengikut statistik WHO. Untuk meningkatkan keselamatan jalan raya, projek itu menyemak kajian terdahulu, menekankan pengenalpastian tiga julat kritikal untuk pengguna jalan raya berhampiran kenderaan berat: julat selamat, berhati-hati dan bahaya. Berikutan kajian, komponen utama yang penting untuk kejayaan projek ditentukan, mengiktiraf kesannya terhadap kefungsian litar. Metodologi menggariskan pendekatan yang dirancang untuk mencapai objektif projek, memastikan setiap tugasan yang telah selesai menyumbangkan pandangan yang berharga untuk usaha masa hadapan. Kritikal kepada kejayaan projek ialah fasa ujian yang komprehensif. Ujian kestabilan suria menilai faktor pengeluaran tenaga, seperti kelajuan dan cuaca, penting untuk sistem berkuasa solar. Sensor ultrasonik menjalani ujian jarak, mensimulasikan pelbagai keadaan untuk menentukan keupayaan pengesanannya pada jarak maksimum dan minimum. Keseluruhan litar, daripada input solar kepada output pada LCD, LED dan buzzer, menjalani ujian kefungsian. Keputusan dan data daripada ujian ini direkodkan dan dinilai, membimbing penambahbaikan dan mencegah isu dalam penyepaduan semua komponen ke dalam sistem bersatu. Projek ini menekankan penggunaan pengetahuan, analisis dan pengalaman yang diperoleh untuk menjana hasil yang memberi kesan kepada masyarakat. Dengan menangani kemalangan titik buta yang berkaitan dengan kecuaian, projek ini bertujuan untuk menyumbang secara signifikan kepada objektif yang lebih luas untuk mengurangkan kemalangan jalan raya global dan memupuk persekitaran jalan raya yang lebih selamat.

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LIST OF ABBREVIATIONS

V	-	Voltage
w/m2	-	Watt per meter (irradiance)
PV	-	PhotoVoltaic
A	-	Ampere
LED	-	Light Emitting Diode
LCD	-	Liquid Crystal Display
DC	-	Direct Current
Km	-	Kilometer
LDR	-	Light Dependent Resistor
BDP	-	Banchelor Degree Project
LiDAR	-	Light Detection and Ranging
ADAS	-	Advanced Driver Assistance Systems

CHAPTER 1

INTRODUCTION

1.1 Background

Blind spot detector & informer equipped with solar energy system for heavy vehicle is a project to increase the safeness and also to prevent from traffic accidents. The idea to produce this project was sparked after seeing the statistics of road accidents that are increasing every year and even more worrying among the main causes of road accidents is the negligence of road users towards the blind spots of vehicles especially heavy vehicles such as lorries and busses.

This project equipped with solar energy system as a source to generate the entire project system without disrupting the vehicle's main energy source. Therefore, this project will always provide the best service without any power interruption, if there is an interruption, then it will disrupt the function and efficiency of each component involved.

UN SDG consist of 17 goals, each with its own set of targets and indicators, according to the UN SDG states that in SDG3 (good health & well-being) there is an explanation about road safety, which is in 3.6, By 2020, halve the number of global deaths and injuries from road traffic accidents [1]. In line with what has been focused in SDG3 especially in 3.6, this directly shows that this project is able to some extent to help in reducing the number of road accidents. This project will help in improving the annual statistics of road accidents especially accidents involving loss of life. as we know the current statistics in Malaysia from January 2022 to September 2022 there are 402,626 road accidents with 4379 deaths recorded and an increase of 52 percent in road accidents involving death[2]. Among the main causes of these accidents is negligence at the blind spot area.

Figure 1.1 UN-SDG 17 goals for global [1]

1.2 Problem Statement

Road accidents and accidents involving death are increasing dramatically every year and in the data that has been recorded, WHO estimates that 1.3 million people die in road accidents every year [3]. but this data is only an estimate when referring to the data released by JPJ showing a more detailed number of accidents for Malaysia which is that road accidents for a year have reached 402,626 and accidents involving death are as many as 4379 [2]. Among the main causes of road accidents is due to the blind spot area, according to a survey prepared by the National Highway Traffic Safety Administration (NHTSA), 840,000 incidents caused by blind spots occur in the United States each year, with 300 people killed [4]. The most common problems involving blind spots while driving is, first, road users do not pay attention to the surrounding conditions and are willing to drive vehicles that are used close to the blind spot area of heavy vehicles such as lorries and buses. Next, drivers of heavy vehicles are not aware and cannot recognize vehicles that are close to their blind spot area.

In addition, at night or in dark places road users driving around heavy vehicles cannot see where the heavy vehicle's blind spot is.

1.3 Project Objective

Power distribution Power This project’s major purpose is to develop an efficient and structured safety system for reducing traffic accidents caused by vehicle blind spots, especially heavy vehicles. The effectiveness of this blind spot detector & informer equipped with renewable energy system for heavy vehicle will be compared to others vehicle’s blind spot detector product. Specifically, the objectives are as follows:

a) To study about renewable energy (solar energy) and blind spot area of heavy vehicle

b) To identify safe distance, caution distance and dangerous distance for vehicles when in blind spot position.

c) To design and develop an Arduino-based circuit that can accurately control and improve security by using suitable sensors such as Ultrasonic sensors and LDR sensors.

1.4 Scope of Project

The scope of the project is defined as follows:

a) Circuit Design

- This system consists of an Arduino circuit which is the main circuit connected to other components such as Ultrasonic sensors, LDRs, LEDs, LCDs. and this system also has a solar energy system circuit that will be connected to the main circuit as an energy source.

b) Program Development

- To use the Arduino IDE software to write C++ programming language commands for an Arduino UNO microcontroller to perform as a controller to control the input and output

c) Software Development

- To construct the circuit connections using suitable online based simulation such as PROTEUS software or TINKERCAD website, which can display the output for this design circuit

d) Hardware

- This project will be in prototype model, when it is to be commercialized it will improve to be more user-friendly and more organized.
- Ultrasonic sensor is one of main component it will be sensor that detect range for vehicle that near the blind spot, since it can detect until max. range 70 feet/ 21m. it will be range for safe, cautions and danger. Ultrasonic sensor will be placed near LED at each blind spot area

1.5 Sustaineable Development

Sustainable development in a project is necessary, because it is important to ensure that a product that is constructed is able to continuously have a positive impact on the community, to develop Blindspot detector & informer equipped with solar energy systems for heavy vehicle while considering sustainable development, several tools and procedure can be implemented, first prioritize energy efficiency by using components and technologies that consume minimal power. Incorporate a solar panel to harness renewable energy, ensuring proper positioning and orientation for maximum sunlight absorption. Additionally, utilize high-efficiency solar panels and implement a smart charging system to optimize battery management. Consider eco-friendly and recyclable materials for the device's housing and components, while avoiding hazardous substances. Design the device with end-of-life considerations, emphasizing recyclability and providing clear instructions for proper disposal. Educate road users to be more prudent and for this project will form a community that is responsible for each other and also it will minimizing energy consumption and environmental impact

1.6 Summary

From this chapter 1, it provide some introductory information about how the idea to create this BDP came about to the readers, and additionally in this chapter is also included data taken from the latest sources that have been updated and trusted. for the next chapter which is literature review chapter will explain about the sources of reference materials taken to strengthen all explanations and as a reference to help facilitate the process of making this project, in the next chapter which is methodology chapter will explain about the components involved in this project and how this project will be formed through several processes that will be expressed in the form of flow charts and block diagrams. The next chapter is the most important chapter which is results and discussion chapter, this chapter shows the tests that carried out to observe the functionality of each component and the stability of each output produced, and to ensure the entire circuit can operate accordingly. The last chapter is conclusion, in this chapter will summarize all the information, knowledge and experience obtained as a result of the research that has been done related to this project to achieve the objectives.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter (literature review) is a past study from a collection of academic references, such as journal articles and thesis, related to renewable energy and vehicle's blind spot especially heavy vehicle. The review process involves reading and evaluating various sources, taking notes, and organizing the information in a form that makes it easy to understand. The final result of this literature review chapter is typically a comprehensive report that summarizes the key findings and insights from the literature.

2.2 Vehicle's Blind Spot Area

Accidents caused by blind spots happen a lot and often happen to road users, many road users mostly don't know where the blind spot is for vehicles, and most of them don't care about it, various initiatives have been carried out by responsible parties, such as the government in dealing with accident cases, but the community needs to know that in order to deal with these accident cases from continuing to increase and continue to worsen, the community needs to join hands to deal with this issue by being a more attentive and responsible road user, in order to be a responsible and prudent road user, basic things such as knowing and caring about the vehicle's blind spot area need to be mastered and applied in everyday life.

As we all know, a vehicle's blind spot is an area around the vehicle that is difficult to see or cannot be seen by the driver even using vehicle facilities such as side mirrors and rear mirrors [5]. As shown in figure 2.1, This area is usually located behind the driver's seat and can extend outward to the side of the vehicle. The size and shape of the blind spot can vary depending on the type of vehicle, but it is usually larger for larger vehicles such as trucks and buses [6]. Therefore, drivers must pay attention to blind spots, by knowing their vehicles' blind spots and taking extra precautions, such as checking their blind spots before changing lanes or turning. because if there is negligence, it can cause danger to pedestrians and other road users.

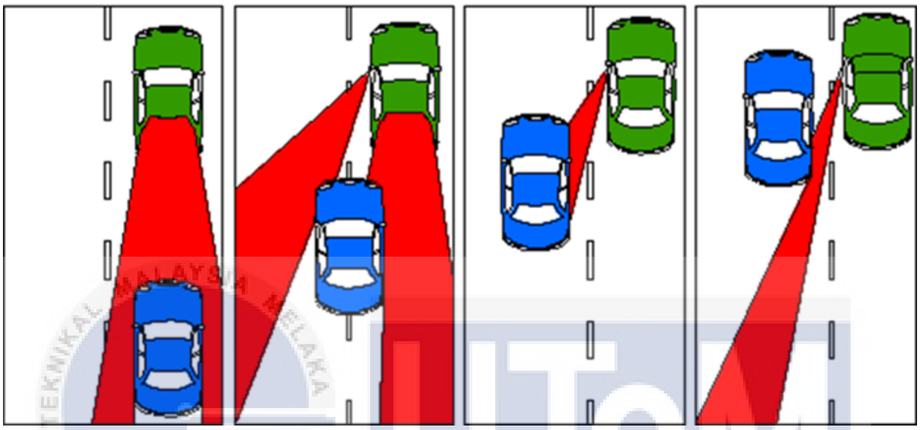


Figure 2.1 Car's Blindspot area

2.3 Blind Spot Area for Heavy Vehicle

Many road users expect heavy vehicle drivers to have a wide and clear driving view because their large vehicles are tall and have large mirrors, but what is expected is the opposite of what heavy vehicle drivers feel. Be aware that the blind spot area on heavy vehicles such as buses and lorries is larger than on light vehicles such as cars [7]. This is due to the width and length of the large vehicle, which creates several blind spots.

The number of blind spots for heavy vehicles is determined by various factors, including the size and type of vehicle. As shown in figure 2.2, Heavy vehicles often feature at least four blind spots, also known as "no-zones," or front blind spots, which are areas in front of the vehicle where the driver's view is obstructed by the hood, engine, and other vehicle components [6]. The second type of blind spot is the rear blind spot, which is the area behind the vehicle that the driver cannot see in the mirror or through the windshield.

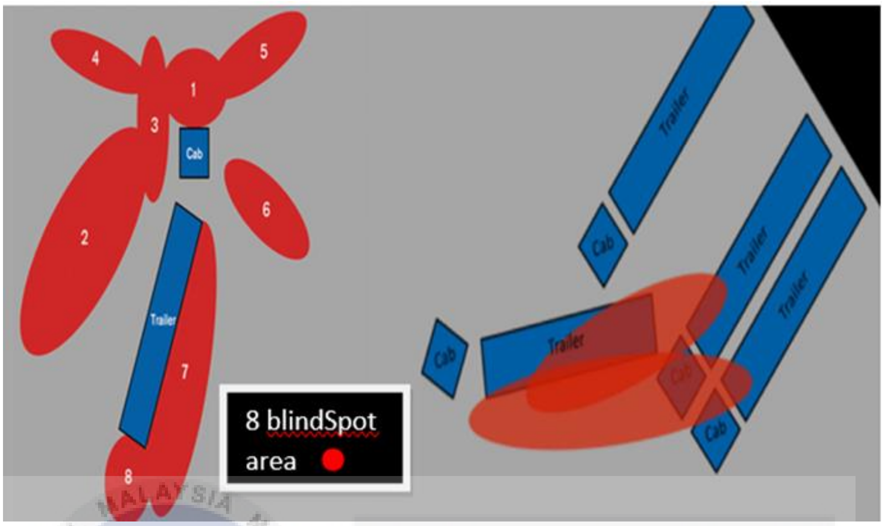


Figure 2.2 Truck trailer's (heavy vehicle) Blindspot area

Other than that, is the side blind spot which is the area on both sides of the vehicle where the driver's view is obstructed by the vehicle's body and mirrors. And finally, as shown in figure 2.3 and 2.4, blind spots when turning left and right, the areas left and right of heavy vehicles that are very dangerous when the vehicle is turning, because it can be difficult for drivers to see pedestrians and cyclists in those areas[6].

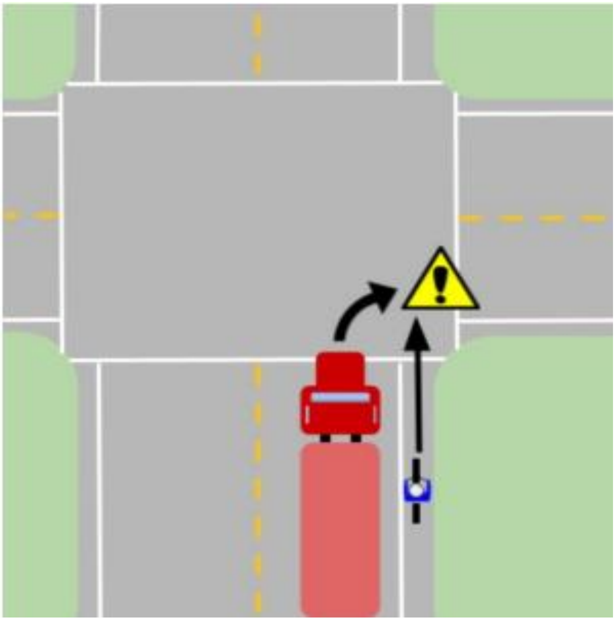


Figure 2.3 Blindspot area on the right side of heavy vehicle [6]

Figure 2.4 Driver's view during make a turn [6]

2.4 Suitable Energy Source for The Project System

When doing projects related to vehicles, we need to use energy sources that are compatible with vehicles, to ensure that the entire project can operate as planned without power supply interruptions. In this project there are two energy source systems that are suitable to be installed on the body of a heavy vehicle, the first is a energy source is an energy source from a regenerative braking system and the second is, renewable energy source which is a solar energy system.

2.4.1 Regenarative Braking System

Regenerative braking system (RBS) is a system that uses kinetic energy from the movement of vehicle tires to produce electricity. This regenerative braking system is widely used in hybrid vehicles and vehicles that use fully electricity to function [8]. Specifically, how this system is able to produce electricity is, as shown in figure 2.5, when the driver wants to stop the vehicle by pressing the vehicle brake, the electric motor is reversed, becoming a generator. This generator converts the kinetic energy of the moving vehicle into electrical energy. That energy is then stored in the vehicle's battery, ready to be used to power the electric motor again [9]. This process is achieved through the use of electric motors and generators that work together to slow down the vehicle and generate electricity. Regenerative braking systems also help reduce wear on the vehicle's brakes, as traditional friction brakes are used less often [8].

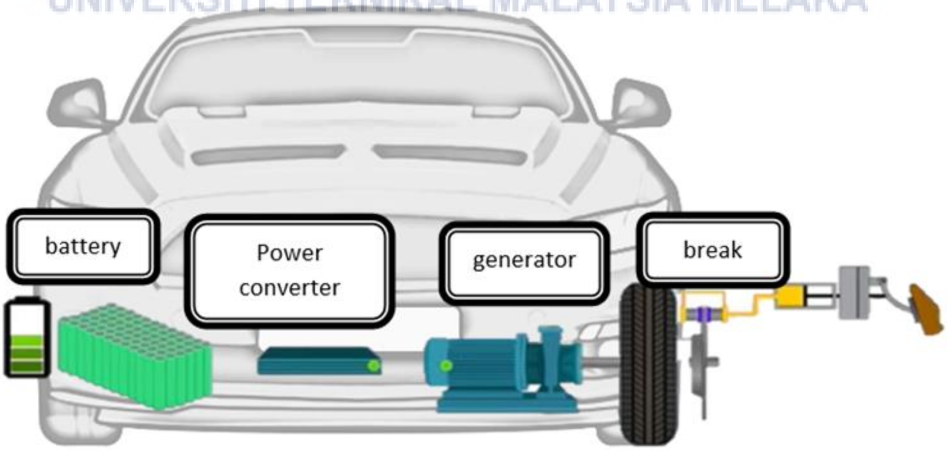


Figure 2.5 Main components and flow of operation for RBS

When opposed to traditional brakes, the usage of regenerative braking systems on automobiles offers numerous advantages to both the driver and the vehicle. Regenerative braking has the advantage of extending the range of electric vehicles by collecting part of the energy wasted during braking [8]. However, regenerative braking is not as effective as traditional braking at stopping a car, especially at higher speeds, it has a significant impact on driving and has a negative impact on other road users [10]. This implies that traditional brakes are still required to provide the stopping power required in an emergency.

2.4.2 Solar Energy System

Solar energy is produced from the rays of the sun. It is a renewable energy source that is considered one of the most promising clean energy sources due to its ability to reduce greenhouse gas emissions and combat climate change [11]. Furthermore, this energy is sustainable and can be used to power homes, businesses and industries. The essential components found in a solar energy system include solar panels, inverters and batteries. The Sun produces energy through nuclear fusion reactions that occur in its core, and this energy radiates out into space in the form of sunlight. Solar panels consist of photovoltaic cells and they are made of semiconductor materials such as silicon, which absorbs the energy from the sun and converts it into direct current (DC) electricity [12]. It is also becoming increasingly affordable, making it a viable alternative to traditional fossil fuels in many parts of the world.

