UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF REMOTELY OPERATED TRASH CLEANING ROBOT FOR RIVER CLEANING PROCESS

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Industrial Automation & Robotics) (Hons.)

by

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2017

DECLARATION

I hereby, declared this report entitled "Development of Remotely Operated Trash Cleaning Robot for River Cleaning Process" is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honors. The member of the supervisory is as follow:

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(MR. MOHD ZAIDI BIN MOHD TUMARI)

ABSTRAK

Robot pembersihan sampah sungai kawalan jauh direka untuk tujuan untuk mengumpul sampah di atas permukaan sungai. Ia digunakan untuk proses pembersihan sungai. Projek ini adalah gabungan reka bentuk elektronik, reka bentuk mekanikal dan reka bentuk perisian. Untuk bahagian elektrik, dua Arduino UNO digunakan dalam projek ini. Satu Arduino UNO berada di sebelah alat kawalan jauh dan satu lagi Arduino uno akan berada di sebelah robot. Robot ini mengawal dari jauh dengan pemancar RF. Funduino bertindak sebagai alat kawalan jauh. Motor servo untuk pengumpul untuk mengangkut dan mengumpul sampah dikawal oleh Arduino sebagai pengawal mikro untuk mengawal sudut. Isyarat pemancar akan menghantar kepada Arduino lain untuk memandu motor DC untuk bergerak. Bagi reka bentuk perisian, terdapat beberapa program yang sesuai akan dimasukkan ke kedua-dua Arduino supaya robot berfungsi. Perkakasan dan perisian akan digabungkan bersama-sama. Akhir sekali adalah reka bentuk mekanikal. Robot pembersihan sungai direka untuk membuat ia terapung di atas air. Ia boleh membawa kira-kira 2kg sampah.

ABSTRACT

The remotely operated trash cleaning robot is designed with a purpose of collecting trashes on the river surface. It is used for river cleaning process. This project is a combination of electronic, mechanical and software design. For the electrical part, two Arduino UNOs are used in this project. One Arduino UNO board is on the remote control side and another piece of Arduino board UNO is at the robot side. The robot is controlled remotely by the RF transmitter. A Funduino joysticks shield will act as a remote control. The servo motor is used as a collector to pick and collect the trashes and controlled by Arduino as microcontroller to control the angles. The signal of the transmitter will send to another Arduino to the motor driver to drive the DC motor for the moving purpose. For the software design, there are some suitable programs will be uploaded to both Arduino UNOs to make the robot function. The both hardware and software will be combined all together. Lastly is the mechanical design. This river cleaning robot is designed to make it floating on the water. It is expected to carry about 2kg of trashes.

DEDICATION

To my beloved parents, I acknowledge my sincere indebtedness and gratitude to them for their love, dream and sacrifice throughout my life. Their sacrifice had inspired me from the day I learned how to read and write until what I have become now. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to achieve my dreams

ACKNOWLEDGEMENT

First of all, I would like to express my special thanks to my supervisor, Mr Mohd Zaidi Bin Mohd Tumari who gave me the golden opportunity, encouragement, guidance and advice to do this excellent project on the topic of development of remotely operated trash cleaning robot for river cleaning process. Besides that, I am really appreciate my supervisor Mr Zaidi which help me in doing a lot of research and I came to know about many new things I am really thankful to him. This project report might be impossible to complete without all of your help. Last but not least, thank you to everyone that directly and indirectly involved in helping me finishing this Finale Year Project report. Thank you very much.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ASV	-	Autonomous Surface Vehicle
CAD	-	Computer- Aided Design
DOE	-	Department of Environment
GPS	-	Global Positioning System
IDE	-	Integrated Development Environment
IFR	-	International Federation of Robotic
LCD	-	Liquid Crystal Display
NWQS	-	National Water Quality Standard
PIC	-	Peripheral Interface Controller
PVC	-	Premature Ventricular Contraction
USB	-	Universal Serial Bus
WQI	-	Water Quality Index

