Faculty of Electronics and Computer Technology and Engineering

DEVELOPMENT OF SOLAR-POWERED WAVE DETECTION SYSTEM FOR THE MARINE TOURISM INDUSTRY USING ARDUINO BASE ON DOS-BUOY CONCEPT

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Bachelor of Computer Engineering Technology (Computer Systems) with Honours

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DEDICATION

Mother & Father

I dedicate this report with profound gratitude to my beloved mother, *Zaileha Binti Ismail*, and my father, *Shaharul Nizam Bin Zaulkifli*. Your unwavering support and encouragement have been the guiding light throughout my academic journey. The sacrifices you made and your unshakeable belief in my abilities have been the driving force behind my success. I am genuinely thankful for the immeasurable love and inspiration you have provided.

Along with all hardworking and respected

Lectures

ABSTRACT

The term waves are seawater that rolls towards the coast and crashes the coast. These waves occur when the wind blows, and the earth rotates on its axis. As it is known that calm sea waves are not a safe sign for bathing as changes in the volatile sea waves can cause drowning to occur in the waters of the sea. To improve the safety of the marine tourism sector, the proposed construction of the "Solar Powered Wave Detection System for the Marine Tourism Industry Using Arduino (Dos-Buoy)" is to solve the problems faced by the community. This project are integrates with solar energy Arduino technology where the wave detection system can detect wave patterns and water temperature precisely at the same time. Through the merger of solar panels, the project highlights the use of renewable energy while promoting sustainability and reducing operating expenses. The addition of GSM also provides notification of wave and temperature data in order to make users available at the same time. The system can help avoid accidents and allows operators to make informed decisions by using wave and temperature sensors to know the current warnings issued on the system.

ABSTRAK

Istilah ombak ialah air laut yang bergolek ke arah pantai dan meranapkan pantai. Gelombang ini berlaku apabila angin bertiup, dan bumi berputar pada paksinya. Seperti yang diketahui bahawa ombak laut yang tenang bukanlah tanda selamat untuk mandi kerana perubahan terhadap ombak laut yang tidak menentu boleh menyebabkan lemas berlaku di perairan pantai. Bagi meningkatkan keselamatan sektor pelancongan marin, cadangan pembinaan "Sistem Pengesanan Gelombang Berkuasa Suria untuk Industri Pelancongan Marin Menggunakan Arduino (Dos-Buoy)" adalah untuk menyelesaikan masalah yang dihadapi oleh masyarakat. Projek ini diintegrasikan dengan teknologi Arduino tenaga solar di mana sistem pengesanan gelombang dapat mengesan corak gelombang dan suhu air dengan tepat pada masa yang sama. Melalui penggabungan panel solar, projek ini mengutamakan penggunaan tenaga yang boleh diperbaharui sambil mempromosikan kemampanan dan mengurangkan perbelanjaan operasi. Penambahan GSM juga menyediakan pemberitahuan data gelombang dan suhu untuk menjadikan pengguna tersedia pada masa yang sama. Sistem ini dapat membantu mengelakkan kemalangan dan membolehkan pengendali membuat keputusan termaklum dengan menggunakan sensor gelombang dan suhu untuk mengetahui amaran semasa yang dikeluarkan pada sistem.

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LIST OF ABBREVIATIONS

V	-	Voltage
I	-	Current
P	-	Power
W	-	Watt
PWM	-	Pulse Width Modulation
A	-	Ampere
mA	-	Milliampere
h	-	Hours
VCC		voltage common collector
GND		Ground
TX & RX		Transmit and receive

CHAPTER 1

INTRODUCTION

1.1 Background

Marine tourism activities can enhance the economy of Malaysia's tourism industry, according to research conducted on the nation's rapidly expanding tourism industry. Malaysia has a beautiful coastline as a result of which visitors do not stop to appreciate nature and recreation along the coastline. After the MCO is loosened during the Recovery phase (RMCO), the coastal community can engage in recreational activities such as fishing, picnicking, swimming, and water sports without fretting about the movement control. However, there is a significant concern regarding our society's decreased sensitivity to safety, guidelines, and compliance issues, particularly when it comes to recreation or leisure activities at sea [1]. Each shore area has a security guard who will monitor the safety of visitors and be prepared for any problems that may arise in the event of an emergency. However, security guards and proximity to recreational visitors are lacking in the extensive coastal area. This will make it difficult for security personnel to determine the circumstances of visitors experiencing problems during leisure time. According to research conducted by the Malaysian Department of Fire and Rescue (JBPM), the daily drowning figures and statistics are alarming, particularly in relation to shore locations. This is because the public should be able to avoid drowning if they are better informed about the danger of drowning on the beach [2].

Therefore, the solar-powered Wave Detector System was constructed to ensure the welfare of tourists in the marine tourism industrial zone. In the field of communication, wireless technology is now extensively used to facilitate the transmission and exchange of information in wireless networks. Thus, the system employs the GSM 900a module as a wave signal conduit to facilitate the concept of frequency network to users by employing the Short Message/Messaging Service (SMS) as a hazard warning notification if it is hazardous for beachgoers to engage in recreational activities. The benefit of using wireless technology is that the user can monitor the condition waves transmitted through the wave detetctor system to the GSM that inserted the Sim card and send the data via SMS, which is a better communication for a long distance and time used are the same. This system features a genuine connection between the wave detector system and the microcontroller, GY-87 10DOF sensor, and DS18B20 sensor. When GY-87 sensor detects dangerous movement of the wave and the DS18B20 detect the temperature readings of the seawater, the microcontroller connected to the GSM 900a module transmits the data through the GSM 900a module and then alerts the identifier via SMS. The system is powered by solar energy that charges the battery that is used to power the system. With solar available as a charging system, this product can reduce electricity consumption and is environmentally beneficial.

The implementation of this system will not only inform users but will also assist the security department in being prepared to monitor the state of the beach and decrease the danger of undesirable mishaps by beachgoers participating in recreational activities.

1.2 Problem Statement

The marine tourism industry confronts a significant challenge in ensuring the safety of watercraft movement while also providing travellers with an exceptional experience. The absence of real-time and exhaustive data on wave patterns and ocean conditions poses significant risks for both tourists and operators. The lack of accurate wave detection systems impedes the ability to optimise watercraft routes, resulting in the risk of collisions and a reduction in safety. In addition, the absence of water temperature monitoring hinders the tourism industry's ability to make informed decisions regarding tourist activities, as temperature fluctuations can have an effect on activities such as swimming, snorkelling, and observing fauna.

Furthermore, most existing systems or devices use non-rechargeable battery power. Batteries are energy that has a lifespan. It needs to be changed if the power runs out. When the battery power is exhausted, notifications cannot be given. This can cause significant harm and risk to tourists and operators if the battery runs out during big waves. In addition, changing the battery during a big wave can be life-threatening due to the device being far from the beach.

Therefore, there is an urgent need for an innovative system that integrates solar power, Arduino technology, wave detection sensors, and monitoring capabilities for water temperature. Such a system would enable real-time monitoring of wave patterns, increase the optimisation of watercraft movement, enhance safety measures, and provide accurate water temperature data. By combining cutting-edge technology, environmental sustainability, and data-driven decision-making, the marine tourism industry can make significant progress towards safer and more efficient operations while promoting sustainable practices that preserve marine ecosystems and improve the overall tourist experience.

1.3 Project Objective

The "Solar-Powered Wave Detection and Temperature System for Marine Tourism Industry Using Arduino (Dos-Buoy)" project's main goal is to create and put into action a comprehensive solution that tackles the problems the marine tourism sector.

- To develop a water wave detection system using Arduino.
- To implement the use of IOT to notify user about water wave.
- To analyze the use of solar energy in the water wave detection system.

1.4 Scope of Project

This project focus includes making, putting in place, and testing a full system for detecting waves and keeping track of water temperature in the marine tourism business. The project has the following important parts:

1. Wave Detection: To design and build a system that can correctly detect and track the movement of sea waves. This result will give information about how waves behave in real-time so that boats can move more efficiently and safely.

2. SMS Notification: SMS (Short Message/Messaging Service) is a text messaging service that is available on most telephone, Internet, and mobile device networks. The wave detection alarm delivers the wave hazard data. This result can notify the user to the dangers of sea waves and also inform the security department to prepare for the worst.
3. Renewable Energy Integration: The solar energy as the main source of power to run the machine. This result makes things more sustainable and less dependent on traditional energy sources, which saves money and helps the earth.

By achieving these objectives, the project intends to deliver a functional wave detection system with accurate data monitoring, water temperature measurement, and reliance on renewable energy, thereby contributing to enhanced safety, improved tourist experiences, and sustainable operations in the marine tourism industry.

1.5 Project Significance

The project's significance lies in its ability to enhance safety and efficiency in the marine tourism industry through the development of a solar-powered wave detection system. By accurately detecting wave patterns and monitoring water temperature in real time, the system enables optimized watercraft movement, prevents collisions, and facilitates informed decision-making. The integration of renewable energy sources promotes sustainability, reducing reliance on conventional energy and minimizing operational costs. Overall, the project's innovative approach contributes to improved safety, enhanced efficiency, and a more sustainable marine tourism industry.

1.6 Summary

The goal of the project is to create a wave detection system powered by the sun for the marine tourism business. By correctly detecting wave patterns and checking the temperature of the water in real-time, the system improves safety, makes it easier for boats to move, and helps people make better decisions. Integrating green energy sources helps the environment and keeps costs down. Overall, the project aims to make the marine tourism business safer, more efficient, and more sustainable by using new technology and eco-friendly methods.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Marine tourism is one of the primary elements driving Malaysia's tourist sector growth. Malaysia is one of the countries with the most gorgeous islands and the most diversified marine life. It attracts guests who want to appreciate the beauty of the sea and the environment. The brisk activity provides a chance for local tour operators to enter the tourism industry. As a result, while commercial operations might help local tour operators, they can also have a detrimental influence on the economy, society, and the environment [3]. Figure 2.1 show maritime tourism activities that are often held in coastal area.

Figure 2.1 Activities Maritim Tourism

2.2 Ocean Wave

Ocean waves can be regarded as energy transfers visible as rising and falling sea water with certain times and wavelengths. This flow of energy in the water is generated by a variety of variables, resulting in diverse types of waves in the sea. Sea waves, also known as ocean waves, are classified into different varieties based on their generating technique. This ocean wave can be created by a variety of sources, including wind (wind waves), the pull of the earth-moon-sun (tidal waves), volcanic or tectonic earthquakes that occur at sea, and ships or boats [4].

In order to have a safe and enjoyable ocean experience, it is essential to comprehend wave height and swimming safety. Small waves, typically between 0 and 1 foot in height, are considered secure for swimming, especially for novices and children. Waves between 1 and 3 feet in height have slightly more force, making them suitable for competent swimmers. However, if lack swimming ability or are unfamiliar with the ocean, exercise prudence. Large swells ranging in height from 3 to 6 feet are typically challenging for the majority of swimmers. Due to the increased risk of strong currents and wave-related injuries, it is recommended that novice ocean swimmers avoid swimming in these conditions. Lastly, extremely enormous waves that transcend 6 feet in height are extremely powerful and potentially hazardous. Even experienced swimmers should avoid swimming in such conditions due to the elevated danger of rip currents, forceful shore breaks, and severe injuries. Prioritize personal safety at all times and adhere to any instructions or warnings issued by lifeguards or local authorities [5]. Figure 2.2 show significent of wave height have a level type that dangerous for swim.

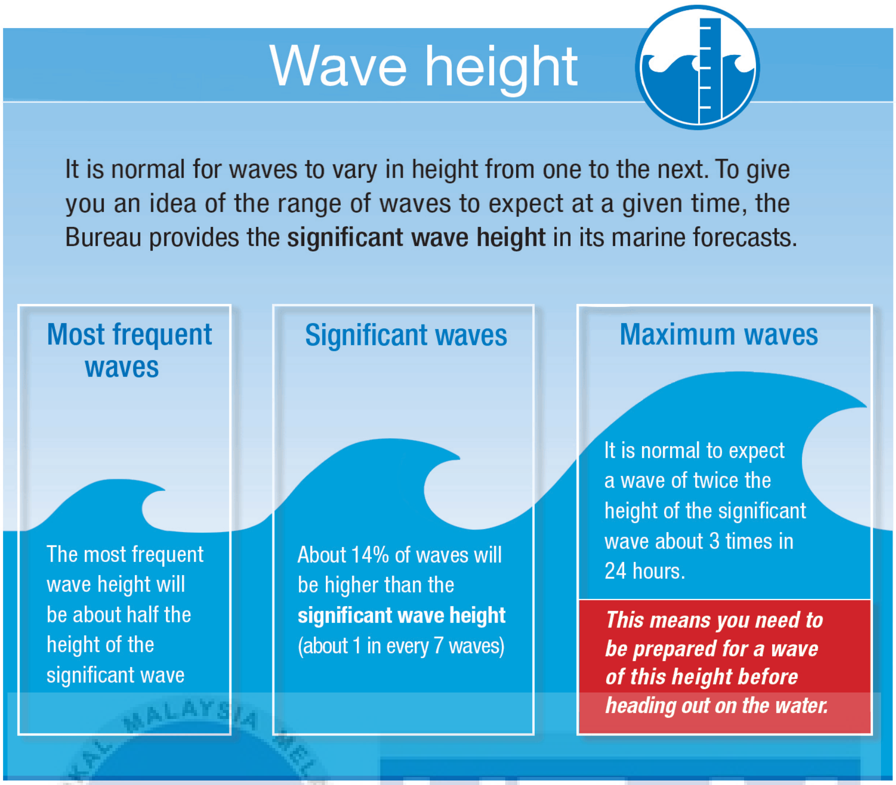

Figure 2.2 The significant wave height.