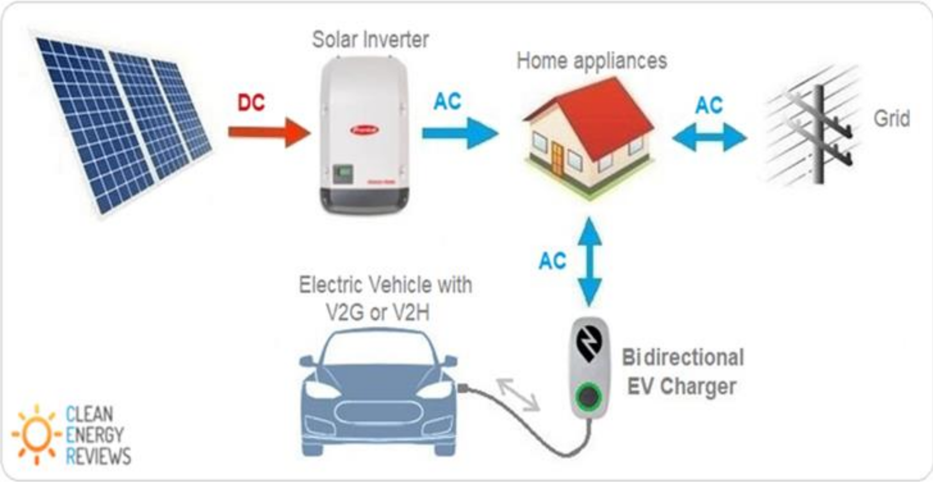


Figure 2.6 Solar system on-grid for daily use [13]

Figure 2.6 shows, there are two forms of installation in this solar energy system: off-grid and on-grid, and each has its own set of advantages for users. Solar is also suitable to be installed on vehicles and there are several vehicle brands that have included this energy system in their vehicle systems [14]. Solar for vehicles is the use of solar panels to capture sunlight and convert it into electricity, which may then be utilized to power various vehicle components. These panels, which are normally positioned on the vehicle's roof or body, create renewable energy that can be used to charge the vehicle's battery or directly power the vehicle's electrical systems. Solar power integration in automobiles promotes sustainability and ecologically friendly transportation options by reducing reliance on fossil fuels, lowering emissions, and increasing energy efficiency [14].

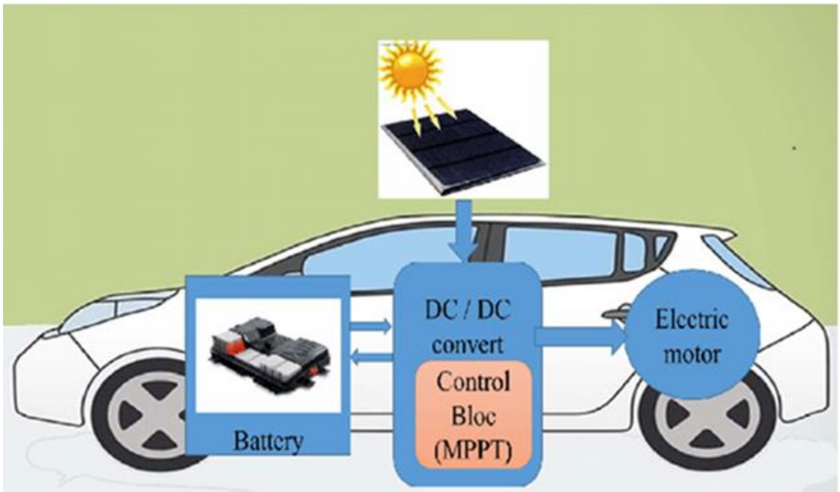


Figure 2.7 Solar system for vehicles

2.4.3 The Suitable Energy Source

After doing some studies and research, taking into consideration several factors such as suitability for vehicles, safety and consistency energy production. this project seems more appropriate to use solar energy sources which are renewable energy sources to distribute electricity throughout the project system, this is because the solar energy system completes all factors such as suitability for vehicles, safety, and consistency energy production.

Table 2.1 Comparison between RBS and solar system in terms of suitability for vehicles, safety, and consistency of energy production

Source of Energy	**Suitability for Vehicles**	**Safety**	**Consistency of Energy Production**
Regenerative braking system [10]	Less appropriate for installation on typical heavy vehicles that rely on fossil fuels as their primary energy source, because the installation will interfere with the driving mechanism and will almost certainly incur significant costs	Less safe because it will interfere with the braking system and efficiency when braking will decrease .	Energy production will be interrupted if the brakes are pressed only slightly, the weight of the vehicle is raised and

			the vehicle is in a slow state, etc .
Solar system [15]	Suitable to be placed on the body part of a heavy vehicle and it does not interfere with the vehicle's driving system such as brakes and others .	Safe to install and does not pose a risk to other road users .	Consistent energy production and depends only on sunlight .

Each of these renewables can have a positive impact on the environment, but in this situation renewable solar energy is more suitable for this project because most of the road users, especially drivers of heavy vehicles, spend more than 7 hours on the road, and from there it can be used to harvest solar energy for the use of this system project without having to make major modifications to the existing vehicle and it will not interfere with the main system of the vehicle.

2.5 Type of Solar Panel

In terms of solar panel efficiency and site suitability, as well as potential financial savings and environmental benefits for users, are important factors for solar panel selection. Solarpanels are classified into three types: polycrystalline, monocrystalline, and thin film.

- **Polycrystalline**

Polycrystalline solar panels as in figure 2.8 are composed of the same material as monocrystalline panels, however they are made up of many bits of silicon together. It is somewhat less efficient, but it is the most environmentally friendly to make and thus costs less to the end user [12].

Figure 2.8 Polycrystalline solar panel [12]

- **Monocrystalline**

Monocrystalline solar panels as in figure 2.9 are constructed of cells that have been cut from a single crystalline silicon. It is slightly more efficient than polycrystalline solar panels. As a result, monocrystalline panels produce a lot of power [12]. It is also the smallest and most durable of the other panels.

Figure 2.9 Monocrystalline solar panel [12]

- **Thin Film**

Thin film solar panels as in figure 2.10 are made of various materials such as cadmium telluride (CdTe), amorphous silicon (a-Si), and Copper Indium Gallium Selenide (CIGS). As a result, these cells are 350 times thinner than monocrystalline and polycrystalline panels [12]. These lightweight and versatile panels are useful for any roof design.

Figure 2.10 Thin film solar panel [12]

2.6 Energy Solar System for Vehicle

The solar energy systems and vehicles are practical elements that are suitable to be combined due to the daily use of vehicles on the road and under the sun, making them suitable for use in the daily life of road users. The use of solar energy in the automotive field is growing due to the improvement of increasingly sophisticated technology systems, and it has become an effort by most countries to reduce greenhouse gas emissions. There are several studies that have been done related to solar energy and vehicles, about the amount of energy that can be produced when a vehicle is installed with a solar energy system. A study was done by Alireza Aliakbari and Vahid Vahidnasab about (optimal charging scheduling of solar plugin hybrid electric vehicles considering on-the-road solar energy harvesting) [15] to see how much energy can be produced in a vehicle-mounted solar energy system, but this study does not tell in detail how much energy is produced, but it can still be related and be used as effective knowledge. this research to prove that the installation of solar energy systems on vehicles is relevant and very useful to create a clean and advanced environment.

The study they did was about comparing SPHEV and PHEV vehicles, SPHEV is (solar plug-in hybrid electric vehicle) while PHEV is (plug-in hybrid electric vehicle). in this study, our focus is on SPHEV vehicles, because we want to see statistical data done on what can be attributed to the energy production from the solar energy system. The system structure for the SPHEV vehicle has solar mounted on the roof of the vehicle and has two batteries which are batteries for solar energy storage and batteries for the grid.

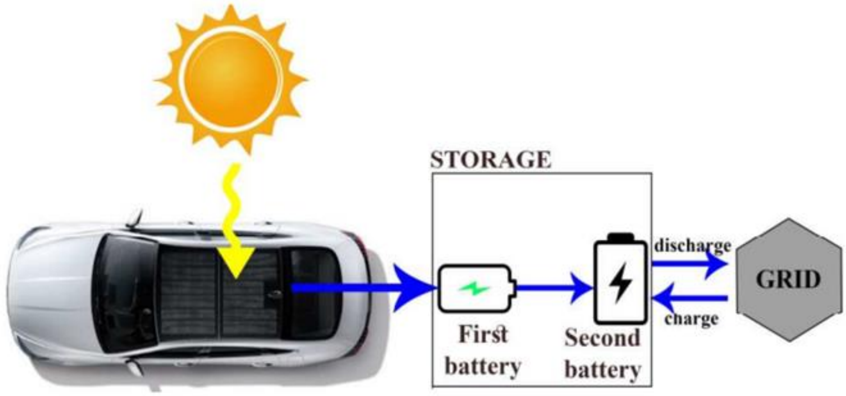


Figure 2.11 flow of SPHEV system [15]

In this study, SPHEV outperforms PHEV in cost savings, energy absorbed from the grid, and has a balanced suitability for use throughout the journey. the research done by the researcher, in this study shows that SPHEV energy consumption is as much as 120W/km with a speed of 80 km/hour, but during the journey, as in figure 2.12, the energy used has been replaced after getting energy from solar energy harvesting. The harvest in solar energy production as in figure 2.13 and 2.14 continues to increase when the car is in the parking lot because the vehicle is stationary and under the sunlight.

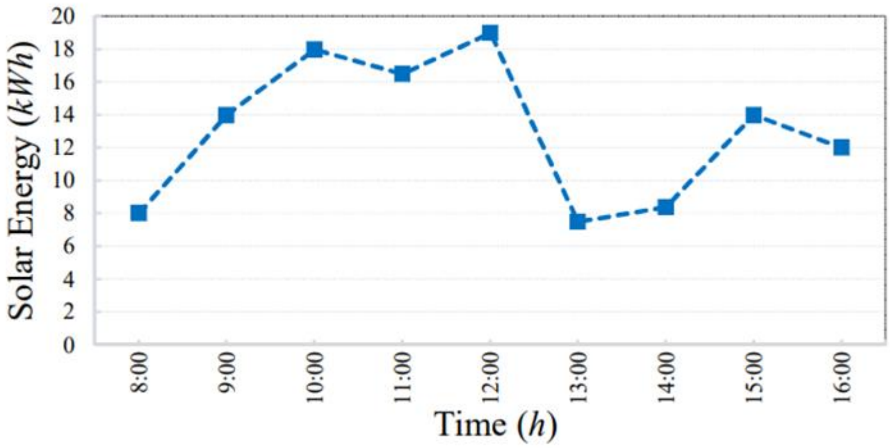


Figure 2.12 Solar energy produced from 8:00 to 16:00 on the road [15]

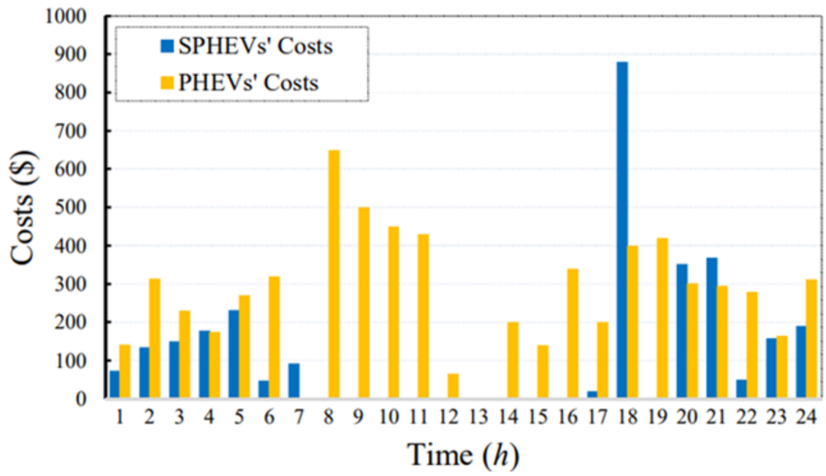


Figure 2.13 The cost incurred by SPHEV and PHEV when making a trip [15]

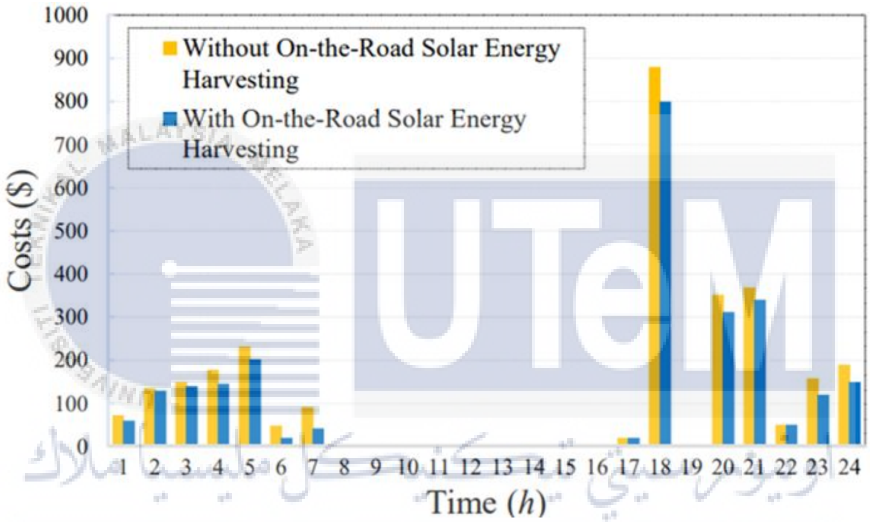


Figure 2.14 Difference in energy produced that impacts the cost of EV vehicle charging [15]

Overall, the installation of solar energy systems on vehicles is very relevant because significant energy production occurs throughout the trip depending on the weather and shading conditions, based on a study conducted by students of Shahid Beheshti University in Tehran, Iran, it is as evidence that the installation of solar energy on vehicles for example that can be taken from this study is SPHEV, is able to harvest a lot of solar energy, and can directly reduce charging costs and get energy the resulting is used for the entire system while in route to the destination.

2.7 Advantages and Disadvantages of Reading Material Related to This Project

There are several reading materials or previous studies related to this project that have been used as references to strengthen all the contents explained. but there are still deficiencies in the reading material/previous studies to make it fully a reference medium for this project, the table below shows the advantages and disadvantages found in each reading material taken as a reference:

Table 2.2 Comparison of studies made by several researchers related to this project

No.	Topic of Research	Year	Authors	Advantages	Disadvantages
[5]	BlindSpotNet: Seeing Where We Cannot See	2022	Taichi Fukuda, Kotaro Hasegawa, Shinya Ishizaki Shohei Nobuhara, and Ko Nishino	Explains about the study to detect blind spot areas by using the LiDAR system	1) No exposure to heavy vehicles and the study focuses more on cars
[6]	A semi-trailer truck right-hook turn blind spot alert system for detecting	2023	Charles Tang and Nicholas Medeiros	Can find out how to detect vehicles close to the blind spot of heavy vehicles when turning	1) No warning is included in the form of a sound such as the use of a buzzer, plus it does not seem

	vulnerable road users with transfer learning			by using visual warnings from the camera	to help other road users when in dark areas.
[7]	The Implementation of Rilpot Sensor Integration In the Real Blindspot Application as a Media for Millenial Generation Driving Safety Learning In the 4.0 Era	2022	Winoto Hadi, Kencana Widawati and Anthony Costa	1) States traffic accident data caused by blind spots 2) Produce an effective project to prevent accidents caused by blind spots 3) This system also teaches about the appropriate distance to avoid being in the blind spot	1) This system is lacking in terms of warning in the form of a sound like a buzzer and does not explain about the coding used in this system
[8]	Research on Regenerative Braking Systems: A Review	2020	Baker Guney and Halil Kilic	Explains the process of generating electricity from the kinetic energy that comes from the movement of the tire	1) Does not explain more specifically about the speed limits for producing minimum and maximum energy

[9]	To Study and Analysis on Performance of Regenerative Braking System (RBS)	2023	Rahul Gupta and Ajit Singh	Explain how regenerative braking systems work and the mechanisms involved.	1) Does not explain how much minimum and maximum speed isrequired to produce energy.
[10]	Regenerative Braking System (RBS)	2021	Angkit Mamgai	Has shared knowledge about RBS, how to produce energy and the good and bad effects of its use	1) The sharing given is only focused on basic knowledge about RBS and is not comprehensive.
[12]	Solar Panel and Types	2022	Yousef	Explains about the solar system, how solar can produce energy from sun by using solar panels, and the types of solar panels.	1) lack of deeper exposure and explanation about the solar system

[14]	Solar Car	2014	Khairul Euhsan Fahim	1) Explained the suitability of installing solar panels on vehicles 2) Has shared knowledge about solar types and more knowledge about solar	1) The research done does not explain how much distance is used when doing the test and the speed used is either constant or there is acceleration.
[15]	Optimal Charging Scheduling of Solar Plugin Hybrid Electric Vehicles Considering On-the-Road Solar Energy Harvesting	2020	Alireza Aliakbari and Vahid Vahidnasab	1) Has explained the difference between the two states of EV cars with solar installed and without solar installed 2) Has elaborated on the data analysis with good explanations	1) Does not explain the type of solar and the components used in more depth.

[16]	Blind-Spot Collision Detection System for Commercial Vehicles Using Multi Deep CNN Architecture	2022	Muhammad Muzammel, Mohd Zuki Yusoff, Mohamad Naufal Mohamad Saad, Faryal Sheikh and Muhammad Ahsan Awais	1) Explain the study in using RCNN to detect blind spots for heavy vehicles 2) This system can detect the type of approaching vehicle by focusing on the width of the vehicle	1) Has a weakness if it is on a dark and potholed road
[17]	Defensive Ecological Adaptive Cruise Control Considering Neighboring Vehicles' Blind-Spot Zones	2016	Yu Hee, Youngki Kim, Dayoung Lee, and Sang Hwa Kim	This study explains how to calculate the appropriate speed limit and the speed limit of other drivers using the ADAS system	1) It is very difficult to understand the process of this system 2) Looks unsuitable for use on heavy vehicles because it has different lengths and widths

[18]	LaRASideCam: a Fast and Robust Vision-Based Blindspot Detection System	2007	Nicolas Branc, Bruno Steux, Ecole des mines de Paris, and Thomas Hinx	This project is designed to detect the condition of the front of the vehicle and the surrounding vehicle tires	1) This study/project is more focused on light vehicles, especially cars
[19]	Realtime Object Monitoring and Warning Systemin Vehicle Blind Spot Region	2021	Atikkuzzaman Ullash and Prasanjit Das	1) This project/study is very helpful because it has a similar concept to prevent accidents caused by blind spots 2) Explains the deeper function of the ultrasonic sensor function	1) The project is only focused on motorists, and no signs or warnings are displayed to other road users if they are on a dark road 2) This project is more focused on light vehicles, especially cars

[20]	Analysis of Blind Spot in Heavy Vehicles Driving Using VIKOR Method	2022	Jomon Jose, Vidhya Prasanth, M. Ramachandran and Ashwini Murugan	Provides an analysis of the use of the VIKOR method on heavy vehicles to detect blind spots	1) This study is lacking in terms of data and also the explanations are in the form of long sentences and difficult to understand
[21]	An analysis of the impact of the driver's height on their visual field range	2018	Emilia Magdalena Szumska and Paweł Tomasz Grabski	1) Explained the advantages of safety systems on branded vehicles such as Mitsubishi in dealing with blind spot issues by using certain sensors 2) Shows data/studies on what drivers see when driving by using drivers who have differences in GMI, height, weight, etc.	1) Data/studies incomplete, only focus on light vehicles, especially cars

2.8 Summary of The Articles

Articles that shares the research knowledge and project that has been made by a group of students or researchers related to the blind spot, regenerative braking system and solar energy is a very helpful article and in addition this article shares very important data for the project that can help in the improvement of this project, such as data. about the appropriate distance when close to heavy vehicles, the position of the driver's gaze in large and tall vehicles, the appropriate speed to detect blind spots, a clear description of the relevant components and others. This informative article is very useful in ensuring that this project successfully produces a blind spot detector equipped with a solar energy system that has an impact on the community and can achieve its objectives.

2.9 Summary

By referring to the reading material in chapter literature review of the knowledge and experience gained regarding the blind spot area, the appropriate energy to use, and other things that can be obtained as a result of reading past studies related to this project, it helps to some extent in facilitating all processes and also being able to help achieving the project's objectives.

