UNDERWATER REMOTE OPERATING VEHICLE

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For my lovely family

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ABSTRACT

The remote operating vehicle (ROV) is designed to be used for an underwater surveillance such as in ecological studies or environmental parameters survey. For that reason, the ROV will be equipped with suitable tools such as a video camera and robotic arm to accomplish its mission. Several limitations are made as a guideline in designing and developing the ROV. Most ROV must be big enough to accommodate adequate tools for surveillance. As their functions increase, the size will also increase. Consequently the cost for producing such vehicle will also expand. Based on the situations mentioned above, the goals for this project are to design and develop a small and effective ROV and to produce it with expenses as low as possible. In order to meet the objectives, research regarding to the design and developing the ROV is mostly depends on internet resources. These resources are from an internet forum which discuss mainly on homebuilt ROV, journals and research paper that are related to the project. The secondary resources are from books available locally. The outcome is expected to meet all objectives mentioned above and the limitation should be obeyed. Constructed ROV should be reliable with the help of real-time monitoring system to aid controller. It also should be safe to use and operated by human as well as do not harm the environment at any cost.

ABSTRAK

Remote operating vehicle (ROV) atau kenderaan kawalan jauh yang dibina adalah bagi memenuhi keperluan dalam membuat kajian ekologi dan tinjauan ciri-ciri persekitaran di dalam air. Bagi mendapatkan hasil kajian yang terbaik, ROV tersebut akan dilengkapi dengan peralatan yang sesuai seperti kamera video ataupun lengan robotik. Beberapa had batasan telah digariskan sebagai panduan dalam proses mereka dan membina ROV tersebut. Pertambahan bilangan peralatan yang akan digunakan secara lazimnya akan menyebabkan saiz ROV turut bertambah dan secara tidak langsung akan meningkatkan kos pengeluaran ROV tersebut. Oleh yang demikian, projek ini adalah dicadangkan untuk membina ROV yang efisyen dalam bidang tugasnya dan dihasilkan menggunakan modal serendah yang mungkin. Bagi memenuhi objektif-objektif projek, kajian berkenaan rekabentuk dan pembikinan ROV tersebut adalah bergantung kepada sumber daripada forum internet, jurnal dan kertas kajian berkenaan projek ini. Sumber kedua merupakan buku-buku yang berkaitan yang boleh diperolehi secara percuma di perpustakaan. Pada akhir semester ke-2, adalah diharapkan supaya projek ini akan memberikan hasil yang memenuhi objektif ini secara menyeluruh. Penggunaan ROV yang dibina diharapkan adalah efisyen dengan bantuan sistem pengawasan secara *real-time*. Hasil projek ini juga diharapkan dapat berfungsi tanpa memberikan ancaman keselamatan kepada pengguna dan juga kepada alam persekitarannnya.

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LIST OF ABBREVIATION

BS-II	– Basic Stamp II
CAD	– Computer Aided Design
CCTV	– Closed Circuit TeleVision
CCW	– Counter Clockwise
CW	– Clockwise
DOF	– Degree of Freedom
GUI	– Graphical User Interface
hp	– Horse Power
IC	– Integrated Circuit
IR	– Infra Red
PC	- Personal Computer
PS2	– PlayStation® 2
PSM	– Projek Sarjana Muda
PVC	– PolyVinylChlorida
RF	– Radio Frequency
TTL	– Transistor-Transistor Logic
UV	– UltraViolet

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CHAPTER I

INTRODUCTION

1.1 Introduction

Remote operating vehicle (ROV) technology appears since early 1900's until become widely used in 1970's [1]. Back then, the underwater ROV is mainly used in oil industry while manned submersible vehicle is the preferred tools for underwater scientific studies. As the technology developed, its functions have expanded to be used in both industries and scientific studies [1][2]. ROV is defined as the underwater robot that allows the vehicle's operator to remain in contented environment while the piloted robot performs the work underwater.

In order to perform various task [1][3], suitable tools are equipped to the underwater ROV. Generally, a camera, depth sensor [1][3] , pressure sensor and temperature sensor are the main features of a ROV. For special task, tools such as mechanical arm [2], radiation sensor [3] and sonar is used. As human supervision is critically needed, the camera and sensors are interfaced using suitable graphic interface and consoles [1][2][3][4] for monitoring purposes. In addition, various types of method are developed to meet the needs of reliable ROV maneuvering and ground control scheme.

The underwater vehicle came in various size, shape and purposes. While its size is depended on its purposes, their shapes are made based on performance factor. There are six classes of ROV existed which define their size and its mission.

1.1.1 Micro Class

Very small in size and weight as it only carry lightweight tools for surveillance. Most Micro ROV nowadays can weight less than 3kg and used in a place which are dangerous and too small for a diver such as pipeline, sewer or small cavity [17] [21].

1.1.2 Mini Class

A Mini class ROV is bigger than Micro ROV with weight less than 50kg. Mini ROV is also used as a diver replacement and could perform intervention tasks. As its size is bigger than Micro ROV, it could be equipped with more tools and equipment. This ROV also could be used where medium water current exists [16] [17].

1.1.3 General Class

Work at a depth of less than 1000m with additional manipulator grippers onboard and may carry sonar unit for light survey applications. More tools and complex equipment are installed for data collection purposes. The General Class ROV usually came up with less than 5hp propulsion power [17].

1.1.4 Light Work Class

The Light Work Class ROV works at a depth less than 2000m and uses less than 50hp propulsion power. It can carry more than one manipulator for its light work missions. For its frame, polymers such as polyethylene is used rather than the conventional stainless steel or aluminium alloys. Its weight is ranging between 1000kg to 2200kg. Typical tasks for this class are drilling support, light construction support, pipeline inspection and general "call out" work [17][19].