2.3 Microcontroller

A microcontroller is a type of processor that includes a Central Processing Unit (CPU), Random Access Memory (RAM), Read Only Memory (ROM), input/output ports, a serial interface port, and other components. It contains all of the capabilities necessary for a computing system and acts as a computer without any external digit parts linked to it. The majority of the pins on a microcontroller chip may be programmed by the user. The most essential mechanism employed in the development of this system is the microcontroller. The microcontroller utilized in the development of this system is critical, and all requirements must be examined. Following some investigation, the Arduino microcontroller board was chosen as the core of this project. The differences in the properties of all Arduino boards are shown in Table 2.1 [6].

Table 2.1 Difference in the properties of all Arduino board

Name	Processor	Operating Voltage/Input Voltage	CPU Speed	Analog In/Out	Digital IO/PWM	EEPR OM [KB]	SRAM [KB]	Flash [KB]	USB	UART
Uno	ATmega32 8	5 V/7-12 V	16 Mhz	6/0	14/6	1	2	32	Regular	1
Due	AT91SAM 3X8E	3.3 V/7-12 V	84 Mhz	12/2	54/12	-	96	512	2 Micro	4
Leona rdo	ATmega32 u4	5 V/7-12 V	16 Mhz	12/0	20/7	1	2.5	32	Micro	1
Mega 2560	ATmega25 60	5 V/7-12 V	16 Mhz	16/0	54/15	4	8	256	Regular	4
Mega ADK	ATmega25 60	5 V/7-12 V	16 Mhz	16/0	54/15	4	8	256	Regular	4
Micro	ATmega32 u4	5 V/7-12 V	16 Mhz	12/0	20/7	1	2.5	32	Micro	1
Mini	ATmega32 8	5 V/7-9 V	16 Mhz	8/0	14/6	1	2	32	-	-
Nano	ATmega16 8 ATmega32 8	5 V/7-9 V	16 Mhz	8/0	14/6	0.512 1	1 2	16 32	Mini-B	1
Ether net	ATmega32 8	5 V/7-12 V	16 Mhz	6/0	14/4	1	2	32	Regular	-
Pro Mini	ATmega16 8	3.3 V/3.35-12 V 5 V/5-12 V	8 Mhz 16 Mhz	6/0	14/6	0.512	1	16	-	1

Based on the comparison in Table 2.1, the Arduino Uno microcontroller board will be used as the system's microcontroller unit. Arduino Uno is the finest option for those just starting out with the platform. This microcontroller circuit is ATmega328 MCU-based. ATmega238 MCU is a high-performance 8-bit AVR RISC-based microcontroller from Microchip with 16Mhz CPU speed. It combines with read-while-writing-capable 32KB ISP flash memory. The storage capacities of 1KB for EEPROM and 2KB for SRAM are sufficient for the development of this system, as it does not require image, video, or audio storage, which requires larger capacities. The number of input/output ports for analogue is six, whereas digital has only four.

This project does not require greater input/output ports, so the input/output count of 14 is sufficient. In the most recent revision, the bridge is the ATmega16U2, which features both a USB transceiver and a serial interface (UART interface). In addition to being simple to use, one of the primary advantages of Arduino technology is that software can be inserted directly into the device without the need for a hardware programmer to encode the software. Arduino's software is compatible with a variety of operating systems, including Windows, Linux, and Mac OS X [7]. Figure 2.3 show detail of Arduino Uno microcontroller board diagram.

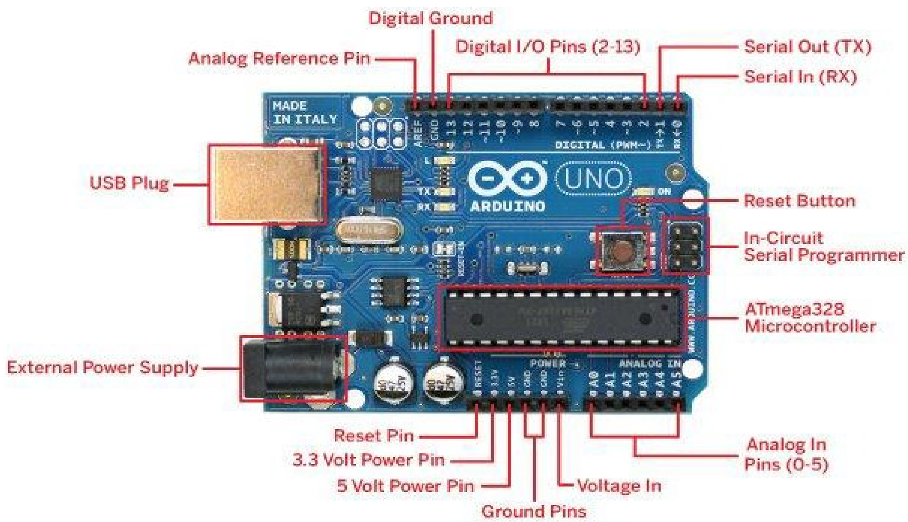

Figure 2.3 Arduino Uno microcontroller board diagram

2.4 Short Message Services (SMS)

SMS is a text message service that may be accessed by most phones, mobile phones, and the Internet. SMS employs well-known communication protocols to allow mobile phone devices to send short text messages of up to 160 characters between phones via the network operator's message center. There must be no images or visuals in the message, and it cannot include more than 160 alphanumeric characters.

The benefit of utilizing SMS is that the message is sent immediately to the recipient's mobile phone. An SMS can reach its intended receivers at any time or in any location. If the phone loses signal or is turned off, the message will be delivered once the signal is restored and the phone is turned on again. SMS Control Channels are used to receive messages while a voice or data transmission is taking place. SMS (Short Message Service) is a basic communication method offered by mobile phone networks. SMS messaging is currently available on mobile phone networks based on the Global System for Mobile Communication (GSM), Time Division Multiple Access (TDMA), and Code Division Multiple Access (CDMA). Figure 2.4 show the structure of the SMS, GSM system, TDMA and CDMA.

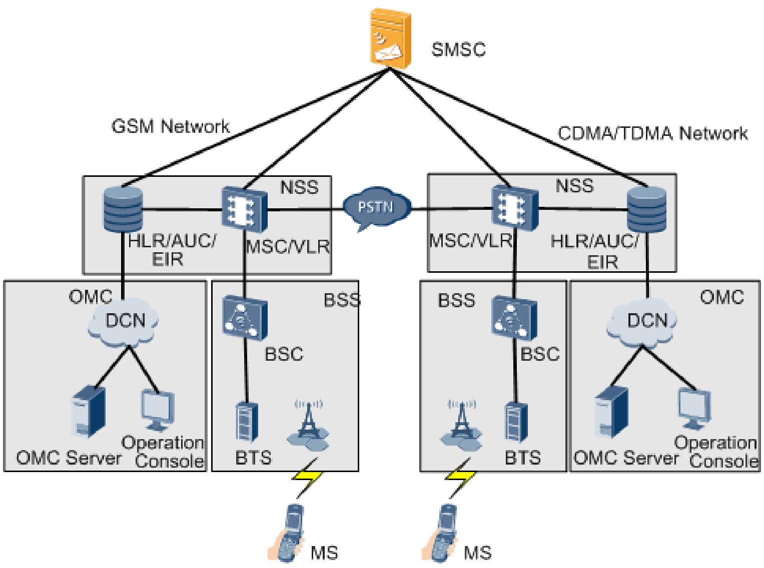

Figure 2.4 Structure of the SMS, GSM system, TDMA & CDMA.

2.5 Global System for Mobile Communications (GSM)

Bell Laboratories began developing GSM in 1970. GSM is widely utilized in mobile communication networks across the world to deliver and receive information. It provides mobile voice and data services on the 850MHz, 900MHz, 1800MHz, and 1900MHz frequency bands. It is a digital, open cellular technology. This technology was developed as a digital system for communication purposes, employing the time division multiple access (TDMA) method. It compresses and digitizes the data such that it may be transmitted over a channel with two different client data streams, each with its own time slot. The digital system can handle data speeds of up to 120 Mbps and 64 kbps. The GSM network has four cell sizes: umbrella, micro, pico, and macro. Each cell's coverage region is determined by the implementation environment [8].

2.5.1 GSM architecture

A GSM network is made up of several components. To begin, a network is controlled by a mobile station, which is a mobile phone equipped with a transceiver, display, CPU, and is controlled by a SIM card. The next component is the Base Station subsystem, which acts as an interface between the mobile station and the network subsystem. It contains the Base Transceiver Station, which has a radio transceiver and handles the mobile communication system's protocols. The base transceiver station is controlled by the Base Station Controller, which acts as an interface between the mobile station and the mobile switching center. The network subsystem, which provides the primary network link to mobile stations, is the third component of GSM architecture. Figure 2.5 below show the structure of GSM network [9].

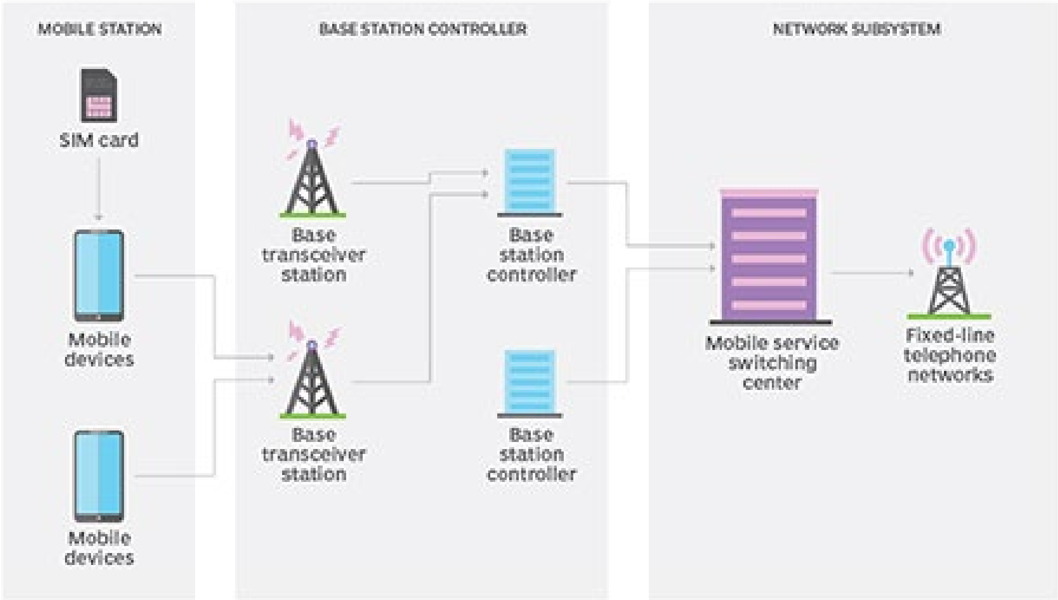

Figure 2.5 Diagram structure Global System of Mobile (GSM) network.

2.5.2 GSM modem

A GSM modem is a device that may be used to connect a computer or other processor to a network. This device, which might be a phone or a modem, requires a SIM card to operate over a network range subscribed to by the network provider. GSM can be linked to other devices via serial, USM, or Bluetooth, such as a microcontroller board or a computer.

A GSM modem may be used as a regular GSM phone by connecting it to a computer's USB or serial port with the appropriate cable and software driver. GSM modems can be used for data recording, transaction terminals, security applications, supply chain management, and weather stations while operating in GPRS mode. Figure 2.6 depicts the pinout of the GSM 900a module board.