Then in chapter methodology, will discuss the process flow in making this project, type of equipment or software will be used and explanation in more depth, and will also explain the main components involved in this project.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In general, chapter methodology will discuss the approaches and procedures used in this project, as well as the hardware and software required to complete it, with a focus on the efficacy of blind spot detector and informer equipped with solar energy system for heavy vehicle. This project will employ an Arduino Uno microcontroller as well as appropriate software and hardware to assure its success.

3.2 Methodology

In every research, challenges in implementing a certain process or approach, analyzing information and others will definitely exist and it is not an obstacle that can make the research or project implementation process stop, but it is an obstacle that matures and increases self-motivation to continue to be enthusiastic in achieve the objective. Methodology is defined as a family of logic used to study reasoning or as a method of doing something. This project (Blindspot detector & informer equipped with solar energy system for heavy vehicle) will be designed on a small-scale in the form of a prototype, it will analyze the effectiveness of this project system blind spot detector & informer for heavy vehicle with battery-based solar system as electrical energy supply for this system.

3.3 Project Architecture

The process of this project needs to be designed well and clearly so that the results of its manufacture do not run away from the main objective, every statistic in the making of a project needs a flow chart to see its functional process. A flowchart is a simple graphical representation of a complete project or program. It displays the steps in a logical order. A flowchart displays the progress of a project from start to finish. A flowchart illustrates the evolution of a project from start to finish. Predevelopment consists of research and information gathering, as well as an understanding of all programming languages and functional design. Following the pre-development phase, the first stage of development is to include the data collection procedure in the Arduino coding. During the post-development step, the simulation results are output to the hardware for the last time.

3.3.1 Project Main Flowchart

This project work flow chart aims to explain the work system of this project in order to better understand the overall process of project work and to know the important main processes required in the making of this project.

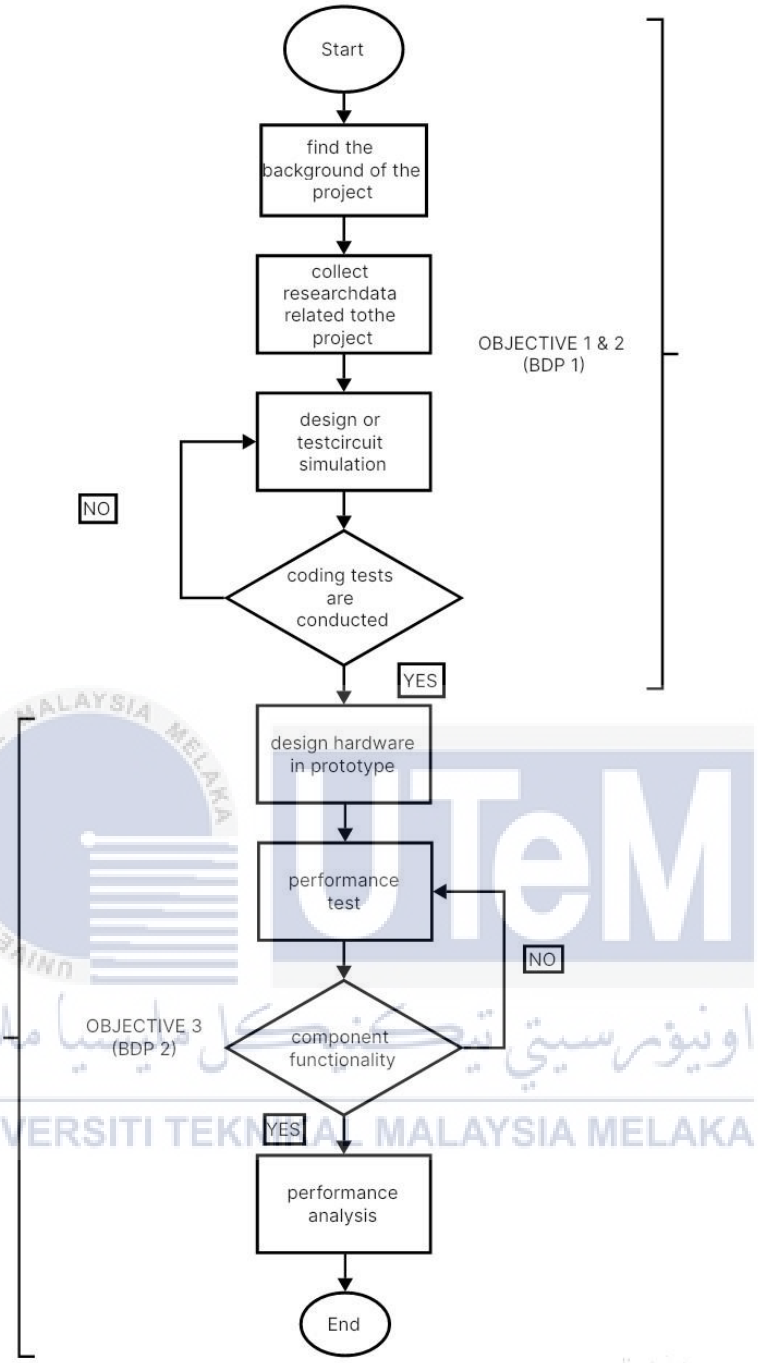


Figure 3.1 Project main flowchart

- **Find the background of the project**

find appropriate data to strengthen the explanation of the selected project title and to show the motive of this project that will provide benefits to the community

- **Collect research data related to the project**

Data or knowledge obtained from reading material research that can be used as evidence to strengthen the explanation in each chapter, especially chapter 2

- **Design or test circuit simulation**

This project will be designed using TinkerCAD, or proteus software

- **Design hardware in prototype**

The project will be developed by using 2 or 4 ultrasonic sensor, LCD, buzzer, solar panel, charge controller, battery, LDR sensor, LED and Arduino microcontroller.

- **Performance test**

The project will be tested under sunlight to see how many watts of energy will be produced and how many volts will be required to power the entire system. next, to test the sensors found in the project such as the ultrasonic sensor and the LDR sensor will be tested in different ways

- **Performance analysis**

The effectiveness of the developed project will be analyzed in terms of output functionality, consistency, and sensor efficiency.

3.3.2 Project Simulation Flowchart

This flowchart simulation project shows as in in figure 3.2 explains how this project operates in the form of software, and the software that will for this simulation is ThinkerCAD or Proteus.

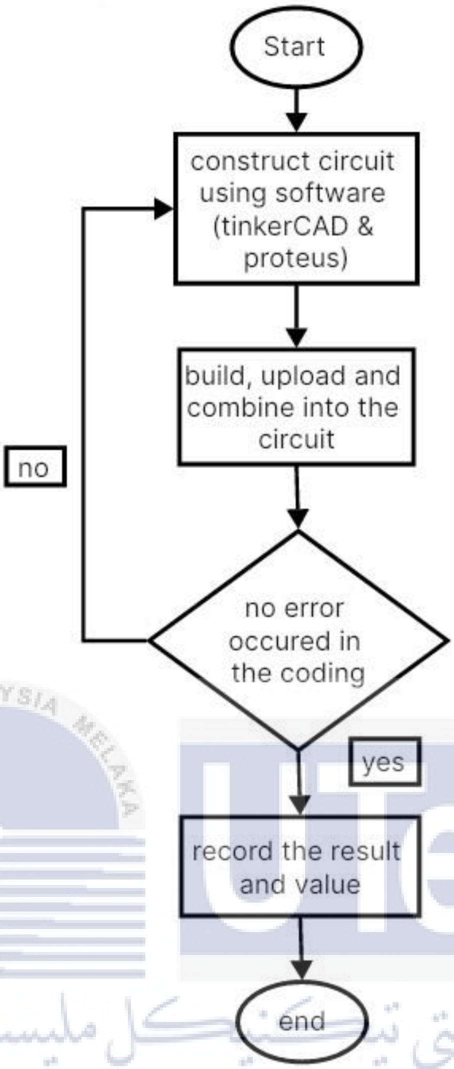


Figure 3.2 Flowchart for project simulation

3.3.3 Project System Flowchart

The flow chart as in figure 3.3 the project system is a step to see how this project will work and interact between one component with another in form of hardware, it also aims to give the reader an understanding of how this project operates in detail from the reception of solar energy, about how the sensors respond to the surrounding condition, and until the output is turned on. it will be the initial plan to achieve the project objectives.

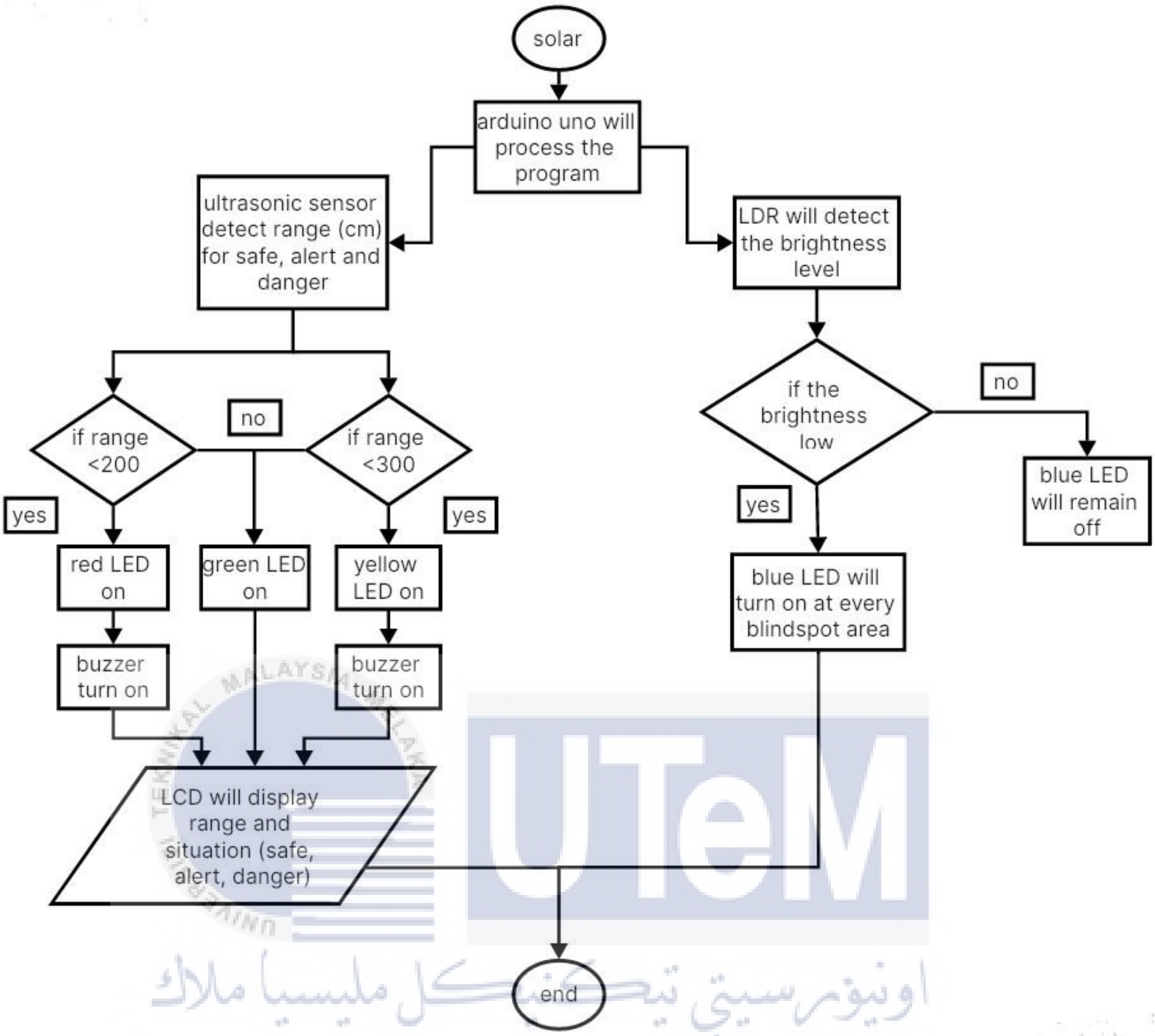


Figure 3.3 Flowchart for system project

3.4 System Architecture

The most important principle to carry out this process is the sensors that detect the surrounding conditions and also the Arduino uno as the "brain" in controlling the system. In addition, the generated solar energy is used as the main source to power this system. The voltage stored in the charge controller will then be split between the battery and the Arduino UNO. Figure 3.4 presents the block diagram of this project.

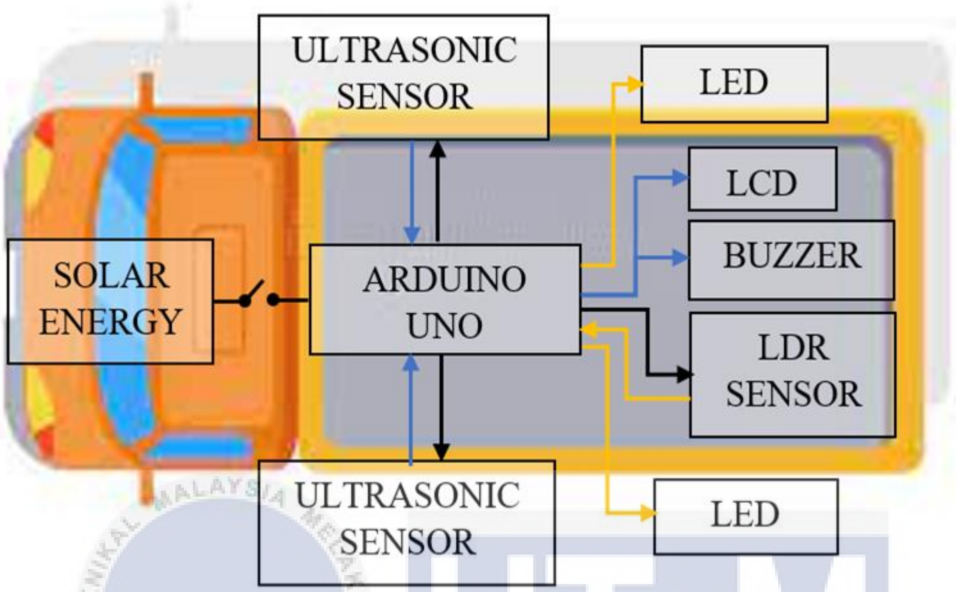


Figure 3.4 Block diagram of project process flow

a) Solar energy is the main power supply for this system and it will work to power the entire circuit and also charge the battery.

b) Arduino will work as the brain in controlling the input and output in this project system. The components involved will work according to what has been set in the coding that has been programmed in the Arduino.

c) Sensors like ultrasonic sensor and LDR will work if they detect something related to it, ultrasonic sensor will detect distance for alert area and danger area. for LDR will detect dark and sunny weather.

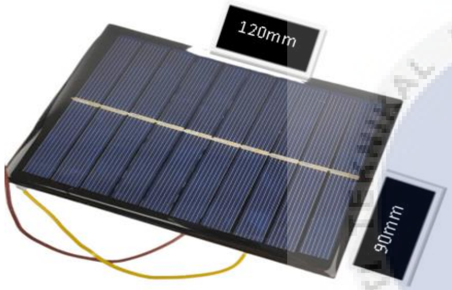
d) The buzzer will work after receiving the Arduino signal from the relevant input

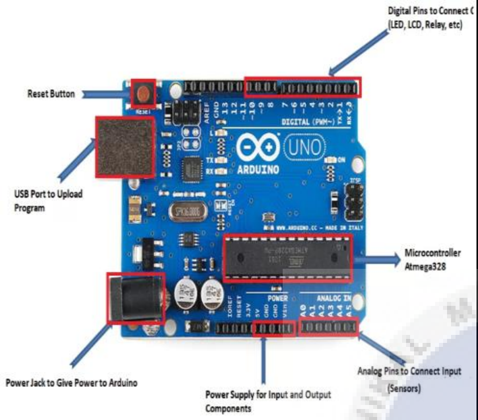
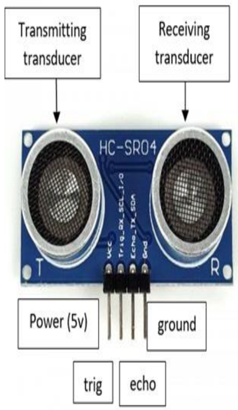
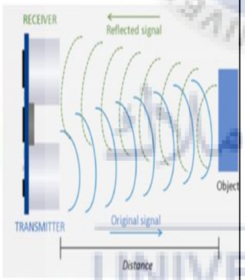
e) The other outputs such as LCD, red and yellow LEDs will work according to certain situations, i.e. alert and dangerous situations, meanwhile the blue led turns on after receiving input from the LDR.

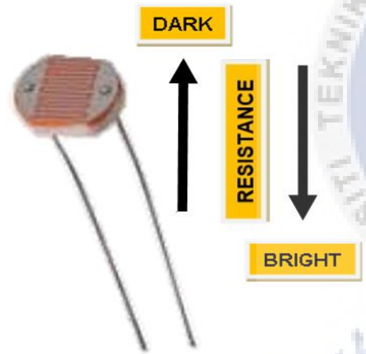
3.5 Hardware Components

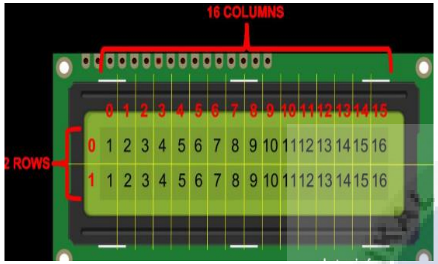
Hardware is an essential component of any project, particularly a prototype model because it allows us to reflect all of our real data and work. Because the simulator's output is based on computer/software calculations, which excludes other aspects such as environmental conditions, a project that solely relies on software, such as simulation, will be unable to collect actual data/work. The best hardware enables us to study both hardware and software while also enhancing our design and modeling skills.

Table 3.1 List of main component with expanation, specification and purpose for this project

Hardware component	Explanation	Specification	Purpose for this project
Solar Panel 	As explained in the previous chapter related to the types of solar panels, there are 3 types of solar panels which are monocrystalline, polycrystalline and thin film. each has its own advantages, but the solar panel that is suitable to be installed on a car is the thin film type because it is flexible and can be installed according to the shape of the car.	• **(Pmax):** 1.25w • **2. (Vmp):** 5v • **3. Size :** 120mm x 90mm	In prototype form, this project is suitable to use polycrystalline or monocrystalline due to their efficiency and availability in smaller sizes to supply voltage to turn on the entire system of this project.
Arduino Uno [22]	The Arduino Uno is a microcontroller board based on the ATmega328P processor that is open-source. There are 14 digital I/O pins, 6 analogue	• **Operating Voltage:** 5V	Arduino uno is used in this project as a center that controls the input and

	inputs, a USB connection, a power jack, an ICSP header, and a reset button. It contains all of the modules necessary to support the microcontroller [22]. Furthermore, the microcontroller and other components on the Arduino board require 5V to operate.	• **Input Voltage:** 7-12V • **Digital I/O Pins:** 14 • **Analog Input Pins:** 6	output to operate as programmed
Ultrasonic Sensor 	The ultrasonic sensor HC-SR04 is a detection device with an Arduino output that consists of a pair of transmitters and ultrasonic receivers that can be used to measure the distance of objects based on the beam of waves on a target and the sound waves being reflected after hitting the target [7].	**HC-SR04** • **Maximum Range:** 2 cm to 400 cm (or 1 inch to 13 feet) • **Operating Voltage:** 5V DC • **Accuracy:** ±3 mm	In this project, the use of ultrasonic sensors is to detect vehicles that are close to the blind spot area of heavy vehicles. It will be installed in the blind spot area on heavy vehicles, in the form of a prototype, this project will only use 2 or 3

		• **Trigger Pulse Width:** 10 µs	ultrasonic sensors to demonstrate its functionality
LDR Sensor 	A LDR (Light Dependent Resistor) sensor is a passive electrical component that alters its resistance in response to the intensity of light. In the dark, their resistance is very high, sometimes reaching 1 M, but when exposed to light, the resistance reduces rapidly, often dropping to a few ohms, depending on the light intensity [23].	• **Resistance Range:** 1kΩ - 100kΩ • **Dark Resistance:** 1MΩ • **Light Resistance:** 1kΩ	In this project LDR functions as an input that will respond to the situation if the heavy vehicle is passing through a dark area to turn on the output related to the situation it gives.

