UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF REMOTELY OPERATED UNDERWATER CRAWLER ROBOT FOR UNDERWATER INSPECTION

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

by

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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 Honours. The member of the supervisory is as follow:

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(Mr. MOHD ZAIDI BIN MOHD TUMARI)

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ABSTRAK

Projek ini menerangkan pembangunan kawalan jauh robot merangkak di bawah permukaan air (ROC) untuk pemeriksaan di bawah permukaan air. Antara pilihan kaedah pemeriksaan di bawah permukaan air, menggunakan robot di bawah permukaan air menjadi terkenal dan lebih cekap. ROC adalah sebuah robot tenggelam kosong yang dapat berjalan melalui di bawah permukaan air dan tanpa mempunyai manusia di dalamnya. ROC adalah jenis yang selamat dan digunakan secara meluas kenderaan bawah permukaan air yang menyajikan pelbagai ketenteraan, komersial, keperluan saintifik dan direka untuk persekitaran kerja akuatik. Dalam projek ini, reka bentuk yang terlibat adalah reka bentuk mekanikal, reka bentuk elektronik dan reka bentuk perisian ROC. Masalah dengan ROC ini adalah untuk bergerak di sepanjang air dengan hubungan secara langsung ke lantai bawah air. ROC perlu tenggelam ke bawah air dan mempunyai kestabilan yang hebat untuk merangkak sepanjang mana-mana keadaan permukaan di bawah air. Oleh itu, reka bentuk mekanikal ROC adalah berdasarkan kepada bentuk kereta kebal untuk memastikan ia boleh merangkak sepanjang mana-mana keadaan permukaan di bawah air. Selain itu, litar pengawal ROC adalah pada bahagian atas air supaya litar tidak akan dirosakkan oleh air. Akhirnya, ROC akan diuji dalam beberapa percubaan untuk memastikan ia boleh melakukan dengan baik di bawah permukaan air.

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ABSTRACT

This project describes development of remotely operated underwater crawler robot (ROC) for underwater inspection. Among varies inspection methods of underwater, using underwater robot becomes famous and more efficiency. ROC is a vacant submerged robot which is able to walk through in underwater and without having the human maneuver inside it. ROC is a safe and widely used type of underwater vehicle serving a range of military, commercial, scientific needs and designed for aquatic work environments. This project involves mechanical, electronic and software design of ROC. The problem with this ROC is to move along underwater with direct contact to the underwater floor. The ROC needs the negative buoyant and the great stability to crawl in along any surface condition underwater. Therefore, the mechanical design of ROC is based on the shape of tank to make sure it can crawl in along any surface condition underwater. Besides that, the controller circuit of the ROC is on the surface of water so that the circuit will not be spoilt by water. As a result, the ROC is tested in few experiments to make sure it can perform well on the surface floor of underwater.

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DEDICATION

To my beloved parents, I acknowledge my sincere indebatedness 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.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AC	–	Alternating Current
AUV	–	Autonomous Underwater Vehicle
DC	–	Direct Current
LED	–	Light Emitting Diodes
PS2	–	PlayStation 2
PVC	–	Polyvinyl chloride
PWM	–	Pulse Width Modulation
ROC	–	Remotely Operated Crawler
ROV	–	Remotely Operated Vehicle

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CHAPTER 1

INTRODUCTION

1.0 Introduction

In this chapter 1, it provides an introduction about this projects. Basically, it contains the background of the project, problem statement, objective, work scope and conclusion of development of remotely operated underwater crawler robot for underwater inspection.

1.1 Project Background

The oceans cover 71% of the Earth’s surface. They manage climate conditions, are utilized for transport, control temperature, give natural surroundings to huge division of life on Earth and give vitality that can be bridled by people. In spite of their significance just 5% of the world's seas have been investigated. This is because of the absence of reasonable innovation and technology for use in investigation.

Nowadays, the underwater territory of the ocean are still mystery for us and till today still not totally discovered. Since that the inspection of the deep of the water is very dangerous because there are so many unknown for us now. Therefore, different underwater vessels and innovation technology are produced as an instrument to review and discover the ocean such as Autonomous Underwater Vehicle (AUV), Underwater Remotely Operated Vehicle (ROV), sonar and submarine.

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Remotely operated vehicles (ROVs) which have been utilized as a part of the past are of a sort wherein an organization confine is suspended from a surface vessel, and the vehicle is tethered to the enclosure, the vehicle being of significantly nonpartisan buoyancy and in this way ready to change its own particular vertical position by somewhat adjusting its buoyancy.

Inspection class Remote Operated Vehicles (ROVs) are commonly used as a underwater video camera. The ROV usually consists many electronics hardware and they are connected to a main controller by a wire tie. To move the ROV, the motor in the truster of ROV will driven the propeller to produce a force and the force push the ROV moves forward.

Underwater Remotely Operated Crawler (ROC) is one of the unmanned underwater robots. The idea of the ROC is follow the wheel mechanism design with the controlling application. To decrease the hazard to human life when divers seeking ancient rarities, submerged vehicles have more advantage which is they can work at more noteworthy profundities, have less human obligation and have longer working hours than any commercial divers.