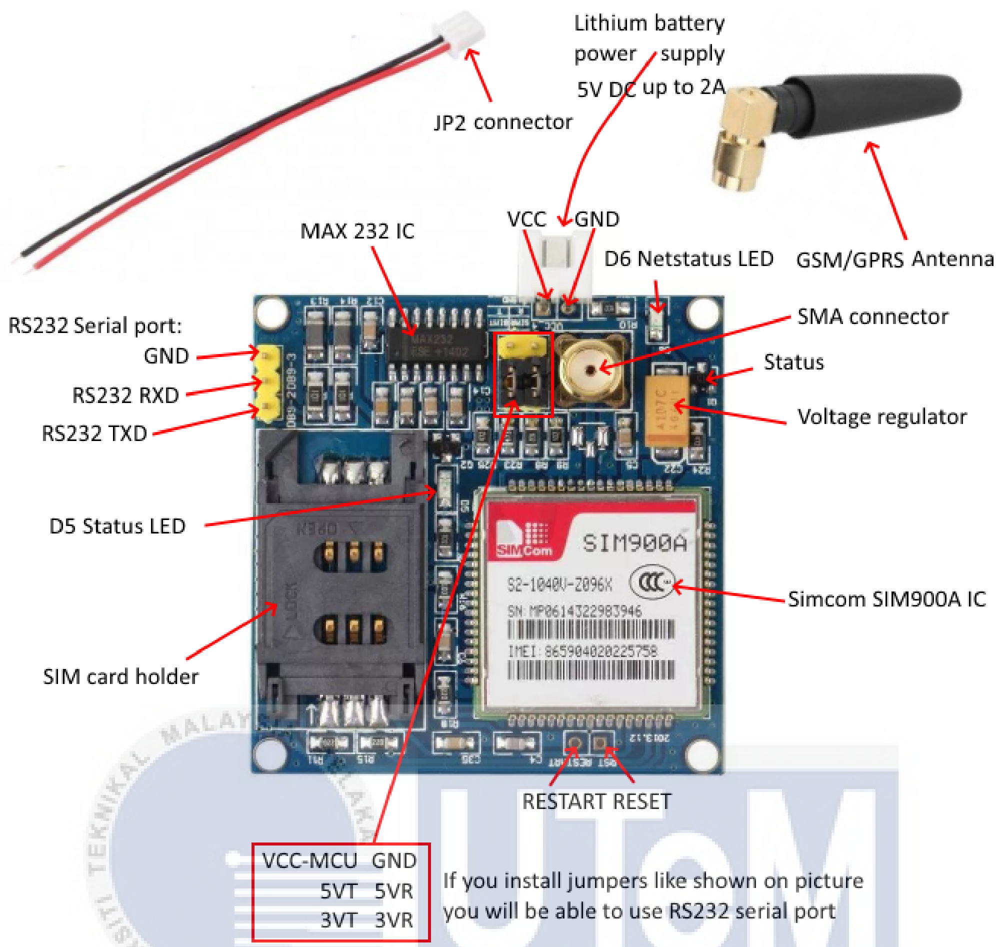

Figure 2.6 Details of pin of the board GSM 900a module

2.5.3 AT Command

A modem that interacted with the host via a Universal Synchronous/Asynchronous Serial Receiver-Transmitter (USART) needed an industry standard AT command. An AT command is a set of instructions used to control a modem, each of which begins with "AT" or "at." It starts with AT to indicate that the modem is listening. The AT command for GSM SIM900 is shown in Table 2.2

Table 2.2 The AT command for GSM SIM900

COMMAND	DESCRIPTION
A/	RE-ISSUES LAST AT COMMAND GIVEN
ATA	ANSWER AN INCOMING CALL
ATD	MOBILE ORIGINATED CALL TO DIAL A NUMBER
ATD><N>	ORIGINATE CALL TO PHONE NUMBER IN CURRENT MEMORY
ATD><STR>	ORIGINATE CALL TO PHONE NUMBER IN MEMORY WHICH
	CORRESPONDS TO FIELD <STR>
ATDL	REDIAL LAST TELEPHONE NUMBER USED
ATE	SET COMMAND ECHO MODE
ATH	DISCONNECT EXISTING CONNECTION
ATI	DISPLAY PRODUCT IDENTIFICATION INFORMATION
ATL	SET MONITOR SPEAKER LOUDNESS
ATM	SET MONITOR SPEAKER MODE
+++	SWITCH FROM DATA MODE OR PPP ONLINE MODE TO
	COMMAND MODE
ATO	SWITCH FROM COMMAND MODE TO DATA MODE
ATP	SELECT PULSE DIALLING
ATQ	SET RESULT CODE PRESENTATION MODE
ATS0	SET NUMBER OF RINGS BEFORE AUTOMATICALLY ANSWERING THE CALL
ATS3	SET COMMAND LINE TERMINATION CHARACTER
ATS4	SET RESPONSE FORMATTING CHARACTER
ATS5	SET COMMAND LINE EDITING CHARACTER
ATS7	SET NUMBER OF SECONDS TO WAIT FOR CONNECTION COMPLETION
ATS8	SET NUMBER OF SECONDS TO WAIT WHEN COMMA DIAL
	MODIFIER ENCOUNTERED IN DIAL STRING OF D COMMAND
ATS10	SET DISCONNECT DELAY AFTER INDICATING THE ABSENCE OF DATA CARRIER
ATT	SELECT TONE DIALING

2.6 System of Ocean Wave Sensor and Water Temperature Sensor

Monitoring and evaluating oceanic conditions may be accomplished with a device that combines an ocean wave sensor and a temperature sensor. A device like this would allow for the simultaneous observation of wave parameters and water temperature, giving vital data for oceanography, coastal engineering, and marine research.

2.6.1 Ocean Wave Sensor

Ocean wave sensors are devices that detect wave height, period, direction, and frequency. They are often made up of pressure transducers, accelerometers, and wave radars. These sensors collect wave data by measuring pressure or accelerations induced by wave motion. A data collecting system, specialised software, or algorithms are used to analyse and interpret the obtained data. The outcomes, which include wave height, period, and other characteristics, can be shown in a variety of ways, including numerical numbers, graphs, and charts [10]. Figure 2.7 show hardware of wave and tide sensor that develop from company Aanderaa.

Figure 2.7 Aanderaa Wave and tide Sensor

2.6.2 Water Temperature Sensor

A water temperature sensor is a device that measures the temperature of water for use in environmental monitoring, aquaculture, and hydrology. It comprises of a temperature probe that contacts the water, a temperature transducer that turns the measurement into an electrical signal, and a signal transmission line. A data logger or reader is attached to the sensor, which analyses and interprets the signal. Water temperature sensors are critical for monitoring temperature changes, studying aquatic ecosystems, analysing water quality, and assisting climate change studies. Water temperature sensors' specific characteristics and features may differ depending on the manufacturer and application. Referring to product specifications or contacting the manufacturer for more specific information is advised. Figure 2.8 show DS18B20 Waterproof Temperature Sensor is examples of the equipment hardware of the water sensor [11].

Figure 2.8 DS18B20 Waterproof Sensor

2.7 Solar Panel and Their Effect on the Environment

Solar panels play an important role in the production of power from sunlight. They are made up of individual solar cells that absorb photons from sunlight to start the photovoltaic effect. These solar cells are mainly silicon-based semiconductors. A direct current (DC) of electricity is produced when sunlight strikes the solar cells, which excites the electrons inside the semiconductor material and causes them to flow. Solar panels, which may be joined to produce solar arrays that can produce more power, are constructed by connecting several solar cells in series and parallel.

The advantages of solar panels contribute to a cost-effective and sustainable energy solution. To begin with, solar energy is a renewable source that harnesses the power of sunlight, which is unlimited and limitless. Solar energy may be used to reduce greenhouse gas emissions, so addressing climate change and reducing air pollution. Second, solar panels significantly reduce or even eliminate power costs, resulting in considerable energy cost savings. This encourages homes, companies, and organisations to save money. Furthermore, solar panels increase energy independence by allowing for local electricity generation, minimising reliance on external energy sources. Figure 2.9 shows how solar panels work to light up the bulb [12].

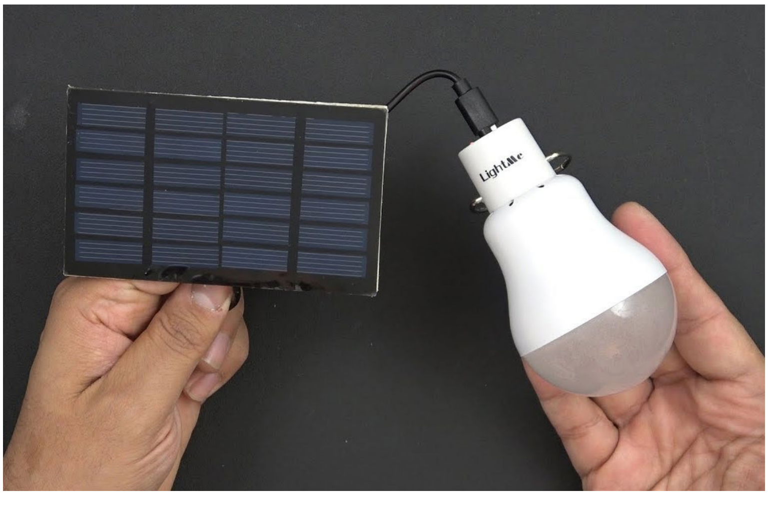

Figure 2.9 Solar Panel light up the bulb.

2.8 Related Research on Previous Project

Some study has been conducted from earlier journals, articles, and papers in order to acquire knowledge and information about the produced product, technologies employed, and technique. The majority of the study is focused on the Buoy system, which employs a wave detector and temperature. Table 2.3 summarizes prior published studies on this project's development.

Table 2.3 Previous Research

Project Title	Author's name	Year	Summary of Project
Measurement of Sea Waves [13].	Giovanni Battista Rossi, Andrea Cannate, Antonio Lengo, Maurizio Migliaccio, Gabriel Nardone, Vincenzo Piscopo, Enrico Zambianchi	2022	The function of this project was to get a measurement of the wave of the ocean and the temperature of the ocean. Using the microcontroller is an interface to control all of the functional hardware used in this project and the system operation. This project also uses the GPS that will track the position of the buoy and satellite remote sensing to get the output in real-time sea wave.
High-Low Detection Of Sea Water Waves With Multi-Sensor System Based On IOT [4].	Muhamad Hendri Kurnia, Randy Erfa Saputra, Casi Setianingsih.	2021	The project are create for the function to detect the height of the wave. The hardware component is quit expensive, to reduce it components that use on this project ultrasonic sensor with the accuracy 93.96% and Adafruit BNO056 the accuracy 73.06% to detect the wave of ocean.

Project Title	Author’s name	Year	Summary of Project
Measurement principle and technology of miniaturized strapdown inertial wave sensor [14].	Feng Zhou, Rongwang Zhang, Shaowei Zhang.	2022	The DWS19-2 project introduces the measurement concept and technology of a tiny strapdown inertial wave sensor. It employs an integrated controller and a 9-axis MEMS inertial module to measure buoy motions and estimate wave characteristics. The buoy data recorder communicates with data centers in real time. The paper discusses the wave processing method, performance evaluation, and sensor design. The DWS19-2 is an affordable option for capturing wave data for environmental research, offshore activities, and weather forecasting.
Wave Height Measuring Device Based on Gyroscope and Accelerometer [15].	Shoujun Wang, Lu Liu, Ruijia Jin, and Songgui Chen	2019	The project utilized accelerometer sensors and gyroscopes as data readers, which were transmitted to the server via LoRa. Functionally developed devices are capable of delivering data up to a distance of 3.8 kilometers. This research reveals an 80% degree of accuracy.
Wireless Ocean Wave Height Monitoring Based on Inertial Measurement Sensor [4].	Gunawan Zain and Wanda Rahmawati	2020	The study used gyroscope sensors and accelerometers as data readers to estimate the height of ocean waves. The buoys in the study were compared to high-meter capacitive waves in prototype-like wave motion circumstances, and the measurement results were confirmed. Investigate this gadget using inertial navigation principles and four parameters. Transformational coordination approaches. The accuracy is great and satisfies the measuring criteria.

2.9 Summary

This chapter describes a variety of contemporary technologies that can be utilized in the creation or development of a product that is functional and advantageous to the community. Microcontrollers are an essential component for system development. In serves as the primary control element of any system. There are numerous microcontrollers available, each with unique specifications such as CPU speed, storage capacity, and number of input and output ports. The Arduino Uno board was chosen for this project because its specifications are adequate, and it is affordable. GSM 900a module is chosen as the function to send the data and notification results from the simulation project. The wave sensor and temperature sensor need to do the simulation for this project and have backup power to recharge the battery using solar power that is user-friendly and has clean electricity.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter demonstrates the methods used to complete the development of a Solar-Powered Wave Detection System for the Marine Tourism Industry using Arduino and the (Dos-Buoy) Concept. This chapter will describe the beginning of the project, the direction and actions taken to complete the project, and the significance of the project's completion. The workflow and system architecture will be described as the technical aspect of the endeavour. This chapter contains the system's flowchart, which explains the system's functions in detail. Each component of the system's hardware and its functions will be described.

3.2 Project Overview

The development of a Solar-Powered Wave Detection System For the Marine Tourism Industry Using Arduino Based On the (Dos-Buoy) Concept is divided into four phases it is design and development, material purchase, and lastly, testing and evaluation.

3.2.1 Design and Development

Solar-Powered Wave Detection System For the Marine Tourism Industry Using Arduino Based On the (Dos-Buoy) Concept are consist of three part which is the input, processing, and output.