Liquid Crystal Display (LCD) [24] 	LCD is an acronym for Liquid Crystal Display. It is a flat-panel display technology that generates images using liquid crystals. The 16x2 LCDtransforms a 16-character-per-line display into two such lines. Each character is presented in a 57 pixel matrix on this LCD [24].	• **Operating Voltage:** 4.5V to 5.5V • **Display Size:** 16 characters per line, 2 lines (16x2)	In this project, the LCD will display 2 different conditions, the first is the “caution” distance (0.8m - 1.5m) and the second is the “danger” distance (0.1m - 0.8m)
Buzzer [25] 	An auditory signaling device, such as a beeper or buzzer, can be electromechanical, piezoelectric, or mechanical. The primary function of this is to transform the audio signal into sound. In general, it is powered by DC voltage and utilised in timers, alarm devices, printers, alarms, computers, etc. It can make sounds such as alerts, music, bell, and siren according to the design [25].	• **Operating Voltage:** 5V • **Operating Current:** 20mA • **Sound Frequency:** 2.5kHz	In this project, the buzzer will work if it receives a "danger" signal that has been programmed in Arduino uno from the sensor input

Light Emitting Diode (LED) 	A light-emitting diode, or LED, is a semiconductor diode that generates incoherent narrow-spectrum light when electrically biassed in the forward direction of the p-n junction, as in the conventional LED circuit [26].	• **LED Type:** 5mm Round • **2. LED Color:** Red, Yellow, and Blue • **Forward Volt:** 2.0-2.2V • **Forward Current:** 20mA	In this project the LED as an output will operate for the first two conditions when receiving a signal from the LDR and the second when receiving a signal from the ultrasonic sensor for yellow "caution" and red "danger".

3.6 Software Development

This is an essential software program that helps fulfill the entire project system. The use of software in this project is part of the manufacturing process to ensure that the objectives set are accurate and achievable, the software used helps a lot to facilitate all processes.

Table 3.2 List of software used for the simulation with explanation/definination

Software	**Definition / Explanation**
Tinkercad	Tinkercad is a free 3D modelling program that is well-known for its simplicity. It is entirely web-based, so anyone with an internet connection can access it. It is used by children, educators, and enthusiasts to design anything they can think of. It also has simulation features, which allow you to see how your circuit might perform in real life. The use of this website is very helpful to see the pre-result that will be produced.
Proteus	Proteus is a simulation software that allows you to design, simulate, and test electronic circuits prior to physical implementation. It creates and connects electronic components in a virtual environment, simulates their behavior, and analyses circuit performance. It assists engineers and students in the design and development process by identifying and resolving potential issues prior to prototyping.

Arduino IDE  	The Arduino IDE (Integrated Development Environment) is software that allows you to program the Arduino microcontroller. It offers a simple interface to create, compile and upload code to the Arduino board. It comes with a code editor, compiler, and serial monitor to interact with Arduino.

3.7 Development Process

This subtopic will show the main processes in terms of software processes and hardware processes involved in this BDP, there are some improvements from BDP1 to BDP2 in terms of software processes in the Arduino c++ program, and the hardware processes also have some improvements, especially regarding the system circuit, in This subtopic will describe the improvements that have occurred.

3.7.1 Software development

In developing and building this project to meet the objectives that have been set as a benchmark for the success of BDP, this project needs to go through the software development phase, this is very important because this phase is decisive in seeing the flow of this project, which is the project itself using arduino c++ program. In this sub topic will show how the software development process is carried out starting from designing a c++ program for arduino up to circuit testing in simulation through proteus.

- **C++ programming language**

```
#define KIRI      0
#define KANAN     1
#define DEPAN     2
#define BELAKANG  3

const int LEDBluePin = 2;
const int LEDRedPin = 3;
const int LEDYellowPin = 4;
const int trigPinLeft = 5;
const int echoPinLeft = 6;
const int trigPinRight = 7;
const int echoPinRight = 8;
const int trigPinFront = 9;
const int echoPinFront = 10;
const int trigPinBack = 11;
const int echoPinBack = 12;
const int buzzerPin = 13;
const int ldrPin = A0;


const float RANGE1=30.00;    // <= 200 = danger
const float RANGE2=60.00;    // > 200 < 300 = beware
```


Figure 3.5 Pin declaration for c++ Arduino program

```
void turnOnRedLED() {
  digitalWrite(LEDRedPin, HIGH);      //turn on RED LED
  digitalWrite(LEDYellowPin, LOW);    //turn off Yellow LED
}

void turnOnYellowLED() {
  digitalWrite(LEDYellowPin, HIGH); //turn on Yellow LED
  digitalWrite(LEDRedPin, LOW);     //turn off RED LED
}

void turnOffLED() {
  digitalWrite(LEDRedPin, LOW);      //turn off RED LED
  digitalWrite(LEDYellowPin, LOW);   //turn off Yellow LED
}

void turnOffBlueLED() {
  digitalWrite(LEDBluePin, LOW);      //turn off Blue LED
}

void turnOnBlueLED() {
  digitalWrite(LEDBluePin, HIGH);      //turn off Blue LED
}

void onBuzzer() {
  digitalWrite(buzzerPin, HIGH);
}
```

Figure 3.6 C++ Arduino program for Void system

```
int getMinDistanceId(float distanceLeft, float distanceRight, float distanceFront, float distanceBack) {
  int minDistanceId = -1;
  if ((distanceLeft <= distanceRight) && (distanceLeft <= distanceFront) && (distanceLeft <= distanceBack))
    minDistanceId = KIRI;
  else if ((distanceRight <= distanceLeft) && (distanceRight <= distanceFront) && (distanceRight <= distanceBack))
    minDistanceId = KANAN;
  else if ((distanceFront <= distanceLeft) && (distanceFront <= distanceRight) && (distanceFront <= distanceBack))
    minDistanceId = DEPAN;
  else if ((distanceBack <= distanceLeft) && (distanceBack <= distanceRight) && (distanceBack <= distanceFront))
    minDistanceId = BELAKANG;
```


Figure 3.7 C++ Arduino program for Condition system

In this section shows how to design a c++ Arduino program for this BDP project, the pictures as shown in figure 3.5, figure 3.6 and figure 3.7 are among the main parts that make the Arduino system able to act according to the instructions given. In Figure 3.5, the depicted portion represents the declaration of pins where, in this C++ program section, it provides signals to the electronic components declared to operate. Figure 3.6 corresponds to the part known as void, serving as the determinant of output functionality within the system when in a particular state. Moving to Figure 3.7, it illustrates specific conditions set for input components to respond to and signal output components accordingly.apart from that, through the success of this c++ programming language, we can proceed to the next methodological process to see if this C++ Arduino program is suitable for the entire circuit and is able to help in achieving the objectives that have been set in this BDP

- **Circuit functionality in simulation (proteus)**

1. Ultrasonic sensor HC-SR04

This component will be tested using proteus software to find out the max and min range and also the appropriate range to set the "caution" and "danger" range for the hc-sr04 type of ultrasonic sensor. In addition, to test the C++ program that has been made to make this sensor work according to what has been programmed and can send "caution" and "danger" range signals to the LCD.

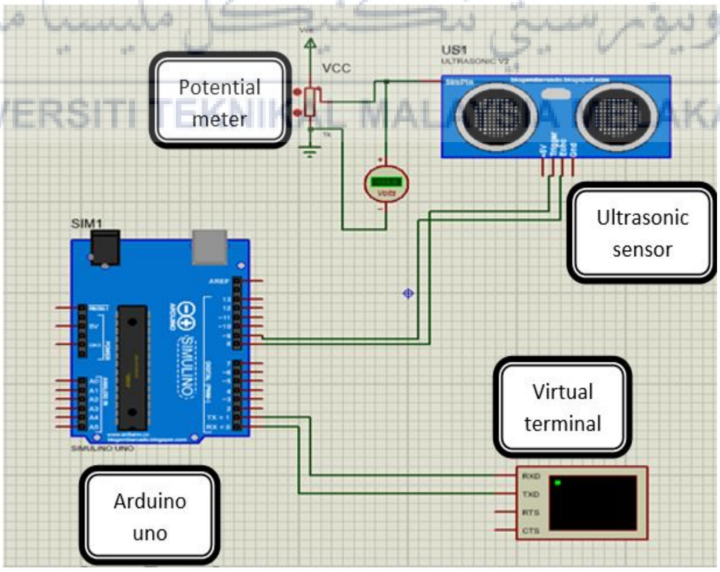
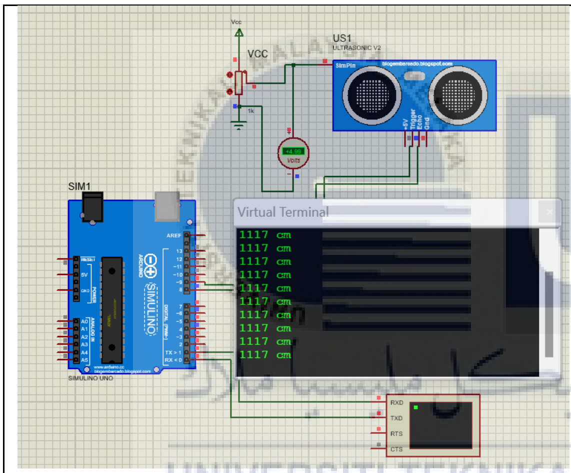
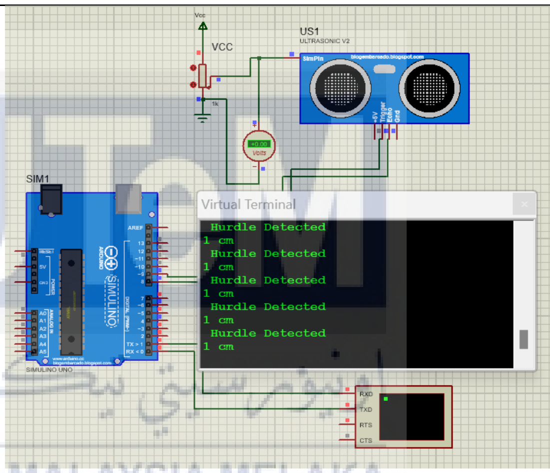


Figure 3.8 Simple circuit to measure range min and max

- This simple circuit as shown in figure 3.8 is used to shows the min and max distance for this hc-sr04 type ultrasonic sensor.
- This circuit consists of main components such as Arduino uno, potential meter and virtual terminal. and simple coding has been uploaded in the Arduino.
- The potential meter plays a role in determining the distance of the ultrasonic sensor in virtual testing using software (proteus). The virtual terminal also serves to display the distance delivered by Arduino uno from the sensor signal input

Table 3.3 The distance of min. and max in proteus simulation.

	
Maximum range: 1117 cm / 11.17 m	Minimum range: 1 cm / 0.01 m

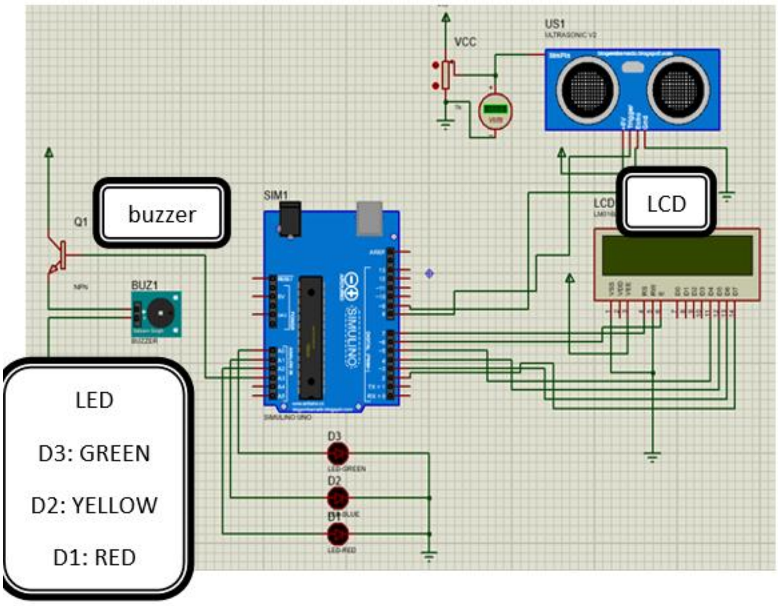
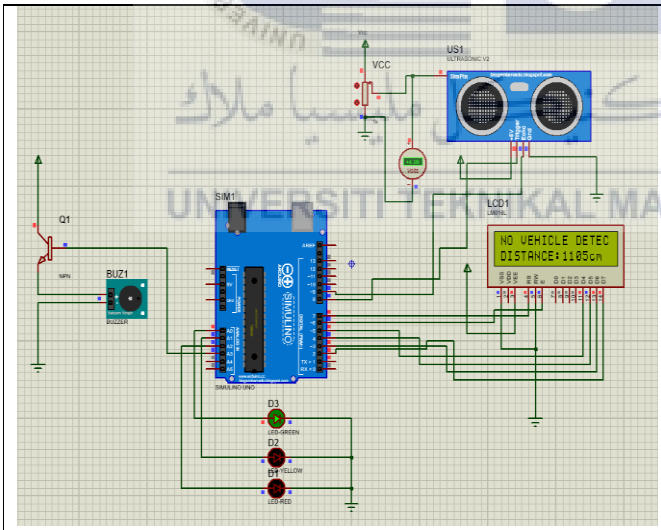
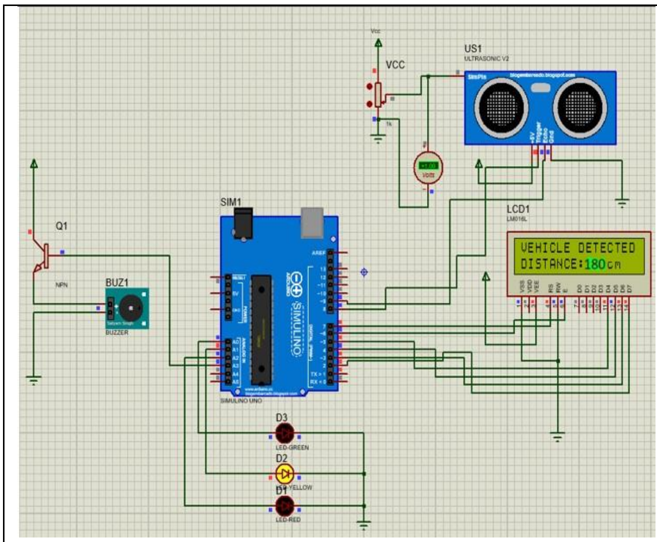
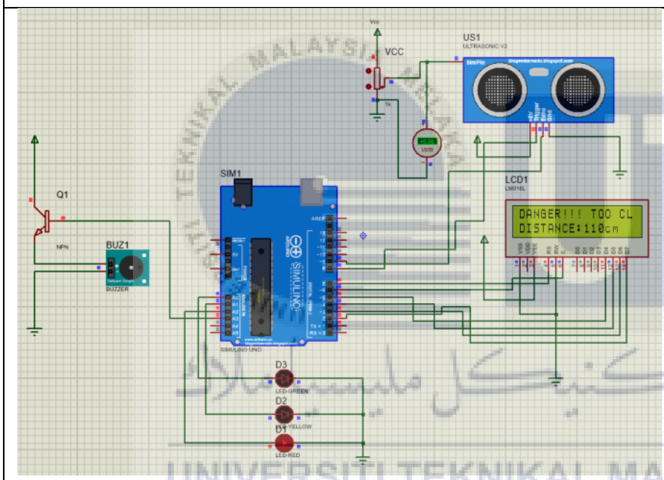


Figure 3.9 Simple circuit to for LCD, LED and buzzer

Table 3.4 The functionality for ultrasonic sensor connected with the LCD, LED and buzzer in proteus simulation

	• Range: 300cm and above (> 200) • LED Green will turn on • LCD will display "NO VEHICLE DETECTED" DISTANCE (200cm and above) • Buzzer remain off

	• Range: 200cm to 300cm (> 200 < 300) • LED yellow will turn on (blink 1s) • LCD will display "VEHICLE DETECTED" DISTANCE (200cm to 300cm) • Buzzer will on off (1s and keep repeating)
	• Range: 200cm and below (< 200) • LED Red will turn on • LCD will display "DANGER!!! TOO CLOSE" DISTANCE (200cm and below) • Buzzer will turn on

For table 3.4 shows the distance that will be detected by the ultrasonic sensor that has been programmed in the Arduino to shows the distance that has been set in the objective, that is the safe distance, the caution distance and the danger distance, but in the hardware development, Safe distance will not be shown and the green LED will not light up and the LCD will not display any signal as shown in the proteus simulation for the reason of reducing and saving the use of solar energy stored in the battery. However, it does not mean that there is no safe distance for the blind spot area in this project, the Arduino c++ program has set for each distance, for the danger distance of 200cm and below, the red light will light up, the buzzer will sound and the LCD will display the distance, for the caution distance of 201cm to 300cm, the yellow LED light is on, the buzzer does not sound and the LCD will display the distance while the safe distance is 301cm and above, all outputs are in a state of rest or off mode for energy saving purposes.

2. Light Dependent Resistor (LDR)

This component will be tested through software testing (TinkerCad) and will focus on testing the value of resistance, voltage, and current resulting in 2 conditions, dark and bright.