CHAPTER 1

INTRODUCTION

1.0 Introduction

A river is a complex body of water. Rivers in this world is older than the flow of human blood, a “mini cosmos” history. Flowing rivers are the largest renewable water resource for humans and aquatic ecosystem. Rivers also used to providing some food, and supply the drinking waters in our daily life as well. Besides that, the rivers also act as a source of tourist attraction, for example the Malacca River. The rivers are grouped by strait or sea. There are 117 major rivers and 356 small and short rivers in Malaysia. Unfortunately, they are becoming more and more polluted. Out of the 473 rivers, there are 186 rivers, or 39%, were little polluted while 244 rivers or 52% were clean monitored by the Department of Environment. The rivers in the urban areas are the most polluted rivers. It consists of high pollution things from multiple sources, including wastewater plants, industries and commercial. Therefore, a remotely operated trash cleaning robot for river cleaning process can reduce the trash or wastewater plants in the river. The trash or waste product can be reduce or cleaning by controlling the cleaning robot to collect the trash. This autonomous surface vehicle is help to reduce the ecosystem imbalance, human health issues and environmental pollution.

1.1 Project Background

According with the amazing technological advances, the industrial revolution of the mid nineteenth century introduced new method of monitoring the water pollution. In the mid of the twentieth century, the impact of changes was starting to be felt in countries around the globe. In the 1960s, a natural development started to monitor the river of pollutants flowing into planet's ecosystem. As stated by department of environment (DOE), they use Water Quality Index (WQI) and National Water Quality Standards for Malaysia (NWQS) to test the water quality of the river. The WQI introduced by DOE is being practiced in Malaysia for about 25 years and serves as the basis for the assessment of environment water quality, while NWQS classifies the beneficial uses of the watercourse based on WQI. In 2012, nine rivers inside the Klang River Basin were included of the national river water quality monitoring program under River of Life Project. The river water quality was recorded based on a total of 5,083 samples taken from a total of 473 rivers. Out of 473 rivers monitored, 278 (59 percent) was clean, 161 (34percent) little polluted and 34 (7percent) polluted. Figure 1.0 shows the 473 rivers water caliber pattern from 2005 to 2012.

