UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Electrical Technology and Engineering

DEVELOPMENT OF WATER SURFACE OIL CLEANER BOAT POWERED BY SOLAR SYSTEM

NORSYAZLIN BINTI MOHD ZAID

Bachelor of Electrical Engineering Technology with Honours

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A project report submitted
in partial fulfillment of the requirements for the degree of
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Disahkan oleh:

DR. ZUL HASRIZAL BIN BOHARI
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan
Fakulti Teknologi dan Kejuruteraan Elektrik
Universiti Teknikal Malaysia Melaka

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DEDICATION

I want to start by giving appreciation to Allah Ta'ala for giving me wellness and power during my final year project. To my cherished parents, Mohd Zaid and Zarina, who have never ceased encouraging and supporting me during my life and time at Universiti Teknikal Malaysia Melaka. I would also like to express my gratitude to Dr.Zul Hasrizal bin Bahari, my supervisor, who has always been encouraging and helpful in helping me finish my final year project. Finally, I would like to express my profound gratitude to all of my classmates in BELT 1/1 who have consistently assisted me with problem-solving, advice, and ideas.

ABSTRACT

Urbanisation and population growth have increased Malaysia's water pollution levels while resulting in an increasing need for water. In Malaysia, the need for water in general and the quality of the water are major concerns. Lakes and reservoirs supply a variety of water resources, including those for domestic use, agriculture, navigation, hydroelectricity, commerce, and recreation. Since 98% of water comes from rivers, river pollution has been a significant issue. According to Malaysia's Department of Environment, 34 of the country's, 195 rivers are polluted. Due to its frequent use as a quick waste dump, Malaysia's Klang River is now among the most polluted rivers in the country. An oil-cleaning boat system powered by solar energy is demonstrated in this project. A fibre belt conveyor will be used on the boat to collect and separate the oil from the water. The navigation of the boat will be controlled by an Rc remote. A battery and a solar panel will also be used to power the boat, the solar panel will be used to generate power for the battery to be continuously charged. The boat will be guaranteed to function for a long time due to it. The oil that is surfacing on the water will be collected by this boat system, which will then dump it into a tray. This project indicates the boat's controllable ability to gather oil from the water's surface, which could reduce river pollution.

ABSTRAK

Perbandaran dan pertumbuhan penduduk telah meningkatkan tahap pencemaran air di Malaysia sekaligus mengakibatkan peningkatan keperluan air. Di Malaysia, keperluan air secara umum dan kualiti air menjadi kebimbangan utama. Tasik dan takungan membekalkan pelbagai sumber air, termasuk untuk kegunaan domestik, pertanian, pelayaran, hidroelektrik, perdagangan dan rekreasi. Memandangkan 98% air berasal dari sungai, pencemaran sungai telah menjadi isu penting. Menurut Jabatan Alam Sekitar Malaysia, 34 daripada 195 sungai di negara ini tercemar. Disebabkan ia kerap digunakan sebagai tempat pembuangan sisa cepat, Sungai Klang di Malaysia kini merupakan antara sungai yang paling tercemar di negara ini. Sistem bot pembersih minyak yang dikuasakan oleh tenaga suria ditunjukkan dalam projek ini. Penghantar tali pinggang gentian akan digunakan pada bot untuk mengumpul dan mengasingkan minyak daripada air. Navigasi bot akan dikawal oleh alat kawalan jauh Rc. Bateri dan panel solar juga akan digunakan untuk menghidupkan bot, panel solar akan digunakan untuk menjana kuasa untuk bateri dicas secara berterusan. Bot itu akan dijamin berfungsi untuk jangka masa yang lama kerananya. Minyak yang timbul di atas air akan dikumpulkan oleh sistem bot ini, yang kemudiannya akan membuangnya ke dalam dulang. Projek ini menunjukkan keupayaan terkawal bot untuk mengumpul minyak dari permukaan air, yang boleh mengurangkan pencemaran sungai.

TABLE OF CONTENTS

PAGE

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful.

First and foremost, I thank Allah SWT for all the trials, opportunities and strength that have been given to me for me to complete my Final Year Project successfully. Without His blessing, I would not have gotten this far.

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LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

$	-	US Dollar
≈	-	Almost equal
ɳ	-	System efficiency
%	-	Percentage

LIST OF ABBREVIATIONS

V	-	Voltage
A	-	Ampere
Wh	-	Watt-hour
Ah	-	Amp-hour
C	-	Celcius
W	-	Watt
cm	-	Centimetre
ml	-	Mililitre
lit	-	Litre
min	-	Minutes
rpm	-	Revolution per minute
mm	-	Millimetre
iot	-	Internet of things
Ac	-	Alternative Current
Dc	-	Direct Current
Rc	-	Radio Control
Pv	-	Photovoltaic
Usv	-	Unmanned Surface Vehicle
LAN	-	Local Area Network

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Population growth leads to oil spills, causing water pollution from various industries, including plastics, drugs, fertilizers, paint, electricity, machinery, and vehicles. Although oil is used in many different processes, not all oils are the same. Oil spills create a serious threat to marine life and can seriously contaminate beaches and soil because of their positioning. Fish can become suffocated by oil spills, which can also suffocate the feathers of birds and mammals and dim the light of marine photosynthetic plants. Oil spills result from weathering processes like spreading, evaporation, dissolution, biodegradation, and water-oil emulsions, affecting oil viscosity and density referring to Figure 1.1 [1].

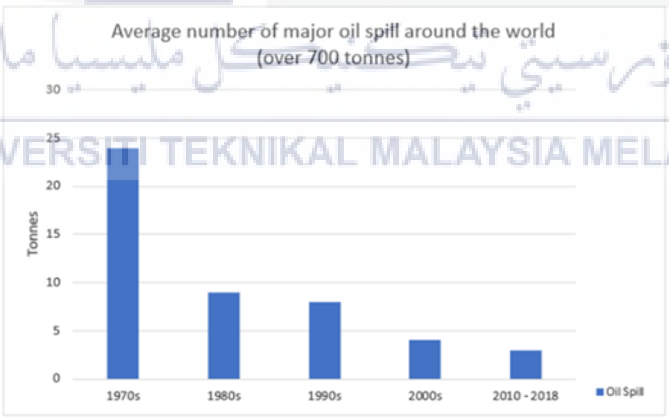


Figure 1.1 The global average number of significant oil spills [1].

An oil skimmer is a reliable device for removing oily particles from liquids to control pollution. It removes oil, grease, and hydrocarbons from water and coolants. Design factors like specific gravity, surface tension, and the use of a flowing medium impact oil skimmers' success [2]. Skimmers are boats that can

remove oil from the water's surface. The benefit of using a skimmer to remove oil from water is that, unlike techniques like using chemical agents, it does not changing the oil's physical or chemical properties. Skimmers frequently come with attached settling tanks so that the water and oil can be separated in the tank. If the oil is relatively fresh, it can be refined. The oil is sometimes burned. The type and extent of the oil spill, the amount of dripping in the water, the location, and the weather all have an impact on the success of skimming (skimming is most effective in calm weather) [3].

Regular oil spill incidents are characterized by large oil spills, a variety of pollution, and long-lasting effects. As a result, there is significant environmental harm, enormous economic loss, and a worsening fossil fuel shortage. Therefore, the need for quick and efficient oil spill recovery technology is urgent, but it is still a huge challenge. However, many spilt crude oils have low fluidity and a high viscosity (103-105 mPa at room temperature), making it impossible to use conventional hydrophobic sorbents for viscous oil [4].

Therefore, developing efficient alternatives for high-viscosity oil spills is crucial. Floating oil sticks to media used for skimming, such as a disc, belt, tube, rope, or mop. A belt skimmer is used for this project to collect floating oils.

1.2 UN Sustainable Goal Relation

The Sustainable Development Goals (SDGs) are a collection of 17 Goals and 169 to address issues like poverty, hunger, food security, health, gender equality, education, water, sanitation, urbanization, economic growth, ethical production, climate change, and biodiversity. Oil Cleaner Boats can contribute to achieving the sixth SDG, ensuring sustainable water and sanitation services, and Target 6.3,

improving water quality by reducing pollution and minimizing hazardous substances. Oil spills, particularly in maritime environments, are a significant contributor to water pollution. Oil spills can be dangerous to human health, marine life, and aquatic ecosystems. Oil cleaner boats are specialized boats made for cleaning up oil spills from water surfaces. To gather and remove oil, it employs a variety of methods, including suction, absorption, and mechanical separation.

So, this project, which uses the absorption method, belt-conveyor oil cleaner will also help to achieve a clean river and reduce water pollution.

Figure 1.2 UN Sustainable Goal[5].

1.3 Problem Statement

Large oil spills and tanker traffic in Malaysia have negatively impacted the ecosystem. Since offshore hydrocarbon exploration, Malaysia has become a source of pollution, contaminating coastal and marine habitats. Offshore Malaysian oil exploration is limited to the South China Sea off Peninsular Malaysia, Sarawak, and west Sabah.

In addition, oil spills occur from time to time due to continuing and careless behaviours in the use of oil industries and oil products. Oil spilt in a river has

various negative consequences for the environment and the people who live nearby. Water supply to residential areas has been disrupted. It also causes harmful effects to marine life and wildlife animals. An automatic oil skimmer belt-type powered by solar is designed to reduce impact and improve design requirements, including shaft size, sorbent material, oil scrapping design, solar panel type, and scrapper material

Furthermore, if the water surface oil cleaning boat is widely used around the world, water pollution can be reduced. Cleaning up water bodies is a far more important issue in the long run in order to reduce water pollution. As a result, pollution can have a significant impact because of its ability to cause illness in individuals, it has a significant impact on the global economy.

1.4 Project Objective

The objective of this project is:

1) To analyse the existing oil cleaner boat in Malaysia.

2) To design and model an oil belt-skimmer boat powered by solar PV.

3) To develop and evaluate the efficacy of a boat that can collect oil from the water's surface while preventing it from dispersing.

1.5 Scope of Project

The scope of the project is designed as follows:

a) Circuit Design

The system is made of a belt-type oil skimmer made out of belt type for the prototype. Controlled the skimmer using a 12V DC motor. The skimmer is installed onto a boat made from foam with low density for high buoyancy force. The boat moved and was controlled by an RC remote.

b) Program Development

To use the RC remote to manipulate the boat and control the movement of the oil skimmer remotely.

c) Software Development

To construct the connections using Proteus software, which can display the output for circuit design.

d) Hardware

Oil water cleaner solar boat needs an RC remote to control the movement of the boat. The lead acid battery will be used to keep voltage incoming from the solar charge controller to power the DC motor and the belt conveyor to separate the oil from water. Belt-conveyor, DC motor(5V), Lead acid battery (12V), Solar panel (12V,2W).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The literature review elaborates from the past study from a collection of various academic references regarding this topic such as journals, articles, and scholarly.