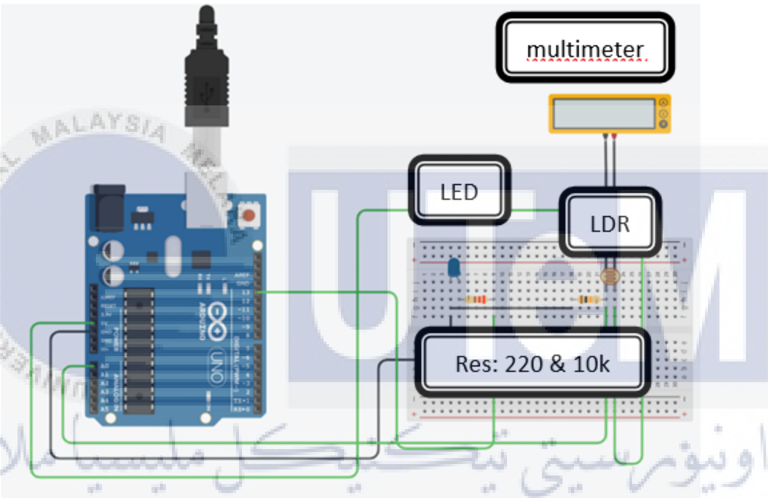
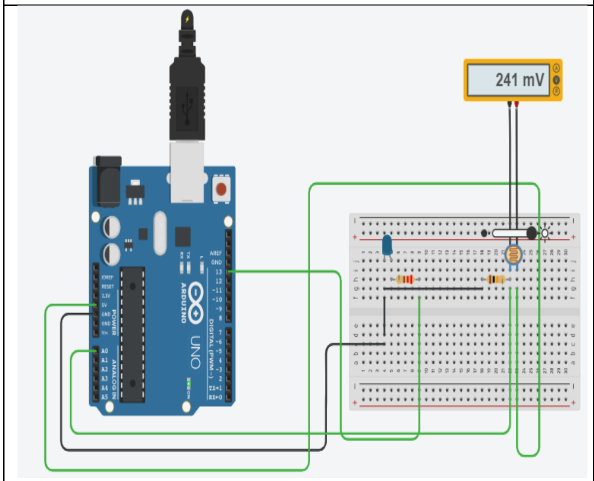
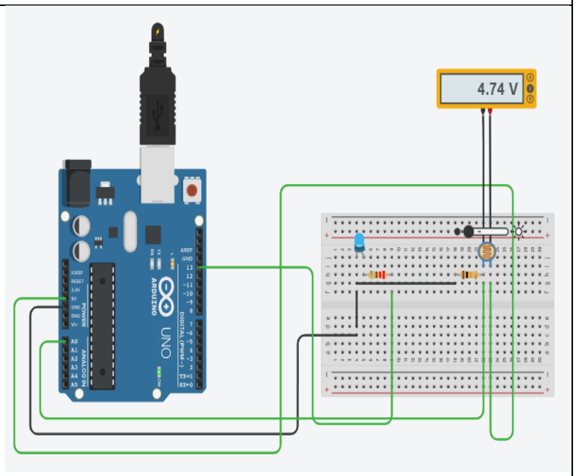
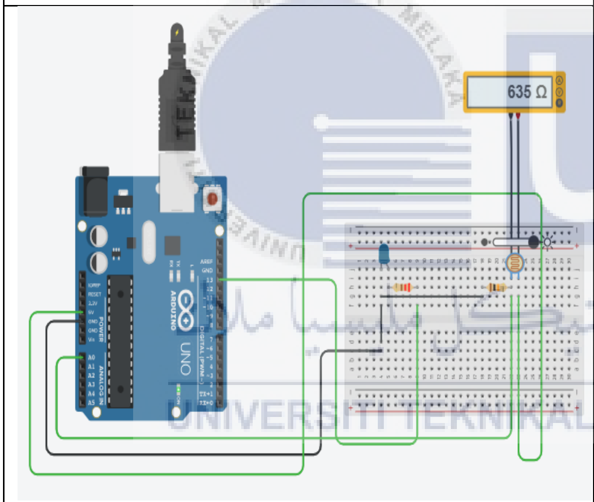
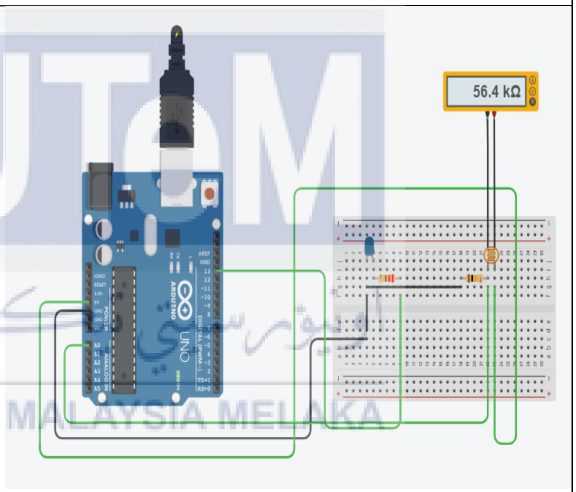
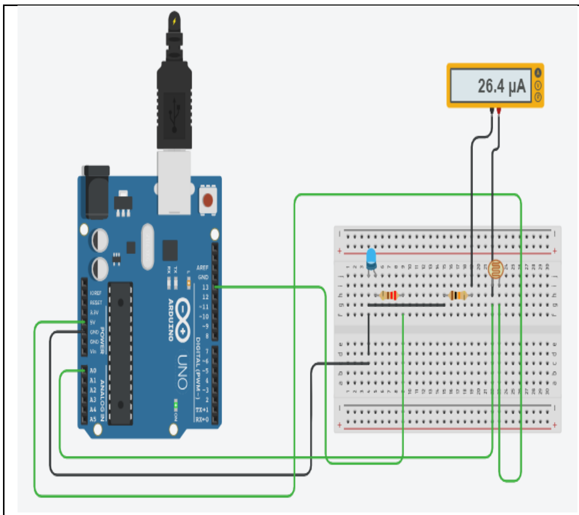
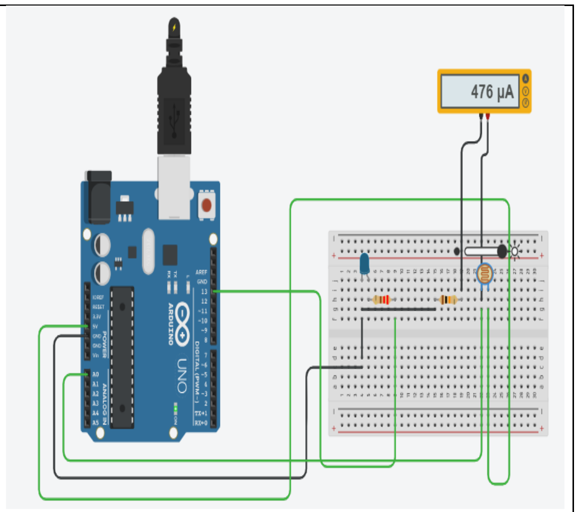


Figure 3.10 Simple circuit for LDR test to measure voltage, current and resistance

In Figure 3.10 and Table 3.5, the operation of a basic LDR circuit is demonstrated in two states: dark and bright. By utilizing illustrations from the ThinkerCAD application, one can observe how the concept of Light Dependent Resistors (LDR) functions.

Table 3.5 The value for voltage, current and ressitance during bright and dark condition.

Bright Condition	**Dark conditoin**
 Voltage: low voltage (0.241V)	 Voltage: high voltage (4.74V)
 Resistance: low resistance (635 ohm)	 Resistance: high resistance (56.4k ohm-error)

	
Current: low current (26.4uA)	Current: high current (476uA)

3. Functionality of Entire System Circuit in Proteus Simulation

In this section shows the overall functionality of the project circuit in the simulation (proteus), the circuit works well starting from the input such as the ultrasonic sensor and the LDR can provide a good signal to the output such as the LCD, LED and buzzer.

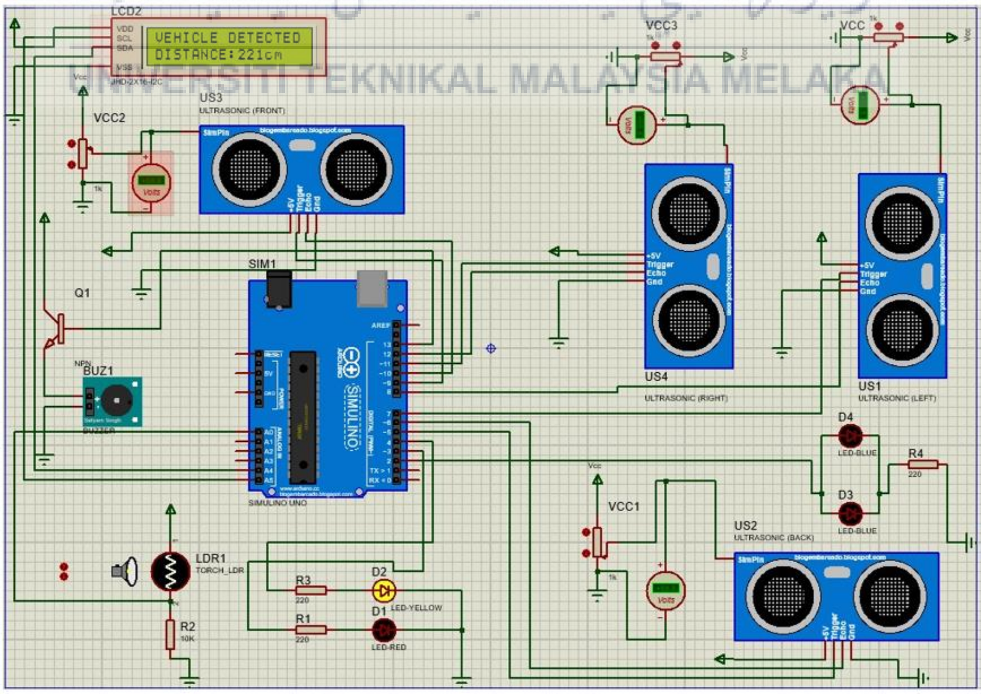


Figure 3.11 Entire cicruit system in proteus simulation

The successful simulation process depicted in Figure 3.11 within this software development methodology holds promise for seamless integration into the subsequent hardware development phase. By leveraging Proteus simulation, the groundwork laid in software development can be translated effectively into hardware development, thereby enhancing the likelihood of achieving all set objectives. This transition facilitates a coherent and structured approach, where insights gained from software simulations can inform hardware design, streamlining the overall development process. The synergy between software and hardware methodologies fosters synergy, allowing for refined iterations and ensuring that the objectives are met efficiently and comprehensively.

3.7.2 Hardware davelopment

In this BDP project, the hardware software is an important phase to see the processes of the BDP project that have gone through the software development phase can be created successfully when changed in the form of hardware to see the success of the project from before to the last. phase which is the testing and data collection phase. in this hardware development phase, processes such as soldering, construct basic solar energy circuit connection, and making connections on each component have been carried out to see and evaluate whether the connections made in the proteus simulation can be used or not when making connections in the form of hardware.

- **Cicuit connections**

The circuit connections illustrated in Figures 3.12 and 3.13 demonstrate how the operation is carried out for the interconnection of circuit components. This is achieved by utilizing a donat board and connecting them using tin and a soldering iron to ensure a neater, stronger, and more organized circuit layout.

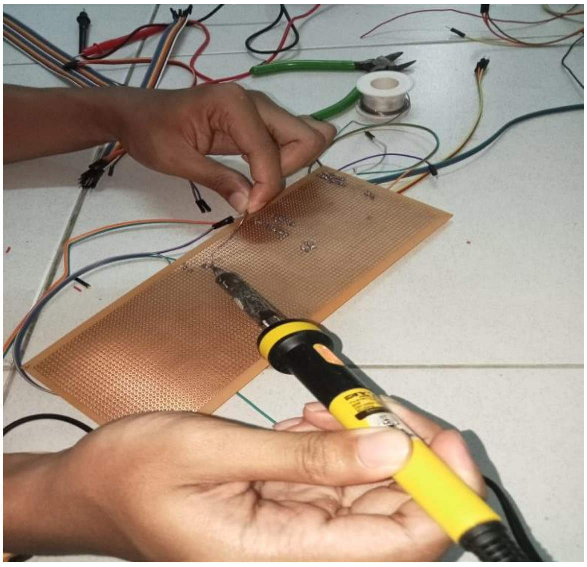


Figure 3.12 Solder the circuit connections for each component

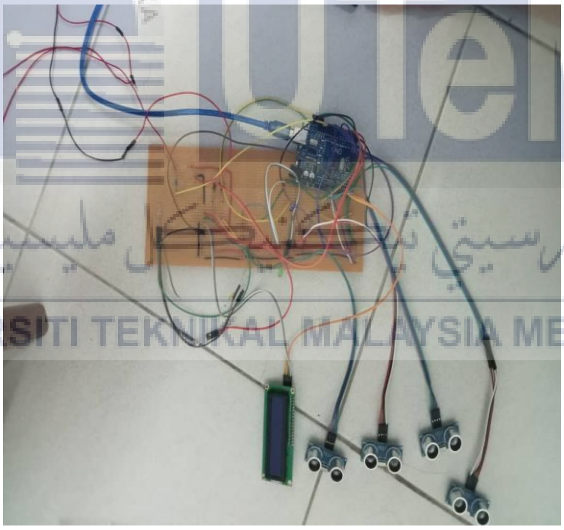


Figure 3.13 The result of circuit soldering to connect components to others

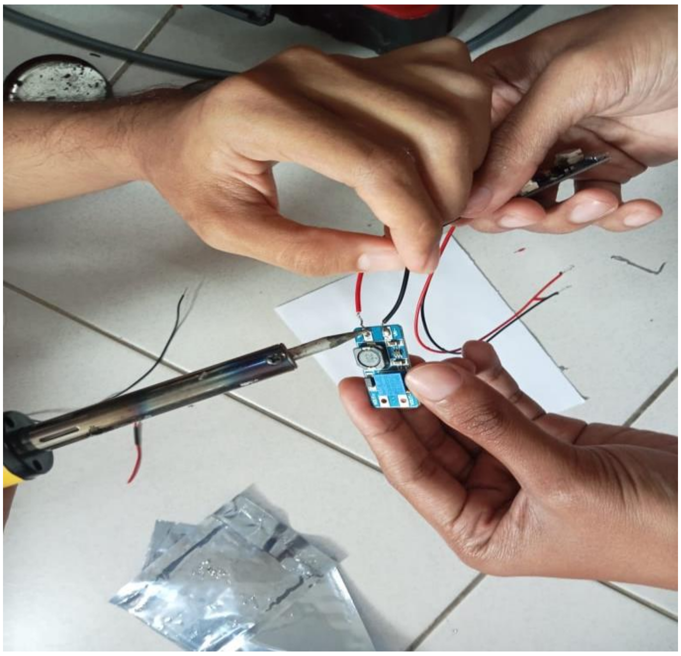


Figure 3.14 Make connections from solar to charge controller and to step up converter

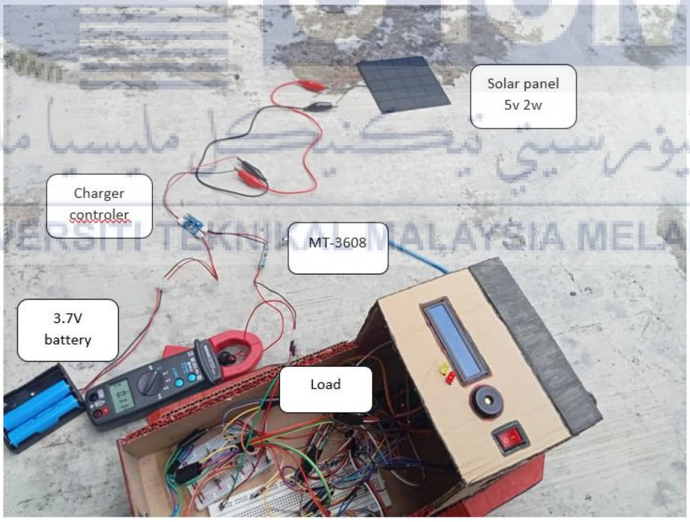


Figure 3.15 The solar energy connection circuit to the load circuit

This section shows some of the processes involved in forming a more efficient and neat circuit, in this section it also explains about the basic solar circuit required in forming the energy that will help supply the 5v supply to the circuit system. Among the components involved in forming the basic circuit for solar energy as shown in figure 3.12 are the solar panel, the charge controller, the 3.7v lithium ion battery and the last one is the step-up converter. in the methodology phase for this hardware development proves that the success in combining all the components in one circuit and then will continue to the next phase to evaluate and see the overall functionality.

3.8 Gantt Chart and Milestone

Gantt charts and project milestones are preliminary planning sketches in the making of the project and the structuring of the steps that need to be taken to achieve all the objectives that have been set for this project. planning in perfecting all the processes involved in this project will be shown in the Gantt chart and milestone to give a clear flow of what has been planned to be done each week to achieve the main objectives.

