

# **Faculty of Electrical and Electronic Engineering Technology**



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

10

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Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

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## DEVELOPMENT OF WATER SURFACE ROBOT FOR WATER MONITORING VIA INTERNET OF THINGS (IOT)

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A project report submitted in partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours UDDECEMPTOR Faculty of Electrical and Electronic Engineering Technology

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#### DECLARATION

I declare that this project report entitled "DEVELOPMENT OF WATER SURFACE ROBOT FOR WATER MONITORING VIA INTERNET OF THINGS (IOT)" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



## APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours.

Signature : ABLAYS. Supervisor Name TS. DR. SUZIANA BINTI AHMAD Date 11.01.2022 **TEKNIKAL MALAYSIA MELAKA** UNIVERSITI

# DEDICATION

Dedication and appreciation towards my parent, lecturers, friends and my siblings for their encouragement, support, understanding and help in completing this final project.



#### ABSTRACT

Water is a valuable resource for human. Therefore, water resources must be preserved and taken care of so that they are not contaminated with harmful substances such as chemicals released by factories or from other sources. To conserve water resources, data need to be taken from those water sources either through traditional means by collecting data manually or with current technology in an automatic way. This project is capable of collecting data automatically because it uses various sensors. The sensors used are pH, temperature and turbidity. This project can be controlled using IOT platform. ESP 32 is used as a microcontroller in this project. The hardware consist of MDD10A motor driver, two underwater motor and lithium polymer battery. Finally, to control and retrieve data, coding from Arduino IDE is used.

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#### ABSTRAK

Air merupakan sumber yang berharga buat manusia. Maka dengan itu sumber air perlu dipelihara dan dijaga agar tidak tercemar dengan bahan yang merbahaya seperti bahan kimia yang dilepaskan oleh kilang mahupun dari sumber lain. Untuk memelihara sumber air, kita perlu mengambil data daripada sumber air tersebut sama ada melalui cara tradisional dengan mengumpul data secara manual mahupun dengan teknologi semasa dengan cara automatik. Projek ini mampu mengumpul data secara automatik kerana menggunakan pelbagai penderia. Penderia yang digunakan merupakan pH, suhu dan kekeruhan. Projek ini dapat dikawal menggunakan IOT. ESP 32 digunakan sebagai pengawal mikro di dalam projek ini. Projek ini juga terdiri daripada MDD10A pemandu motor, dua motor bawah air dan juga bateri lithium polimer. Akhir sekali, untuk mengawal dan mendapatkan data, pengkodan daripada Arduino IDE digunakan.



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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA** 

# TABLE OF CONTENTS

|                                 |  | PAG   |
|---------------------------------|--|---|
| DEC                             | LARATION   |   |
| APP                             | ROVAL  |   |
| DED                             | DICATIONS  |   |
| ABS'                            | TRACT  | i   |
| ABS'                            | TRAK   | ii  |
| ACK                             | NOWLEDGEMENTS  | iii   |
| ТАВ                             | LE OF CONTENTS   | iv  |
| LIST                            | T OF TABLES  | vi  |
| LIST                            | T OF FIGURES   | vi  |
| LIST                            | T OF APPENDICES  | X   |
| CHA<br>1.1<br>1.2<br>1.3<br>1.4 | PTER 1 INTRODUCTION<br>Background<br>Problem Statement<br>Project Objective<br>Scope of Project  | <b>11</b><br>11<br>12<br>12<br>13                   |
| CHA<br>2.1<br>2.2<br>2.3<br>2.4 | PTER 2 NIVEFLITERATURE REVIEW LAYSIA MELAKA<br>Introduction<br>Previous related paper<br>Comparison between previous research paper<br>Summary   | <b>14</b><br>14<br>14<br>27<br>28                   |
| CHA<br>3.1<br>3.2               | APTER 3       METHODOLOGY         Introduction       Methodology of work flow         3.2.1       First milestone         3.2.2       Second milestone         3.2.3       Third milestone         3.2.3.1       Electronic design         3.2.3.2       Software design         3.2.3.3       Mechanical design | <b>29</b><br>29<br>30<br>30<br>32<br>33<br>38<br>40 |
| 3.3                             | Summary  | 41  |
| <b>CHA</b><br>4.1<br>4.2        | APTER 4 RESULTS<br>Introduction<br>Results and Analysis  | <b>42</b><br>42<br>42                               |

|     | 4.2.1  | Mechanical design              | 42 |
|-----|--------|--------------------------------|----|
|     | 4.2.2  | Electronic design              | 46 |
|     | 4.2.3  | Software Design                | 48 |
|     | 4.2.4  | Result                         | 48 |
| 4.3 | Summ   | ary                            | 54 |
| СНА | PTER 5 | CONCLUSION AND RECOMMENDATIONS | 55 |
| 5.1 | Conclu | ision                          | 55 |
| 5.2 | Recon  | nmendations                    | 56 |
| REF | ERENC  | ES                             | 57 |
| APP | ENDICE | S                              | 59 |



# LIST OF TABLES

| TABLE                   | TITLE                     | PAGE |
|-------------------------|---------------------------|------|
| Table 2.1 comparison    | between previous journal  | 27   |
| Table 3.1 List of elect | tronic component          | 33   |
| Table 4. 1 Test condu   | ct for motor              | 49   |
| Table 4. 2 Data collec  | eted from measurement     | 49   |
| Table 4. 3 Data collec  | cted from pH measurement  | 51   |
| Table 4. 4 Measureme    | ent from different sample | 53   |