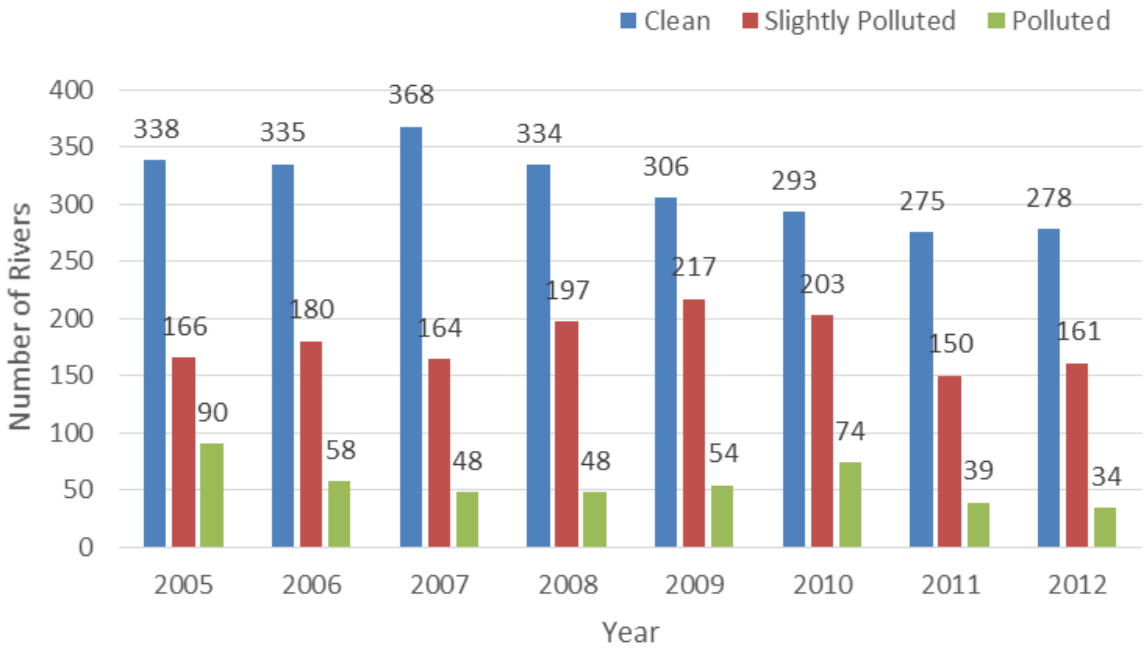

Figure 1.0: 473 Rivers Water Caliber Pattern from 2005 To 2012

The primary reason of water pollution in the river is the increase in the various human activities, population density and throw away of various harmful industrial wastes into the river. To solve this problem, the river cleaning robot is a need in our life. River cleaning robot is an autonomous river cleaning robot with suitable of floating mechanical design and control remotely for controlling river cleaning process and provides a sustainable development environment. Besides that, river cleaning robot is designed based on hydrodynamic design and vibration analysis also. It is a combination with a stable mechanical system with air propulsion and water propulsion.

1.2 Problem Statement

Nowadays, we can see that there are so many trashes floating on the trench, river and sea even though we are not allow to throws the trash into the trench or river. Besides that, our government is giving some punishment to offender but unfortunately there are still have people that throw the trash into the river. This is a serious problem when we throw the trash into the river. It can make the river become dirty and smelly. Besides that, it can also harm the organism that lives in the river. The flowing rivers in the world are the largest renewable water resource for humans and aquatic ecosystem. Rivers also often used to supplying food, and provides drinking water to human. So, we need to decrease the pollution and rubbish in the river. Therefore, the river cleaning robot is used to solve the problem in the river which is collecting the trash that floating on the river by using a remotely operated surface robot. Besides that, the river cleaning robot can makes the work of the cleaner to become easier when they collecting the trash on the river.

1.3 Objective

1. To develop a remotely operated trash cleaning robot for river cleaning process.
2. To design the mechanical structure, electronics circuit and control of the robot system.
3. To analyse the functionality and reliability of the river cleaning robot in aspect of collecting trash.

1.4 Work Scope

In this project, the aim of design is based on three designs, which are mechanical design, electronic design and software design.

1.4.1 Mechanical Design

- To design the body structure of a remotely operated trash cleaning robot for river cleaning process by using Solidworks software.
- The body structure is design floating on the water and the structure is almost like a hovercraft. All the electronic devices will be on the surface of the water including the motor to drive the robot.

1.4.2 Electronic Design

- Two Arduino UNO will be used. One is used as the controller of the circuit and the other one is connected to the motor driver. A joystick is used for control the motor. A transmitter that connected at the control part is used to send the signal and a receiver that connected at the robot part is used to receive the signal in order to control the motor. A servo motor is used to collect the trash.

1.4.3 Software Design

- The Arduino Integrated development environment (IDE) software is used to program, code editor, build automation and to debug.

1.5 Conclusion

This chapter mainly brief about introduction of the project. Nowadays, the river pollution is keep increasing and this will affect out daily live and the aquatic ecosystem. Therefore, a river cleaning robot is required to collect the trash on the river. The river cleaning robot can makes the work of the cleaner to become easier when they collecting the trash on the river. Besides that, it can decrease the trash on the river and decreased the pollution as well. This chapter also discussed about the objectives and work scope of this project.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter will discuss the application of river cleaning robot (autonomous surface vehicle) and other types of robot that helps us in daily life. Besides that, this chapter will also discuss about the control system design of a river surface cleaning robot.

2.1 A Brief Development of Robot

Robot is a machine that can perform a variety of tasks either on order or being programmed. Besides that, it is additionally a machine that works automatically or by remote control. Robot has created from being negligible arms in manufacturing plants doing same and repetitive work that you would regularly connect with people. They can conduct battle war; discard bombs, harvest farm product as well as clean river. As indicated by the International Federation of Robotic or IFR, there are about 134500 new service robot for professional use will be installed from 2014 to 2017. IFR says that over a 12-year time span till 2008, just around 63,500 administration robots for expert utilize were sold. In any case, the following five years saw deals shooting up to around 100,000. Unmistakably, request is rising around the world.