2.2 Past Studies

2.2.1 Oil pollution in the North Sea: the impact of governance measures on oil pollution over several decades

Carpenter A claims that oil contamination from rivers, land, ships, and offshore drilling has been an issue in the marine environment for many years. There have been initiatives aimed at reducing or preventing pollution from offshore oil drilling and shipping since the late 1960s. By figuring out these situations, new remediation techniques can be created [7].

2.2.2 Oil spill clean-up project

Oil spills have occurred frequently throughout history as a result of oil drilling mishaps. As a result of the Deepwater Horizon semisubmersible rig sinking, one of the largest oil spills in history recently occurred in the Gulf of Mexico. Between 1978 and 1990, and 2000 large-scale oil spills occurred globally, causing over 10,000,000 gallons of liquid. The Deepwater Horizon was not the first offshore oil rig to sink. Traditional clean-up methods include skimmers, boats, burning, and

chemical dispersants. Dispersants should not be used near the shore because of their potential negative effects on marine life [8].

2.3 Design of Skimmer Boat

2.3.1 Boat-type oil recovery skimmer

According to Manivel R. and Sivakumar R., Oil skimmer technology uses coated materials like Teflon or activated carbon to attach oil more easily than water. The main purpose of an oil recovery skimmer system is to move the skimmer in all directions while providing sticky materials like Teflon and activated carbon for oil recovery. The roller component is the main component. The roller component is made of sheet metal or plastic [9].

2.3.2 A Review of User-Centred Design Methods for Designing a Portable Oil Spill Skimmer

Using an oil skimmer, oil that floats on liquid surfaces is removed. It can be utilised for a variety of activities depending on the technical setup, such as cleaning up oil spills as part of systems for treating oily water, removing oil from machine tool coolants and wet parts washers, and digesting fat, oil, and grease in wastewater treatment facilities to produce food. Skimmers are used in industrial applications to extract oils, grease, and fats before further processing to adhere to environmental discharge regulations. Oil retention, odour, and unsightly surface waste may be decreased by removing the top layer of oils [10].

2.3.3 Design and Simulation of Autonomous Water Tank Cleaning Robot in Gazebo

Megalingam states that this paper describes a new robot system for performing cleaning work instead of manual cleaning which is characterized by low efficiency, low safety, long time, and water pollution problems. The system is designed to address the shortcomings of conventional water storage tank cleaning procedures. We have described a robot system in this paper that can clean the water tank's walls and floor. The robot is created in Fusion 360, and Gazebo simulates it in a water tank-like environment [11].

2.4 Type of Oil Skimmer

2.4.1 Belt Skimmer Boat

2.4.1.1 Design and Development of Belt-Type Oil Skimmer

According to Maisuriya, there are a lot of oil skimmers available on the market right now, but they are big and expensive. They created an oil skimmer that is more affordable and effective than the previous model as a result. The main objectives of this work are to separate more oil by using a belt material with a higher absorption property. higher oil recovery efficiency, lower costs, and environmental friendliness with a type of oil skimmer that requires less maintenance. The belt, tank, and scrapper are among the other parts of the device that are mounted on the main body frame, according to them. To reduce weight, aluminium is the material used. A shaft and bearings were used to attach the belt to the pulley before it was finally put together. This metal plate holds the solar panel, electric motor, pulley,

bearing, and shaft and holds them to the top of the structure. Figure 2.1 shows the design of the belt-type oil skimmer boat [12].

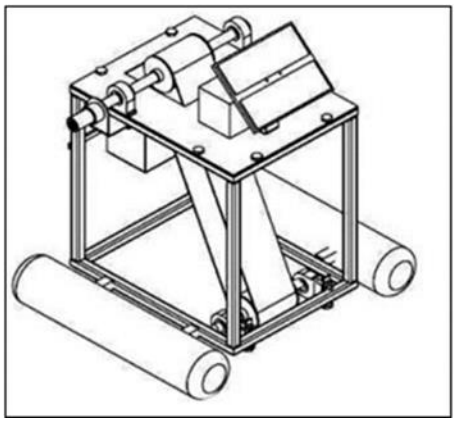


Figure 2.1 CAD Assembly Design [12].

2.4.1.2 A Review of The Oil Skimmers for the Sugar Industry

An oil skimmer proposed by Shankar Miraje & Joshi will remove oil from water without causing damage to the apparatus used to do so. Because of the adhesive properties of oil to the belt material, the oil skimmer will continuously rotate and remove oil from a mixture of oil and water. The milling section of the sugar factory consumes 185 litres/day of oil. The amount of oil wasted is approximately 18-20 litres. This project will create a machine that will allow for the effective removal of oil with minimal effort. The Belt-Type Oil Skimmer is meant to address the serious problem of water pollution in the sugar industry. This feature of the Belt Type Oil Skimmer allows the industry to reuse the extracted oil for general lubrication purposes, such as conveyor rollers, guides, press plates, chain sprockets, gears, and weatherproofing spares, all while reducing pollution. The constant removal of oil from process fluids prolongs the fluid's life, reduces the cost of machine fluid refilling, and improves the quality of wastewater [13].

2.4.1.3 Oil Separator Skimmer

M. Pavan, Kumar K, Prithvi Raj, B.Sridhar, Ch. Mohan Sumanth and Dr.K. Srividya proposed that the cheapest and most effective way to remove surface oil from the ocean, washing machines, leaky oils from machinery, with an oil skimmer. The benefits of belt and disc skimmers are numerous. The oil skimmer is simple to install and has a high capacity and excellent oil collection rate. The oil skimmer is a useful tool for cleaning oil and dirt out of water. An oil skimmer can purify water to the desired degree. Before using expensive treatments like chemical processes, oil skimming is a cost-effective way to remove most of the oil in more demanding circumstances. The technique's basis, known as the skimming principle, is based on three physical characteristics of oils: specific gravity, surface tension, and affinity. Belt machines offer a quick, dependable, and reasonably priced way to remove grease, oil, and other hydrocarbons from water. Figure 2.2 shows the diagram of the oil skimmer setup [14].

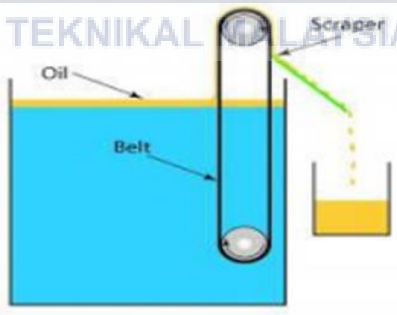


Figure 2.2 Oil skimmer set-up [14].

2.4.2 Disc Skimmer Boat

2.4.2.1 Analysis of Effectiveness of Oil Spill Recovery Using Disc Type Oil Skimmer

Hirekhan S, Hirekhan A, Khedikar A, Nikhade H proposed that oil spill accidents can be handled in several ways, but the mechanical oil skimmer with disc plate is the most efficient option. The depth of the disc submerged, or the area of the disc surface dipped into the oil spill, the area of the wiper sweep, the thickness of the oil on the disc surface, and the rotation speed of the disc are some of the factors that affect how well the oil skimmer handles oil spills. The findings of an oil skimmer experiment at a laboratory scale are presented in this paper. The test takes five minutes to complete for three data. According to theoretical calculations, as the disc's rotation speed increases, spill transport will also increase. Because oil will cover more than water in the transported oil spill result, the lifting process is more effective with low rotation speed [15].

2.4.2.2 Experimental Study and Improvement of The Rotating Disc Skimmer

Christodoulou M, and Turner state that experiments with flow visualisation have provided qualitative data about the flow field created by a rotating disc skimmer. The recovery rate of the skimmer under oil-only and thin-film conditions was then measured, and performance information was obtained. It has been possible to build a system that, depending on the operating conditions, can achieve gains of up to 600 per cent because of this thorough study and the improved understanding of the parameters that control the performance of the skimmer. The design of practical skimmer systems is influenced by the findings of further research into a multiple

disc arrangement regarding interference effects between nearby discs. Figure 2.3 shows the test apparatus and disc skimmer support structure[16].

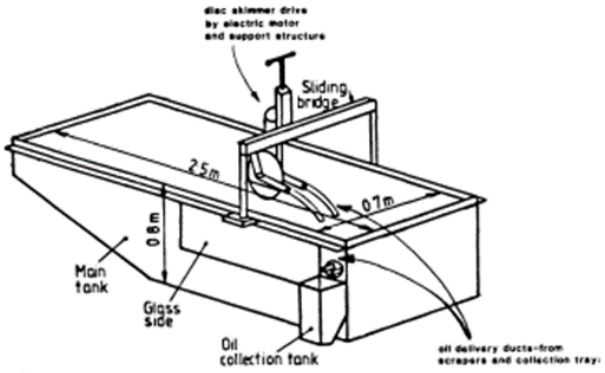


Figure 2.3 Test apparatus and disc skimmer support structure [16].

2.4.2.3 Floating oil skimmer design using rotary disc method

There have been numerous oil accidents in the sea over the last few years. Oil spills, offshore drilling operations, and pipeline leaks are all potential causes of oil accidents. If the oil in the sea is not removed, it will float and harm the local ecosystem. As a result, an oil skimmer system is used in this paper to separate and remove oil from water. A rotating disc to collect oil from the water's surface and two propellers to move the oil skimmer make up the oil skimmer system. The motor driver and Arduino Mega serve as the controller for the DC motor that powers the rotary disc and propeller. A joystick is also included with the oil skimmer, which is used to control the movement of the oil skimmer and modify the speed at which the rotary disc rotates. According to test results, the oil skimmer can take oil from the water's surface and separate it at a speed of 620.28 ml/min at 18 rpm. Figure 2.4 shows the block diagram of the oil skimmer by using the rotary disc method [17].

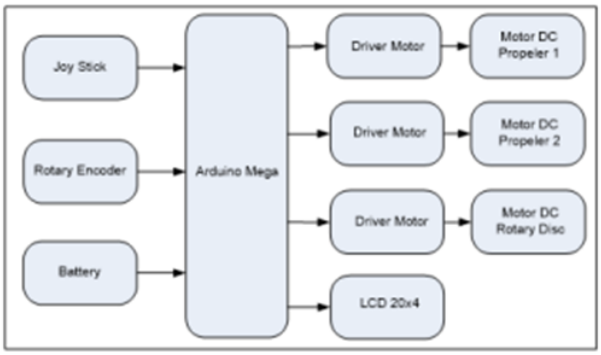


Figure 2.4 Block diagram of oil skimmer by using rotary disc method [17].

2.4.3 Drum Skimmer Boat

2.4.3.1 Oil-recovery performance of a sponge-covered drum skimmer

Study and experimental research were done on a rotating drum skimmer covered in sponge to recover oil under various operating conditions. Two drums with diameters of 300 mm and 200 mm and lengths of L = 300 mm and L = 455 mm, respectively, were tested. Oil viscosity, rotational speed, slick, thickness, and centre height above the oil/water interface were all factors under consideration. Regardless of the oil's viscosity, the results show that the sponge-covered steel surface recovers oil more effectively than standard steel surfaces. When both were used in the same manner, the sponge-covered drum collected 24% more oil than the plain steel drum. Due to its capacity to absorb oil, the porous cover enhances the performance of the skimmer. Oil slick thickness increased from 10 to 25 mm, and sponge-covered drums had an improved recovery rate of 59% compared to plain steel drums' 17.5%. The research opens the door to using various porous sorbent materials to cover the oleophilic skimmers to increase their effectiveness and rate of oil [18].