# LIST OF FIGURES

| FIGURE  | TITLE                                       | PAGE |  |  |  |
|---|---|------|--|--|--|
| Figure 2.1 Block diagram                              | system                                      | 15   |  |  |  |
| Figure 2.2 Low-cost Auto                              | onomous Surface Vehicle (ASV)               | 16   |  |  |  |
| Figure 2.3 Hardware com                               | ponent diagram                              | 16   |  |  |  |
| Figure 2.4 Overall system                             | ı block diagram                             | 17   |  |  |  |
| Figure 2.5 General idea o                             | f this project                              | 18   |  |  |  |
| Figure 2.6 Flow chart of V                            | USV   | 18   |  |  |  |
| Figure 2.7 Unmanned Sur                               | rface                                       | 18   |  |  |  |
| Figure 2.8 Block diagram                              | for robot system                            | 19   |  |  |  |
| Figure 2.9 Block diagram                              | for monitoring system                       | 19   |  |  |  |
| Figure 2.10 Aquatic Iguar                             | 20  |      |  |  |  |
| Figure 2.11 The structure                             | of Aquatic Iguana                           | 20   |  |  |  |
| اونيوم سيتي تيڪنيڪل م                                 |   |      |  |  |  |
| Figure 2.13 General idea ITI TEKNIKAL MALAYSIA MELAKA |   |      |  |  |  |
| Figure 2.14 Design for Io                             | T sensor                                    | 23   |  |  |  |
| Figure 2.15 Flow chart                                |   | 23   |  |  |  |
| Figure 2.16 Sensor with F                             | Raspberry Pi 3 model B use as Active Sensor | 23   |  |  |  |
| Figure 2.17 The flow of t                             | he process                                  | 24   |  |  |  |
| Figure 2.18 EXO Module                                |   |      |  |  |  |
| Figure 2.19 The system st                             | tructure                                    | 25   |  |  |  |
| Figure 2.20 System archit                             | tecture                                     | 26   |  |  |  |
| Figure 2.21 OpenROV D                                 | IY Platform                                 | 26   |  |  |  |
| Figure 3.1 Methodology                                | work flow                                   | 29   |  |  |  |

| Figure 3.2 Flow chart of project            | 31 |
|---|----|
| Figure 3.3 Flow chart of project            | 32 |
| Figure 3.4 ESP 32                           | 34 |
| Figure 3.5 Underwater motor                 | 35 |
| Figure 3.6 Lithium polymer battery          | 36 |
| Figure 3.7 DS18B20                          | 36 |
| Figure 3.8 pH sensor                        | 37 |
| Figure 3.9 Turbidity sensor                 | 38 |
| Figure 3.10 MDD10A motor driver             | 38 |
| Figure 3.11 Arduino IDE software            | 39 |
| Figure 3.12 How Blynk works                 | 40 |
| Figure 3.13 Basic design of the project     | 41 |
| Figure 4.1 Model view                       | 43 |
| Figure 4.2 Isometric view                   | 43 |
| Figure 4. 3 Mechanical design (back)        | 44 |
| Figure 4. 4 Mechanical design (front)       | 44 |
| Figure 4. 5 Implement on water surface      | 45 |
| Figure 4.6 circuit                          | 46 |
| Figure 4.7 circuit connection               | 46 |
| Figure 4. 8 Connection ESP32 with sensor    | 47 |
| Figure 4. 9 MDD10A with power supply (LiPo) | 47 |
| Figure 4. 10 Blynk Application Interface    | 48 |
| Figure 4. 11 Temperature measurement graph  | 50 |
| Figure 4. 12 Test setup                     | 50 |
| Figure 4. 13 pH measurement graph           | 51 |

| Figure 4. 14 Test setup for pH sensors           | 52 |
|--|----|
| Figure 4. 15 Graph from turbidity measurement    | 53 |
| Figure 4. 16 Measurement sample and test conduct | 53 |



# LIST OF APPENDICES

# APPENDIX

# TITLE

PAGE

Appendix A Source code program

59



#### **CHAPTER 1**

#### **INTRODUCTION**

#### 1.1 Background

Water is an essential need for human life and the availability of good quality or clean water is important so that water-based disease can be prevent. During Movement Control Order (MCO) that have been implement by authorities due to pandemic outbreak (COVID-19), the water quality at river in Malaysia has been improved. It is because of the decrease in industrial sector activity. The water quality in the river improved significantly as reported by media. The river that has been report is Gombak river, Klang river, Way river, Kemunsing river, Melaka river and Kim Kim river. Before MCO, the river mention is cloudy and some of them appear blackish. As example, river around urban area such as Selangor that are contaminate always appear cloudy if not blackish. It happen because the waste from industrial and human as well. Melaka river can be seen cleaner and greener during MCO due to decrease in tourist activity such as Melaka River Cruise.

Due to concern on our river and water source, this project can be use to monitor the water quality by using sensors such as pH sensor, turbidity sensor and temperature sensor. The data collect from the sensor then can be monitor through Internet of Things (IOT). This project using IOT equipped with sensor to measure the water quality from the water environment.

## **1.2 Problem Statement**

Nowadays even in modern era, issue related to water pollution still exist. All of this happen because of human attitude such as selfish and greedy. The waste from factory directly dumped into the river is a great example because it happen again and again in our beloved country, Malaysia. At some area, it is hard to get sample from the river. So this project will be handy because it can be used to maneuver on water surface and at the same time it will collect data from the river. Some researcher might need data to be collect in the middle of the river, it will be difficult without a boat so this project can be use in that situation.

# **1.3 Project Objective**

The main purpose of this project is to develop the unmanned water surface robot that can be control and monitor through internet of things (IOT). Specifically, the objectives are as follows:

- a. To develop the water surface robot system for water quality monitoring using microcontroller based on Internet of Things (IOT).
- b. To analyze the PH, turbidity and temperature of the water using sensors via IOT.
- c. To construct the robot movements by controlling the thrusters via IOT.
- d. To evaluate the water surface robot system by testing in different water quality.

#### **1.4** Scope of Project

This project involved the development of a water surface robot. The robot can maneuver on the water surface and monitor the PH, turbidity and temperature of the water via IOT. To complete the task, pH sensor is use to monitor pH level, turbidity sensor is use to monitor turbidity level and temperature sensor is use to monitor temperature of the water. The movement of the robot is done by controlling the thruster through IOT platform. ESP32 will be used as the main controller and motor driver will be used to control the thrusters. To evaluate the water surface robot system, the sensors are dip in different water sample. For temperature sensor, the test are conduct by dipping the sensor in water sample with different temperature. For pH sensor, the test include vinegar, lime, drinking water, soap, pH4 and pH7 solution. for turbidity sensor, it is tested by dipping in water sample from muddy water, lake, soap, rain water and drinking water.