Generally, ROC running steadily when the ROC had a satisfactory weight in water and sufficient focus of gravity and also focal point of buoyancy. Thus, the wheel relies upon the weight and the segregation line is acquired with the weight and the buoyancy of ROC, the water living arrangement, the purpose of its application and the measurement of crawlers. So it's important to examine the impact of the weight on the portability normal for crawler framework keeping in mind the end goal to have satisfactory versatility on ocean bottom.

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1.2 Problem Statement

Nowadays, robot have been broadly used in environment since ability to do work that unsafe to human particularly in the ocean bottom. Therefore, human no compelling reason to convey possess air supply (oxygen) and shield their body from pressure and temperature under the water. Crawler robot can carry out the jobs in underwater environments that are inconceivable for human to explore the issues in the ocean bottom, which human can't specifically interface with harmed equipment and it have constrained capacities in doing jobs in underwater. Other than that, the real issue with this sort of use crawler is bridging uneven surface. While vehicle move uneven surface the crawler might be insecure so it influenced the framework advance. So the wheel of ROC is thought to be capable go on uneven surface.

1.3 Objectives

a) To develop remotely operated underwater crawler robot for underwater inspection by using Arduino controller.

b) To design mechanical structure, electronics circuit and control of the crawler robot.

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1.4 Work Scope

In this project, the aim is to develop a remotely operated underwater crawler robot for underwater inspection by using Arduino controller. This project will involve in mechanical design, electronics design and control design of underwater crawler robot.

a) Mechanical design

- To develop an underwater crawler robot by using waterproof motor and the shape of the robot should be like a tank with track belt wheel. The structure of ROC is designed and draw by using Solidworks software before the ROC is built up.

b) Electronics design

- For the controller path, Arduino UNO is used as the controller of the circuit and joystick used for control the motor direction. All the electronics system are on the surface of water.

c) Software design

- The software which is used in this project is Arduino IDE for programming.

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1.5 Conclusion

This chapter mainly brief about introduction of this project. Nowadays the underwater terrain of the sea are still mystery for us and till today still not completely discovered. The main reason is the inspection of underwater is very dangerous for a human being. Therefore, with the improvement of technology, ROC is developed to replace human for inspection underwater. This chapter also discussed about the objectives and work scope of this project where is to develop a remotely operated underwater crawler robot for underwater inspection by using Arduino controller. This project will focusing on the design of mechanical structure, electronics circuit and control of the crawler robot.

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CHAPTER 2

LITERATURE REVIEW

2.0 Remotely Operated Underwater Crawler

Remotely operated underwater crawler (ROC) is a vacant submerged robot which able to walk through in underwater and without having the human maneuver inside it. ROC is a safe and widely used type of underwater vehicle serving a range of military, commercial, scientific needs and designed for aquatic work environments. Remote control is usually carried out through copper or fiber optic cables. These cables can transmit command and control signals between the operator and the ROC to control navigation of the crawler. A human operator sits in a shore-based station, boat or submarine bubble while watching a display that shows what the robot "sees." Most ROC are equipped with at least one video camera and lights. Additional equipment may include one or more sonars, a stills camera, a manipulator or cutting arm and a wide range of sampling options. ROC can be used to replace divers in conditions that are too dangerous or too deep to operate in. Underwater tasks can become more efficient through the use of 24 hours operations with video feedback and other scientific data constantly relayed to the operator on the surface.

Aras et al. (2013) present the depth controlling the underwater Remotely Operated Vehicle (ROV) by using system identification proof method. ROV is a fastened unmanned submerged robot and mostly used in review and explore of underwater, elicitation of hydrocarbon, oiling gas and etc.

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The ROV is developed with an integrated sensor to measure its movement and position. Its contains underwater camera, ballast tank, vertical thruster, pressure hull, integrated sensor, horizontal thruster, control panel and floats. For the electronics design, PSC28A is used as controller of the system and a H-bridge circuit is used to generate the thruster of ROV. To control the movement direction, PS2 joystick is used.

System identification is a procedure of getting models based on an arrangement of information gathered from tests. The data will collected from the sensor and the parameter is calculated to give out the signal to the ROV. The purpose of system identification used is to control the how depth the ROV can stay underwater. The MATLAB System Identification Toolbox is used to show the result of ROV maneuever.

Zainal et al. (2016) present the design process and hydrodynamic analysis of underwater remotely operated crawler. The difference design of the shape of the underwater remotely operated crawler will affect its speed to move underwater and also the power utilization. The SolidWorks software is used to test the design by simulation based on hydrodynamic properties. The body of the underwater remotely operated crawler is designed follow the theory and shape of the tank and the tracking wheel is used to make sure it can climb rock and walk on the soft land like surface of underwater. Figure 2.1 and 2.2 show the design of the ROC.