Cheng et al., (2014) had been designed a flexible surface vehicle. A surface vehicle must be outline and develop in light of mobility, strong strength and self-ruling ability. In this paper, the surface vehicle outlined and built with an adaptable design structure whose shape can be bowed by servo motor. The center segment is the control chamber to keep the equipment including detecting gadgets, the handling units and

driving circuits. The back area comprises of the primary actuators including DC motor and propeller for the autonomous surface vehicles. It used sensor for self-balancing mechanism. The sensor is used to measure the position and orientation of the vehicles in order to prevent the vehicles overturn. The vehicles also have a visual tracking (Ebox embedded system) to track the target. The inside view of the control chamber as shown in Figure 2.1. This project required three tests, the first test is primary parameters test which is to understand the basic circling radius and bending angle. The second test is visual tracking test. This test is for target tracking performance. The last test is obstacle avoiding test which is test the vehicles to avoid the barrier or obstacle and move towards to the target. Figure 2.0 shows the model of flexible surface vehicle.

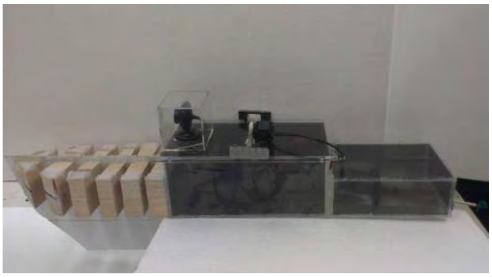

Figure 2.0: The Model of Flexible Surface Vehicle

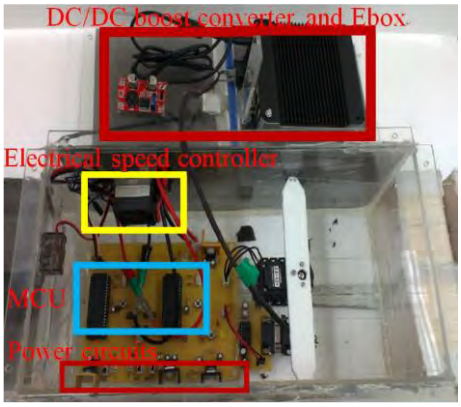

Figure 2.1: The Inside View of Control Chamber

Anderson et al., (2015) had been presented the improvement of a framework of three autonomous surface vehicles for observing water quality and checking in order to calculate the test bed. In this project, the autonomous surface vehicles body geometry design should provide enough capacity depression to batteries and different other electrical component. The hull of the boat should have been ready to sufficiently vigorous to stay on the water for a period time. The two hulls of the ship structure sorts

incorporate displacement and planning, which are portrayed by how the boat can moves through the water from facing the water force and water waves. Displacement hulls use only buoyancy for support and the weight of the boat to stabilize while in movement. The design of the hull bottoms incorporate round, square and V-formed. An autonomous surface vehicle known as the ROAZ, uses a twin body design, which shows sensational strength because of the decreased frame volume presented to the water and it increase the buoyancy of water.

The twin hulls at stationary or at the low speeds will act like a displacement boat and depend entirely on buoyancy force. So the planning of hull bottoms include flat and v-shaped. The flat bottom has a lower sketch which is the most suitable for rivers and lakes. The v-shaped bottom is better than a flat bottom boat would in turbulent water. A V-shaped boat could potentially roll or bank in sharp turns. However, the position of the thrusters on the second autonomous surface vehicle was mounted deeper to prevent cavitations during suddenly change in thrust.

The second design of the autonomous surface vehicle was a twin hull boat with round bottomed barges. The front of each body has a 30 degree vertical pitch to decrease the force of the water. The electric thruster with a rudder is place on the back of the boat. The electronic case houses the miniaturized micro-controller, humidity sensor, temperature sensor, leak sensor, GPS and other electrical components as well as a battery charger. The battery compartments are put roughly 10 cm before and behind the geometric centroid of the structure to make the boat more stable. This plan additionally adjusted the focal point of gravity with the center of buoyancy. After studied of this paper, the round bottom of the hull is the best design in order to maintain the buoyancy of the boat. Besides that, the front of the hull should be a 30 degree vertical pitch, so that, it can reduce the force of the water waves. Figure 2.2 shows the CAD image of the second ASV design.