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#### **CHAPTER 2**

#### LITERATURE REVIEW

#### 2.1 Introduction

In today's modern society, the technology has evolved more and more. The evolved technology can be use in various place let it be around us and as far as space and as deep as sea. The various technology has taken people to space and deep sea, it all happen because technology has evolved. By using technology also we can connect with people around the globe with the help of internet and smartphone or laptop. So, by the help of technology people can research and develop interesting project. Also, by the help of technology, this project which is water surface robot is possible to complete and working as we need. To complete this project, ten research has been made to identify how other researcher build their robot or project.

#### 2.2 Previous related paper EKNIKAL MALAYSIA MELAKA

Many related research paper have been done in order to complete this project. The first research paper in the list is the project that are researched and build by student from Indonesia (Wibowo *et al.*, 2018). In this project, Arduino mega and wireless telemetry has been used. It work by gathering data using wireless sensor network along Field Programmable Gate Array (FPGA) and ZigBee. The hardware consist of GPS sensor (NEO-M8), pH sensor, turbidity sensor, temperature sensor, dissolve oxygen sensor (DO) and motor pump. In future development, the coordinate of the location might be needed so the GPS sensor is used for that purpose. Temperature sensor will collect temperature data of water in location chosen. The temperature sensor code DS18B20 is a digital thermometer

measures the temperature of Celsius 9-bit to 12-bit. Turbidity sensor (analog) is used to provide data on water density. This sensor related to the ability of sunlight that able to penetrate water. As example, sunlight cannot penetrate cloudy water. For some ecosystems, this sunlight is critical. The acidity level of a water can be measured using a PH sensor. This level of acidity is also linked to the ecosystem. The dissolved oxygen sensor (DO) is used to calculated important variable in water quality analysis. Aquatic organisms will have difficulty breathing if there is a lack of dissolved oxygen in the water. Motor pump is used to control direction of the vehicle. Figure 2.1 and 2.2 show block diagram system and ASV.



Figure 2.1 Block diagram system



Figure 2.2 Low-cost Autonomous Surface Vehicle (ASV)

Next research in the list is the researcher from Indonesia that point the pollution of the Citarum watershed in Indonesia (Lestari *et al.*, 2019). They have design IoT-based river water quality monitoring system using Low-Power Wide Area Networks (LPWAN) and Long Range (LoRa) mesh notification using mesh network topology a medium to long distance transmission. This project require MQTT broker to acquire data. The hardware design consist of microcontroller and sensor. The sensor used in this project included temperature sensor, pH sensor, metal concentration (Pb and Fe) sensor and turbidity sensor while the microcontroller used in this project is Arduino. Figure 2.3 and 2.4 show hardware component diagram and overall system block diagram.



Figure 2.3 Hardware component diagram



Figure 2.4 Overall system block diagram

The third research in the list is from a university in Thailand and their aim is to make an autonomous platform for replacement of human works in high-risk areas (Siyang and Kerdcharoen, 2016). This researcher team used RC boat and low cost acrylic sheets to creating the robot. By using RC, they able to use the robot to maneuver in water surface. This robot using sensor to record data from the watershed or river. The sensor that are used include oxidation reduction potential (ORP), pH sensor, electrical conductivity (EC), dissolved oxygen (DO) and temperature sensor. The Arduino Mega 2560 are used as microcontroller in this project. This project also makes use of a telemetry module to connect with Ardupilot in order to obtain sensor data about the robot, an XBee module to collect data about water properties, and a radio transmitter to manually control the robot. Figure 2.5, 2.6 and 2.7 show general idea, flow chart of USV and final project.







**Figure 2.7 Unmanned Surface** 

Further in the list is a research by a university from Indonesia (Adhipramana, Mardiati and Mulyana, 2020). The robot system use Arduino uno then the robot will be controlled by using remote control that has a frequency of 2.4GHz. The output is a DC motor

controlled by an L298N motor driver. This system was designed and built to be used as a sensor bearer capable of collecting pH data, NTU data, and PPM water. The robot can cover a distance of up to 140 metres at a speed of 0.46 kilometres per hour. Designed and implemented IoT-based pH, NTU, and PPM-driven water monitoring systems can deliver data at an average data transfer rate of 30 seconds. The system can monitor by displaying the parameter value data of the sensor output using the Thingspeak cloud server, and it can also store the sent data in the Thingspeak cloud server.. Figure 2.8 and 2.9 show block diagram for robot system and block diagram for monitoring system.



Figure 2.9 Block diagram for monitoring system

The list continue with the research by a university from Bangladesh (Turesinin *et al.*, 2020). The aim of this project is to assemble robot that can collect floating waste and at the same time it can collect water data through sensor. This project is also intended to provide

a real-time view of the surface of the water using a monitoring camera attached to the robot. Flysky 2.4G FS-CT6B 6CH Remote Control was used by this team of researches for robot control. In an effort to boost the waste collection system, two lithium batteries with a length of 11.1V 1500 mAh, 1 5V 4 channel relay module and 1 5V 2 channel relay module were used to control the conveyor belt. Figure 2.10, 2.11 and 2.12 show aquatic iguana robot, the structure of the robot and the circuit.



Figure 2.11 The structure of Aquatic Iguana



**Figure 2.12 Circuit simulation** 20

This project able to live streaming. The objective is to facilitate the operator's navigation and waste collection. The team used the raspberry pi to create a frame transmitting station, combined with the pi camera module. The camera captures at 5MP and the raspberry pi can reach 2,4 GHz via the WiFi channel. Including the sensor pH, turbidity sensor, and temperature sensor, the water monitoring system can collect data on the site. NodeMcu, Arduino Nano processes sensor values and sends them every 30 seconds to ThingSpeak server.