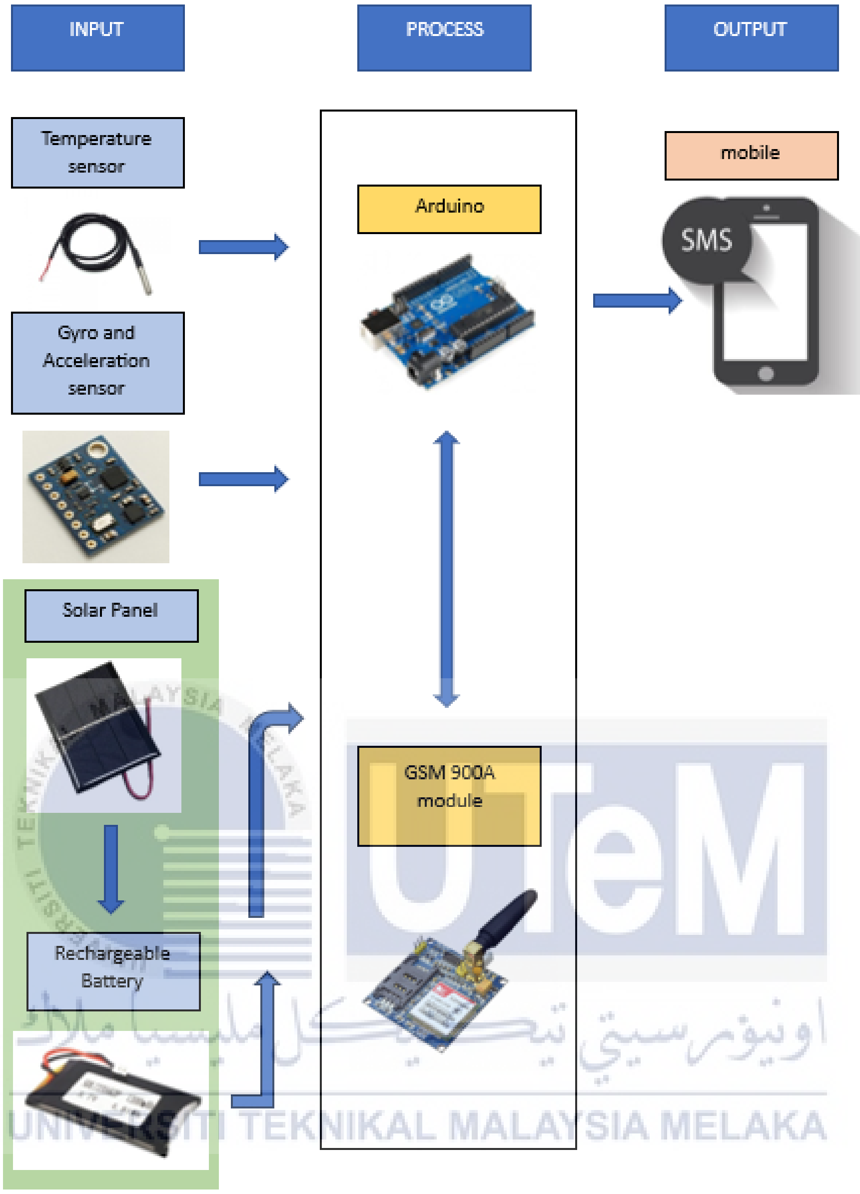

Figure 3.1 Architecture of the system block diagram.

Based on Figure 3.1, Arduino Microcontroller will be interfacing with the conventional DOS-Buoy. The buoy system and how it works have been explained in Chapter 2. The gyro and acceleration will produce the result of a wave when the circuit is completed by showing the result on the notification. A voltage battery of 5V will be connected to the Arduino and the positive solar panel will be connected as a rechargeable for the battery. When the analogue input pin is HIGH, the Arduino alerts that the wave or temperature is showing the dangerous warning of a waving ocean sends the notification to the coast guard. The Arduino will use GSM 900A module to send the alert message by wireless to the user's mobile. Therefore, when the battery is low the Arduino will detect and the solar will set to charge the battery, when it's full the Arduino will decide to set uncharged from the solar.

3.3 Function of each hardware

The hardware that will be used on this project development is Arduino Uno, DS18B20 waterproof temperature sensor, GSM 900A module, GY-87 10D0F sensor and solar panel.

3.3.1 Arduino Uno

The Arduino microcontroller is the brain of this system. It controls all the operations of the whole system and acts as an interface between other components. This microcontroller will be connected physically to a conventional DOS-Buoy system to get the wave and temperature ocean. Then it will be programmed with a command using the GSM library to send the data result by signal wave frequency to the mobile user. Solar panel also communicate with Arduino to recharge the battery and discharge with the renewable source of power.

3.3.2 DS18B20 Waterproof Temperature Sensor

DS18B20 Waterproof Temperature Sensor provides precise temperature readings in settings exposed to wet or water. The sensor transmits temperature data over a single data cable using the One-cable protocol. Temperature measurements from the DS18B20 can be obtained and translated into useful numbers by programming the Arduino. Incorporating precise temperature sensing capabilities for a variety of applications, including environmental monitoring or temperature-controlled systems, is made possible by this combination.

3.3.3 GSM 900a Module

The GSM 900A module is a small device that helps other machines or devices communicate using the GSM network. Think of it like a translator that allows devices to talk to cell phone towers. It works in a specific frequency range called GSM 900, which is used for phone calls, text messages, and data connections. This module is used in many things, like devices that track locations, send information remotely, or even in some basic phones to connect to the mobile network.

3.3.4 GY-87 10DOF Sensor

Figure 3.5 show GY-87 10DOF Sensor offers thorough data on orientation, motion, and environmental conditions. It incorporates a barometric pressure sensor, an accelerometer, a magnetometer, and a 3-axis gyroscope. Using I2C or SPI protocols, the Arduino Uno can connect with the GY-87 sensor to precisely detect buoy orientation, tilt, acceleration, magnetic field, and air pressure. Numerous uses for this data exist, including wave monitoring, navigational tracking, and environmental sensing in projects involving buoys.

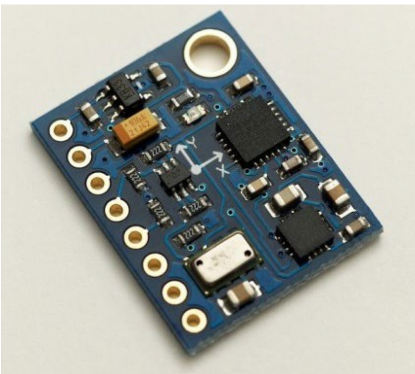

Figure 3.2 GY-87 10DOF Sensor.

3.3.5 Solar Panel

The solar panel works as a sustainable power source when paired with an Arduino Uno for a DOS-Buoy application. It collects sunlight and transforms it into electrical energy that may be used to directly operate the buoy components or recharge the Arduino's battery. The Arduino Uno controls the power flow, minimizing energy use and guaranteeing the DOS- Buoy ongoing operation. With the buoy being powered by solar energy, this combination provides a self-sustaining and sustainable solution.

3.4 Function of each software

The software application is a necessary component of accomplishing defined actions connected to task execution or project completion. To complete this project, we use two types of software: schematic and layout circuit software and programming software.

3.4.1 Proteus

Figure 3.3 shows the logo of how the Proteus work to robust CAD programme for creating electronic schematics and PCB layouts. In this project, it is utilised to create and design the schematic diagram that depicts the relationship between each component. The main reason for using this CAD application is that we may convert to layout design and acquire the right and exact pinhole position as well as choosing the perfect size board layout before designing a PCB layout.

Figure 3.3 Proteus Logo

3.4.2 Arduino IDE

Figure 3.4 shows the function of Arduino IDE, or Arduino Integrated Development Environment, is a software application used to programme Arduino microcontrollers. It includes an easy-to-use interface for creating, compiling, and uploading code to Arduino boards. The IDE includes a code editor that supports syntax highlighting and auto-indentation, as well as a compiler that turns code into machine-readable instructions. It comes with a library of pre-written code snippets and methods to make programming easier. Users may use the board manager to pick and install board definitions for various Arduino-compatible devices. In addition, the IDE includes a serial monitor for communicating with the Arduino board and an upload manager for transferring code to the board. Overall, the Arduino IDE is a popular open-source tool for programming and developing Arduino-based projects.

Figure 3.4 Arduino IDE Logo

3.5 Material Purchase

All the necessary equipment and materials for this project will be purchased before the implementation process started. For this project, the components that are used and their prices are shown in Table 3.1.

Table 3.1 Component Price

Component	Quantity	Price	Total
Arduino Uno	1	RM35.00 x1	RM35.00
DS18B20 – Temperature Sensor Waterproof	1	RM8.00 x1	RM8.00
Solar Cell/Panel 5V 250mA (5W)	1	RM16.50 x1	RM16.50
GY-87 10DOF Sensor MS5611 HMC5883L GY 87 M P U 6050 Module MWC Flight Control Board 3-5v	1	RM75.00 x1	RM75.00
Waterproof Enclosure Box IP66/Junction Box	1	RM16.00 x1	RM16.00
5V LiPo Battery (Lithium Polymer)	1	RM36.00 x1	RM36.00
Switch Button momentary self-lock.	1	RM5.00 x1	RM5.00
GSM 900A	1	RM25.00 x1	RM25.00
TOTAL			RM216.50

3.6 Testing and Evaluation

There will be functional testing, including unit testing, integration testing, and system testing. The outcome must guarantee that all system-expected output and requirements are met.

3.7 Project Flowchart

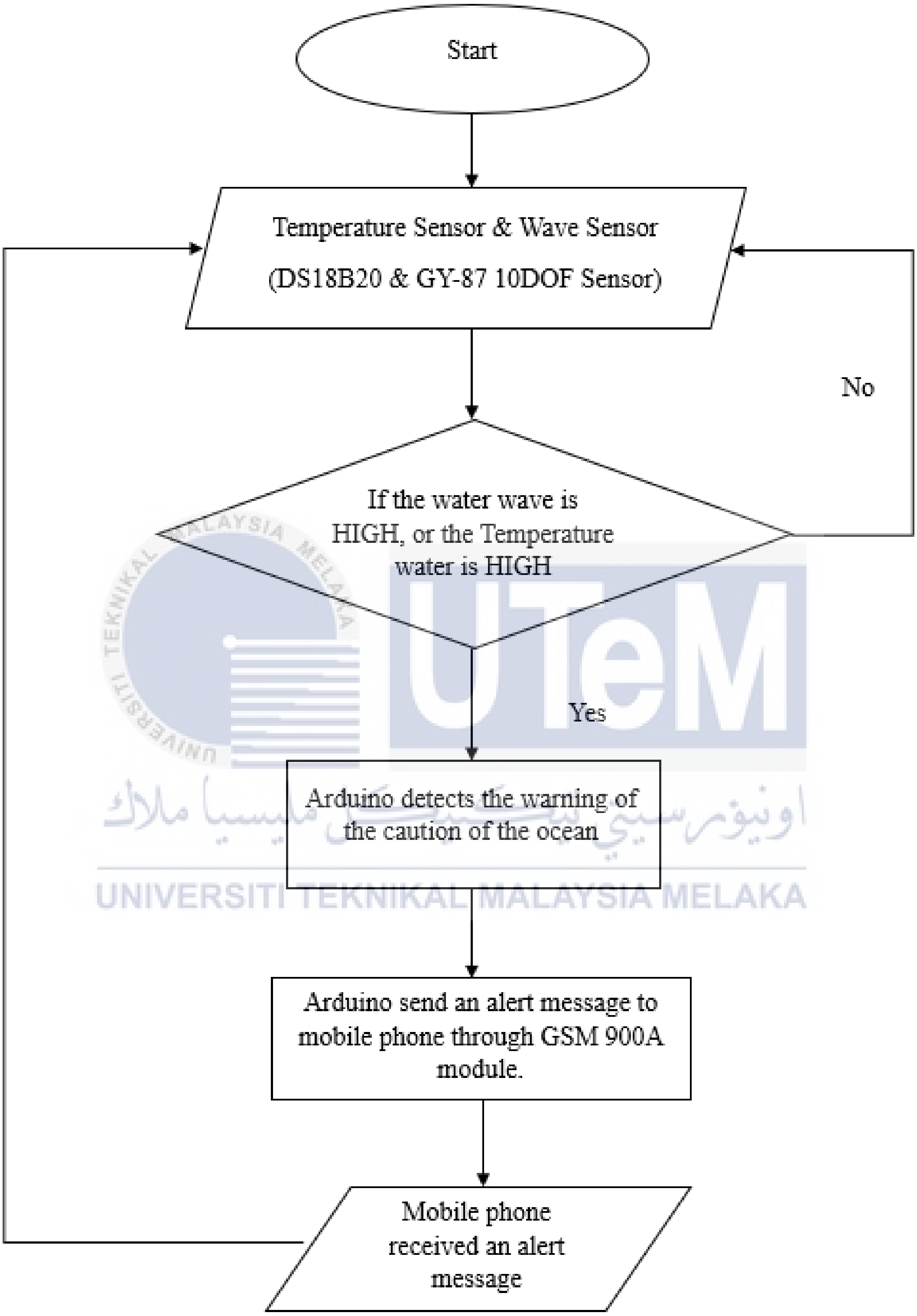

Figure 3.5 Flowchart Diagram DOS-Buoy.

The development process of the Solar-Powered Wave Detection System, Dos-Buoy, tailored for the Marine Tourism Industry, is depicted in Figure 3.5. This system incorporates a GSM 900A module alongside an Arduino Uno microcontroller to monitor the environment. Upon activation, the sensors, notably the wave sensor, continuously assess seawater's wave height. If a significant surge in wave height is detected, indicating potentially hazardous conditions, the system triggers a response. The Arduino, serving as the central processing unit and equipped with the GSM 900A module, swiftly gathers and transmits relevant data signals. This allows Dos-Buoy to establish an internet connection and relay collected data to a designated server or cloud platform.

In response to perilous wave conditions, Dos-Buoy rapidly collects pertinent data using the wave sensor connected to the Arduino Uno. Through the integrated GSM 900A module, the system efficiently communicates this data to an external server or cloud platform. This transmission of critical information ensures swift notification to users' mobile phones via SMS in real-time alerts. This streamlined process enables Dos-Buoy to promptly detect and respond to hazardous wave conditions, ensuring the safety of individuals participating in marine tourism activities.

3.8 Project Planning

The project schedule and planning must be carefully planned in order to complete a project on time. The deadline for critical schedules must be met to ensure that no procedure is missed. We will be able to monitor and assess everything that has to be done ahead of time, as well as determine when the activity should be completed. As a consequence, Table 3.2 shows how a Gantt chart is utilized to visually represent project activities. The Gantt chart will outline all of the tasks in this project, with the sequence shown against timeframes.