2.4.3.2 Improved recovery of oil spills from water surfaces using tailored surfaces in oleophilic skimmers

According to Broje V, Keller A, and Bren D, the study aimed to test new oleophilic drum recovery surfaces for oil spill cleanup and a relationship were determined between operational variables and oil recovery effectiveness. It evaluated skimmers with various configurations, capacities, sizes, and recovery mechanisms. Figures 2.5 and 2.6 show the effects of temperature and film thickness as well as the effects of temperature and oil type on the hydrocarbon recovery efficiency of aluminium drums[19].

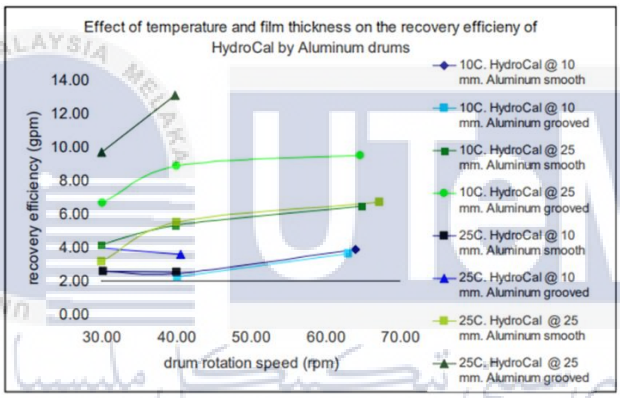


Figure 2.5 Effect of temperature and film thickness on the recovery efficiency of Hydro Cal by aluminium drums[19].

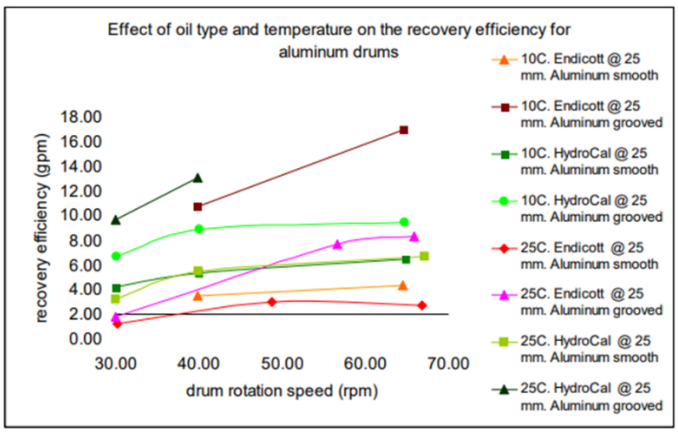


Figure 2.6 Effect of temperature and oil type on the recovery efficiency of aluminium drums [19].

2.4.3.3 Evaluation of Oleophilic Skimmer Performance in Diminishing Oil Slick Thickness

McKinney states that a shallow draft, lightweight grooved drum skimmer is the TDS 118G. Two drums with oleophilic grooves measuring 43 cm in diameter and 43 cm in width are used in the skimmer, which is 135 cm wide and 91 cm long. Oil sticks to the grooved surfaces of the drums as they move through the slick. By using contour-conforming scrapers, the surface is raised and scraped off. The drum motors and the offload pump are both powered by Elastec American Marine D-10 hydraulic power units (HPUs). Figure 2.7 shows the Elastec TDS 118G Drum Skimmer [20]

Figure 2.7 Elastec TDS 118G Drum Skimmer [20].

2.5 Comparison of Belt, Disc and Drummer Skimmer.

2.5.1 Belt-Type Skimmer

Table 2.1 shows the type of Belt Skimmer and the description.

Table 2.1 Belt-type Skimmer

Belt-type Skimmer	Description
Design and Development of Belt-Type Oil Skimmer[12]	• Use a belt material with a higher adsorption property to separate more oil. • Achieve higher oil recovery efficiency, lower cost, and eco-friendliness with less maintenance type oil skimmer.
A Review on The Oil Skimmers for Sugar Industry [13]	• Allows the industry to reuse the extracted oil for general lubrication purposes, such as conveyor rollers, guides, press plates, chain sprockets, gears, and weatherproofing spares, all while reducing pollution and reducing cost of machine fluid.
Oil Separator Skimmer [14].	• Suggested using an oil skimmer as the most affordable and effective way to eliminate surface oil from the ocean, and leaky oils from machinery, and washing machines.

	• The properties of the oil that will be used for oil skimmings, such as viscosity and adhesiveness, should be taken into consideration when choosing skimmers.

2.5.2 Disc-Type Skimmer

Table 2.2 shows the type of Disc Skimmer and its description.

Table 2.2 Disc-type Skimmer

Disc-Type Skimmer	Description
Analysis of Effectiveness of Oil Spill Recovery Using Disc Type Oil Skimmer, [15]	• Disc's rotation speed increases, spill transport will also increase. Because oil will cover more than water in the transported oil spill result, the lifting process is more effective with low rotation speed.
Disc Type Oil Skimmer [21]	• use filtered water in daily life and recycle it by filtering it again

Experimental Study and Improvement of The Rotating Disc Skimmer, [16]	• Then, performance data was collected by measuring the skimmer's recovery rate in both thin-film and oil-only environments.
Floating oil skimmer design using the rotary disc method, [17]	• The DC motor that drives the rotary disc and propeller is controlled by an Arduino Mega and motor driver. Additionally, the oil skimmer comes with a joystick that can be used to steer it around and alter how quickly the rotary disc rotates.

2.5.3 Drum-Type Skimmer

Table 2.3 shows the type of Drum Skimmer and description.

Table 2.3 Drum-type Skimmer

Drum-Type Skimmer	Description
Influence of operational parameters on the recovery rate of polyester resin surface of locally designed drum oil skimmer, (Sabbar et al., 2021)	• Examines operational parameters using a custom drum skimmer for viscosity, temperature, and rotation speed. • Drum rotation increases recovery rate, with maximum improvement at the highest temperature.
Improved recovery of oil spills from water surfaces using tailored surfaces in oleophilic skimmers, [19]	• The study did not evaluate operational factors like spill thickness, surface pattern, ambient temperature, and drum rotation speed for comparing oil recovery rates of skimmers.
Evaluation of Oleophilic Skimmer Performance in	• Oil sticks to the holes of the drums as they move through the slick. Using contour-conforming scrapers, the surface is raised and removed.

Diminishing Oil Slick Thickness [20].	

From the research of the past studies, this project is referred to Oil Skimmer System. Overall “Design and Development of Oil Skimmer Belt is about an automatic boat that operated by using an RC remote and less time consumption. So, this project used the same concept as the Oil skimmer to clean the river. In this project, the mechanism and endurance of this boat were studied and tested. Thus, this project is suitable to remove the oil on water surfaces and clean the river.

2.6 RADIO CONTROL (RC)

This topic describes about how radio control works and the movement of a skimmer's boat.

2.6.1 Unmanned Surface Vessel for Monitoring and Recovering of Spilled Oil on Water

The USV uses a wireless LAN-based control system with a base station on a host boat or land. The system allows real-time transmission of 8 video channels, command guidance, state data, and oil recovery. The network has a 6M bandwidth for 15 miles. Figure 2.8 shows the block diagram of the remote control (RC) and video monitoring system [22].

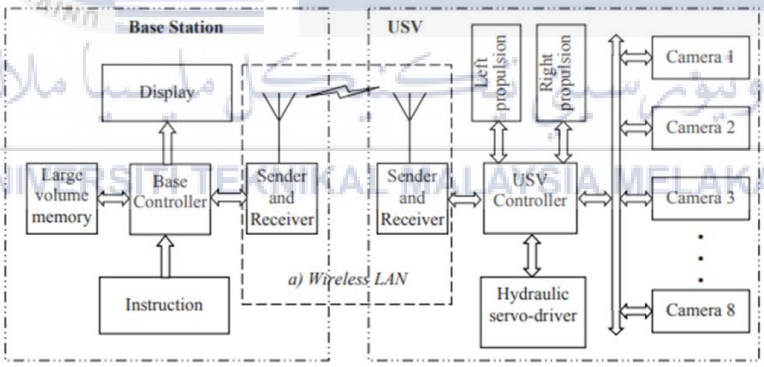


Figure 2.8 Remote control and video monitoring system[22].

The USV controller uses an industrial control computer with RS-232, and 485 communication interfaces, extending to each compartmentalized hull cabin for easier equipment connection and disconnection. The hydraulic system block diagram is shown in Figure 2.9.

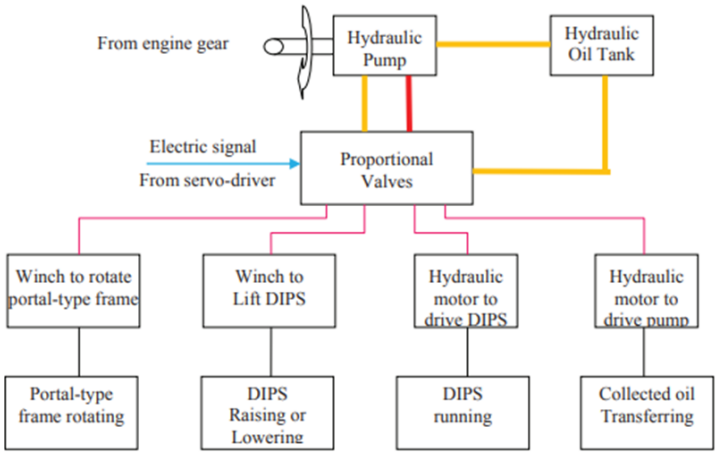


Figure 2.9 Hydraulic system[22].

2.6.2 Water Surface Cleaning Robot

The RF-controlled robot operates using four push buttons on the transmitter side. It includes an RF transmitter and an RF encoder, which receive commands to move forward, backwards, turn left or right, or stop.

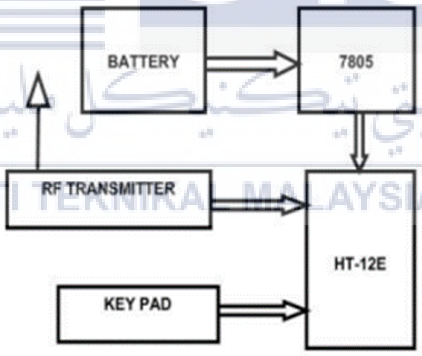


Figure 2.10 Block diagram of RF Transmitter[23].

The Wi-Fi module uploads readings to Thing Speak's website. The boat's rear DC motors and remote control controls enable steering. The carrier draws 4.5mA from a 3 Volt power source when logic one is sent. The tuned receiver receives data repeatedly from the transmitter. [23].