Move to the next research paper, the researcher team is from a university from Indonesia(Budiarti *et al.*, 2019). The aim is to design IoT system that measure water quality. The author uses Internet of Things technology, including a YSI 600R water sensor, a Raspberry Pi 3 as an embedded system, and 4G communications, in this study. Researchers prepare infrastructure and create Web UI (User Interfaces) in the early stages, followed by the development of a database system for the IoT Platform. After the database system has been built, use Web Scraping to get data from passive sensors and Python serial programming to get data from active sensors. The data is then sent via the MQTT protocol to the database system. As a result, as the IoT platform can obtain the results of the status sensor monitoring system from sensor data, the development of IoT sensor devices can be viewed.

Next, Python programming was used to retrieve data from YSI600R water quality sensors connected via serial port RS232. Python has its own module called pySerial that allows you to retrieve data from a serial port. The communication parameters provided by pySerial include 8 bits of non-parity and 1 stop bit, abbreviated as 8N1. The data transfer rate used in this study was 9600 bps. When pySerial calls modules with serial import to read and write data, the serial is identified by /dev/ttyUSB0 in Raspbian OS. The researcher using

RDBMS is known as the SQLite application for SQL. SQLite can read and write directly to a disc storage system. SQLite is also a very handy library, which allows SQLite to work well in a restricted storage environment like raspberry pi-3. MariaDB has already been used for another DBMS system for database development, since MariaDB supports high availability, security and interoperability. Then MQTT is used for efficiency data transfer. The MQTT platform broker used are mosquito. Figure 2.13, 2.14, 2.15 and 2.16 show general idea, design for IoT sensor, flow chart and sensor with Raspberry Pi 3 model B use as active sensor.



Figure 2.13 General idea







# **Figure 2.15 Flow chart**



Figure 2.16 Sensor with Raspberry Pi 3 model B use as Active Sensor

Next in the list is a research team that is form by various researcher from different countries(Junior *et al.*, 2021). The goal of this project is to create the Internet of Water Things(IoWT), a new online system for monitoring and managing water resources. The goal of this system is to control and manage raw water resources. This researcher team using Raspberry Pi 3 as their microcontroller combine with piezoelectric level sensor to collect water level data. A modem was used to get access to the internet. Figure 2.17 show the flow of the process.



Next researcher team is from India and the aim of this research is to monitor water parameter through software (Krishna *et al.*, 2020). The sensor that are used in this research is EXO Sonde. The sensor is an independent sensor that can read conductivity, dissolved oxygen, pH, rhodamine, algae and turbidity. The other available parameters are absolute pressure, ammonia, depth, salinity, solid suspensions and water density. ZigBee, Ethernet and GSM are the methods used for transmitting data. The processing part will include IoT platforms for monitoring tools, such as Ubidots for visualization. Figure 2.18 show EXO module.



Figure 2.18 EXO Module

Further in the list is researcher team from China (Bai, Wu and Jin, 2020). The aim is to monitoring water quality and monitoring system based on wireless sensor network. The research team develops a system, including five modules, the acquisition module for information, the coordinator module, the host computer module, GSM module and the mobile terminal module. There is a sensor and a microcontroller for the information acquisition module. There are several ZigBee acquisition nodes for the information acquisition module. In order to gather and transmit environmental parameters like temperature, the pH and dissolved oxygen, each node is linked to sensors. A ZigBee Receiver and an embedded microprocessor compose the coordinator module. The ZigBee receiver receives environmental parameter data and sends it to the host computer through serial port for information processing. The host computer's GSM module can transfer data to the mobile terminal. The mobile terminal module receives data from the scene through a short message from the water quality parameter. Figure 2.19 show the system structure.



Figure 2.19 The system structure

The last research paper in the list is researcher team from Indonesia (Prabowo, Tresnawati and Kusumastuti, 2020). The objective of this study is to establish a water quality monitoring system using different sensors to indicate water quality. A pH sensor, a temperature sensor, and TDS sensors (total dissolved solids) are equipped for this remote operated vehicle, and data are sent to the server using HTTP protocol. The OpenROV platform, the open source robotic platform underwater, is a remote driven vehicle. The microcontroller used in this project is Arduino Uno R3. The Arduino is equipped with the sensor and ethernet module. Figure 2.20 and 2.21 show system architecture and openROV diy platform.



Figure 2.20 System architecture



Figure 2.21 OpenROV DIY Platform

# 2.3 Comparison between previous research paper

The table show comparison between previous journal or research paper in term of method and application. Table 1 show comparison between previous journal.

| No. | Author                           | Method                       | Application                    |
|-----|----------------------------------|------------------------------|--------------------------------|
| 1   | (Wibowo <i>et al.</i> , 2018)    | -Arduino Mega                | - monitoring the               |
|     |                                  | - Wireless Telemetry         | quality of watersheds          |
|     |                                  | 915MHz.                      |                                |
|     |                                  | Sensor:                      |                                |
|     |                                  | -GPS, temperature,           |                                |
|     |                                  | turbidity, pH, DO(Dissolve   |                                |
|     |                                  | Oxygen).                     |                                |
|     |                                  | -camera                      |                                |
| 2   | (Lestari et al., 2019)           | -IoT , LoRa                  | -monitor and get information   |
|     | AALAYSIA                         | Sensor:                      | of water quality at Citarum    |
|     | 14                               | -temperature, pH, metal      | watershed.                     |
|     | Star Ve                          | concentration, turbidity     |                                |
| 3   | (Siyang and Kerdcharoen,         | -Arduino Mega, Ardupilot,    | - to make an autonomous        |
|     | 2016)                            | XBee module, Radio           | platform                       |
|     | E.                               | Transmitter.                 | for replacement of human       |
|     | Pa                               | Sensor:                      | works in high-risk areas       |
|     | AINO                             | -Temperature, pH, dissolve   |                                |
|     | 2 . 1                            | oxygen(DO), oxidation        |                                |
|     | 1. ahmend all                    | reduction potential          | noug                           |
|     | 0                                | (ORP), electrical            | 1                              |
|     |                                  | conductivity (EC)            | =1.01/20                       |
| 4   | (Adhipramana, Mardiati           | -Arduino, remote Y SIA M     | - designed and implemented to  |
|     | and Mulyana, 2020)               | controller, Dc motor.        | be                             |
|     |                                  | Cloud service:               | used as a sensor bearer that   |
|     |                                  | -Thingspeak                  | will take pH data, NTU and     |
|     |                                  | Sensor:                      | PPM                            |
|     |                                  | - pH, turbidity, TDS (total  | water can run well             |
|     |                                  | dissolve solid)              |                                |
| 5   | (Turesinin <i>et al.</i> , 2020) | -Arduino, remote control,    | -collect floating waste        |
|     |                                  |                              | -collect water data            |
|     |                                  | Sensor:                      |                                |
|     |                                  | -pH, turbidity, temperature. |                                |
| 6   | (Budiarti <i>et al.</i> , 2019)  | -Raspberry pi, IoT.          | -lo1 system that measure water |
|     |                                  | - YSI                        | quality                        |
|     |                                  | 600K Sensor                  |                                |
| 7   | (Iunion at al 2021)              | LaT                          | Developed and tests d for LT   |
| /   | (Junior <i>et al.</i> , 2021)    |                              | -Developed and tested for 101  |
|     |                                  | Jourse tomporature           | system for efficient and scale |
|     |                                  | -ievei, temperature          | resource                       |
|     |                                  |                              | resource                       |