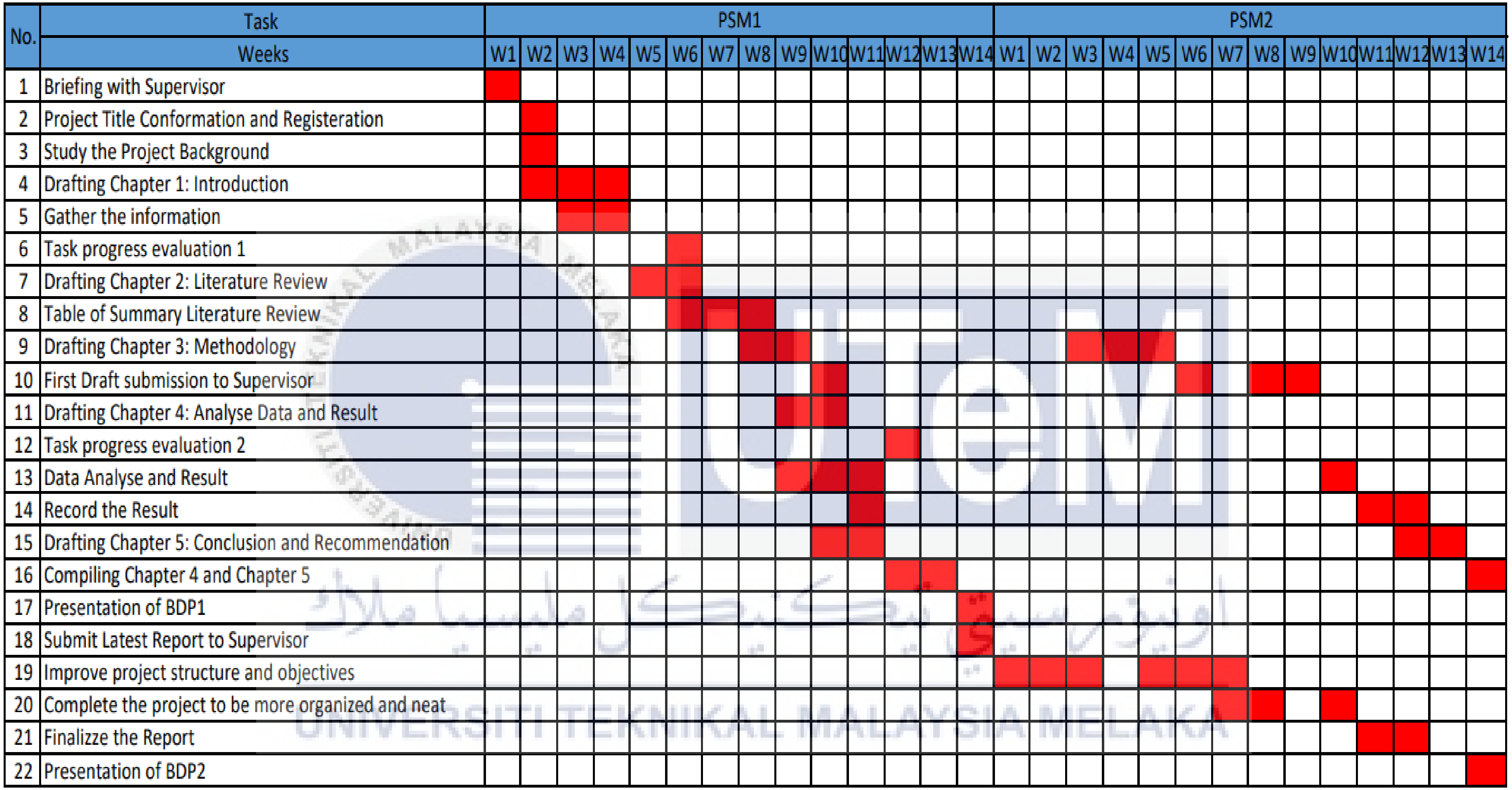


Figure 3.16 Gantt chart for BDP1 and BDP2

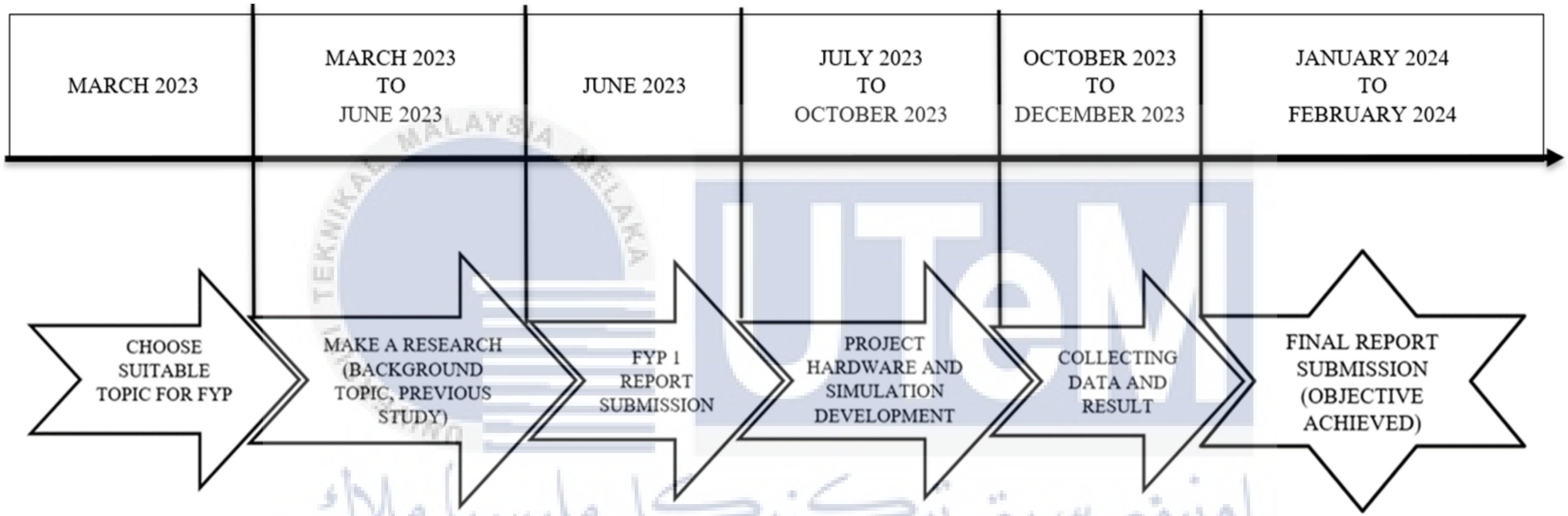


Figure 3.17 Milestone for BDP

3.9 Summary

In this chapter's methodology, the detailed processes involved in completing the project are elucidated, encompassing both software and hardware aspects. This comprehensive overview delineates the project's workflow, providing readers with a clear understanding of the journey undertaken to achieve its objectives. The meticulous explanation of work processes underscores the importance of methodological transparency, offering readers tangible evidence of the project's progression.

Moving forward to the subsequent chapter on results and discussion, the focus shifts to presenting the outcomes pertaining to the project. This section will delve into operational data gathered from system components and circuits, acquired through various testing methodologies. The results will be analyzed to evaluate the functionality of individual components as well as the entire system employed in the project. Through systematic testing and analysis, insights will be gleaned to facilitate meaningful discussions and draw conclusions regarding the project's efficacy and performance.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the functional results of the main components and the entire circuit system used in this project. Specifically, it will be more focused on how the components play a role and function for this project either in the form of software or hardware analysis data and the project system to ensure the system runs smoothly starting from solar to the final output, this is necessary to ensure the overall objective BDP can be achieved.

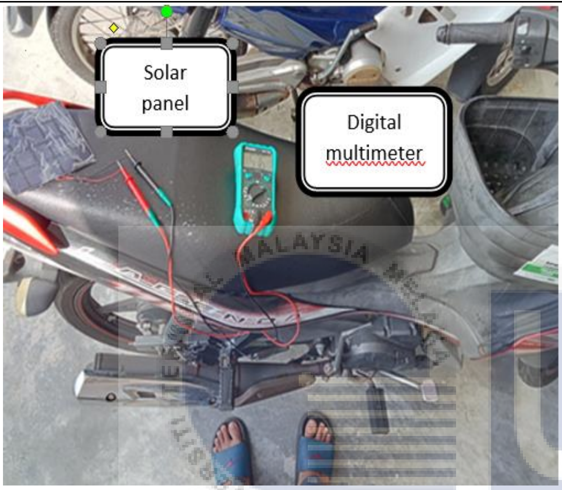
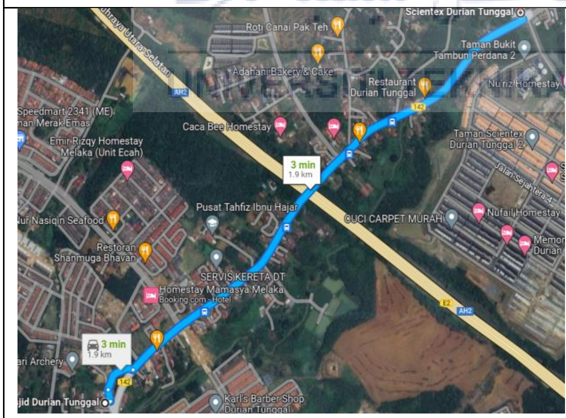
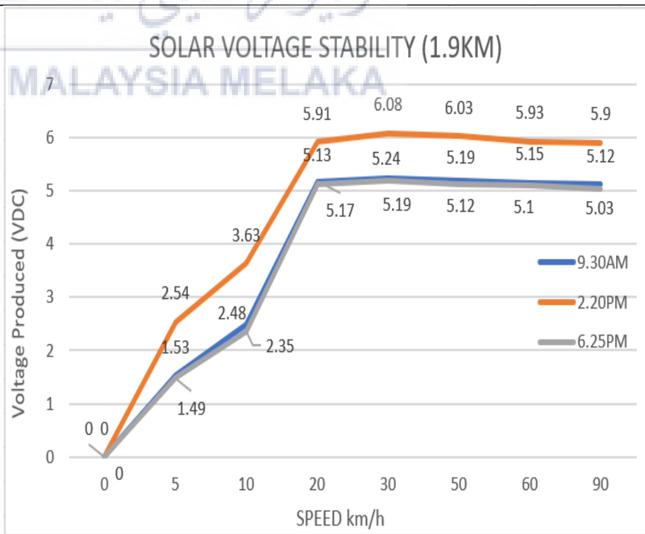
4.2 Data Analysis of The Main Parts

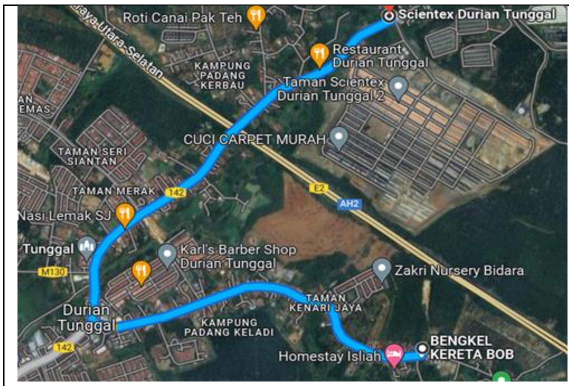
In this sub topic shows how data is taken for the main parts directly involved by using several methods to observe and test the level of functionality. The main parts in this project system that have a significant impact on the success of this project are solar panels system, LDRs and ultrasonic sensors system, these main parts will be tested for functionality in several conditions. in addition, tests on the entire system will be carried out to ensure that the circuit is in good condition and that all components can function properly after being combined into a circuit system, starting from the functionality of battery charging by solar panels to the functionality of the main components in producing outputs such as LEDs, Buzzers and LCD.

4.2.1 Stability of Solar Voltage

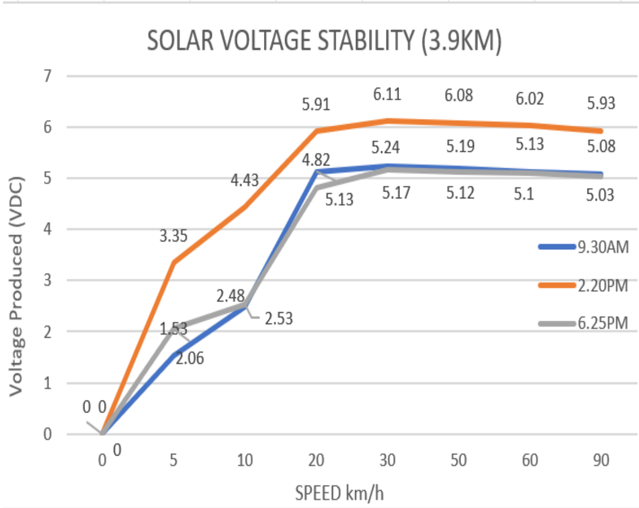
The analysis data taken to test the functionality of this solar panel (5V 2W) through hardware testing. As in table 4.1 the testing is about to see the production of solar voltage on certain factors or conditions such as the distance of a destination, time or weather during the journey, and the level of speed

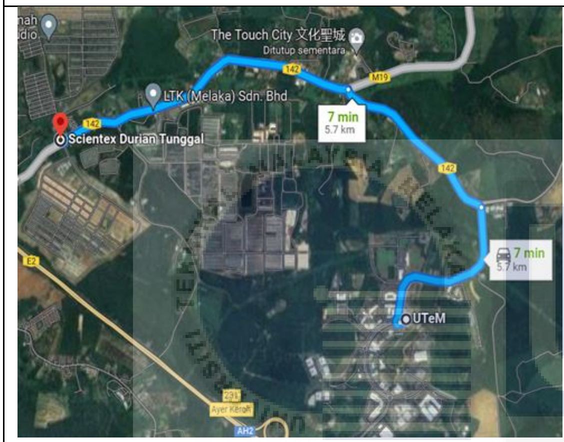
Table 4.1 Solar panel testing to test the stability of voltage production

	• This test was carried out using a polycrystalline solar panel (1.25W), length 120mm x width 90mm and also a set of digital multimeters on the VDC range. • Using a motorcycle as vehicle to observe the factors of speed and travel distance that will have an effect on the stability of the solar voltage.
 From Scientex durian tunggal to Masjid Durian Tunggal : Distance (1.9km)	

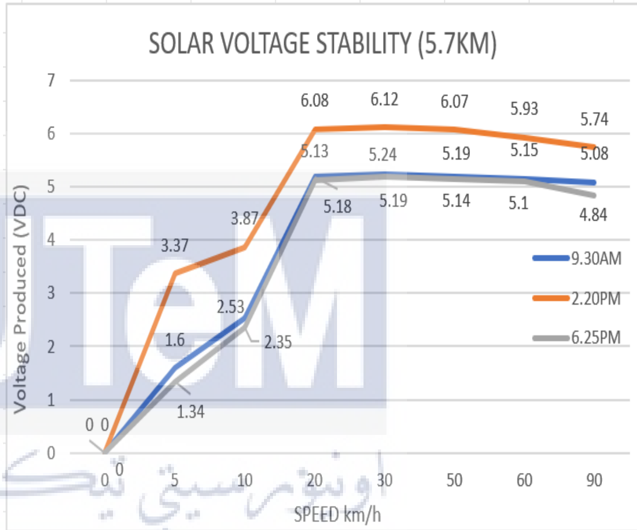


From Scientex Durian Tunggal to Bengkel Kereta Bob : Distance (3.9km)





From Scientex Durian Tunggal to UTeM : Distance (5.7km)



From the conducted tests on the solar panel, it's observed that the speed and distance of travel don't significantly impact its performance. However, the stability of solar voltage production is notably influenced by time and weather conditions during the tests. The data, recorded at different times like 9:30 AM, 2:20 PM, and 6:25 PM, under varied weather conditions such as partly cloudy, post-rain, and hot weather, reflects this trend. Moreover, factors like roads lined with trees or buildings affect voltage stability by casting shadows on the solar panel surface. Nonetheless, according to Table 4.1, these shadows don't drastically disrupt voltage stability unless vehicle speed becomes a controlling factor in the scenario.

4.2.1.1 Time Taken to Charge Without Load

This panel illustrates the connection of the solar circuit with various components, including the charge controller and the step-up module MT3608. In this system, solar power is the primary source to generate energy for the entire system. The generated power is directed to charge the battery without load. Several conditions have been considered to determine the time required for charging the battery. Data will be systematically collected and analyzed to provide valuable insights for this BDP, making it a comprehensive and informative study.

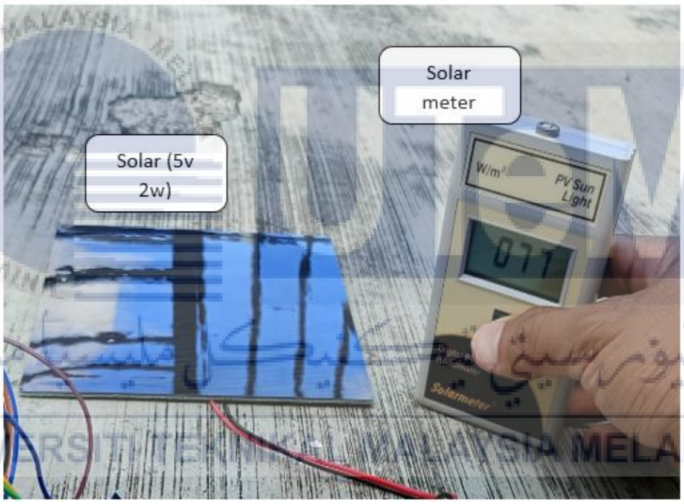


Figure 4.1 Digital pv radiometer shows the lowest irradiance value

Figure 4.2 Irradiance value in peak hour 12.50 pm

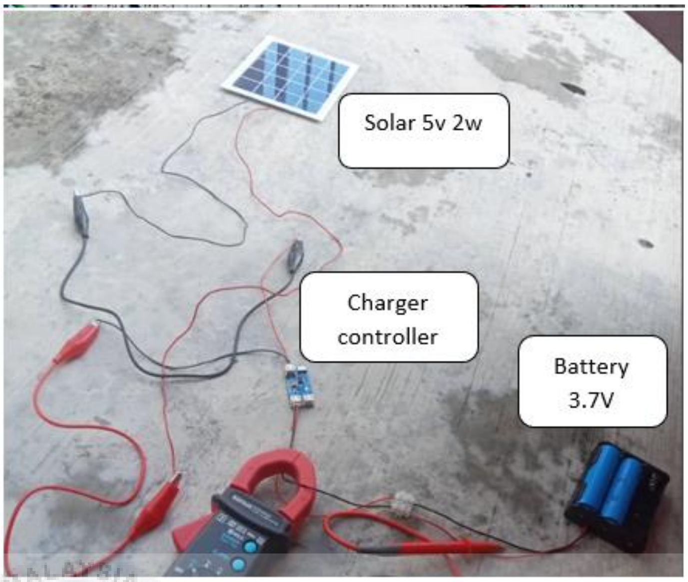


Figure 4.3 Solar power test to charge the battery without load

In Figures 4.1, figure 4.2, and figure 4.3, the processes of data analysis are illustrated, depicting how the functionality of the charging system in this project operates under various weather conditions. These figures provide insights into observing, monitoring, and evaluating the system's performance, focusing on its stability in generating power and charging capabilities amidst changing weather conditions. The data analysis aids in understanding how the charging system responds to different environmental factors, ensuring its reliability and effectiveness across diverse weather scenarios.

Table 4.2 Comparison between normal wheater and cloudy wheater for stability of voltage production and charging time testing

Max. battery volt. 4.2V, the initial battery volt. For normal conditions is 2.43V and cloudy conditions is 2.381V						
Wheater						
	Normal			**Cloudy**		
Time	**Solar volt**	**Batt. volt**	**irradiance w/m2**	**Solar volt**	**Batt. volt**	**irradiance w/m2**
10.20am	4.54	2.43	371	3.41	2.381	77
10.50am	4.61	2.65	388	3.45	2.39	93
11.20am	4.69	2.94	435	3.454	2.396	114
11.50am	4.75	3.31	531	3.501	2.42	119
12.20pm	4.89	3.53	654	3.523	2.45	125
12.50pm	5.12	3.67	716	3.53	2.47	136
1.20pm	5.43	3.85	755	3.56	2.53	138
1.50pm	5.57	4.05	816	3.561	2.56	140
2.20pm	6.01	4.2	857	3.603	2.69	140
2.50pm	6.11	-	893	3.618	2.75	149
3.20pm	6.05	-	861	3.553	2.76	141
3.50pm	5.23	-	734	3.152	2.79	118
4.20pm	4.56	-	619	3.089	2.801	106