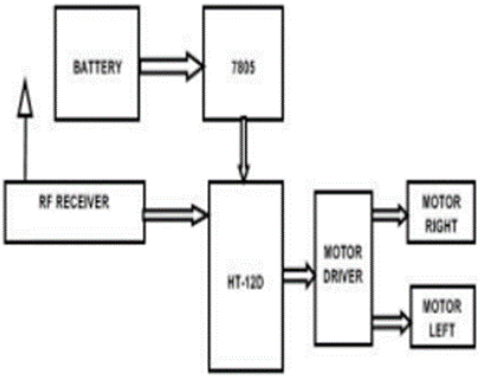


Figure 2.11 Block diagram of RF receiver [23].

2.6.3 Iot Based Water quality monitoring system using RC boat

Gunjal suggested that the sensors in this wireless remote-controlled boat monitor the water's pH, conductivity, temperature, and turbidity. The system consists of two parts: a wireless Wi-Fi camera and sensors on the boat, an LCD, a Wi-Fi module, and an Android smartphone on the remote control. The two are linked using wireless RF modules. The remote's LCD screen, which is attached to the remote, receives all sensor readings and displays them. The Wi-Fi module will upload the same reading to the Thing Speak website. The boat has two DC motors on its back, guided by a remote, powered by two batteries, as shown in Figure 2.12 [24].

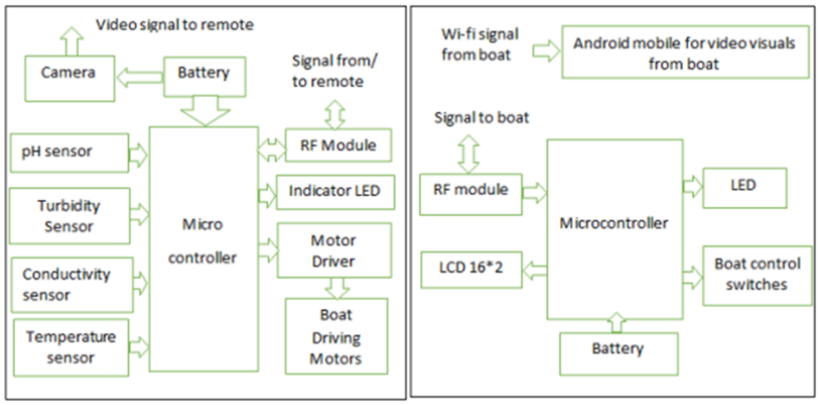


Figure 2.12 Process of two different batteries to power the remote and boat [24].

2.7 Solar as a source of energy

2.7.1 Grid-tied, off-grid, and hybrid solar systems

To achieve a clean energy carrier, solar energy will be a key component of the world's future energy scenario. Solar energy conversion to hydrogen is one such method. Solar energy systems are inherently safer than some potentially risky electricity generation techniques because they are an advanced technology. In Malaysia, four different kinds of solar systems can be used for residential purposes. These systems include grid-connected, hybrid, direct current, and off-grid residential solar systems reffering Figures 2.13 [25].

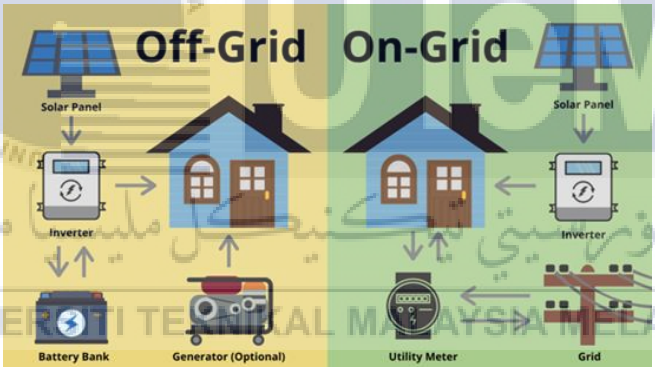


Figure 2.13 Differences between solar systems [25].

Hybrid solar, also referred to as grid-connected solar with energy storage, is the first type of solar system. This solution saves consumers money when compared to residential solar systems that are off-grid. This is so that the battery can use any stored energy instead of drawing power from the grid. However, the higher cost of this technology is one drawback.

The most frequently used system is the Grid-Connected System. The local grid and the home's electrical system are both connected to it. Any extra electricity is

supplied back to the grid. The operational costs are relatively low because less equipment is required. For a direct current solar system, it is more efficient because it only needs to be converted once, to direct current. pumped storage-compatible off-grid solar power system. In smaller DC-coupled systems, the battery charging is managed by a solar charge controller. An off-grid inverter then transforms the DC power into AC and supplies it to the load. Figure 2.14 shows the off-grid solar power system [25].

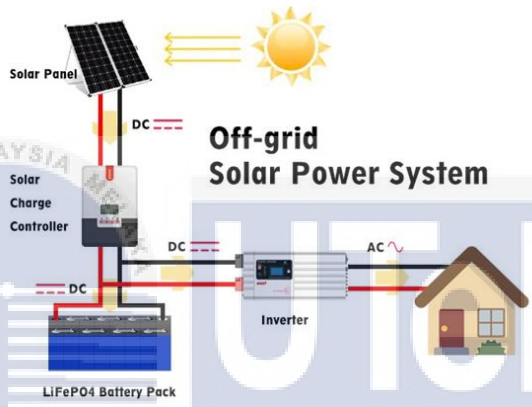


Figure 2.14 Off-grid solar power system[25].

2.8 Type of solar panel

2.8.1 Monocrystalline vs. Polycrystalline vs. Thin-Film Solar Panels

Regarding site suitability, solar panel efficiency, potential user financial savings, and advantages, solar panels are an essential consideration. Solar panels come in three different varieties: monocrystalline, polycrystalline, and thin film (TF)[26].

2.8.1.1 Monocrystalline

Solar panels with a single silicon crystal are known as monocrystalline as shown in Figure 2.15. It is marginally more effective than polycrystalline solar panels. Monocrystalline panels therefore produce a lot of power. Of the other panels, it has the smallest size and longest lifespan.

Figure 2.15 Monocrystalline solar panel [26].

2.8.1.2 Polycrystalline

Polycrystalline solar panels as shown in Figure 2.16 use the same material as monocrystalline panels, but multiple silicon pieces are combined to create polycrystalline solar cells. The solar cell is made by moulding and treating smaller pieces of silicon. Since so little raw material is wasted during manufacturing, this process is less wasteful.

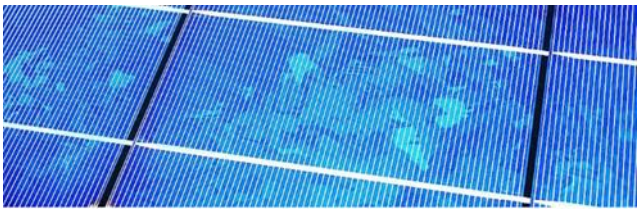


Figure 2.16 Polycrystalline solar panel [26].

2.8.1.3 Thin Film (TF)

Thin film panels as shown in Figure 2.17, the third type of solar technology, are frequently used in huge utility projects and a few specialized applications. To create thin film panels, a conductive material is thinly coated onto a glass or plastic backing plate. Thin film panels are typically not used in residential installations due to their significantly lower efficiency compared to mono or poly panels. Residential customers prefer more traditional crystalline silicon panels because they are lightweight, flexible, and work with any type of roof design.

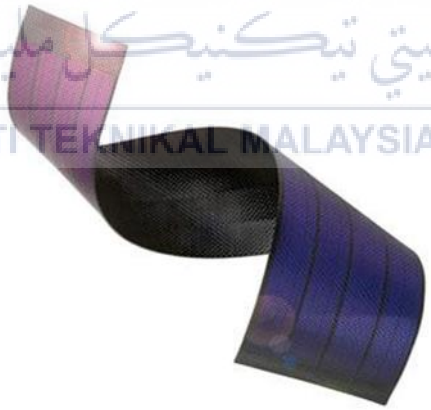


Figure 2.17 Thin Film solar panel [26].

2.9 Summary of Literature Review

Table 2.4 shows the summary of the literature review

Table 2.4 Summary of Literature Review

Author	Title	Technique	Remarks
Filomena Lelario, Giuliana Bianco, Sabino Aurelio Bufo, Laura Scrano (2021)	Simulated Ageing of Crude Oil and Advanced Oxidation Processes for Water Remediation since Crude Oil Pollution	Oil is a complex organic mixture with various chemical components.	• Hydrocarbons with hetero atoms (N, S, and O) that are both saturated and unsaturated are found in oil.
Angela Carpenter (2019)	Oil pollution in the North Sea: the impact of governance measures on oil pollution over several decades	Reduce oil pollution	• Education regarding the environmental harm and numerous laws that prevent the disposal of waste at sea.
Hui Wang, Chunchun Wang,	Superhydrophobic and super oleophilic	Adsorption of oil	• Low ability to adsorb oil and poor ability to select for the oil-water mixture.

Shuai Liu, Lin Chen and Sudong Yang (2019)	graphene aerogel for adsorption of oil pollutants from water		
Scott Post (2011)	Oil spill clean-up project	Deepwater Horizon semisubmersible rig sinking	• Traditional oil spill cleanup techniques involve skimmers, boats, burning, and chemical dispersants to spread oil and facilitate vaporization.
Ms Geetanjali Rokade, Mrs Laxmi Kale, and Mrs Sphurti Deshmukh (2023)	Ocean Waste Collection Technology: A Systematic Review	Need a suitable waste collection facility	• When garbage is not properly disposed of, it hurts the environment, particularly aquatic bodies.
Rajesh Kannan Megalingam, Kusumanchi Surya Shanmukh, Aditya Ashvin, Pochareddy Nishith Reddy (2022)	Design and Simulation of Autonomous Water Tank Cleaning robot in Gazebo	A new robot system	• cleaning as compared to manual cleaning, which is inefficient, unsafe, slow, and reduces water pollution.

Raj Maisuriya, Vatsal Maisuriya (2020)	Design and Development of Belt Type Oil Skimmer	Promoting sustainable development of natural resources	• They created and manufactured a more cost-effective and efficient oil skimmer than the previous one. • The primary aim of this effort is to separate more oil by using a belt material with a greater adsorption property.
M. Pavan Kumar, K. Prithvi Raj, B. Sridhar, Ch. Mohan Sumanth, Dr. K. Srividya (2021)	Oil Separator Skimmer	The comparison of belt and disc skimmers	• The technique for skimming principle is specific gravity, surface tension, and affinity. • Belt-type made of corrosion-resistant steel or a synthetic material.
Vijay Shankar Miraje, Prof. G. S. Joshi (2020)	A Review on The Oil Skimmers for the Sugar Industry	Separate more oil by using a belt material with a greater absorption property	• permits the business to reuse the extracted oil for general lubricating applications, such as conveyor rollers, guides, press plates, chain sprockets, gears, and weatherproofing parts, while also lowering pollution. • It can also be used as fuel for boiler firing.
S.G. Hirekhan , A.G. Hirekhan , A.R. Khedikar ,	Analysis of Effectiveness of Oil	The mechanical oil skimmer with disc plate	• Oil skimmer effectiveness depends on disc surface area and absorbed depth, affecting spill cleanup efficiency.