 Table 2.1 comparison between previous journal

| No. | Author                         | Method                    | Application               |
|-----|--------------------------------|---------------------------|---------------------------|
| 8   | (Krishna <i>et al.</i> , 2020) | IoT,                      | -monitoring water quality |
|     |                                | Sensor:                   |                           |
|     |                                | -EXO sonde (conductivity, |                           |
|     |                                | dissolved oxygen content, |                           |
|     |                                | pH, rhodamine, total      |                           |
|     |                                | Algae and turbidity)      |                           |
| 9   | (Bai, Wu and Jin, 2020)        | ZigBee                    | - water quality           |
|     |                                | Module:                   | monitoring and monitoring |
|     |                                | information               | system based on wireless  |
|     |                                | acquisition, coordinator, | sensor                    |
|     |                                | the host computer, GSM,   | network                   |
|     |                                | mobile terminal.          |                           |
|     |                                | Sensor:                   |                           |
|     |                                | temperature, PH,          |                           |
|     |                                | dissolved oxygen(DO).     |                           |
| 10  | (Prabowo, Tresnawati and       | Arduino                   | -water monitoring system  |
|     | Kusumastuti, 2020)             | Sensor:                   |                           |
|     |                                | - pH, Temperature, Total  |                           |
|     | MALAYSIA                       | dissolved solid (TDS).    |                           |

#### 2.4 Summary

From the previous research, there are various design and sensor used in their project. Some of them can be control and some of them are placed in certain area. The microcontroller used also various but most of them using Arduino and Raspberry pi. IOT platform also various from each researcher. Therefore, this project proposed the design similar with Figure 2.2 due the balance of the project and it is compatible with using two motor. Also, for this project ESP32 is chosen as microcontroller because it give new challenge due to no previous journal using it. ESP32 also compatible with Blynk platform. Blynk platform can be use to monitor sensor output and at the same time control the motor in real time.

#### **CHAPTER 3**

#### METHODOLOGY

## 3.1 Introduction

This chapter contains all of the information, explanations, and methodology components that were used to complete this project. This chapter plays an important role in ensuring that the project proceed smoothly by adhering to the correct work flow. Furthermore, this chapter will go over the steps and stages involved in completing this project.



Figure 3.1 Methodology work flow

#### 3.2.1 First milestone

- Project description This section is mainly about the project description which is Development of Water Surface Robot for Water Monitoring via Internet of Things (IOT). This project can be use to monitor water quality by controlling water surface robot that can maneuver at water surface.
- Literature review This part consist of previous research paper. From the previous research, I had learnt and gain knowledge about related project and it help me to complete this project. I also learn and study various sensor and design from previous research paper as well.

## 3.2.2 Second milestone

The second milestone indicate the project or process flow from initial which is get data and information from previous research. This section also cover the study of design and various sensor. This section also consist of different part that must be combine to complete this project. The part is divided to three which is electronic design, software design and mechanical design. Figure 3.2 and 3.3 show flow chart of project methodology in order to planning the sequence for completing this project.



Figure 3.2 Flow chart of project



Figure 3.3 Flow chart of project

#### 3.2.3 Third milestone

This section goes over the component that was chosen. This component was chosen based on the previous research study in chapter 2, which is a literature review. The chosen component is also chosen based on the requirements required to achieve the project's goal. Furthermore, software design and mechanical design that were used in previous research have been learned and will be apply to this project.

#### 3.2.3.1 Electronic design

| No | Component                               | Quantity |
|----|---|----------|
| 1  | ESP32                                   | 1        |
| 2  | Underwater Motor                        | 2        |
| 3  | Lithium Polymer Battery (LiPo)          | 1        |
| 4  | Waterproof temperature sensor (DS18B20) | 1        |
| 5  | PH sensor                               | 1        |
| 6  | Turbidity sensor                        | 1        |
| 7  | MDD10A motor driver                     | 1        |

The list of component use in the project is shown in Table 3.1

## Table 3.2 List of electronic component

#### 1. ESP 32 Microcontroller

The ESP32 DevKit v1 is one of the development board created to evaluate the ESP-WROOM-32 module. It is based on the ESP32 microcontroller that boasts Wi-Fi, Bluetooth, Ethernet and Low Power support all in a single chip. ESP32 is already integrated antenna and RF balun, power amplifier, lownoise amplifiers, filters, and power management module. This board is used with 2.4 GHz dual-mode Wi-Fi and Bluetooth chips by TSMC 40nm low power technology, power and RF properties best, which is safe, reliable, and scalable to a variety of applications. Figure 3.4 show ESP 32.



U This motor is chose because of the application suitable for this project. Costwise and this motor also can rotate clockwise and counter-clockwise which means that it can move forward and reverse. With the thruster design, it provide smooth operation for this motor. Figure 3.5 show underwater motor.