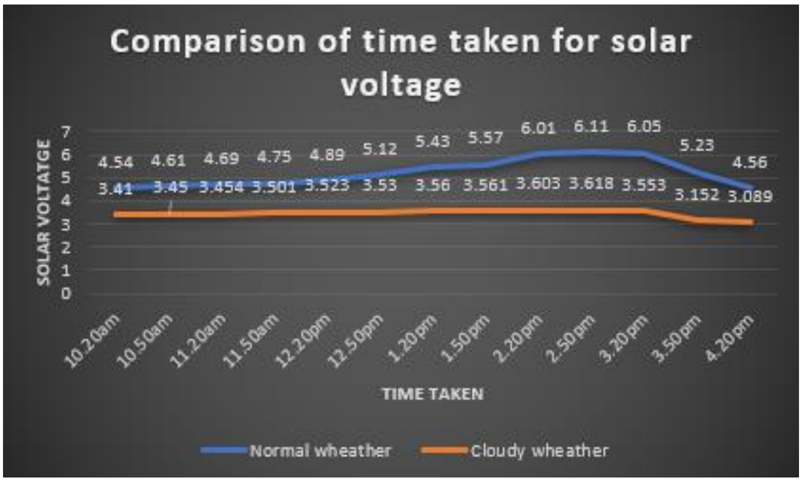


Figure 4.4 Production of solar voltage for normal and cloudy

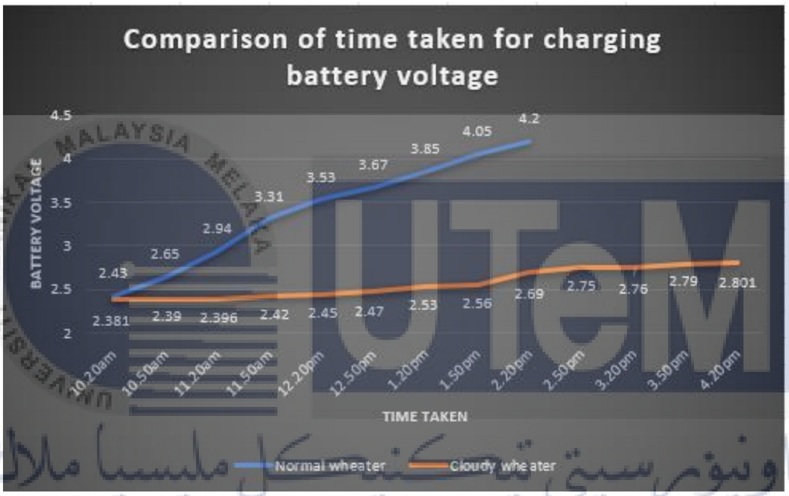


Figure 4.5 Production of battery voltage for normal and cloudy

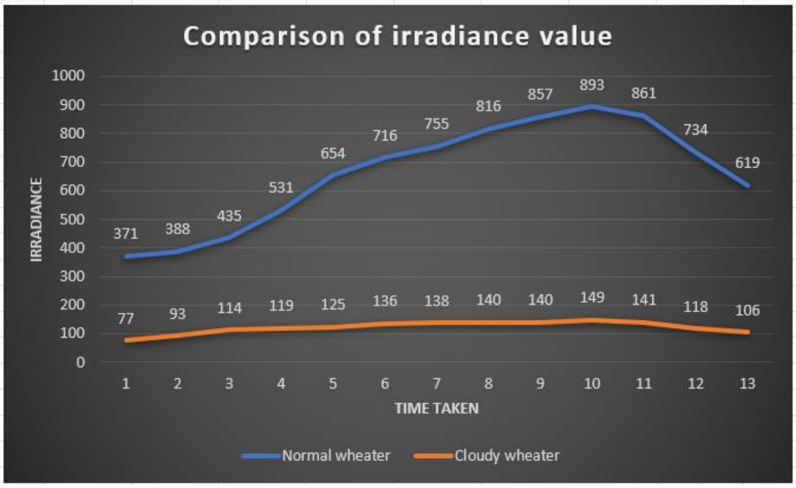


Figure 4.6 Irradiance value for normal and cloudy

Table 4.3 Comparison between normal wheater and windy wheater for stability of voltage production and charging time testing

Max. battery volt. 4.2V, the initial battery volt. For normal conditions is 2.43V and cloudy conditions is 2.441V						
Weather						
	Normal			**Windy**		
Time	**Solar volt**	**Batt. volt**	**irradiance w/m2**	**Solar volt**	**Batt. volt**	**irradiance w/m2**
10.20am	4.54	2.43	371	4.013	2.441	179
10.50am	4.61	2.65	388	4.221	2.481	186
11.20am	4.69	2.94	435	4.3	2.503	194
11.50am	4.75	3.31	531	4.41	2.651	221
12.20pm	4.89	3.53	654	4.53	2.69	268
12.50pm	5.12	3.67	716	4.61	2.93	312
1.20pm	5.43	3.85	755	4.74	3.25	422
1.50pm	5.57	4.05	816	4.74	3.57	438
2.20pm	6.01	4.2	857	4.79	3.71	489
2.50pm	6.11	-	893	4.93	3.96	533
3.20pm	6.05	-	861	4.85	4.08	475
3.50pm	5.23	-	734	4.32	4.15	432
4.20pm	4.56	-	619	4.29	4.2	419

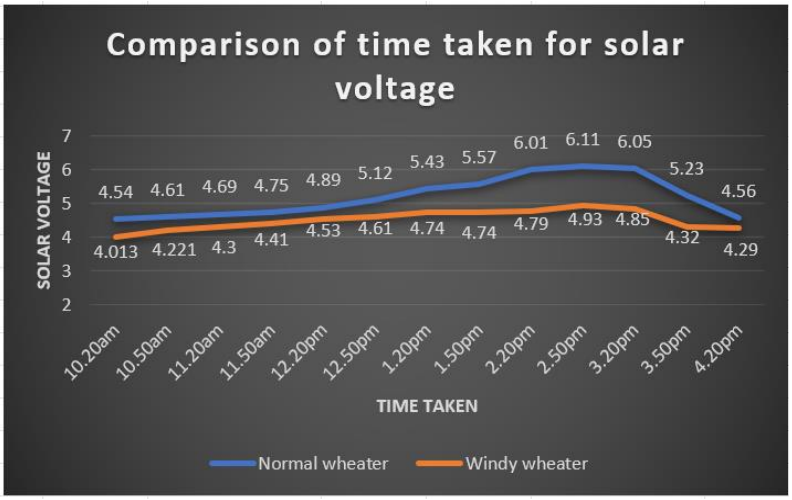


Figure 4.7 Production of solar voltage for normal and windy

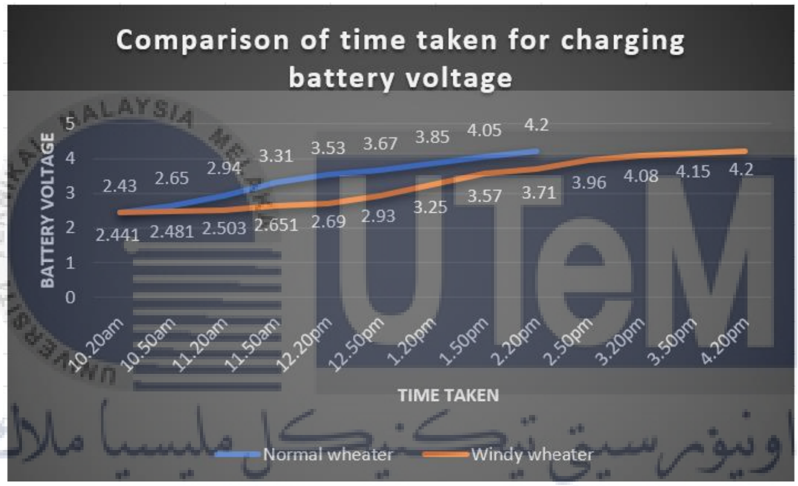


Figure 4.8 Production of battery voltage for normal and windy

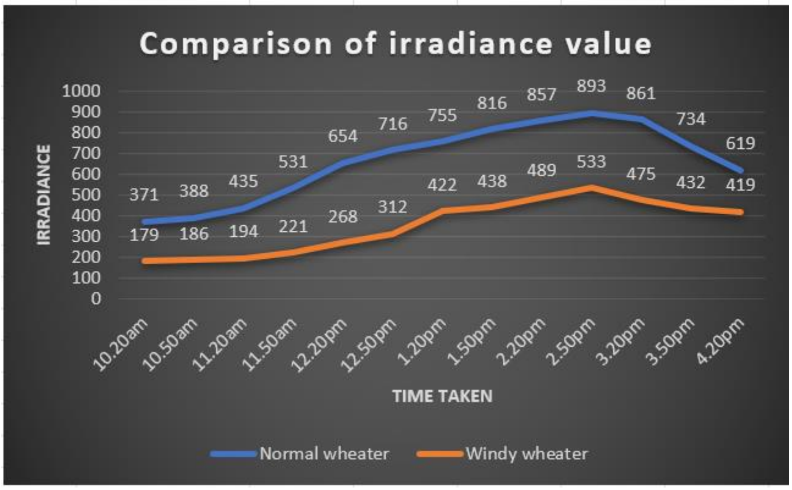


Figure 4.9 Irradiance value for normal and windy

Table 4.4 Comparison between normal wheater and drizzly wheater for stability of voltage production and charging time testing

Max. battery volt. 4.2V, the initial battery volt. For normal conditions is 2.43V and cloudy conditions is 2.392V						
Weather						
	Normal			**Drrizly**		
Time	**Solar volt**	**Batt. volt**	**irradiance w/m2**	**Solar volt**	**Batt. volt**	**irradiance w/m2**
1020	4.54	2.43	371	3.902	2.392	148
1050	4.61	2.65	388	3.982	2.421	150
1120	4.69	2.94	435	3.997	2.476	153
1150	4.75	3.31	531	4.128	2.506	184
1220	4.89	3.53	654	4.183	2.558	197
1250	5.12	3.67	716	4.21	2.613	221
1320	5.43	3.85	755	4.213	2.685	221
1350	5.57	4.05	816	4.256	2.75	235
1420	6.01	4.2	857	4.37	2.91	291
1450	6.11	-	893	4.41	3.018	335
1520	6.05	-	861	4.39	3.052	318
1550	5.23	-	734	4.08	3.13	293
1620	4.56	-	619	3.87	3.22	254

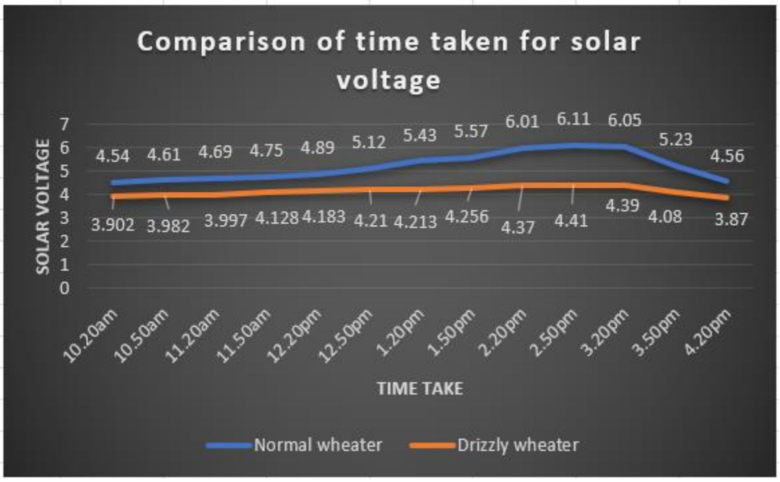


Figure 4.10 Production of solar voltage for normal and drizzly

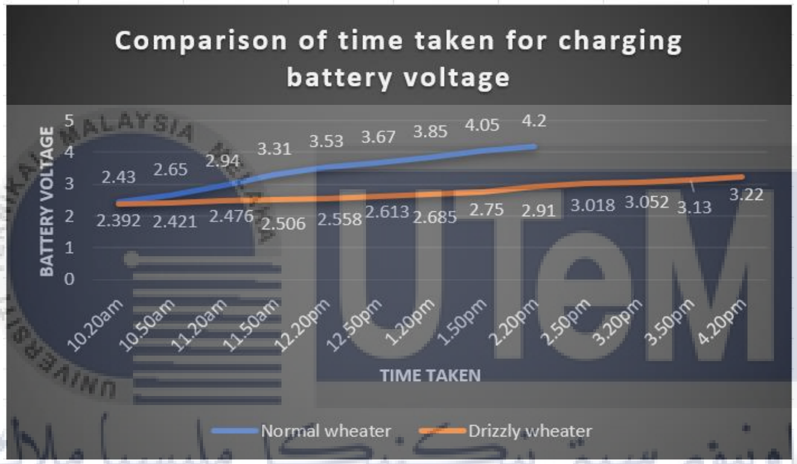


Figure 4.11 Production of battery voltage for normal and drizzly

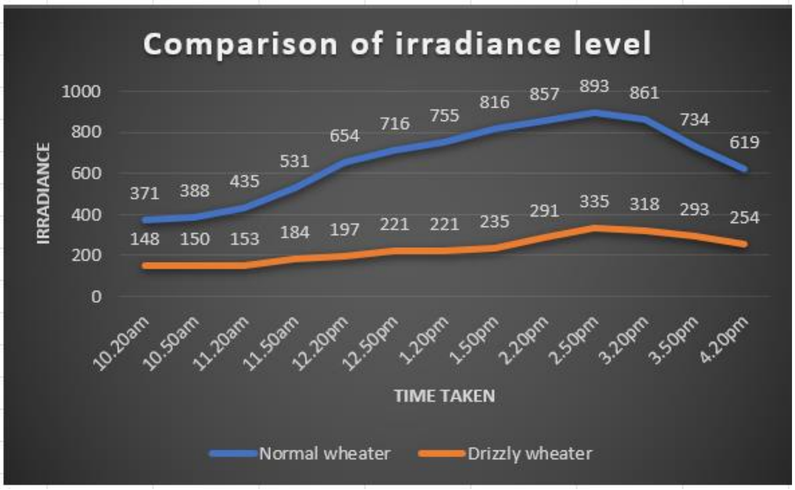


Figure 4.12 Irradiance value for normal and drizzly

From Tables 4.2, 4.3, and 4.4 show a comparison of the data made between four different weather conditions for the purpose of testing the battery charging level from the solar panel (5v 2w) without being connected to the load, the data obtained shows different weather conditions such as normal weather, cloudy, windy, and drizzle, play an important role in the production of solar energy, at the same time having an effect on the level of battery charging speed. The data taken from 10.20 am to 4.20 pm shows that in normal weather it can produce a higher and better result in terms of solar voltage production, battery charging voltage and irradiance, the peak time that can be seen from the data results from all four weathers which is around 12.20 pm to 2.50 pm and the peak radiation is at 2.50 pm which is 893w/m2 in normal weather and the solar voltage that can be produced at that time is 6.11 V the highest compared to the solar voltage in other weather conditions, and a better and balanced increment in the level of battery charging speed when in normal weather conditions when compared to other weather conditions. From this, it can be concluded that appropriate irradiance plays an important role in increasing the level of battery charging.

4.2.1.2 Performance of Circuit System With and Without Solar Panel

This panel shows a comparison made for the state of the BDP project circuit without the connection of the solar panel system and in the state connected with the solar panel system to see the time taken for the process of discharging the battery.

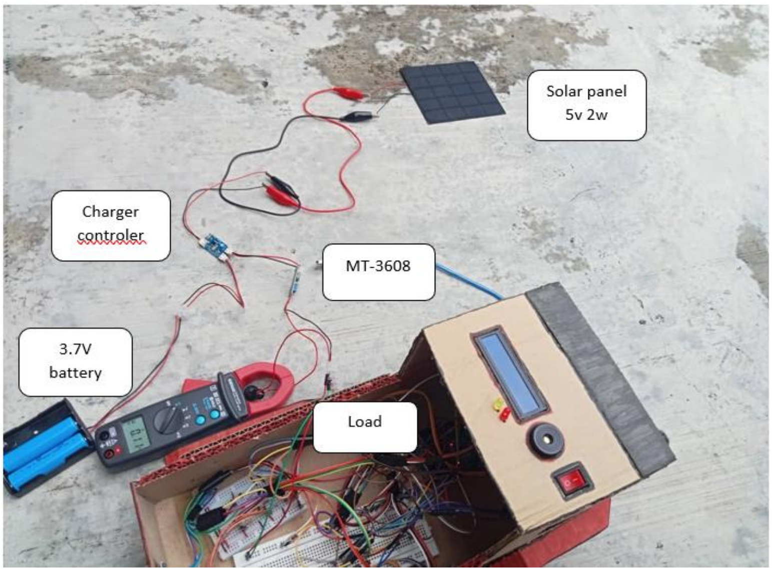


Figure 4.13 Testing the system circuit connection with solar panel

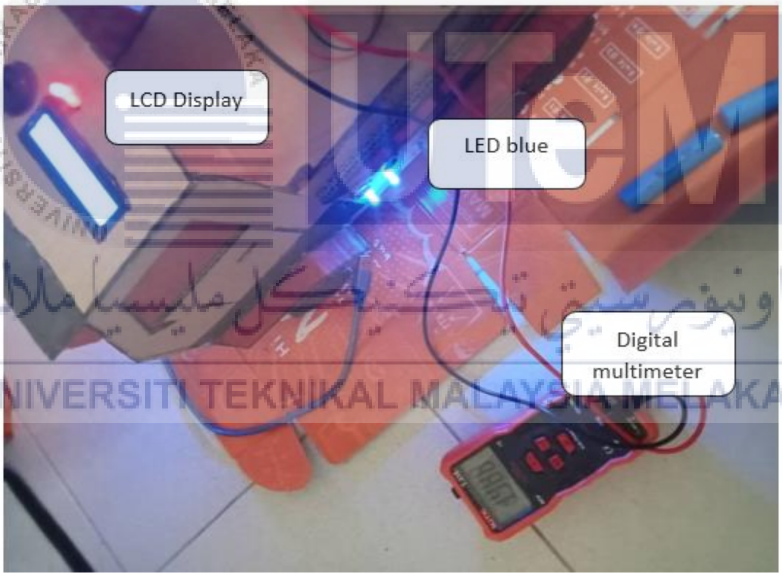


Figure 4.14 Testing the system circuit connection without solar panel

In Figure 4.13 and Figure 4.14, the overall testing of the solar charging system to the battery when connected to the main load is depicted. These figures display the efficiency percentage and the charging and discharging speeds of the system using a 5V 2W solar panel. The testing assesses how effectively the system charges and discharges the battery under real-world conditions, providing valuable insights into its performance and capabilities.

Table 4.5 Comparison between entire circuit system with and without solar energy

Value comparison for battery system with and without solar energy				
Time (24hr)	**With solar panel**	**Without solar panel**	**Low Battery Volt**	**Avg. suitable Battery Volt**
	Batt. Volt	**Batt. Volt**	**Batt. Volt**	**Batt. Volt**
1020	4.12	4.15	2.2	3.5
1050	3.94	3.85	2.2	3.5
1120	3.79	3.55	2.2	3.5
1150	3.61	3.25	2.2	3.5
1220	3.53	2.95	2.2	3.5
1250	3.47	2.65	2.2	3.5
1320	3.35	2.35	2.2	3.5
1350	3.29	2.05	2.2	3.5
1420	3.21	1.75	2.2	3.5
1450	3.16	1.45	2.2	3.5
1520	2.75	1.15	2.2	3.5
1550	2.59	0.85	2.2	3.5
1620	2.34	0.55	2.2	3.5

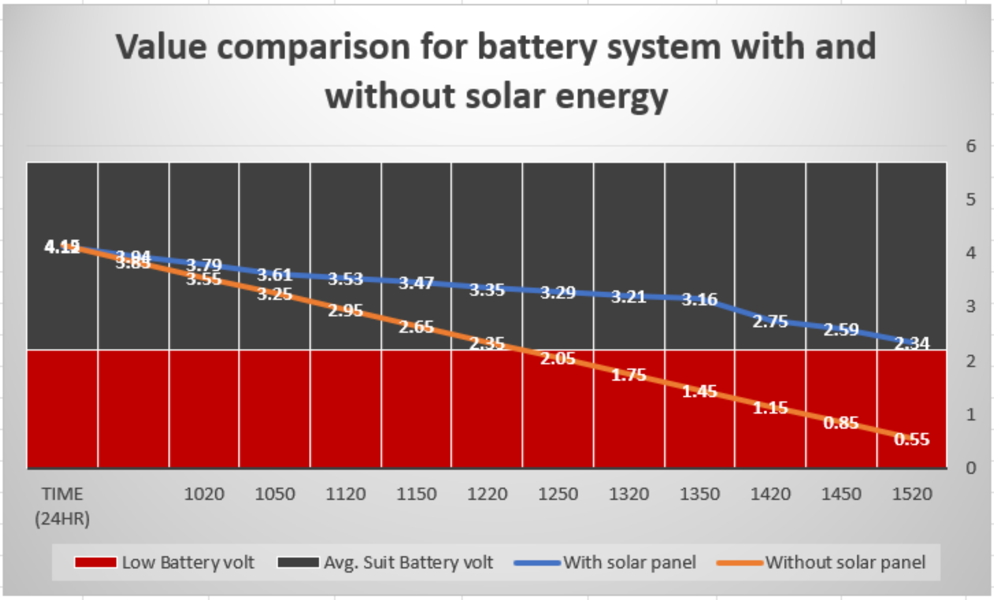


Figure 4.15 Testing the system circuit connection without solar panel

From the data taken in Table 4.5 regarding the comparison between the entire circuit system connected to the solar panel and the entire circuit system that is not connected to the solar panel to see if the circuit system connected to the solar panel (5v 2w) can charge or maintain the battery to full and to see the time taken by the circuit system that is not connected to the solar panel for discharge. this data shows that for the circuit system connected to the solar panel (5v 2w), the solar panel is successful in charging the battery, but the amount that can be charged is very small at the same time can be seen when discharging, the decrement of battery voltage does not decrease directly and drastically, because there is still solar energy flow into the battery to slow down the discharge process, to make the solar panel able to charge and at the same time the battery can flow the supply to the load, the size of the solar panel wattage must be larger. in this BDP situation just want to show how it operates and the concept that is done in accordance with the size of the prototype. For the state of the circuit system that is not connected to the solar panel, it can be seen in the graph that the decrement that occurs is more drastic and constant. from here in this situation, it can be concluded, that with the presence of solar energy (5v 2w) it can slow down the battery discharge process.