Table 3.2 Gantt chart for BDP2

NO.	Project Activities	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1.	BDP 2 Briefing by JK, PSM, FTKEE, and do the correction report and item list based on Panel comment														
2.	Buy and Receive components. Test every hardware to make sure no problem issue.														
3.	Software simulation and Schematic Layout														
4.	Test Component, write program code and simulation														
5.	Make connection between components and microcontroller, finalize Chapter 4 result and Chapter 5 Conclusion														
6.	Prepare for present poster and finalize report														
7.	BDP Presentation														
8.	Submit final report BDP2 and logbook.														

3.9 Summary

The system's project development process was described how to obtain a proper model, software, and hardware. The process involves creating a hardware block diagram and a flowchart to guide the project. It starts with design and planning, taking into account factors like buoyancy, size, and sensor integration. The buoy includes various sensors such as wave sensors and temperature sensors. Data transmission is typically achieved through signal frequency or cellular networks. Additionally, solar panels and rechargeable batteries are commonly used as the power source for the system.

CHAPTER 4

RESULTS AND DISCUSSIONS

This chapter will detail the results gained during and after the project's conclusion. The end product includes hardware testing, software testing, and a mix of hardware and software. The overall output will demonstrate how the entire system operates and how each piece of hardware functions during system activation. Aside from that, this chapter will show the findings of the analysis conducted during the project's development.

4.1 Hardware Simulations Connections

Figure 4.2.1, Figure 4.2.2, Figure 4.2.3, and Figure 4.2.4 show the physical connection of the hardware used to the Arduino board. There are four pieces of hardware that will be interfacing directly to the Arduino board which is the GY-87 sensor, DS18B20, solar cell, and GSM SIM900A module.

4.1.1 GY-87 sensor to Arduino Uno

Figure 4.1 showed the connection of the GY-87 sensor module to an Arduino Uno; the following connections had to be made: For power supply, the VCC pin was connected to the 3.3V pin of the Arduino Uno. For common ground, the GND pin was connected to any GND pin on the Arduino. The SDA pin was connected to A4 (Analogue Pin 4) to enable serial data communication, and the SCL pin was connected to A5 (Analogue Pin 5) to enable serial clock communication. After completing the necessary connections, then the Wire library could be included in the Arduino code to communicate with the GY-86 sensor module using the I2C protocol.

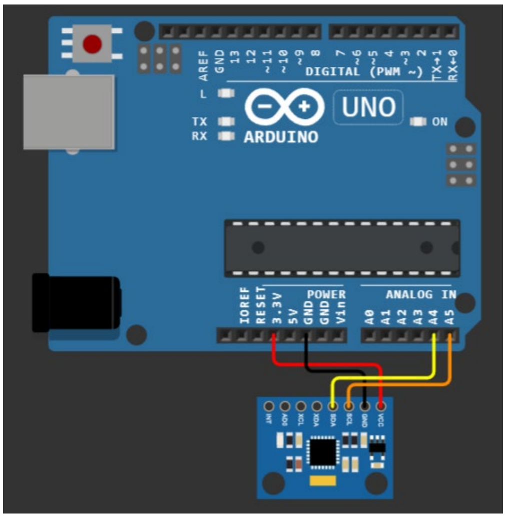

Figure 4.1 GY-87 10DOF sensor to Arduino Connection

4.1.2 DS18B20 to Arduino Uno

The connection of a DS18B20 temperature sensor to an Arduino Uno was demonstrated in Figure 4.2. First, the DS18B20 VCC pin was connected to the 3.3V pin of the Arduino Uno to provide power supply. The sensor GND pin was connected to any GND pin on the Arduino to establish a common ground. The DS18B20 DQ (Data) pin was connected to the Arduino Uno digital pin 5 (D5). To ensure reliable communication, a 4.7k ohm pull-up resistor was connected between the sensor VCC and DQ pins, activating the pull-up feature.

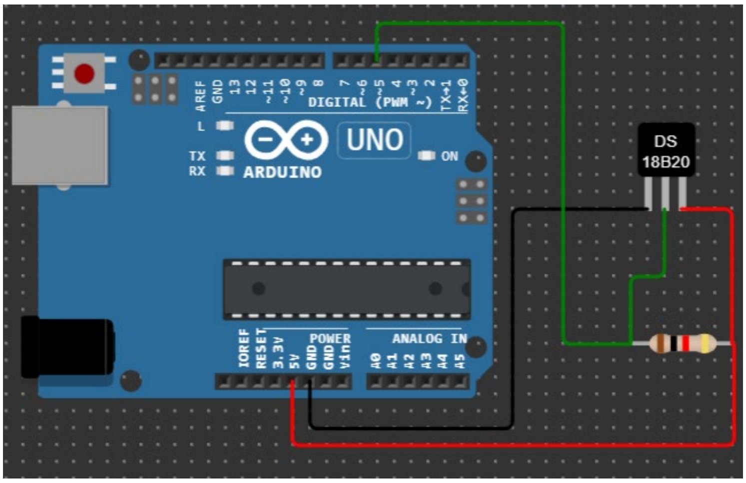

Figure 4.2 DS18B20 to Arduino Uno Connection

4.1.3 Solar Cell Charge Battery

Figure 4.3 showcased the connection of a solar cell to TP4056 module which is a charger module that is equipped with input overvoltage protection, undervoltage alarming, output overcurrent and short circuit protection functions. The battery that uses for this project are 5V with 6600 mAh for power up the Arduino and it will connect to charger module for the battery that will charge by solar cell. The switch button is momentarily functioned to turn on and off for this prototype that have 2 pin it will connect to the negative output of the TP4056 module and negative input of USB step down module. The USB step down module function is the output will connect with the USB-A that will send the power source to the Arduino board and the connection input positive of the USB step down will connect to the positive output at TP4056 module. The USB-A have a 4 pin but only use 2 pin which means VCC pin connect to the VIN pin Arduino board and the GND pin connect to the GND pin Arduino board.

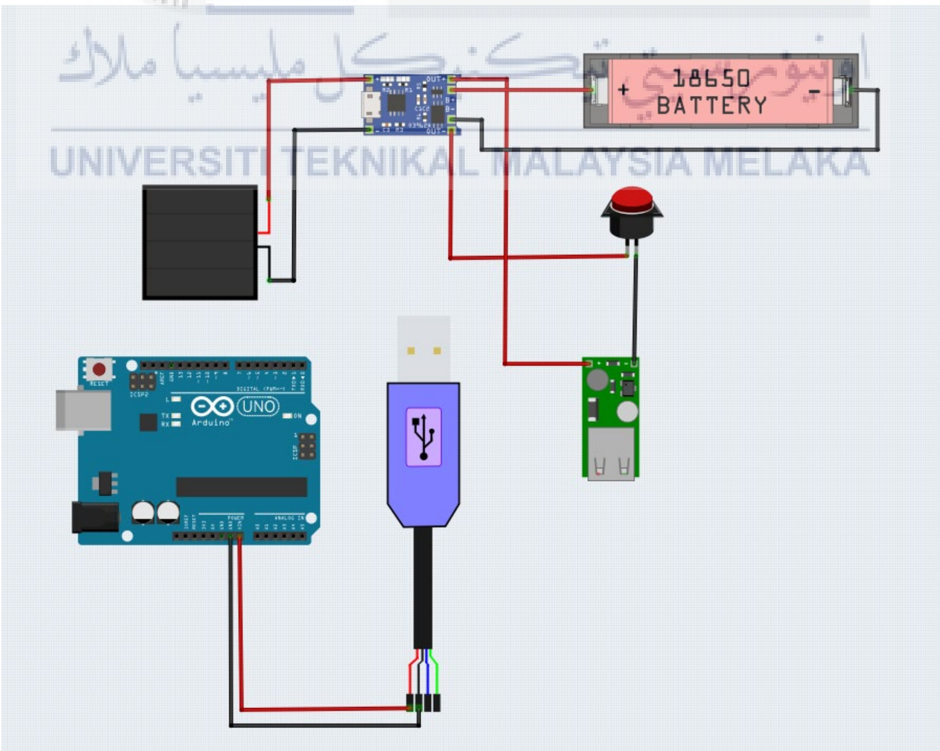

Figure 4.3 Solar Cell to TP4056 charging module connection.

4.1.4 GSM 900A Module to Arduino Uno

Figure 4.4 show the connection of a GSM 900a module to an Arduino Uno. Firstly, the VCC pin (Positive Terminal) of the GSM module connect to the VIN pin (Voltage Input) on the Arduino. The GND pin on the GSM module will connect to the Arduino board for power, but another GND pin in RS232 serial port must connect to the GND pin on Arduino boar for digital port. For the data transmit connection use 5VT in GSM board that connect to the pin 10 and the data receive connection use 5VR in GSM board that connect to the pin 11 on the Arduino board.

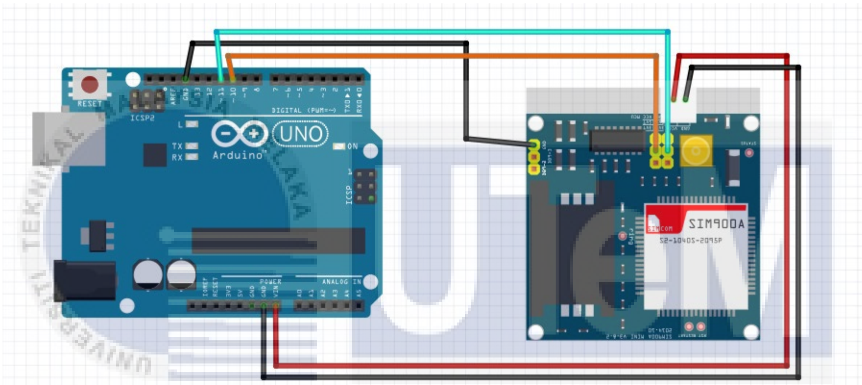

Figure 4.4 GSM 900a module to Arduino connection.

4.2 Hardware Testing

Before going to project execution, every hardware was tested using a basic source code given by the provider.

4.2.1 GY-87 10DOF sensor testing

The GY-87 sensor is able to show the wavelength in the serial monitor after programming the code. The wave of the serial monitor is show acceleration is in stable mode. If the condition of the sensor is moved, that waveform will change and show the result data of the longitude and latitude of the wave. Figure 4.5 shows the coding of the GY-87 sensor and its output on the serial monitor.

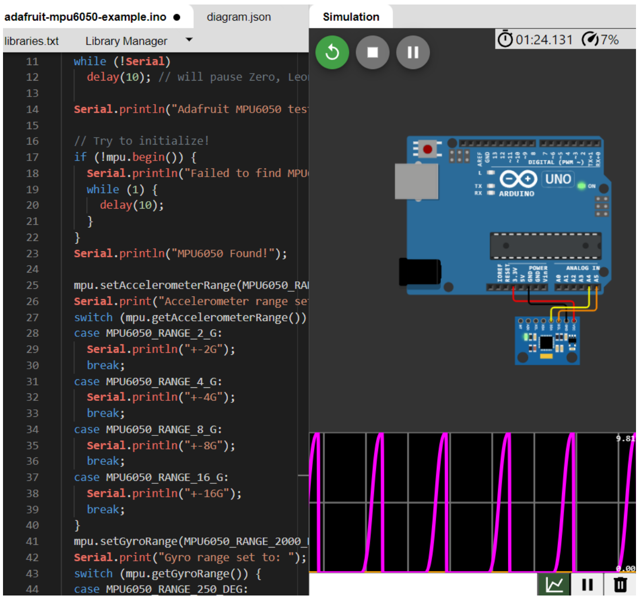

Figure 4.5 GY-87 10DOF sensor testing and running the code.

4.2.2 DS18B20 Sensor Testing

The DS18B20 sensor as we know this sensor detects the temperature of the water and its water resistance to use it in the water. This sensor shows the result on the serial monitor of the data temperature. If the sensor temperature is in the water, it will get the result. Figure 4.6 shows the coding of the DS18B20 and its output on the serial monitor.

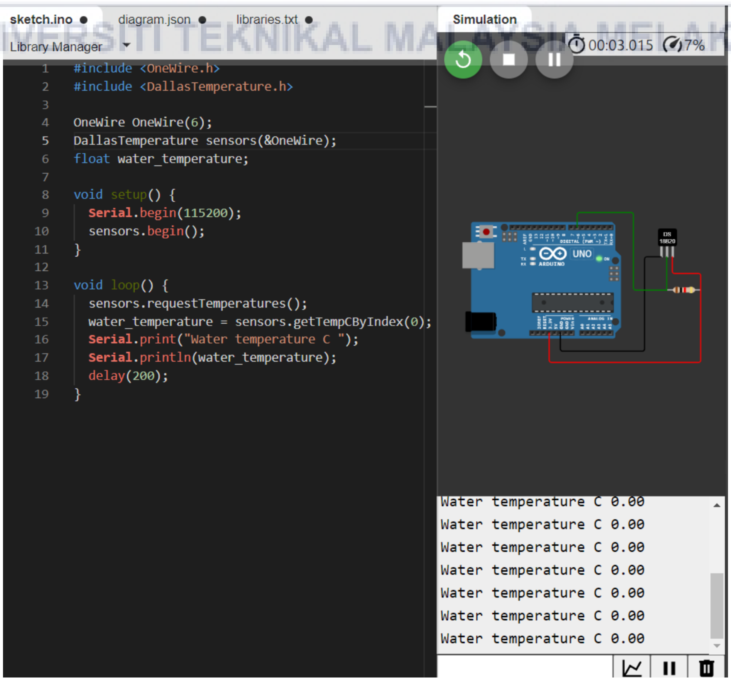

Figure 4.6 DS18B20 sensor testing and running code.