H.R. Nikhade (2020)	Spill Recovery Using Disc Type Oil Skimmer		
Marios S. Christodoulou and John T. Turner (1987)	Experimental Study and Improvement of The Rotating Disc Skimmer	Data on the flow field in rotating disc skimmer.	• Skimmer system design influenced by multiple disc arrangement research to address interference effects.
S Supriyono , D T Nurrohman (2020)	Floating oil skimmer design using rotary disc method.	An oil skimmer system	• The oill skimmer system uses propellers and a rotating disc for oil collection from the water's surface. • Motor driver and Arduino Mega control DC motor, rotating disc, propeller.
M.F. Khalil , Ibrahim El-Boghdady, E.R. Lotfy (2022)	Oil-recovery performance of a sponge-covered drum skimmer	The revolving drum skimmer collects oil under various conditions.	• Oil viscosity, rotating speed, slickness, thickness, and centre height were considered.
Victoria Broje and Arturo A. Keller (2006)	Improved recovery of oil spills from water surfaces using tailored	To fully test the new oleophilic drum	• Comparison of skimmer recovery rates without considering operational factors like spill thickness, surface pattern, ambient temperature, and drum rotation speed.

	surfaces in oleophilic skimmers		• A variety of designs, capacities, sizes, and recovery techniques for these skimmers have been tested.
Kristi McKinney and John Caplis, Dave DeVitis and Keith Van Dyke (2017)	Evaluation of Oleophilic Skimmer Performance in Diminishing Oil Slick Thickness	A shallow draft, lightweight grooved drum skimmer	• Oil sticks to the grooved surfaces of the drums as they move through the slick. • Using contour-conforming scrapers, the surface is lifted and scraped off.
Jianhua Wang, Fuxin Ren, Zhenyi Li, Zhao Liu, Xiang Zheng, Yongsheng Yang (2016)	Unmanned Surface Vessel for Monitoring and Recovering of Spilled Oil on Water	The wireless LAN-based control system for the USV is made up of the base station and the USV.	• The USV receives commands from the base station console, which also displays information about the USV's status and data from its onboard instruments.
R. Raghavi, K. Varshin, L.	Water Surface Cleaning Robot	RF controlled robot	• A RF transmitter and encoder enable a robot to move forward, backwards, left, right, and stop using its transmitter component.

Kemba Devi (2019)			
Gayatri Gunjal, Renu Guraddi, Sonal More , (2022)	IoT Based Water quality monitoring system using RC boat	This wireless remote-controlled boat has sensors that assess the pH, turbidity, and temperature of the water.	• The system consists of a boat with sensors, a wireless Wi-Fi camera, a remote control with LCD, a Wi-Fi module, and an Android smartphone. • Wireless RF modules link sensors, allowing the remote to receive and display readings on an LCD screen.

The most effective of skimmer boat is the Gayatri Gunjal, Renu Guraddi, Sonal More, (2022). They implemented the Iot Water quality monitoring system using an RC boat.

2.10 Summary

RC remote helps people to control the navigation of the boat on the water surface. It shows that this project can reduce the usage of manpower in this field. Next, water surface wastes are one of the causes of the increases of oil pollution in the river and ocean. So, the project is important in tackling this problem.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter outlines the process and criteria for designing project completion using block diagrams and flowcharts, illustrating technical aspects and step functions.

3.2 Methodology

This chapter describes a remotely operated solar-powered oil collector boat. The environmentally friendly approach was selected for this project due to Malaysia's ongoing river pollution issues. Figure 3.1 shows the flowchart of BDP I and Figure 3.2 shows the flowchart of BDP II.

3.3 System of Project

3.3.1 Flowchart of project

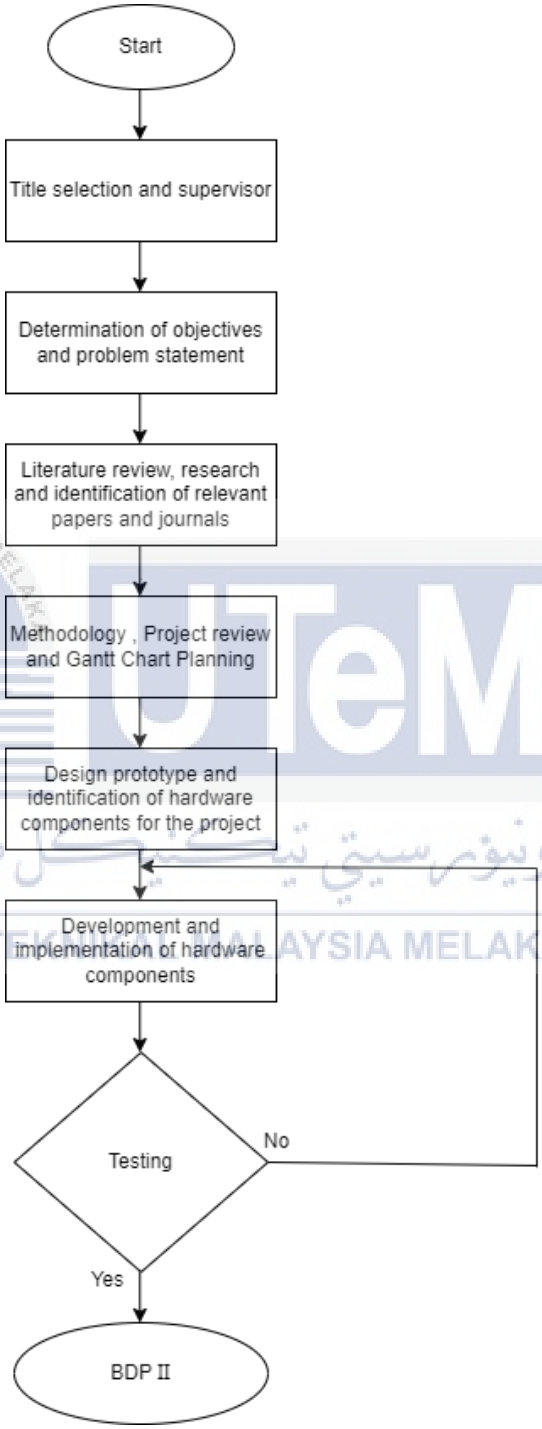


Figure 3.1 Flowchart BDP 1.

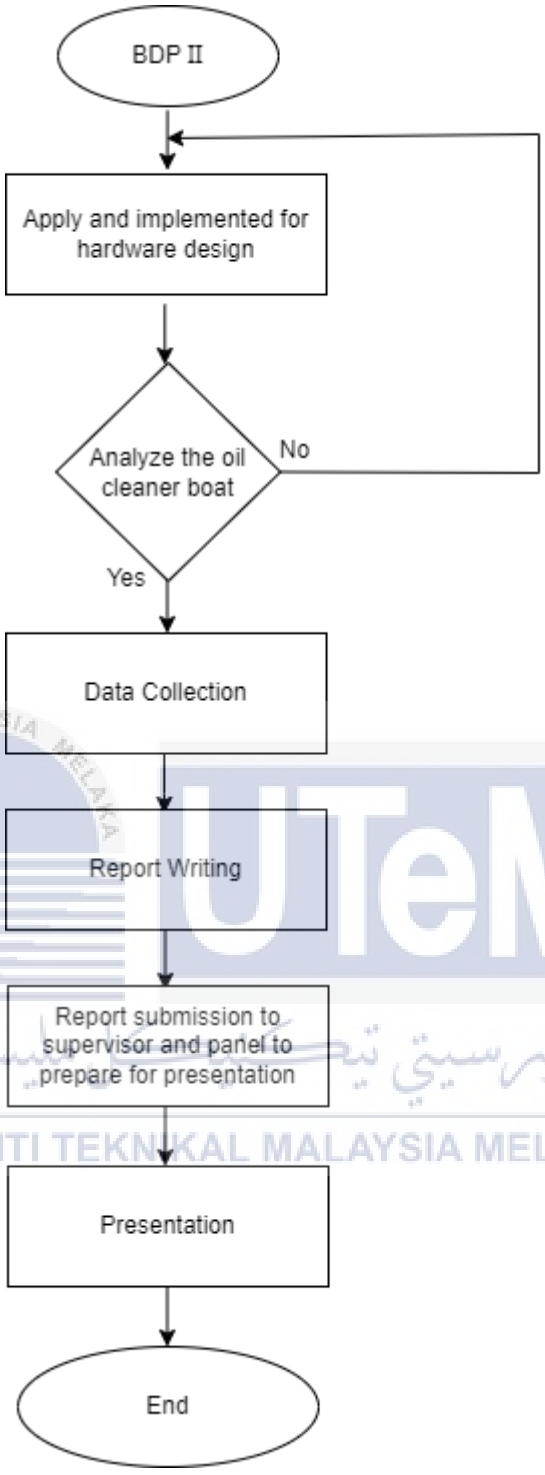


Figure 3.2 Flowchart BDP 2.

3.3.2 Block Diagram of the Project

Figure 3.3 shows the block diagram of the project.

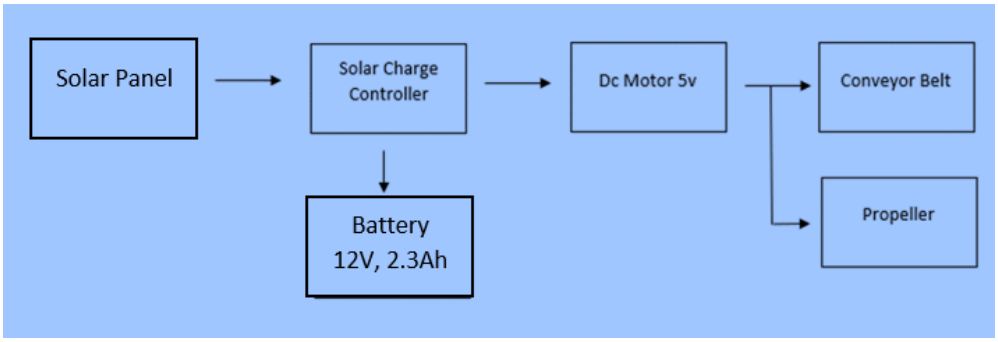


Figure 3.3 Block Diagram of project.

To get started, the proposed project title will be studied to generate ideas, determine the objectives of the project, and come up with a solution based on the problems found.

Additionally, a Gantt chart will be used to plan the timeline for this project because the process took longer or shorter than expected to be completed on time.

Circuit and simulation design and hardware design divide the two sections of this project. The electronic circuit is designed, constructed, and simulated using Proteus 8 Professional Software before proceeding on to the hardware components. In this project, the prototype design is sketched using Fusion360 software.