Figure 3.5 Underwater motor

## 3. Lithium polymer battery

The lithium polymer or also known as a LiPo battery is a rechargeable battery of lithium-ion technology which is used a polymer electrolyte instead of liquid electrolyte. From this electrolyte, it can produce high conductivity semisolid polymers and provide higher specific energy compared to other lithium battery types. This LiPo battery was initially designed for theremote control toys application and after that it become popular in robotic sector. This because, LiPo battery is small in size and also lightweight. Todays, lithium polymer battery has many types which provide different capacity. This 5200mAh LiPo battery is choose to provide high capacity of battery in application. It has an ordinary voltage up to 11.1V and it fully charge voltage is 12.6V. Besides that, it able to use for most of the 12V controllers, motor or any otherappliances. Figure 3.6 shows the Lithium polymer battery.



#### Figure 3.6 Lithium polymer battery

#### 4. Waterproof temperature sensor (DS18B20)

This sensor is chosen because like the name suggest, it is waterproof and suitable for this project. The digital thermometer DS18B20 provides temperature measurements of 9-bit to 12-bit Celsius with alarms that are non-volatile with upper and lower trigger points. The DS18B20 communicates through a 1-wire bus that only needs one line (and ground) to connect to a central microprocessor by definition. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply. Each DS18B20 has its own 64-bit serial code, allowing multiple DS18B20s to operate on the same 1-Wire bus. As a result, it is simple to use a single microprocessor to control many DS18B20s spread across a large area. Figure 3.7 show temperature sensor.



**Figure 3.7 DS18B20** 

#### 5. PH sensor

PH scale is used to measure the acidity and basicity of a liquid. It can have readings ranging from 1-14 where 1 shows the most acidic liquid and 14 shows the most alkaline liquid. 7 pH is for neutral substances that are neither acidic nor alkaline. A pH sensor analogue is used for measuring the solution' s pH value and for indicating the substance's acidity or alkalinity. The module comes with an on-board voltage regulator chip that supports the 3.3-5.5V DC wide-voltage supply compatible with any 5V or 3.3V of any Arduino control board. Figure 3.8 show pH sensor.



#### 6. Turbidity sensor

The water quality is detected by the turbidity sensor by measuring turbidity or opacity. It uses light to measure light transmitting and dispersion rate for suspended particles in water, which changes in water with the total amount of solids suspended (TSS). The level of liquid turbidity increases as the TTS increases. Turbidity sensors are used for river and stream water quality measurement, waste and effluent measurement, settling pond control equipment, sediment transport research and testing in laboratories. Analog and digital signal output modes are provided in this liquid sensor. Figure 3.9 show turbidity sensor.



Figure 3.9 Turbidity sensor

## 7. MDD10A DC motor driver

MDD10A is the dual channel version of MD10C, designed to drive two brushed DC motors at high currents of up to 10A continuously. MDD10A also supports PWM signals with locked antiphase and sign magnitude. It also using full solid-state components, which results in faster response time and eliminates mechanical relay wear and tear. Figure 3.10 show MDD10A motor driver.



Figure 3.10 MDD10A motor driver

## 3.2.3.2 Software design

## 1. Arduino IDE software

The open-source software Arduino Integrated Development Environment (IDE) makes writing and uploading the code to a board of arduinos easy.

This software is used to control the electronic part like the motor, the sensor and other electronic components. This software is also flexible as it can run on Mac OS X and Linux, windows and other applications. This software also compatible with ESP32. Figure 3.11 show Arduino IDE software.

AN OPEN PROJECT WRITTEN, DEBUGGED AND SUPPORTED BY ARDUINO.CC AND THE ARDUINO COMMUNITY WORLDWIDE LEARN MORE ABOUT THE CONTRIBUTORS ARDUINO.CC on arduino.cc/credits AALAYSI Figure 3.11 Arduino IDE software **Blynk platform** 2.

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data and vizualize it. There are three major components in the platform. The first one is Blynk app, it allow to create interface for projects using various widgets provide in the platform. Next is Blynk server, it is responsible for all the communication between the smartphone and the hardware. The third one is Blynk libraries for hardware platform such as Arduino, esp and Raspberry Pi. Figure 3.12 show example how Blynk works.



3.2.3.3 Mechanical design

This section discuss the mechanical design for this project. The design must be able to float at water surface so that this project can work perfectly. This design structure also must be strong enough to bear the weight of the component used. This project consist of 2 thruster that can be control to move forward, reverse, left and right. The material used must be cost effective due to availability of the material and components. Figure 3.13 show basic design of this project.



Figure 3.13 Basic design of the project

# 3.3 Summary

This chapter outlines the proposed methodology for developing and designing based on electrical, software, and mechanical design knowledge. The project's problem and requirements have been examined in order to achieve the desired result. Thus this project will successfully work by implement all the knowledge that has been studied from previous research and project.

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#### **CHAPTER 4**

#### RESULTS

## 4.1 Introduction

This chapter presents the results and analysis on the development of this water surface robot. The result obtain is from actual testing on different sample of water solution for pH and turbidity sensor and for temperature sensor, it is tested in different water temperature from water dispenser.

#### 4.2 Results and Analysis

ALAYS /

This section will show the mechanical design, electrical design and software design that has been develop on this project.

# 4.2.1 Mechanical design

The mechanical design will be shown in this section. This design was created using Solid Work software and illustrated in four different side views which is front, top, side, and isometric. Figure 4.1 show the model view.



# Figure 4.1 Model view

Based on Figure 4.2, it illustrated the water surface robot in isometric view. From the design, the box consist of all the electronic component. The box is attach to clear acrylic plate. The plate then attach to left and right body part. There are 2 underwater motor used in this project and it is placed at left and right body part. The sensor also are placed at both body part.





# Figure 4.2 Isometric view

Figures 4.3 and 4.4 show the actual body design of the water surface robot. To control the movement of the robot, 2 underwater motors are attached to the back of the robot and all the sensors are attached at the front of the body. At top, there are a box that contains all the electronic parts. This design are stable and able to float on the water surface. Figure 4.5 show the water surface robot that has been implemented in real-time situation.