4.2.3 GSM 900A Module testing

As we know the GSM 900A module connects to an Arduino Uno and acts as a link between a wave sensor and a temperature sensor. It uses the cellular network to send the data collected by these sensors directly to the user. This means that without relying on Wi-Fi, the GSM 900A module enables the user to receive real-time updates and notifications from the sensors through their mobile device. Figure 4.7 the coding of the GY-87 sensor and its output on the serial monitor and SMS pop up to the mobile phone for communication with the GSM.

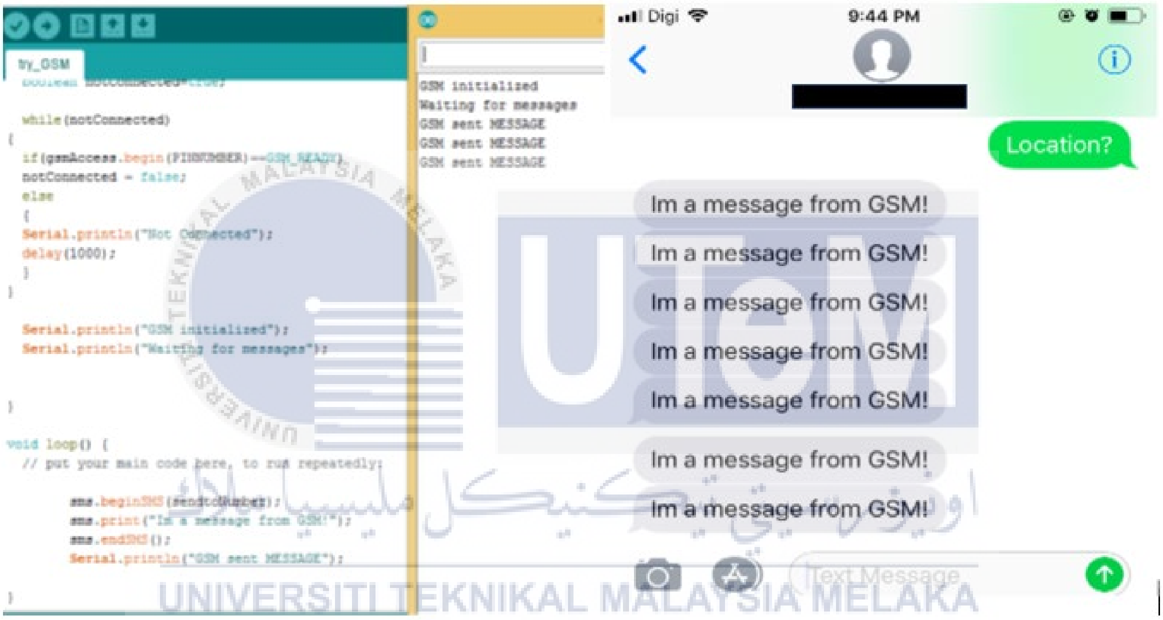

Figure 4.7 GSM 900a module testing, running code and communicating test with mobile phone for SMS setup.

4.3 Prototype Preparation

Figure 4.8 and figure 4.9 the prototype was created for a full circuit and placing all components in a box. The Arduino board, GY-87, DS18B20, and GSM module were neatly arranged within the box and covered with the lid. A hole must be drilled beneath the box casing for the DS18B20 to monitor water temperature. The solar cell was mounted on the top to link wires to the board in the box and to turn on the prototype for a brief period of time. Soldering, a cutter, and a hot glue gun were used to prepare the prototype. Figure 10 show the box will be put on the beach in the beginning, attached by fishing line, and will move by following the sea wave to obtain the result wave.

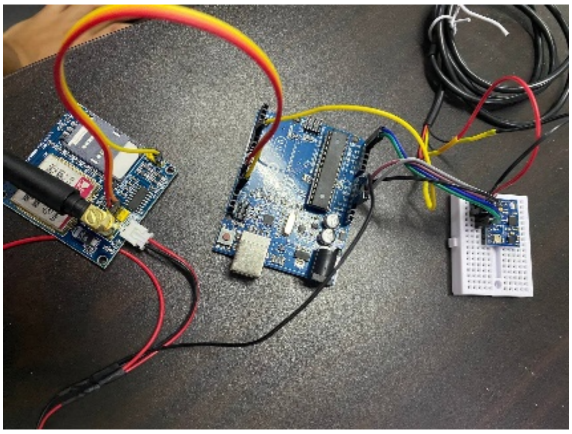

Figure 4.8 Make a full connection circuit of all sensors.

Figure 4.9 Making all component in box for prototype project.

Figure 4.10 Deploy test prototype at seabeach.

4.4 Result

This part consists of the output from the overall system after the Arduino board supplied with 5 volt of input power. Figure 4.11 The solar will be charging the battery when it detects the light of sun and the TP4056 will show the led-on board turn on as the result of active charging to the battery. Table 4.1 shows the setup of the system from the coding in Arduino IDE software. Figure 4.12 shows the Serial monitor running the output result of the temperature water, altitude wave height and connection with GSM which mean the network coverage are ready to send the message to the user number that we set to send the result of the output. During this process, the sensor of the temperature water and GY-87 will continuously show the output result because of the sea wave will keep move and the GSM will send the notification alert to the user continuously update the result of the temperature and altitude of wave. The message received from user is shown in Figure 4.13.

Figure 4.11 The solar cell recharges the battery prototype.

Table 4.1 Coding full scale of the prototype in Arduino IDE.

```
#include "I2Cdev.h"
#include "MPU6050.h"
#include <Adafruit_BMP085.h>
#include <HMC5883L_Simple.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#include <SoftwareSerial.h>
SoftwareSerial mySerial(10, 11);//gsm

#define ONE_WIRE_BUS 4
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);

MPU6050 accelgyro;
Adafruit_BMP085 bmp;
HMC5883L_Simple Compass;

String text;
int16_t ax, ay, az;
int16_t gx, gy, gz;
int con = 0;
int con1 = 0;
double altitudee, min_height, previous_height, wave_height;

#define LED_PIN 13
bool blinkState = false;

void setup() {
  Serial.begin(9600);
  mySerial.begin(9600);
  Wire.begin();
  sensors.begin();
  Serial.println("Initializing I2C devices...");
  if (!bmp.begin()) {
    Serial.println("Could not find a valid BMP085 sensor, check wiring!");
    while (1) {}
  }
  accelgyro.initialize();
  Serial.println(accelgyro.testConnection() ? "MPU6050 connection successful" :
"MPU6050 connection failed");
  accelgyro.setI2CBypassEnabled(true); // set bypass mode for gateway to hmc5883L

  Compass.SetDeclination(23, 35, 'E');
  Compass.SetSamplingMode(COMPASS_SINGLE);
  Compass.SetScale(COMPASS_SCALE_130);
  Compass.SetOrientation(COMPASS_HORIZONTAL_X_NORTH);

  pinMode(LED_PIN, OUTPUT);
```

```
}

void loop() {
  sensors.requestTemperatures();
  Serial.print("WaterTemperature : ");
  Serial.print(sensors.getTempCByIndex(0));
  Serial.println(" *C");
  Serial.print("AirTemperature = ");
  Serial.print(bmp.readTemperature());
  Serial.println(" *C");

  Serial.print("Pressure = ");
  Serial.print(bmp.readPressure());
  Serial.println(" Pa");

  // Calculate altitude assuming 'standard' barometric
  // pressure of 1013.25 millibar = 101325 Pascal
  Serial.print("Altitude = ");
  Serial.print(bmp.readAltitude());
  Serial.println(" meters");
  Serial.print("Pressure at sealevel (calculated) = ");
  Serial.print(bmp.readSealevelPressure());
  Serial.println(" Pa");
  Serial.print("Real altitude = ");
  Serial.print(bmp.readAltitude(101500));
  Serial.println(" meters");
  altitudee = bmp.readAltitude();
  if (altitudee - previous_height > 0.5) {
    if (con1 == 0) {
      text = "Huge wave coming Temp = " + String(sensors.getTempCByIndex(0)) + "
altitude = " + altitudee;
      msg();
      con1 = 1;
    }
  }
  else {
    con1 = 0;
  }
  previous_height = altitudee;

  // read raw accel/gyro measurements from device
  accelgyro.getMotion6(&ax, &ay, &az, &gx, &gy, &gz);

  // display tab-separated accel/gyro x/y/z values
  Serial.print("a/g:\t");
  Serial.print(ax); Serial.print("\t");
  Serial.print(ay); Serial.print("\t");
  Serial.print(az); Serial.print("\t");
  Serial.print(gx); Serial.print("\t");
  Serial.print(gy); Serial.print("\t");
```

```
  Serial.println(gz);
  if (ax > 10000) {
    if (con == 0) {
      text = "Danger wave detected Temp = " + String(sensors.getTempCByIndex(0)) + "
altitude = " + altitudee;
      msg();
      con = 1;
    }
  }
  else {
    con = 0;
  }

  float heading = Compass.GetHeadingDegrees();
  Serial.print("Heading: \t");
  Serial.println( heading );


  // blink LED to indicate activity
  blinkState = !blinkState;
  digitalWrite(LED_PIN, blinkState);

  delay(1000);
}

void msg() {
  mySerial.println("AT+CMGF=1");    //Sets the GSM Module in Text Mode
  delay(1000);  // Delay of 1000 milli seconds or 1 second
  mySerial.println("AT+CMGS=\"+60187612298\"\r"); // Replace x with mobile number
  delay(1000);
  mySerial.println(text);// The SMS text you want to send
  delay(100);
  mySerial.println((char)26);// ASCII code of CTRL+Z
  delay(1000);
}
```

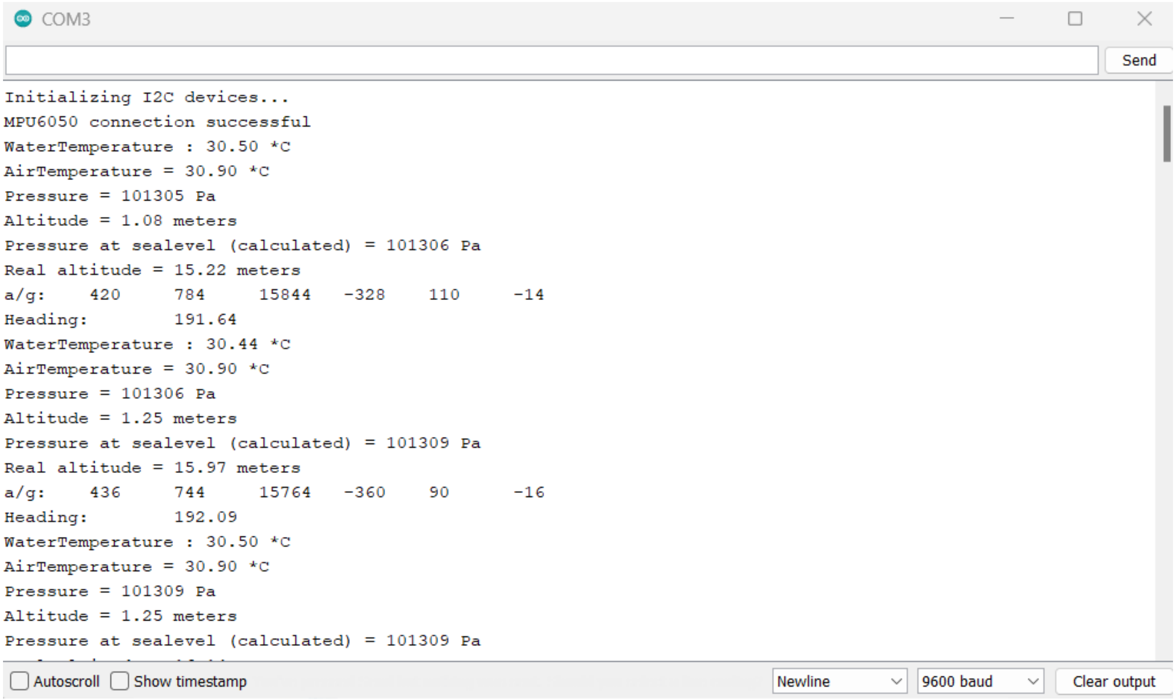

Figure 4.12 Serial monitor show the output result.