3.4 Project Characteristics

This oil collection boat will be used to remove oil from small lakes, rivers, and lakes. This device can be managed with a remote control. The goal of this project is to reduce the pollution of the water's surface, particularly oil pollution. In this project, a belt conveyor will be connected to DC motors. The battery and solar panel attached to the top of the boat serve as the project's power sources.

3.5 Software and Components

Software is a group of programmed, instructions, and data that give the computer instructions to simulate the objective (a variety of tasks). Software components come in a variety of forms, including system software and application software. Application software is created specifically for a project to carry out specific tasks or the user's application. Proteus and Fusion360, for example. Multiple technologies and materials are combined to create hardware. It oversees the execution of software commands, the archiving and retrieval of data, and the enabling of inter-component communication.

3.5.1 Proteus

This Proteus software eases the process of PCB design and simulation. Thus, it is used in many fields such as education and industry. The latest version of Proteus is version 8.14. Figure 3.4 shows that the project was using the Proteus Software to construct the schematic diagram of a control circuit.

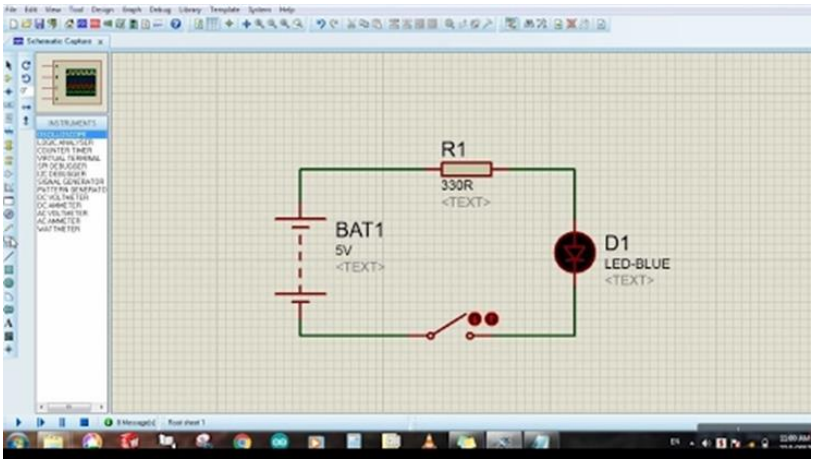


Figure 3.4 Proteus software

3.5.2 Relative Components

3.5.2.1 Dc Motor (5V)

A DC motor is a rotary electrical motor that converts direct current electrical energy into mechanical energy. Its internal system, either electromechanical or electronic, regularly changes the direction of current. Small DC motors are suitable for appliances, toys, and tools, while large DC motors are suitable for cranes, lifts, and electrical vehicles. Figure 3.5 shows the DC motor.

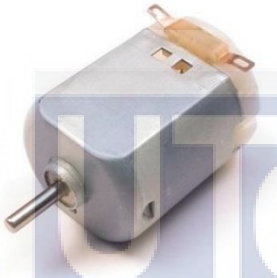


Figure 3.5 DC motor (5V)

3.5.2.2 Polycrystalline Solar Panel

Solar panels that contain multiple silicon crystals within a single PV cell are known as polycrystalline or multi-crystalline solar panels. The wafers of polycrystalline solar panels are created by melting together several pieces of silicon. The surface of these solar panels has a mosaic-like appearance. Due to the fact that the majority of the silicon is used during production, polycrystalline solar panels are more environmentally friendly than monocrystalline solar panels. Polycrystalline solar panels can withstand temperatures up to 85°C and -40°C, but are less heat-tolerant than monocrystalline panels, making them less efficient at higher temperatures.

Their temperature coefficient is higher. For this project, a 12V, 2W solar panel Polycrystalline will be installed at the top of the boat. The solar system will back up as a source of supply to the battery to make sure the DC motor will turn on. Figure 3.6 shows the solar panel Polycrystalline.

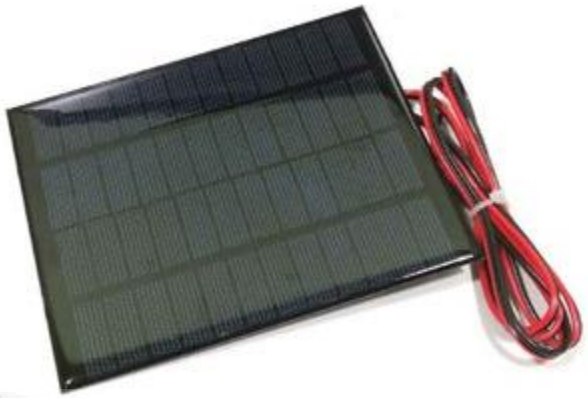


Figure 3.6 Solar panel PV Polycrystalline.

3.5.2.3 Battery Lead Acid

Battery Lead Acid (12V 2.3Ah) refers to the nominal voltage of 12 volts and a capacity of 2.3 ampere-hours (Ah). This type of battery is a rechargeable battery and long-lasting battery life. For many years, lead-acid batteries have been widely utilised due to their dependability, inexpensive cost, and ability to generate large current outputs. However, rather heavy and has a low energy density when compared to other modern battery technologies. They are made up of lead plates immersed in a sulfuric acid electrolyte solution. For this project, battery lead Acid (12V 2.3Ah) will be used to keep the voltage incoming from the solar charge controller. Figure 3.7 shows the Battery Lead Acid (12V 2.3Ah).

Figure 3.7 Battery Lead Acid (12V 2.3Ah)

3.5.2.4 Geared DC Motor 12V

A direct current (DC) motor that is designed to run at a nominal voltage of 12 volts is referred to as a geared DC motor with a 12V specification. The motor was built to operate at its best when it is powered by a 12-volt DC source. A mechanical part that can double the torque and reduce speed (or sometimes amplify it) is called a gearbox. Geared DC motors are often used in electronic projects, robotics, automotive systems, and industrial automation applications that call for precise speed control and higher torque. The Geared DC motor 12V is shown in Figure 3.8.

Figure 3.8 Geared DC Motor 12V

3.5.2.5 Solar Charge Controller

A solar charge controller functions to regulate the incoming voltage from the solar panel. It is also to prevent the battery from overcharging and overcharging to ensure performance and prolong its lifespan. There are many features inside the solar charge controller, such as battery regulation, battery protection, load control, monitoring and display, and maximum power point tracking (MPPT). Figure 3.9 shows the solar charge controller at 10 A MPPT.

Figure 3.9 Solar Charge Controller at 10 A MPPT.

3.6 Calculation for Solar Panel

3.6.1 System-specific requirement of Solar Panel

i. 1.5 hours operation

Energy = 1.5hours x 2W = 3Wh

ii. Peak Sun Hour = 3 hours

iii. System Efficiency = 3Wh ÷ 3 ÷ 0.8 = 1.25 (r.d) = 1 W

Therefore, 1W will be used for this project.

3.6.2 Battery Calculation

i. Energy = 3Wh

ii. Battery Voltage = 12V, 2.3Ah

iii. Days of autonomy(DoA) = 2 days

iv. Depth of discharge(DoD) = 50%

v. Battery bank multiplier = 1.05

vi. Peak Sun Hour = 3 hours

vii. Solar Panel Size = 1W

3.6.3 Average Daily, Wh

Dc average = 3Wh

3.6.4 Battery Bank Capacity, Wh

[Daily average x Days of autonomy x Battery Multiplier] ÷Depth of discharge

= [3Wh X 2 X1.05] ÷ (0.5)

=12.6Wh

3.6.5 Battery Bank Capacity, Ah

[Battery bank capacity ÷ System of Voltage]

= 12.6Wh ÷ 12V = 1.05 Ah

=1.05 Ah ÷ 2.3 Ah = 0.46 (r.up) ≈ 1 Battery

3.6.6 Solar Charge Controller Calculation

i. Solar Panel = 2W

ii. Battery Bank = 12V

iii. Solar Charge Controller = 2W ÷ 12V = 0.17A

Therefore, 12V , 10 A solar charge controller will be used.

3.7 Measurement for solar panel

Figure 3.10 and Figure 3.11 shows the measurement of voltage and current for solar panels.

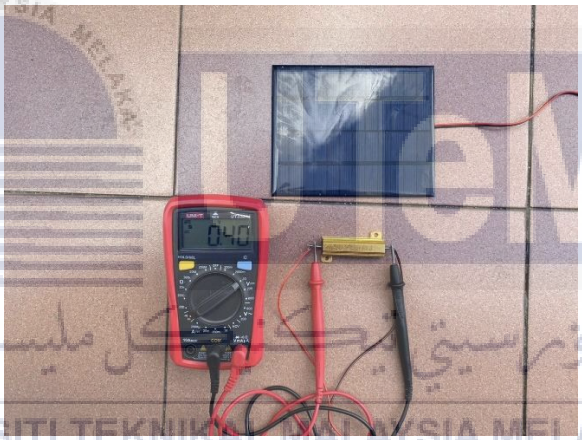


Figure 3.10 Voltage measurement for solar panel.

Figure 3.11 Current measurement for solar panel.

3.8 Design of project

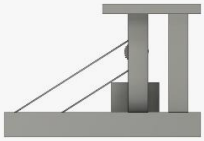
3.8.1 Initial Design of Water Surface Oil Cleaner Boat Powered by Solar System

The oil collector was created using the Fusion 360 software, and a 3D model was made to help visualise the specifications and needs that had been discovered during the analysis. Figure 3.12 shows the design from three different angles, including the top view, side view, and front view.

3D Design

Top View

Front View



Side View

Figure 3.12 3D Design and the three views: the front view, the back view, and the side view.

The base, oil tank collector, conveyor belt, and electronic box are the four main parts that make up the oil collector boat's body. Table 3.1 lists the purpose, substance, and characteristics of each component.

Table 3.1 Main components of oil cleaner boat.

Component	Function	Material	Characteristic
Base	Used for floating in water and supporting boats.	Foam	Lightweight Water resistance
Conveyor Belt	Used to collect oil	MicroFiber Cloth	Absorb oil Thin
Oil tank collector	Used as a temporary oil collector	Plastic	Easy handling Lightweight
Electronic box	used to keep all electrical and electronic supplies in storage.	Plastic	Long life Lightweight

3.8.2 Circuit Design

Figures 3.12 and 3.13 show the circuit that simulates this project's hardware circuit design for remote control use using Proteus Software.

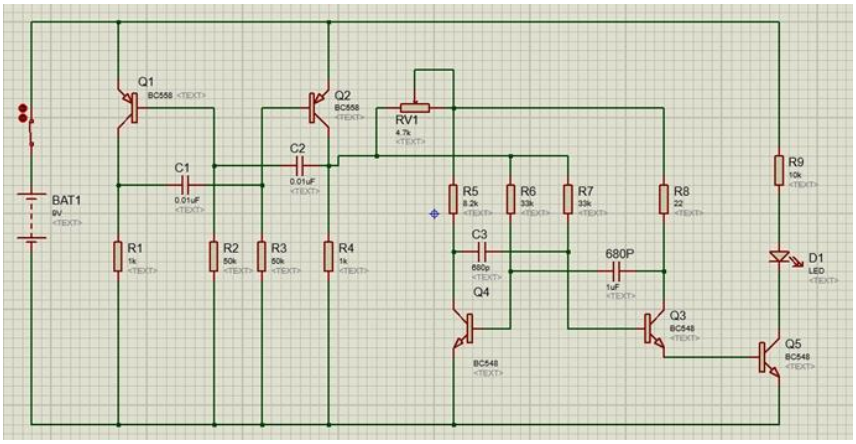


Figure 3.13 Transmitter Circuit.