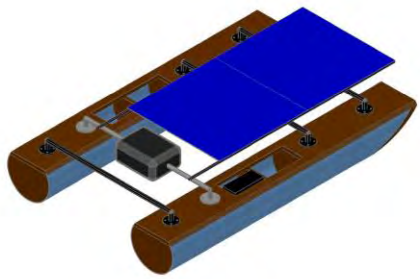

Figure 2.2: CAD Image of The Second ASV Design

Sinha et al., (2014) has been designed an autonomous surface cleaning robot for river cleaning and give a reasonable domain. Ro-boat is outlined in measured mold with plan, for example, mechanical structure plan, hydrodynamic plan and vibration analysis. Ro-boat is designed for the rivers cleaning process like the Ganges, which is the river that are in various pollutants likes floating trash and broke down in nature so as to effectively clean such poisons. The Ro-boat mechanical structural design as the rudder configuration is done to overcome the impact of high speed of the robot traverse on the water. The Ro-Boat's mechanical structure design is comprises of a hull boat structure with two types of propulsion. The boat comprises of a twin structure hull boat system with buoyancy chambers in order to remain the boat above on the water. Development in water is accomplished basically by two methods of drive which is air propulsion and underwater propulsion. Air propulsion is accomplished by the utilization of a BLDC motor (1200 KV) with an 8 inch distance across propeller. A DC servo motor is utilized to drive the particularly rudder.

Air propulsion is utilized to navigate stagnant water in a long distance. Also, the underwater drive is accomplished by two DC motors together with a propeller. The control part of the boat is to change the movement of the motors for the robot to move forward or move backwards. The other aspect of Ro-Boat's design is using a two Degree of Freedom robotic arm to pick up the trash by the help of a DC gear servo with operated mechanical gripper. The trash collector bin is used to store the trash when the boat is in working. The solar panel is used to recharge the batteries to extend the boat's operation in the water and a frame with a stabilized metacenter to achieve stable equilibrium under high currents. The boat has many aspects need to be covered, but the

main thing is to stabilize the boat on to the calculation of metacentric height and the calculation of vertical submerged Rudder. Figure 2.3 shows the CAD design of the Ro-boat.

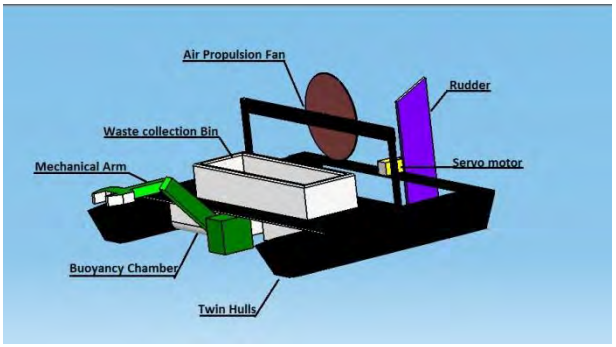

Figure 2.3: CAD Design of the Ro-Boat

Nurlansa et al., (2014) has been presented design a robot model as it can operate in automatic collecting trash on the river. The strategy for execution is design part and construction part. This technique incorporates the identification of needs, give out some solution of the components need to use in this robot. For example hardware design, software developing, and testing the function. The primary driver of the robot is motor, so it takes mechanical wheel and motor driver to drive the motor. The motor driver needs to give out enough of torque and momentum, so it ability to drive the motor for the wheel.

A successful robot is to have the ability to move a suitable movement controller. Besides that, the robot needs a sensor at the robot GPS. The input power supply circuit as voltage provider taken from a lithium polymer battery (Lipo) of 22.2 volt 2.2 AH as voltage provider of the entire system from the robot. The microcontroller is act as a brain of the system and it sending the measured data from sensor to the microcontroller master. Besides that, the microcontroller also used to drive the ultrasonic sensor and the DC motor also. The microcontroller master robot controller used is ATMega16. There is a Motor driver which is used to control 2 DC Motor which serves to move the lever when it receives the trash container full signal. The need of EXPRES PCB