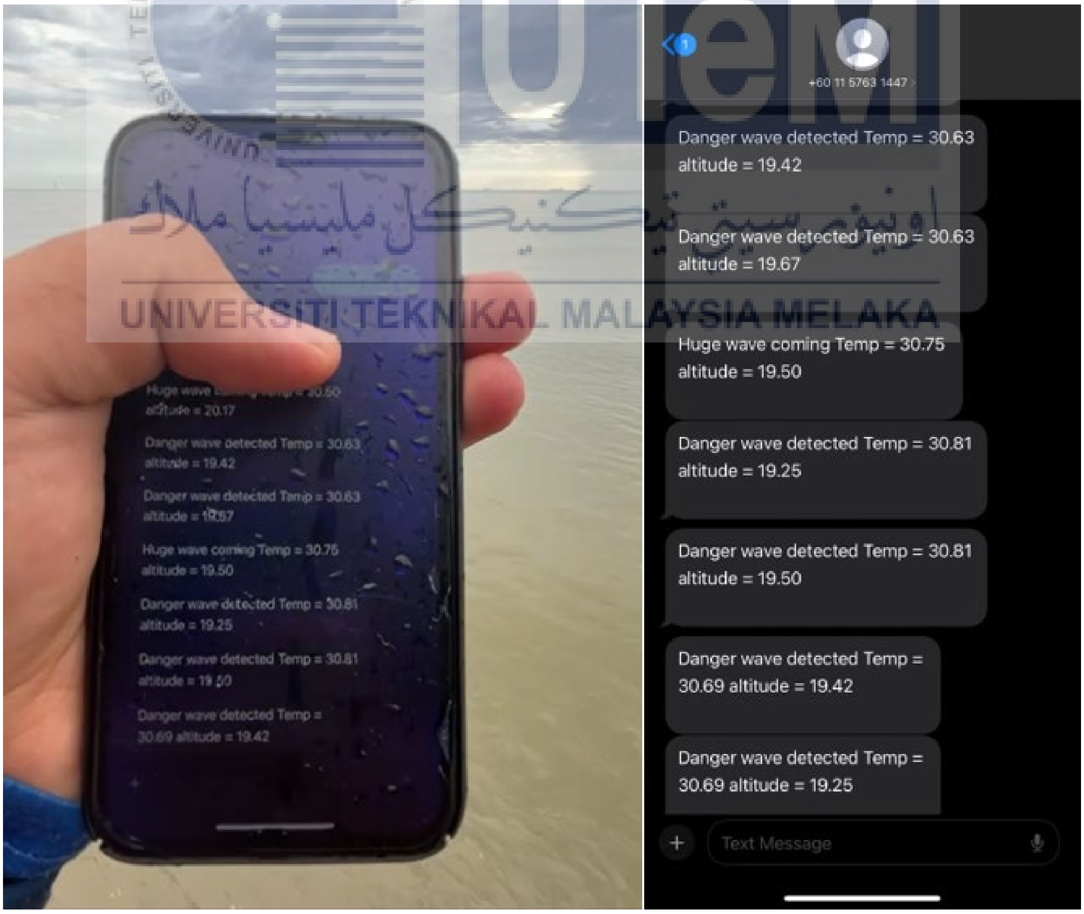

Figure 4.13 Result message alert wave to mobile phone.

4.5 Analysis

The project's study was based on wave detection and GSM. Several tests using wave detection have been conducted to assess its availability set maximum height wave level on 0.5 meter at various time and wave heights with three different length distances in 50-meter, 80-meter and 100-meter. Also, the estimations of battery charging time and battery life when the project is deployed. The results of varied time and wave heights for three different length distances are shown in figure 4.14, figure 4.15, and figure 4.16 simulation. Table 4.2 show the result of how the altitude can get the result of height of wave level and the decision send alert result of incoming huge wave and danger wave. Figure 4.17 and figure 4.18 it is showing the graph of current and voltage usage during the device turn on and included the calculation of how long battery life of the prototype. Figure 4.19 and figure 4.20 show the graph for solar current and voltage of charge time to the device and the calculation of solar panel how long charge time to the battery.

4.5.1 Distance Deploy of DOS-Buoy and Result Wave.

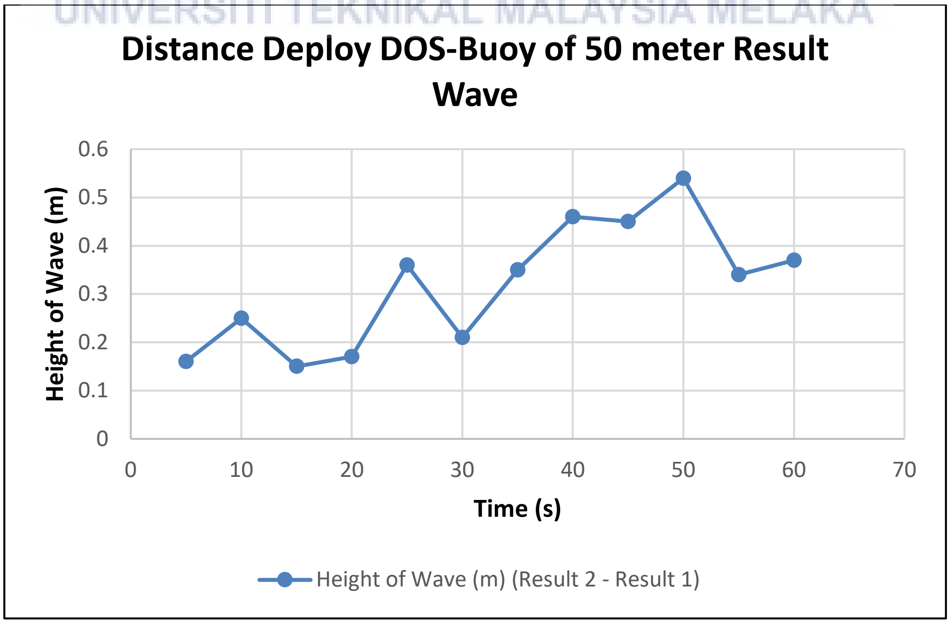

Figure 4.14 Distance DOS-Buoy in 50 meter.

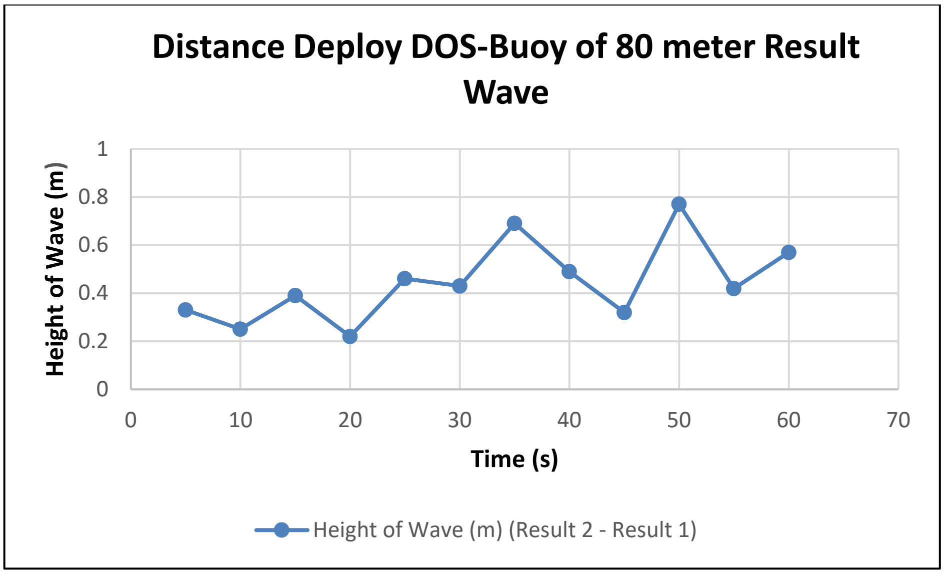

Figure 4.15 Distance DOS-Buoy in 80 meter

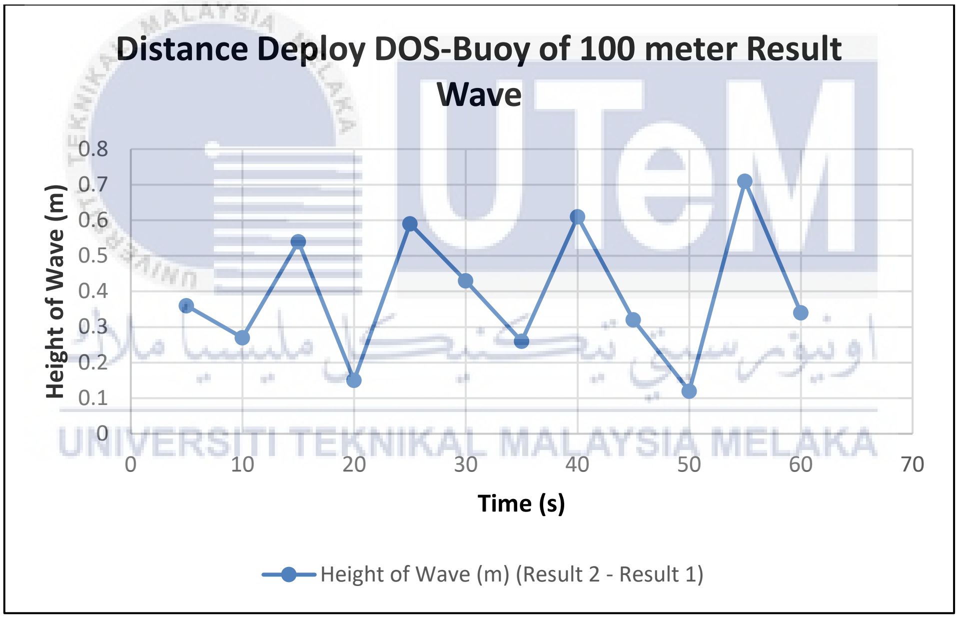

Figure 4.16 Distance DOS-Buoy in 100 meter

Based on the three-figure graph that show the test set 0.5 meter as a maximum height level wave and difference result wave height with different distance set. Figure 4.6 show the best distance to detect an early alert of danger wave which means the user can take an early react if anything happens when the wave of sea level is condition danger to do the activities tourism.

Table 4.2 Data recorded of height wave calculate, and alert message.

Altitude		**Height of wave (m)** (Result 2 - Result 1)	**Send Alert Incoming Huge and Danger Wave**	
Result 1	Result 2		Huge wave	Danger wave
19.17	19.33	0.16	/	
19.42	19.67	0.25	/	
19.25	19.5	0.25	/	
19.5	19.67	0.17	/	
20.13	20.67	0.54		/
20.23	20.7	0.47	/	
20.31	20.89	0.58		/
20.12	20.75	0.63		/
20.22	20.7	0.48	/	
20.26	20.95	0.69		/

Based on this table 4.2 show the data recorded of height of wave by according two result which means the result 2 must be the latest one for estimated the incoming wave of huge or danger decision to send the alert message at user.

4.5.2 The Usage of Battery on Device

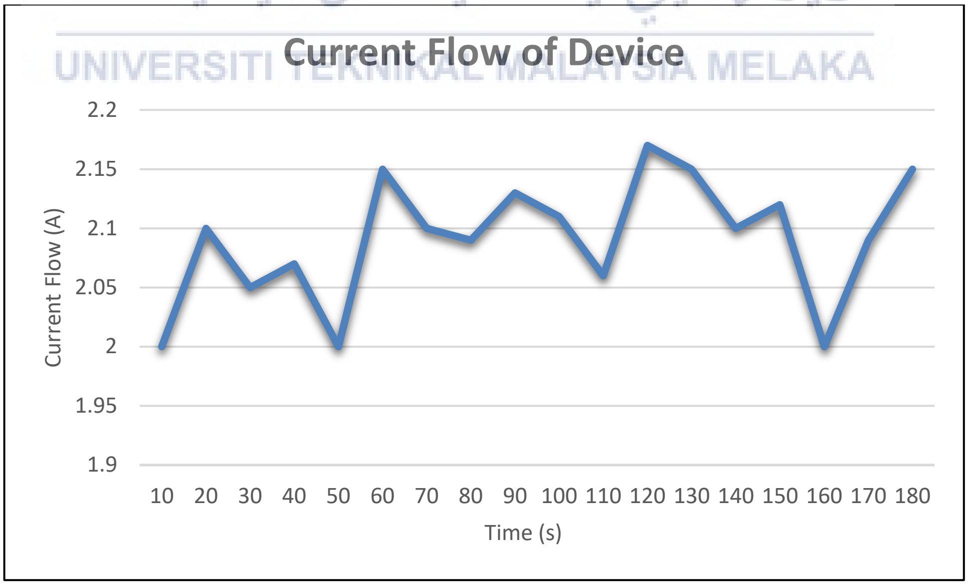

Figure 4.17 The current flow of device usage.

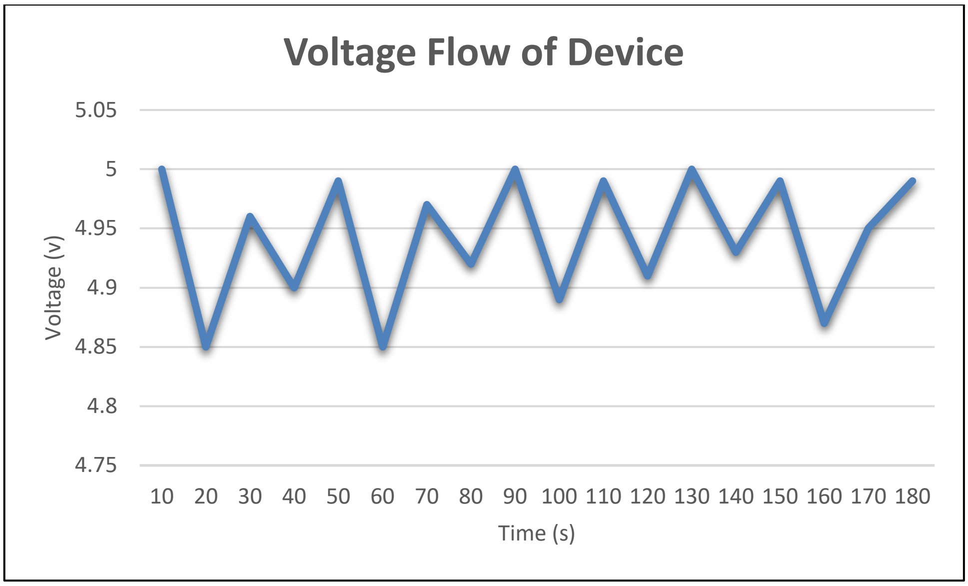

Figure 4.18 The voltage flow of device usage.