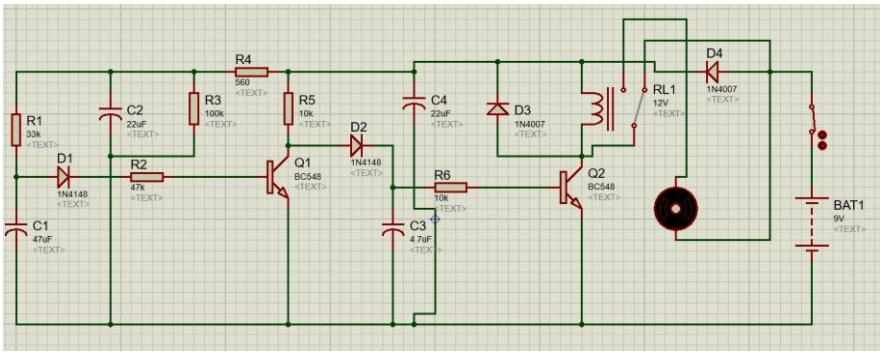


Figure 3.14 Receiver Circuit.

3.8.3 Project Cost

The price list for the hardware used to build the prototype is shown in Table 4.2.

Table 3.2 Price List for Project Hardware.

NO	DESCRIPTION	NO RECEIPT/INVOICE	PRICE		
			WITH GST (RM)	GST (RM)	TOTAL (RM)
1	Solar Charge Controller	230611492AXWB7	15.00	15.00	14.93
2	Polycrystalline Solar Panel 2W 12V	23060906X03JHU	22.50	22.50	22.50
3	Gradle Motor DC 12V	CS00045513	8.00 x 2 = 16.00	8.00 x 2 = 16.00	90.00
4	Lead Acid Battery 12V/2.3Ah		68.00	68.00	
5	Fan Blade 80MM		3.00 x 2 = 6.00	3.00 x 2 = 6.00	
6	Glue Stick	R000722711	3.30 x 2 = 6.60	3.30 x 2 = 6.60	13.80
7	Value Pack Container 3pcs		3.10	3.10	
8	Cable Tie Black		2.00	2.00	
90	Pvc Electrical Tape		2.10	2.10	
10	Stick Foam	224822-P	2.50 x 2 = 5.00	2.50 x 2 = 5.00	5.00
11	Switch 2P	CS00045567	2.00	2.00	6.00
12	Core Cable		1.00 x 4 = 4.00	1.00 x 4 = 4.00	
13.	Corrugated Board	671-596033	8.30	8.30	8.30
TOTAL CLAIM					160.53

3.8.4 Water Surface Oil Cleaner Boat Design

The hardware circuit then was connected to the water surface oil cleaner boat.The hardware circuit connected to the water surface oil cleaner boat design with solar supply is shown in Figure 3.15.

Figure 3.15 Water Surface Oil Cleaner Boat Design.

To make the oil-cleaner boat more stable, it is important to consider its centre of gravity and buoyancy during design. It can therefore move and float on a water's surface. The relationship between the centre of gravity and buoyancy determines the stability of the boat.

3.8.5 Hardware Circuit

The hardware circuit was tested with a direct supply from a 12V Sealed Lead Acid Battery to test its functionality. Figure 3.16 shows the hardware circuit.

Figure 3.16 Hardware circuit.

3.9 Summary

This project, which is based on this chapter, will use all the elements and methods to design the Development of Water Surface Cleaning Boat powered by Solar system.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the findings and analysis from the project "Development of Water Surface Oil Cleaner Boat Powered by Solar System". In each section, the results and analysis are thoroughly explained and supported by the testing experiment.

4.2 Result and Analysis

This topic explains that the result taken will be analyzed when the hardware is tested by controlling the hardware with the Remote Control (RC). The result taken involved the voltage of the battery during the hardware operation, amount of oil collected, speed of motor distance vs time when the hardware is operating. Furthermore, the hardware project will be analyzed in real world situations.

4.2.1 Testing of the Project

The project testing was done in a pool area rather than a river as shown in Figure 4.1 since the ripple waves in the pool are weaker than those in the river. These ripples and waves will affect the stability of the boat. The duration of the boat's operation with solar as a supply is based on the capacity of the battery bank, the efficiency of the solar panel, and the efficacy of the solar system. Solar-powered boats can operate for several hours to a full day based on stored solar energy in the battery.

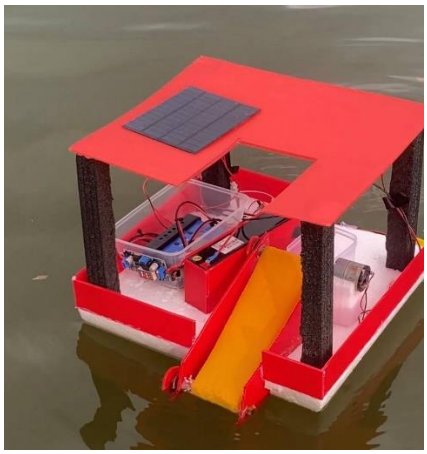


Figure 4.1 Project testing on the water surface.

The dimensions of the belt as a conveyor used to absorb the oil are 20cm by 18 cm, indicating a rectangular shape, and the capacity of the tank that fits to collect the oil on the water surface is 200 ml. An oil absorption rate is also necessary to achieve the stability of the boat.

4.2.2 Operating an Oil Cleaner Boat in Different Water Depths

Depending on the depth of the water, an oil cleaner boat's operation may vary significantly. Table 4.1 shows the advantages and challenges of operating the oil cleaner boat based on three types of water depth.

Table 4.1 Comparison of Oil Cleaner Boat operation based on type of water depth.

Type of water depth	Advantages	Challenges
Deep Water	Effectively covers bigger spill areas.	It is hard to deploy oil booms and skimming at such depths.
Medium Water	More adaptability than operations in deep water. Access to smaller areas.	It is difficult to control wave movement and ensure total oil removal from the water's surface.

Shallow Water	In limited spaces, smaller boats are more fast-moving than deep-water boats.	It is hard to recover oil that has become stuck in rocky or vegetated places.

4.2.3 Time Rotating of the boat.

Table 4.2 shows the movement of the boat is measured three times to take the average based on the time taken for each operation and data on battery voltage with solar supply before and after boat operation.

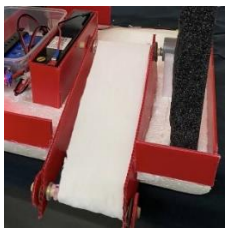
Table 4.2 Time taken for forward movement, left and right turn.

Operation	**Forward**				**Left Turn**				**Right Turn**			
Trial	1	2	3	Average	1	2	3	Average	1	2	3	Average
Time taken for each operation (s)	5.10	4.98	5.05	5.04	4.37	4.56	4.58	4.50	4.46	4.50	5.00	4.65
Battery voltage before operation (V)	12.55	12.56	12.57	12.56	12.56	12.55	12.53	12.55	12.57	12.60	12.62	12.60
Battery voltage after operation (V)	12.50	12.50	12.50	12.50	12.53	12.53	12.53	12.53	12.54	12.54	12.54	12.54

4.2.4 Comparison Type of oil-belt conveyor

Table 4.3 shows the comparison of the oil-belt conveyor for an oil cleaner boat that is suitable to absorb more oil on the water surface.

Table 4.3 Comparison of type of oil-belt conveyor.

Type of conveyor	Description
Cotton Lycra Fabric 	Lycra is a synthetic fibre known for its elasticity and stretchability. Lycra fibres have limited absorbent capabilities compared to natural cloth.
Microfiber Jersey 	Microfiber materials are capable of absorbing and holding a substantial amount of liquid, including oil, because of their fine material, which gives them a high surface area. This makes them useful for situations requiring oil absorption or for clearing up oily spills.

4.2.5 Speed (m/s) vs Distance (m)

Results have been taken based on the time and distance during the operation. The oil cleaner boat moves for the 2 meters to 10 meters to measure the speed of the boat. The following data in Table 4.4 and Figure 4.2 are obtained in shows speed of the motor vs distance based on time.

Table 4.4 Data of time(s), distance (m) and speed (m/s).

Time (s)	Distance (m)	Speed (m/s)
3	2	0.67
6	4	0.67

9	6	0.67
12	8	0.67
15	10	0.67

Figure 4.2 Distance (m) vs Speed(m/s) Graph.

4.2.6 Rate Amount of Oil Collected

Table 4.5 and Figure 4.3 shows the data taken and the bar graph to measure the absorbability of conveyor collecting the oil during the boat operated on the water surface after pouring oil from 2ml to 8ml. It also shows that the effectiveness of the belt to absorb the oil from the water surface is obtained from the data below.

Table 4.5 Rate Amount of oil collected.

Amount of oil (ml)	Before (ml)	After (ml)
2	2	1.5
4	4	2.5
6	6	4
8	8	6.5

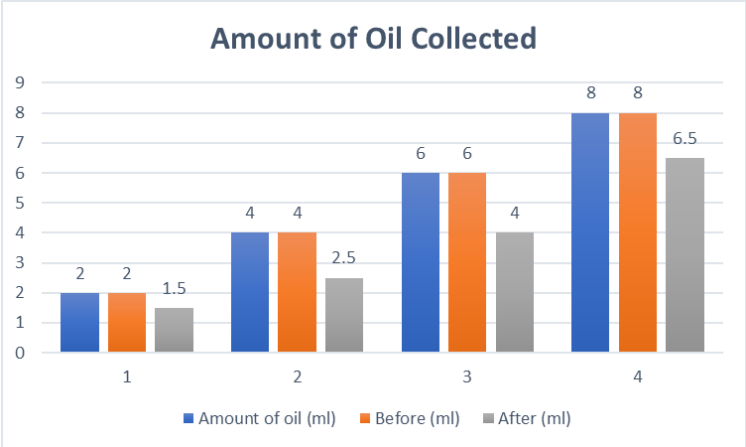


Figure 4.3 Amount of Oil Collected Bar Graph.

4.2.7 Battery Voltage With and Without Solar Panel Attached after 30 Minutes

Table 4.6 shows the battery voltage without a solar panel attached after 30 minutes of operation with each data taken for every 5 minutes while Figure 4.8 shows the bar graph for Battery Voltage vs Time.

Table 4.6 Battery Voltage without Solar Panel Attached after 30 Minutes.