Figure 4. 5 Implement on water surface



# 4.2.2 Electronic design

This section will show the electrical circuit. The circuit consist of ESP32, MDD10A, and sensor. Figure 4.6 and 4.7 show circuit and the connection draw using fritzing.



Figure 4.7 circuit connection

Figure 4.8 show the connection in real life. The esp 32 is connected with all the components. The pH sensor pin is connected with pin 34 from esp 32. For turbidity sensor, it is connected with pin 18 from esp32 and for the temperature sensor, it is connected with pin 32. Next, the motor driver MDD10A is connected with pin 12,13,14, and 27.



Figure 4.9 show the connection of MDD10A with power supply. The figure also show the connection of both underwater motor used in this project. The push-push button is used as switch to turn on and off the motor driver. The led on the motor driver will light up to indicate there are supply to it. In the figure, there are no supply so the led is not light up.



Figure 4. 9 MDD10A with power supply (LiPo)

## 4.2.3 Software Design

This section will show the software design which is Blynk application. Figure 4.10 show the interface of the Blynk application. The interface show all the reading for the sensor used in this project. This water surface robot can be controlled through this application. The motor can be controlled to move forward, reverse, left or right.



UNIVERFigure 4. 10 Blynk Application Interface

#### 4.2.4 Result

This section will cover the result obtained from this project. The result obtained is from the motor and sensors used in this water surface robot. The motor test is done by pressing the forward, reverse, left, and right on the Blynk application, and the test is done up to 10 times. Both underwater motors used for this water surface robot work perfectly without any bug or problem. The test conduct is shown in table 4.1 below.

| Direction | Test         |
|-----------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
|           | 1            | 2            | 3            | 4            | 5            | 6            | 7            | 8            | 9            | 10           |
| Forward   | $\checkmark$ |
| Reverse   | $\checkmark$ |
| Left      | $\checkmark$ |
| Right     | $\checkmark$ |

## Table 4. 1 Test conduct for motor

Next, the test is conducted on the temperature sensor. The test is conducted by testing the sensor in different temperatures of water from the water dispenser. From cold to warm. Also, the data are collected by comparing the measurement from the sensor and measurement from the thermometer. Table 4.2 and figure 4.11 show the analysis for the test conduct.

|                                |                  | 11              | 1 1    |         |                   |        |
|--------------------------------|------------------|-----------------|--------|---------|-------------------|--------|
| Different Temperature<br>Level | Temp 1           | Temp 2          | Temp 3 | Temp 4  | Temp 5            | Temp 6 |
| Difference                     | ERSITI T<br>3.12 | EKNIKAI<br>1.87 | MALAY  | SIA MEL | <b>AKA</b><br>0.5 | 0.5    |
| Difference Percentage          | 24.00%           | 8.90%           | 5.56%  | 4.03%   | 1.47%             | 1.32%  |
| Data From Sensor               | 9.88             | 19.13           | 25.5   | 29.75   | 33.5              | 37.5   |
| Data From<br>Thermometer       | 13               | 21              | 27     | 31      | 34                | 38     |

| Table 4. 2 Data co | ollected from | measurement |
|--------------------|---------------|-------------|
|--------------------|---------------|-------------|



Figure 4. 11 Temperature measurement graph

The data measurement from the table shows that there are differences between measurement from sensor and thermometer. It is because of the difference in sensitivity. Even there are differences, this test is a success because both lines of the graph follow the trend. The sensor and thermometer are dip in the water at the same time to get the measurement. Figure 4.12 shows the test setup.



Figure 4. 12 Test setup

Next is pH sensor data measurement. There are 6 tests conducted to record the data measurement. The test was conducted by comparing pH sensor developed in this water surface robot with pH sensor from the market. Table 4.3 and figure 4.13 show the result from the test.

| Sample                | Vinegar | Lime   | PH 4   | Drinking<br>Water | PH 7  | Soap  |
|-----------------------|---------|--------|--------|-------------------|-------|-------|
| Difference            | 1.02    | 0.9    | 0.82   | 0.08              | 0.66  | 0.08  |
| Difference Percentage | 47.89%  | 37.19% | 19.85% | 1.12%             | 9.38% | 0.87% |
| PH sensor (Developed) | 3.15    | 3.32   | 4.95   | 7.2               | 7.7   | 9.12  |
| PH sensor (Market)    | 2.13    | 2.42   | 4.13   | 7.12              | 7.04  | 9.2   |

Table 4. 3 Data collected from pH measurement



Figure 4. 13 pH measurement graph

The data measurement from the table shows that there is a huge difference between the pH sensor developed in this project and the sensor from the market. This is due to differences in sensitivity. As for pH 4 and pH 7 solution, it has been used to calibrate the sensor, so when the solution is used again, the reading is skyrocketing due to impurities in the solution. Overall, this test is a success because both line graphs follow the pattern. To get the measurement, both sensors are dips in the solution sample. Figure 4.14 shows the test setup.



Figure 4. 14 Test setup for pH sensors

Next is the turbidity sensor. In this test, the higher the value, the clearer the water. It is set like that in the coding to be used in this water surface robot. When the sensor triggers 5V reading, it will display 100 in the Blynk interface and that means the water is clear. The sensor is dipped in different solutions to measure the turbidity. Table 4.4 show the measurement from the different sample and figure 4.15 shows the graph output. Figure 4.16 shows the measurement sample and test conducted.

| Sample                | Muddy<br>Water | Lake | Soap | Rain Water | Drinking-<br>Water |
|-----------------------|----------------|------|------|------------|--------------------|
| Turbidity Measurement | 17             | 40   | 66   | 80         | 95                 |

 Table 4. 4 Measurement from different sample



Figure 4. 16 Measurement sample and test conduct

# 4.3 Summary

In a nutshell, this chapter presents all the data measured by the sensors that used in this water surface robot. In the test conduct, the motor works perfectly. For sensor, the difference in measurement between developed sensor and sensor from the market occur because of the sensitivity of the sensor itself. Even though there is difference and some are huge, as long as it follows the chart or graph pattern, it is a success.