Based on the two figures show the result of the current flow of device usage is average 2.1A and the result of the voltage flow of device usage is average 4.94V in three minutes. Because of it the calculation must do for the last long battery life and the result calculation of this device usage with battery life supports until 3 hours.

Calculation For Battery life:

$$Battery\ Life = \frac{Battery\ Capcity\ (mAh)}{Load\ Current\ (mA)}$$

Battery Capacity is 5V, 6600mAh and the **Load Current** use for the project:

- Arduino Uno: 150mA
- GSM Module: 2A (2000mA)
- GY-87 Module Sensor: 4mA

$$Load\ Current = 150mA + 2000mA + 4mA$$

$$= 2154mA$$

$$Battery\ Life = \frac{6600mAh}{2154mA}$$

$$= 3.064\ hours$$

4.5.3 The Usage of Solar Cell Charge to Device

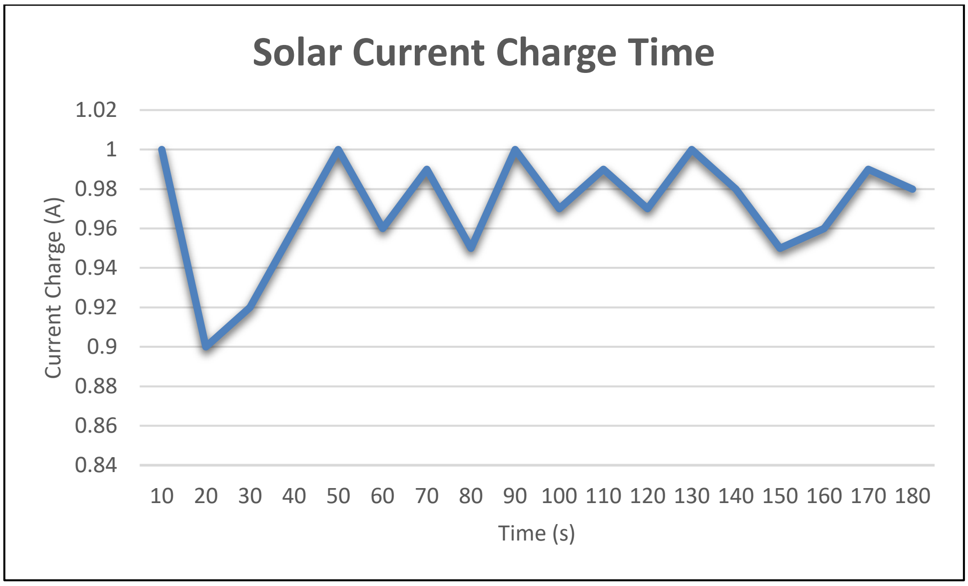

Figure 4.19 The solar current charge time.

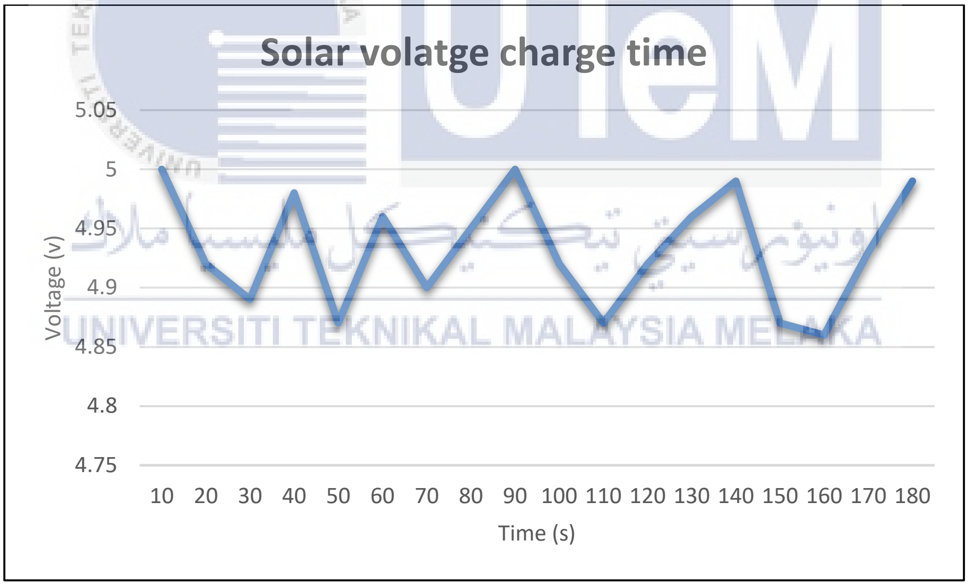

Figure 4.20 The solar voltage charge time

Based on the two figures show the result of the solar current charge time have the average on 0.97A and the solar voltage charge time have the average 4.93V. Because of it the calculation must do and the result of the calculations of the solar panel charge time is 7.04 hours.

Calculation For Solar Panel Charge Time

- Battery Capacity is 5v, 6600mAh.
- Find Watt hour for Battery Capacity

$$I \times V = P$$

$$5V \times 6.6Ah = 33Wh$$

- Decided Battery is Discharge 80%

$$\begin{aligned} Power\ dischagre\ hours &= Wh \times 80\% \\ &= 33Wh \times 80\% \\ &= 26.4Wh \end{aligned}$$

- Using 5W Solar Cell and a Pulse Width Modulation (PWM) charge controller (PWM: 75%)

$$\begin{aligned} Solar\ Power\ Output &= W \times 75\% \\ &= 5W \times 75\% \\ &= 3.75W \end{aligned}$$

- For the estimated charge time:

$$\begin{aligned} hours &= \frac{Power\ disharge\ hours\ (Wh)}{Solar\ output\ power\ (W)} \\ &= \frac{26.4\ Wh}{3.75W} \\ &= 7.04\ hours \end{aligned}$$

4.6 Discussion

The system operates by programming the Arduino board to interface with external devices, as well as to receive, process, and send data. The Arduino board was programmed using the Arduino IDE software. There are three portions to this curriculum. The first section contains instructions for adding libraries depending on hardware and variable definition. The setup part, which comprises system settings and pin declaration, is the second portion. The main code will continue to loop and execute every line of the program until the Arduino board loses power in the third section.

This project makes use of an Arduino Uno powered by rechargeable batteries and a 5V, 5-watt solar cell. The solar cell's primary function, helped by the TP4056 charging module, is to charge the battery. This module includes critical protection mechanisms for batteries operating at 5V and employs the constant-current/constant-voltage (CC/CV) charging method to ensure safe and effective charging of lithium batteries. The USB step-down module is a power distribution intermediary that is powered by the battery and controlled by a push-button ON/OFF mechanism.

A GY-87 10 DOF sensor is included in the system, as are three more sensors: MPU6050, HMC5883L, and BMP180. Relevant libraries must be supplied in the Arduino IDE for each sensor to function. The MPU6050 sensor makes use of the MPU6050.h library, which enables calls like accelgyro.getMotion6(&ax, &ay, &az, &gx, &gy, &gz) to be used to obtain accelerometer and gyroscope data. The HMC5883L_Simple.h library provides compass functionality for the HMC5883L sensor. The BMP180 sensor uses the Adafruit_BMP085.h library to detect fluctuations in altitude, which are crucial for wave height measurements. Depending on the altitude changes, an if-else statement produces different results. The DS18B20 temperature sensor makes use of the "DallasTemperature.h" library as well as the "OneWire" pin library. The temperature and altitude data collected are meant to be communicated to customers via GSM.

Remote communication in this project is facilitated by the SoftwareSerial.h package, which permits GSM connections with the Arduino. Pin 11 correlates to RXD5V in GSM transmission, whereas pin 10 corresponds to TXD5V. The AT+CMGF=1 command enables text-mode messaging, which allows the GSM module to send messages. Furthermore, the AT+CMGS command is utilized to establish message delivery mode number parameters, allowing for more efficient communication.

This system provides critical information to the user by utilizing GSM and a wave sensor. Both pieces of hardware require stability in order for the DOS Buoy, which communicates with the user to receive information, to reliably determine the greatest wave measured. Several tests were carried out at different times and distances to record the altitude result under two situations, assuring true sea level wave height using the wave sensor. The results show that increasing the prototype's distance improves the accuracy of sea level wave detection, providing early alerts of possible wave safety hazards.

The system communicates altitude and water temperature data to the user via GSM connection. There are two conditions: "Incoming Huge Wave" indicates that the sea wave is approaching the safety limit, while "Danger Wave" indicates that the wave level is dangerous for swimming. Because it uses 3G technology, the GSM module takes five to seven seconds to give the wave result notice, producing a minor delay in delivering the critical information.

4.7 Summary

The successful Arduino-based DOS-Buoy project attempts to collect data on altitude, temperature, and wave height utilizing sensors such as the GY-87 10 DOF and DS18B20. The device uses an Arduino Uno to recharge batteries and is powered by a solar cell. However, due to the Arduino Uno's 23kbyte memory restriction, limits exist, necessitating code modification for reliability. Financial limits provide difficulties, notably in obtaining a 12V, 10W solar cell, which is unrealistic for a student. As an alternative, the study investigates the use of the cheapest available solar cell, however at a lower voltage. Despite the challenges, the project exhibits rigorous coding methods and resourcefulness, guaranteeing continuing progress within the restrictions given.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

After completing all planned procedures, the project has finally functioned and gives an expected output. All the hardware work well according to its function. GSM 900A module able to send message with the TX and RX connected to Arduino whenever the “if” statement is TRUE. GY-87 10DOF sensor able to retrieve the altitude of height wave sea level and DS18B20 temperature sensor detect of temperature of water and sent all data result to user using the GSM module. Sensors triggered when the condition set were met, and notification from the phone will show the result of the output temperature and danger alert of wave level altitude.

During the process of system development, there were some problems arise which has disrupted the implementation of the project. One of the problems faced was to get the result altitude with accurate. This GY-87 10DOF module sensor has 3 sensor that combine into one module which is MPU6050 for three-axis accelerometer and three-axis gyroscope, HMC5883L for compass module 3-Axis that sensing device with a digital interface in a low-field magnetic and BMP180 for measure accurately of atmospheric pressure. These sensors need to create separate test function of 3 sensor that’s make harder when the code are too long and the Arduino Uno have a limit memory space. Finally, the code successful can verify and upload to the Arduino Uno with the specific code for this project that need to test for altitude of wave sea level. GSM 900a module use for communicating to user about the system alert of danger wave. But the limit frequency to send the data of this GSM module is using 3G mode, because of that some provider network can’t use on this GSM module. The solution is testing the 3-command network that have use for a long time in Malaysia it is Maxis, Celcom and Digi. Finally, Maxis Sim card was chosen for the GSM module because it seem that Maxis have a good frequency in 3G mode. While testing the program of the system, there were some problem arise where the coding does not given the expected output. The altitude show the negative result. However, the coding does not show any error and it was program correctly according to the flow chart. Multiple tests were done on each hardware to make sure it is functioning. After few testing done, it is proved that the GY-87 sensor module is broken that make it could not show the correct output. After replacing the broken GY-87 module with a new one, the program completely functioning as expected. Therefore, the software part of this project was successfully done.

The objective of doing this system were to develop water wave detection and temperature system for marine tourism industry using Arduino Uno with solar power where user can get the notification alert of danger via SMS. It can be concluded that the objective of the project has finally achieved within due date of the project.

5.2 Recommendation

For future improvements to this project, it is advice that next developer choose a hardware that is cheaper to cut down the cost of the project. The GY-87 module first bought for this project is expensive because it has 3 sensors in 1 module that test all sensor this sensor before to combine it in one code which means it easier interfacing to Arduino Mega board. Unfortunately, this project only using the Arduino Uno board. Therefore, there are some parts of the GY-87 sensor module are not useful for the project. After first GY-87 bought broken, next GY-87 replaced a new one. The second hardware is GSM 900a module use the limit frequency, it is hard to choose which network provider are still support 3G network. In advance, need to find the better GSM that have a better frequency can support all network provider because the technology always growth. Lastly, always to make a test on every hardware used to make sure all of the hardware functioning by testing it with simple coding provide by the suppliers.

5.3 Project Commercialize

Future enhancement could be made to this project. An application on mobile phone could be created for the interaction between user and system. This application can be downloaded at IOS system or android. Therefore, it could make this project as an IOT based project which is more advanced and suitable with current technology where most of users are using smart phone. GPS also could be added as part of the input for this system. The GPS could be place inside the buoy for generate location specific where is the place are safe to do the activities tourism. The data will be sent to user to give more information on what happening at beach.

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FACULTY OF ELECTRONIC AND COMPUTER TECHNOLOGY AND ENGINEERING
CHECKLIST OF PSM FINAL REPORT SUBMISSION
BEEU 4774 (BACHELOR DEGREE PROJECT II)

PSM2

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Project Title: Development of Solar-Powered Wave Detection System for The Marine Tourism Industry Using Arduino Base On DOS-Buoy Concept.

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16	CHAPTER 3 – Methodology		✓	✓
17	CHAPTER 4 – Results and Discussion		✓	✓
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I acknowledge the acceptance of PSM Report from the above-mentioned student. I admit that the Report has been checked and fulfill the BEEU 4774 (BACHELOR DEGREE PROJECT II) requirement.

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