Time (s)	Battery Voltage (V)
0	12.64
5	12.55
10	12.53
15	12.52
20	12.5
25	12.5
30	12.48

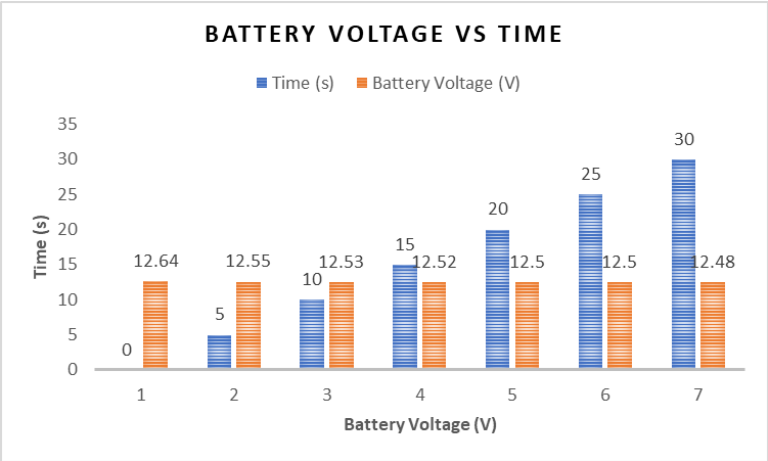


Figure 4.4 Battery Voltage vs Time Bar Graph.

The battery voltage with solar as supply after 30 minutes of operation is displayed in Table 4.7 Figure 4.9 shows the bar graph for Battery Voltage vs Time.

Table 4.7 Battery Voltage without Solar Panel Attached after 30 Minutes.

Time (s)	Battery Voltage (V)
0	12.58
5	12.56
10	12.54
15	12.54
20	12.54
25	12.54
30	12.54

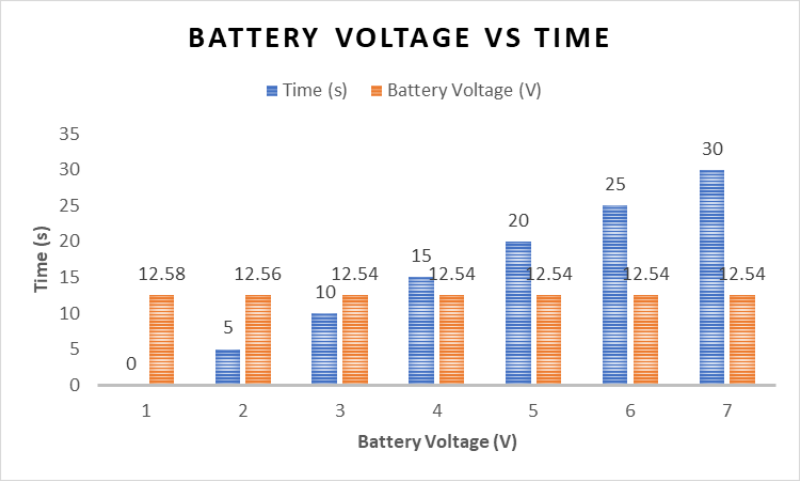


Figure 4.5 Battery Voltage vs Time Bar Graph.

The data on battery voltage was taken in two conditions. It shows that the battery voltage remains constant at 12.54V after 30 minutes while the boat is connected to the solar panel. The solar panel helps the boat to charge while it is operating. The battery voltage for the boat without a solar supply decreases from 12.64V to 12.48V after 30 minutes. This indicates that the more movement required by the motor, the higher the voltage will decrease.

4.2.8 Graph Analysis Solar (Polycrystalline 12V 2W)

Table 4.8 shows the reading and Figure 4.6 shows the graph of the 12V 2W solar panel from tracking and fixed solar panel for 11 hours.

Table 4.8 Reading from tracking and fixed solar panel

	Voltage reading (V)	Current reading(I)	Output Power(W)
Time	Fixed	Fixed	Fixed
7.00 am	2.69	0.05	0.27
8.00 am	5.98	0.11	1.26
9.00 am	6.91	0.13	1.73

10.00 am	7.34	0.16	2.35
11.00 am	8.47	0.18	2.97
12.00 am	8.63	0.2	3.37
1.00 pm	9.91	0.25	4.86
2.00 pm	9.56	0.23	4.4
3.00 pm	8.58	0.21	3.69
4.00 pm	7.86	0.18	2.38
5.00 pm	6.13	0.14	1.67
6.00 pm	4.86	0.09	0.93

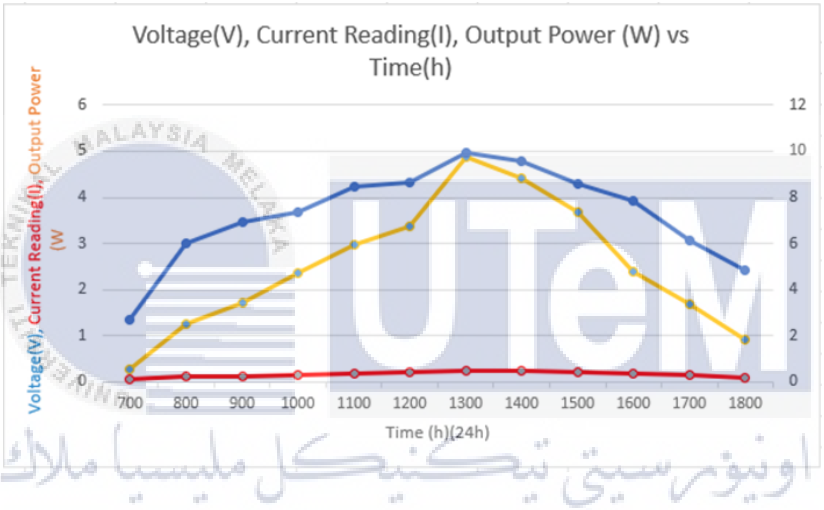


Figure 4.6 Graph from fixed time reading solar panel (2W).

4.3 Summary

All of the results and analyses presented in this chapter have been validated. Based on the analysis results, the amount of oil collected before and after operating was recorded. The differences between cleaner boats operating in different water depths were obtained. Moreover, the hardware can work properly with the Remote Control (RC), which acts as the controller.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, this project has been effectively carried out and demonstrates the construction of a Water Surface Oil Cleaner Boat powered by Solar System, to develop this project specifically for river water surface.

Data and analysis were conducted to obtain the result which included the voltage of the battery during the operation of the hardware, as well as the time taken when the boat was navigated from 1 to 3 meters three times. Next, the data for the amount of the oil collected before and after the operation of the boat. Hence, the data collected demonstrates that the use of the solar panel helped in maintaining the battery voltage while it was operating.

The Remote Control was successfully used to control the movement of the boat. Finally, the solar panel was able to be used as a power supply in this project as can be seen by the data received during testing involving battery charging using solar panels. The battery voltage was measured using a multimeter and Solar Charge Controller.

5.2 Objective Achievement

To conclude, all three objectives are achieved in this project. There are:

1) Analyse the existing oil cleaner boat in Malaysia.

2) Design and model an oil belt-skimmer boat powered by solar PV.

3) Develop and evaluate the efficacy of a boat that can collect oil from the water's surface while preventing it from dispersing.

All the project objectives are achievable as the existence of this project towards water pollution in Malaysia can be analyzed from the data of battery voltage used in this project collected and can be used to be implemented in real-world situations. Next, an oil belt-skimmer boat designed is successfully to operate remotely and uses solar power as a supply. Lastly, the efficacy of a boat that can collect oil from the water's surface while preventing it from dispersing can be evaluated from the data amount of oil collected while operated. Thus, the cost can be accomplished as only RM160.53 is needed to build this project design.

5.3 Commercialization of Product

For the commercialization of products, this project will give a lot of benefits to a consumer by using this Development of Water Surface Oil Cleaner Boat Powered by Solar System.

1. Environmentally Friendly

Small spills of the oil have the potential to destroy marine life and harm ecosystems. This risk is eliminated by emissions-free boats to protect aquatic environments and water quality.

2. Affordable

The boat would be less expensive to operate than traditional oil spill response vessels because it would not require fossil fuels to function. The oil boat cleaner was fully powered by a solar power system.

3. Versatile

Strong crude oil would be among the many types of oil that the boat could clean up. The amazing design of the oil boat cleaner allows for easy movement and collects the oil on the surface.

5.4 Future Works

Improve future outcomes as follows:

i. Addition of an obstacle avoidance module and a sensor to detect oil spills.

ii. Future installations of cameras could be used for image processing to create fully autonomous navigating control systems.

iii. The use of carbon fiber is preferred for frame fabrication or base in order to get a frame that is lighter and easier to install.

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APPENDICES

Appendix A Project Gantt Chart BDP I

No	Project Activity		Week 1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Topic confirmation and discussion with supervisor	Plan														
		Actual														
2	Final year project briefing by panel for PSM 1	Plan														
		Actual														
3	Collecting relevant academic papers related to the project	Plan														
		Actual														
4	Background study of the project	Plan														
		Actual														
5	Introduction: Objective and Problem Statement	Plan														
		Actual														
6	Update to supervisor: Progress Work 1	Plan														
		Actual														
7	Literature Review: (Past study and paper research)	Plan														
		Actual														
8	Methodology: Project review, Flow Chart and Gantt Chart planning	Plan														
		Actual														
9	Initial project: Simulation Rc remote	Plan														
		Actual														
10	Report Draft Submission	Plan														
		Actual														
11	Update to supervisor:	Plan														
	Progress Work 2	Actual														
12	Submission report to panel	Plan														
		Actual														
13	PSM Presentation Evaluation	Plan														
		Actual														

Appendix B Project Gantt Chart BDP II

No	Project Activity		Week													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Planning activities for project development	Plan														
		Actual														
2	Final year project briefing for PSM 2	Plan														
		Actual														
3	Starting to purchase the equipment for the project	Plan														
		Actual														
4	Development of hardware: 1) Design a boat's conveyor belt 2)Design a circuit for solar panel 3)Make a wiring for electrical part	Plan														
		Actual														
5	Development of software : 1)Develop RC circuit for controlling the boat	Plan														
		Actual														
6	Integrating software and hardware	Plan														
		Actual														
7	Collection and data analysis for Oil cleaning boat	Plan														
		Actual														
8	Preparation for chapter 4: Results and Discussion	Plan														
		Actual														
9	Preparation for chapter 5: Conclusion and future works	Plan														
		Actual														
10	Report Draft Submission	Plan														
		Actual														
11	Update to supervisor: Progress work 2	Plan														
		Actual														
12	Submission report to panel	Plan														
		Actual														
13	PSM Presentation Evaluation	Plan														
		Actual														

Appendix C Solar Panel Module 2W Technical Specification

Description

『Solar Panel』

Output Voltage: 12V

Output Current: 167mA

Output Power: 2W

Dimensions: 110mm x 136mm

Photo-voltaic panels work best under full sunlight.

Appendix D Datasheet of Solar Charge Controller