#### **CHAPTER 5**

#### CONCLUSION AND RECOMMENDATIONS

#### 5.1 Conclusion

In conclusion, this is an interesting project because it needs to be controlled using an IoT platform. Most of the previous research and project only control the robot using remote control and only using IoT for collecting data. So, it is challenging to complete this project. The objective of this Development of Water Surface Robot For Water Monitoring Via Internet of Things (IoT) has been successfully achieved. The first objective is to develop the water surface robot system for water monitoring using microcontroller based on Internet of Things (IoT) which has been achieved successfully. The second objective is to analyse the pH, turbidity, and temperature of the water using sensors via IoT. The second objective was also achieved as mentioned in the result. All the sensors can measure data and later the Blynk application will show the measurement from each sensor. The third objective is to construct the robot movement by controlling the thruster via IoT. As mentioned in the result, the test conducted for underwater motor pass perfectly without any bug or error, so the third objective was also achieved. The last objective is to evaluate the water surface robot system by testing different water quality. This objective was also achieved. The test conducted on the sensors are using different samples with different water quality.

## 5.2 **Recommendations**

Overall, this water surface robot is a success but there are always room for improvement. In future, it is better to use high end or high quality sensor to acquired more accurate data and measurement. As for design, in future it should be more stable and sturdy so that it can be use in different water surface condition.



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#### APPENDICES

#### Appendix A Source code program

#define BLYNK PRINT Serial #include <WiFi.h> #include <WiFiClient.h> #include <BlynkSimpleEsp32.h> #include <Arduino.h> #include <analogWrite.h> #include <OneWire.h> #include <DallasTemperature.h> #include "DFRobot\_ESP\_PH.h" #include <EEPROM.h> DFRobot\_ESP\_PH ph; char auth[] = "tkLs6zafG1xffLSdLYttWF1WgQMfxuNT"; char ssid[] = "KurKur"; char pass[] = "123456qw"; const int PWM1 = 14;const int DIR1 = 27; JNIVE const int PWM2 = 13; MALAYSIA MELAKA const int DIR2 = 12;

> int i=255; int s=0;

const int turbidity = 35; const int turbidityout = 18; int sensorturbidity = 0; int outputturbidity = 0;

#define ESPADC 4096.0 //the esp Analog Digital Convertion value #define ESPVOLTAGE 3300 //the esp voltage supply value #define PH\_PIN 34 //the esp gpio data pin number float voltage, phValue, temperature = 25;

const int oneWireBus = 32; OneWire oneWire(oneWireBus); DallasTemperature sensors(&oneWire);

```
void setup()
        Serial.begin(9600);
        Blynk.begin(auth, ssid, pass);
        sensors.begin();
        pinMode(PWM1,OUTPUT);
        pinMode(DIR1,OUTPUT);
        pinMode(PWM2,OUTPUT);
        pinMode(DIR2,OUTPUT);
        void loop()
        Blynk.run();
        trubi();
        phsensor();
       temperatures();
     AALAYSIA
        void trubi()
        sensorturbidity = analogRead(turbidity);
        outputturbidity = map(sensorturbidity, 0, 4023, 0, 100);
        Blynk.virtualWrite(V5,outputturbidity);
        //Serial.print("sensor = ");
       //Serial.print(sensorturbidity);
       //Serial.print("\t output = ");
        //Serial.println(outputturbidity);
INIV
                                             A MELAKA
        void phsensor()
        static unsigned long timepoint = millis();
        if (millis() - timepoint > 1000U) //time interval: 1s
        {
        timepoint = millis();
        //voltage = rawPinValue / esp32ADC * esp32Vin
```

```
voltage = analogRead(PH_PIN) / ESPADC * ESPVOLTAGE; // read the voltage
```

Serial.print("voltage:");

Serial.println(voltage, 4);

//temperature = readTemperature(); // read your temperature sensor to execute temperature compensation Serial.print("temperature:"); Serial.print(temperature, 1); Serial.println("^C");

phValue = ph.readPH(voltage, temperature); // convert voltage to pH with temperature compensation Serial.print("pH:"); Serial.println(phValue, 4); } ph.calibration(voltage, temperature); // calibration process by Serail CMD Blynk.virtualWrite(V6,phValue); } void temperatures() sensors.requestTemperatures(); float temperatureC = sensors.getTempCByIndex(0); Serial.print("Temperature is: "); Serial.println(temperatureC); Blynk.virtualWrite(V7,temperatureC); APLAYS/A BLYNK\_WRITE(V1) int foward = param.asInt(); if(foward == 1)ł //foward digitalWrite(DIR1,LOW); analogWrite(PWM1,i); digitalWrite(DIR2,LOW); analogWrite(PWM2,i); INIV AYSIA MELAKA } else { //stop analogWrite(PWM1,s); analogWrite(PWM2,s); } } BLYNK\_WRITE(V2) ł int lefts = param.asInt(); if(lefts == 1){ digitalWrite(DIR1,HIGH); analogWrite(PWM1,i); digitalWrite(DIR2,LOW); analogWrite(PWM2,i); 61

```
}
 else
 {
 //stop
 analogWrite(PWM1,s);
 analogWrite(PWM2,s);
 }
 }
 BLYNK_WRITE(V3)
 {
 int rights = param.asInt();
 if(rights == 1)
 {
 //foward
 digitalWrite(DIR1,LOW);
 analogWrite(PWM1,i);
 digitalWrite(DIR2,HIGH);
 analogWrite(PWM2,i);
 }
 else
 ł
 //stop
 analogWrite(PWM1,s);
 analogWrite(PWM2,s);
11}
```

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int reverse = param.asInt(); if(reverse == 1){ //foward digitalWrite(DIR1,HIGH); analogWrite(PWM1,i); digitalWrite(DIR2,HIGH); analogWrite(PWM2,i); } else { //stop analogWrite(PWM1,s); analogWrite(PWM2,s); } }