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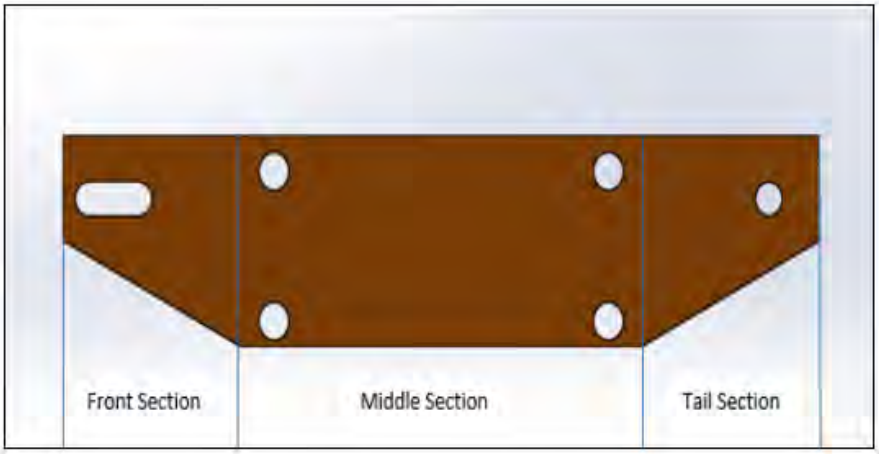

Figure 2.1 : Side View of the ROC

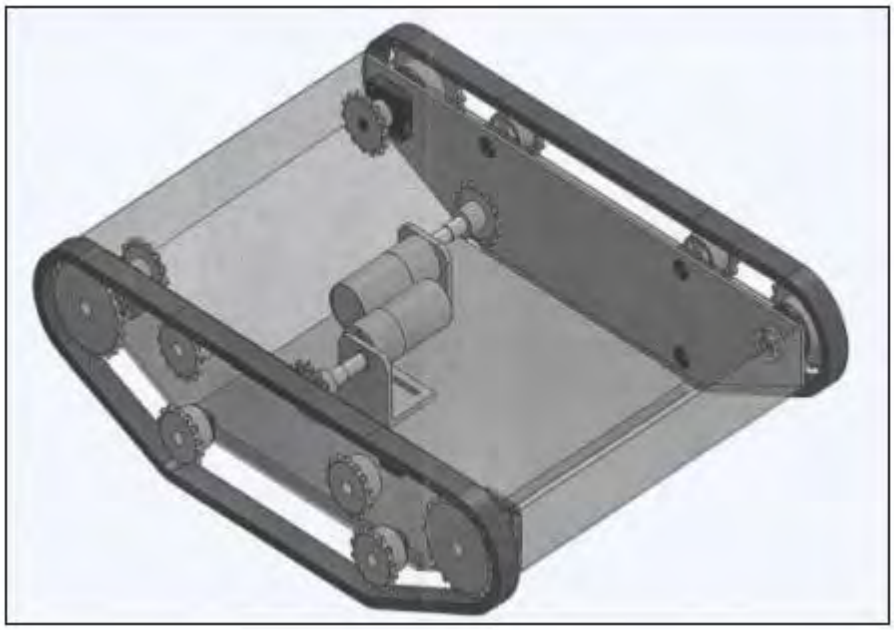

Figure 2.2 : Drawing of ROC Using Solidworks Software

With the SolidWorks Flow Simulation, few types of hydrodynamic properties such as dynamic viscosity, specific heat, thermal conductivity and flow test can be analysis in a real world condition to get the most accuracy data. From the flow test view, the problem of low speed of ROC and large power consumption underwater can be solve by design the ROC follow thier hydrodynamic properties. Figure 2.3 shows the 3D view of the flow test.

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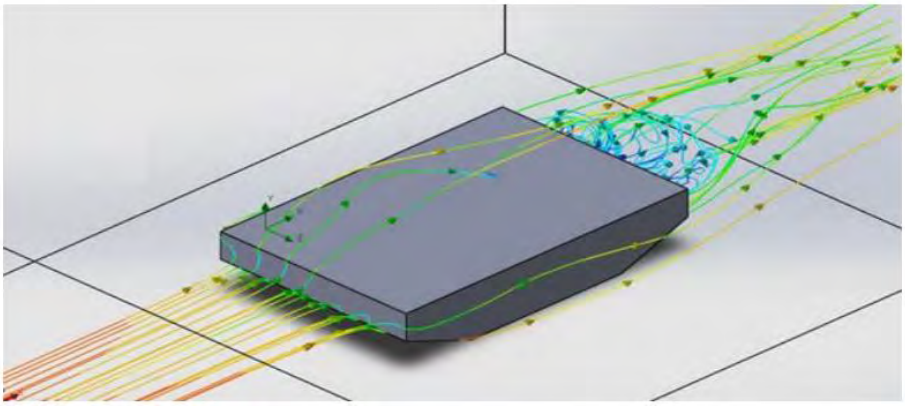

Figure 2.3 : 3D View of the Flow Test

Aras et al. (2016) state that an unmanned underwater remotely operated crawler (ROC) has been developed for monitoring application. ROC is designed which can move along any surface condition underwater. To fulfill the objective of the design of ROC, the concept of tank is taken to build on the ROC and the chain wheel is used to make ROC can move along any surface condition underwater. Figure 2.4 shows the prototype of ROC inside view.

Figure 2.4 : The Prototype of ROC Inside View

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