4.2.2 Sensitivity of Ultrasonic Sensor in a Certain Situation

This panel will show the data that has been taken from the testing carried out on the ultrasonic sensor against a certain condition to see how sensitive this sensor is when going through several conditions in terms of weather changes and in terms of the structure of road conditions such as dusty roads and uneven roads, is there it will interfere with the sensitivity of the ultrasonic sensor or the ultrasonic sensor will not be disturbed and continue to remain efficient. This test is done using a complete circuit equipped with LCD, LDR, LED, and buzzer but in this circuit, only 1 ultrasonic sensor is used, and this test is done using a motorcycle.

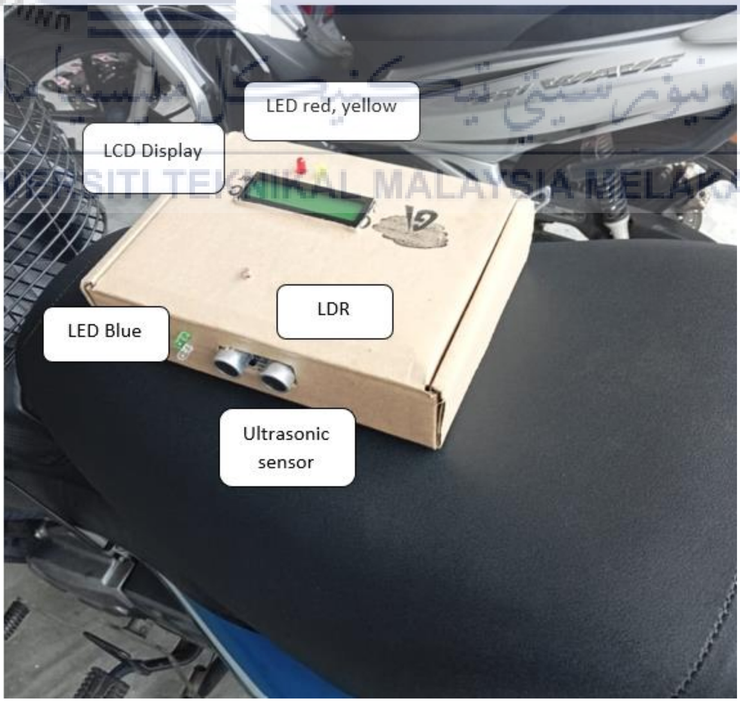
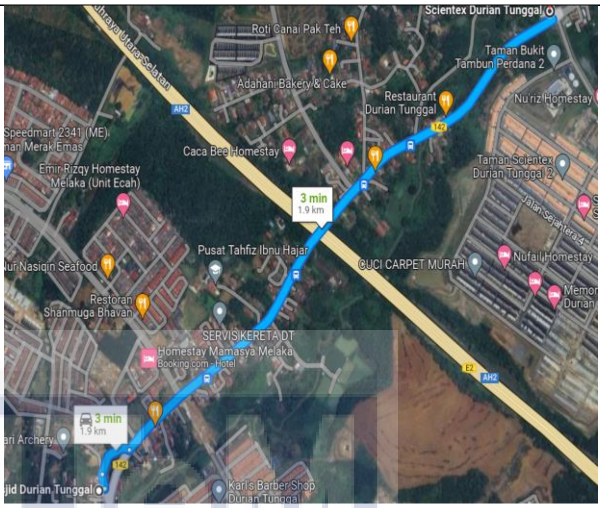
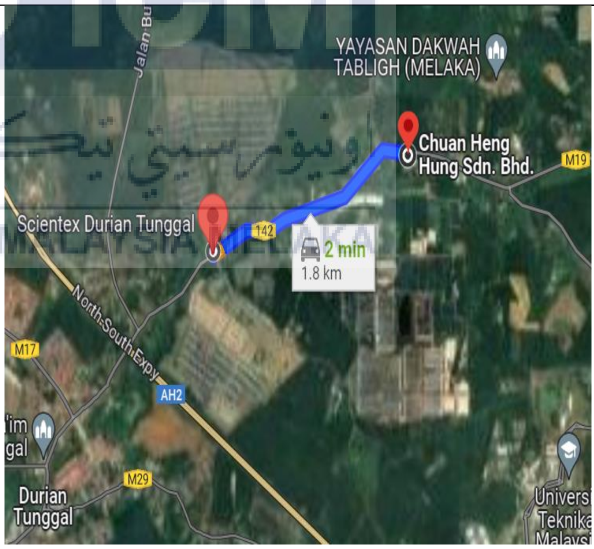


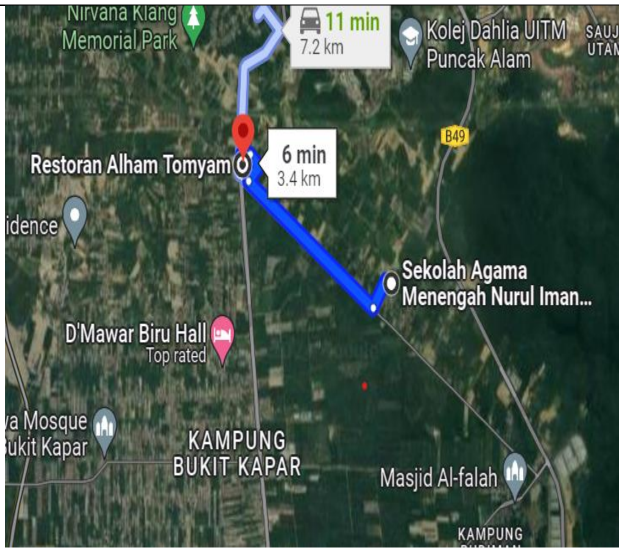
Figure 4.16 The complete circuit is placed in a box for testing purposes

Table 4.6 The results that has been taken to test the ultrasonic sensor to be connected with the LCD, LED and buzzer

Type of conditions	Route used (google maps)
<u>Daytime 16/12/2023 10.45am</u> • From Scientax durian tunggal to Masjid durian tunngal • Many vehicles pass by on this route • There are some uneven road areas along the way	
<u>Night 17/12/2023 8.20pm</u> • From Scientax Durian Tunggal to Restoran Amiera Jaya • There are many heavy vehicles that use this route • It was drizzling on the way home • There are some uneven road areas along the way	

<table>
<tr>
<td>
<u>Dusty road 25/12/2023 11.30am</u>

From Restoran Alham Tomyam to Sekolah Agama Men. Nurul iman
The main route for big trucks taking red soil
There are many uneven road areas along the way

</td>
<td>


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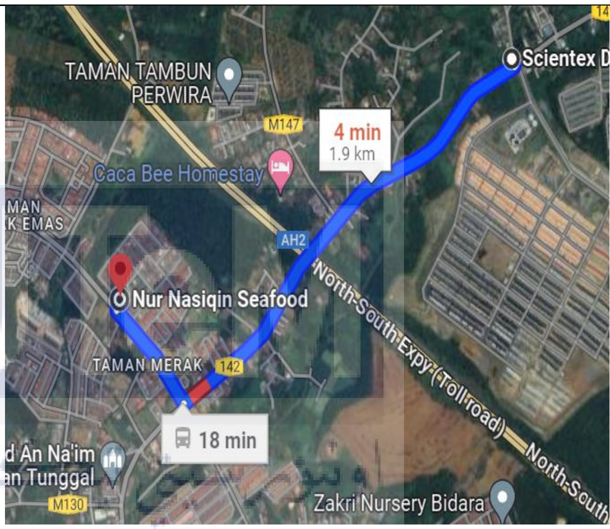
</tr>
<tr>
<td>
<u>Drizzly & Rainy 29/12/2023 4.50pm</u>

From Scientax Durian Tunggal to Nur Nasiqin seafood
It was drizzling halfway to the destination, and then it turned to rain.
There are some uneven road areas along the way

</td>
<td>


</td>
</tr>
</table>

Table 4.7 The sensitivity performance of ultrasonic sensor in certain conditions

Demonstration of ultrasonic sensor sensitivity in certain conditions by using motorcycle						
Speed Km/h	**Type of conditions**					
	Daytime	**Drizzling**	**Raining**	**Night**	**Uneven road**	**Dusty road**
10	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**
20	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**
25	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**
30	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**
50	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**
60	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**
80	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**
overtake	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**	**PASS**

The data obtained from ultrasonic sensor sensitivity tests to some road and weather conditions that are often passed by road users, especially drivers of heavy vehicles, by using the actual range which are for danger distance 200cm below, caution distance 201cm above to 300cm, safe distance 300cm above. This test is done for possible improvements in the future. based on the data, it can be seen that during the day and night the ultrasonic sensor can operate normally in different speeds. When there are disturbances such as uneven roads, drizzle, heavy rain and dusty roads, it will slightly interfere with the sensitivity of the ultrasonic sensor, but the ultrasonic sensor can still read the conditions and distance accurately, only the time it takes to detect will be. a little disturbed. this happens because when there is something attached to the ultrasonic sensor mesh such as water and dust that causes the sensor to be more sensitive, on uneven road conditions, the ultrasonic sensor will be disturbed when there is vibration, and it becomes a little slower to respond, among the causes that can be attributed to the possibility of interference in the circuit connection when there is vibration from an uneven road surface.

4.2.3 Project Functionality

This panel serves to demonstrate the comprehensive functionality of the blind spot detector and informer, integrated with a solar energy system for heavy vehicles. It allows thorough observation of each component, input, and output within the project system, ensuring flawless operation and the attainment of predefined objectives. Notably, the project's presentation is based on the prototype's scale as shown in figure 4.17, hence adjustments were made in the C++ Arduino program, setting danger range at 30cm and below, and caution range at 60cm and below for prototype testing purposes. However, actual distance tests have yielded consistent outcomes with the prototype settings. On-road tests have confirmed the project's success criteria: danger zone below 200cm, caution zone from 201cm to 300cm, and safe zone beyond 300cm.

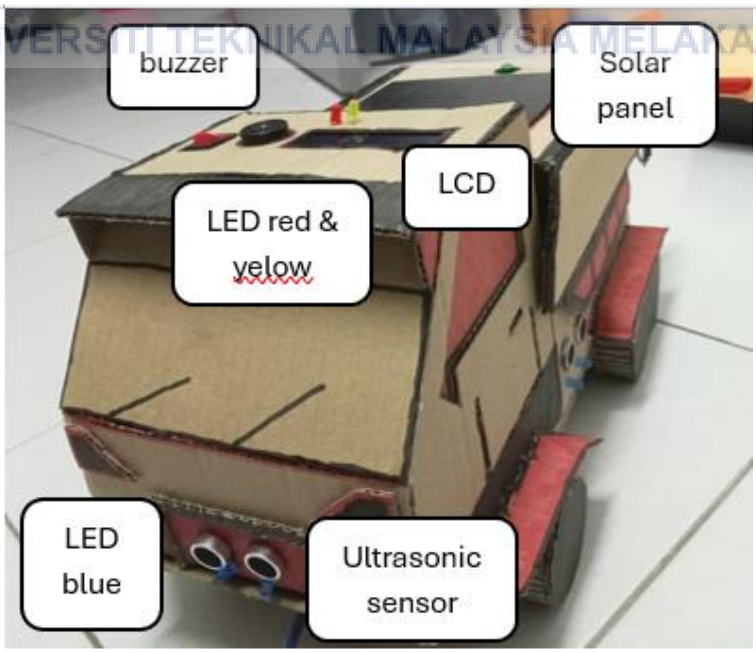
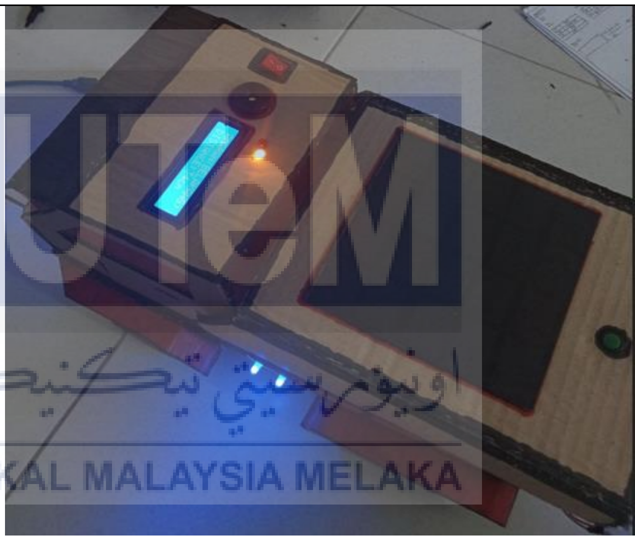


Figure 4.17 The project prototype

Table 4.8 The project fuctionality for LDR and ultrasonic sensor for each side, right, left front and back side

Result of fuctionality	Example of illustrastion
• In front side, the sensor successfully detects objects. • LCD succesfully displayed "Amaran (depan) distance....) and yelow LED turn on. • LDR, LED and Buzzer work well according to the surrounding conditions	
• LCD succesfully displayed "Amaran (kiri) distance....) and yellow LED turn on. • .LCD succesfully displayed "bahaya (kiri) distance....) and red LED turn on. • LDR, LED and Buzzer work well according to the surrounding conditions	

• LCD succesfully displayed “Amaran (kanan) distance....) and yellow LED turn on. • LCD succesfully displayed “Amaran (kanan) distance....) and red LED turn on. • LDR, LED and Buzzer work well according to the surrounding conditions	
• LCD succesfully displayed “Amaran (belakang) distance....) and yellow LED turn on. • LCD succesfully displayed “Amaran (belakang) distance....) and Red LED turn on. • LDR, LED and Buzzer work well according to the surrounding conditions	

4.2.4 Project’s Actual Concept

This section purpose is to show the actual concept of this project when installed on the blindspot part found on heavy vehicles, this design concept has been sketched using Thinkercad to show the appropriate results for the actual design of this project when applied in real conditions

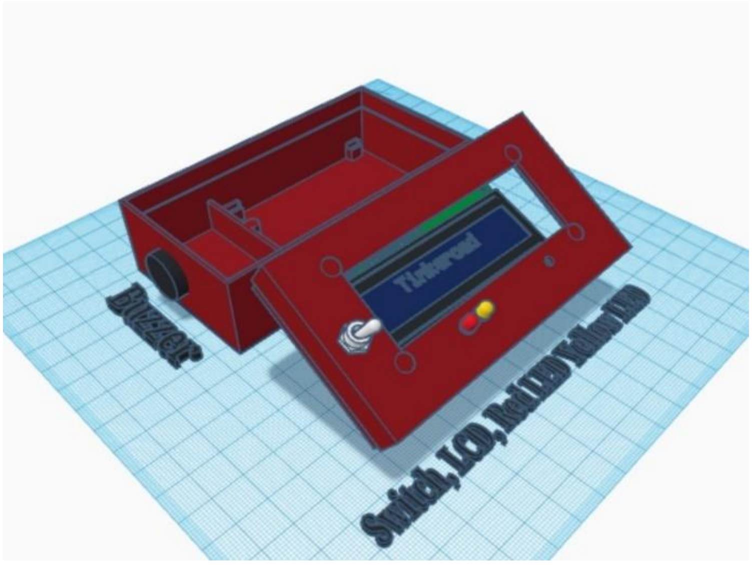


Figure 4.18 The final concept for LCD, buzzer, and LED casing

Figure 4.19 The final concept for Ultrasonic sensor casing

4.3 Summary

In the nutshell, this chapter explains the results of testing the main part of this project's system which is solar energy system and the entire project system in the form of hardware, various method of testing have been carried out to obtain the desired results.

For the next chapter which is chapter conclusion will discuss the overall process, data analysis, knowledge and experience that has been gained throughout conducting research related to this project, and also whether it is appropriate for this project to be commercialized, and in addition, the appropriate improvement or innovation planning added in this project in the future.

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CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Weather This thesis presents the journey of creating a solution to reduce the number of road accidents involving heavy vehicles, which are mostly caused by the blind spot area of heavy vehicles. Several studies have been conducted by researchers such as university students and other responsible parties that can be used as a reference to complete this project in helping to achieve the objectives that have been set.

Throughout the process of creating this project, various knowledge and experiences were gained that will be very useful in the present and future, such as knowledge in determining the appropriate distance of vehicles when on the road and also knowing the shapes or blind spot areas of vehicles, especially on heavy vehicles such as lorries and buses that have more than 6 blinds spots and it depends on the length and width of the heavy vehicle, the larger the size, the more blind spot area it has. various tests have been made to ensure that all the criteria found in this project are able to form to achieve the targeted objectives and to ensure that the number of deaths involving road accidents especially those caused by blind spot areas on heavy vehicles, which is as many as 402,626 road accidents causing 4379 deaths increased, as much as 52 percent every year in Malaysia, can be overcome and become a stepping stone for this country in particular, to be among the great countries that are able to control and reduce the traffic accident statistics.

Overall, the research presented in this thesis has successfully contributed to the understanding of road users about the dangers of blind spot areas that can cause loss of life, and also about how to overcome and prevent this situation or matter from continuing to increase year after year, this shows that, the objectives that have been set have already been achieved. In addition, with this thesis, it is able to open the eyes of road users to be more prudent and careful in using the road and hope that this project can be realized and can help the community globally in preventing the increase in road accident cases, especially involving heavy vehicles.

5.2 Potential for Commercialization

This project shows promising potential for commercialization due to the absence of similar concepts or products in the market addressing blind spots in heavy vehicles. Heavy vehicles are frequently involved in traffic accidents resulting in fatalities, and preventive measures remain limited. With this project, there's an opportunity to mitigate and reduce accident rates. Moreover, the project's cost-effectiveness makes it accessible for all heavy vehicle drivers to install on their trucks or lorries.

5.3 Future Works

For future works, improvements need to be made to make this project more quality by applying IoT elements in the project system. This IoT system will function to send location information to the authorities if the user is involved in an accident, the sensor that will trigger this IoT system is a vibration sensor which will place a high level of vibration to indicate that an accident has occurred and the IoT acts through this signal and sends the location to authorities

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