1.1.5 Heavy Work Class

Its huge size enables the ROV to carry at least two manipulators for its heavy work mission. This heavyweight ROV require not more than 220hp thruster power for movement. For its size and ability, the Heavy Work Class ROV usually works at a depth up to 3500m. With new requirements to perform subsea tie-in operations on deepwater installations and to carry very large diverless intervention systems, this class of ROV is becoming increasingly large, powerful and capable of carrying and lifting large loads thus the term "heavy work class vehicle" has been adopted by the industry. These vehicles can weight more than ten thousand pounds and resemble a minivan in size [17].

1.1.6 Trenching Burial Class

The trenching ROV is used for trenching burial works only. The ROV used more than 200hp propulsion power with an ability to carry a cable lying sled and work at depths up to 6000m. Commonly, the trenchers are not a free flying ROV, instead, it crawls on the seabed cutting trench for cable. Cameras, lights, sonars and other sensors necessary to operate at great depths are readily available. Manipulators capable of lifting hundreds of pounds are commonly installed on these vehicles [6].

1.2 Objective

The goals for this project are determined from the problem statements that are made based on my observation and studies regarding the ROV issues.

First objective of this project is to design and develop a small and yet effective ROV. The ROV will be in a Mini Class ROV which is designed for observation purposes. For data collection process, the ROV will be equipped with basic tools such as camera and compass. The operation of the ROV will be equipped with real-time video monitoring from the camera attached to the ROV to improve the reliability of the ROV.

The second objective determined for this project is to produce a low cost ROV which can be obtained by almost everyone. Even though with as small spending as possible, the first objective of the project will not be sacrificed. The project should prove that a reliable ROV at its own class can be produced at low price.

Thus, in the end, the project is expected to meet all objectives mentioned above and the limitation should be obeyed. Constructed ROV should be very reliable with the help of real-time monitoring to aid controller. It also should be safe to be used and operated by human as well as it do not harm the environment at any cost. In addition, it is also expected that this project will help to improve my problem solving skills, knowledge on field other than electronic, other engineering disciplines and scientific concepts.

1.3 Problem Statement

The following situations stated are the major issues that usually arise among ROV users based on studies made. There are two main issues which led to the conception of this project.

Most ROV must be big enough to accommodate tools for surveillance. For basic observations and data collections, for instance, an observation of environmental parameters, sets of sensor such as pH sensor, temperature sensor, and salinity sensor are equipped to the ROV. As data collecting tools increased, so do the frame area or platform size to accommodate the tools must be sufficiently enough thus increasing the size of the ROV itself. In returns, much higher propulsion power needed to mobilize the ROV and thus increasing the total power needed by the vehicle [7].

As the functions increase, the size will also increase. Consequently, every aspect of producing the ROV also increases. This includes the factor of reliability of the ROV itself as most tools and equipments that come with high quality and great performance will be very costly to acquire. It also involves the cost of obtaining small yet has very outstanding performance equipment. Thus, to produce a very reliable ROV will be too expensive even though producing a micro ROV class [20]. This scenario can be observed from the production of ROV for educational purposes which are hardly affordable prices.

1.4 Scope

Limitations below are created based on several purposes. Firstly, it is used to determine on how reliable the ROV was when operated [5]. Secondly, the limitation is used as a barrier to avoid materials wasting and unnecessary parts of the ROV which consequently will reduce the cost of production.

First limitation determined is the operating depth. The Mini Class ROV should be operating in shallow water which the depth is below than 30m. This is due to the pressure issues that will always appear along the ROV construction process. As we going deeper underwater, the pressure applied on us will increase. If the ROV hull cannot withstand the pressure, it will eventually break and water will flood the hull and consequently destroy all electronic equipments.

Secondly, the ROV is set to be maneuvered inside calm water or with low current. For an area with such current, the ROV should be able to maneuver free and easily without a huge drag forces introduced. Even if operating inside calm water, attention upon current that might exist should be considered during the development of ROV.

Thirdly, the ROV must have its own clear and defined jobs. Due to lack of time given to complete the project, the ROV is limited to perform basic data collection and light observation task. The jobs defined will acquire the ROV to be equipped with general observation tools or payloads such as video camera, digital compass and pressure sensor. Additional tools will be equipped if there are ample times to do so.

Lastly, the ROV developed is small enough to operate inside a test tank. This is due to the PSM II Seminar that will be held inside Faculty's laboratory which did not permit a large test area for the ROV.

1.5 Methodology

In this project, methodology can be divided into two parts. The first part introduced the methodology used for data collecting while the second part describes the methodology used for data processing.

For data collection, there are three main methods used. The first method is by collecting data from internet groups that are dedicated on building their own ROV and anything related to the project such as sensors and microcontroller. Secondary method used in order to gather data is from journal, articles and reports of subject associated with the project obtained from various online database portals such as IEEE website. This source provides data based on professional analysis and test that is valid for citation in this report and most importantly can be used for developing the ROV along with data obtained from the first method. Last method used in order to complete this project is by referencing to the books that must be related to the project.

Data processing methods also comprise of three techniques. The first technique is through discussion among experienced person with matters related. Then, comparison technique is used mainly to choose the best from available choices of material, tools or modus operandi. The third method is through design, simulation and constructs the data obtained in order to achieve desired results.

The following part of the report is organized as follows. Chapter II will describe the literature review done for this project. Chapter III is an extended discussion of methodology used in this project. Chapter IV contains results and discussions, which mainly describe the project progress and lastly Chapter V, the conclusion of the progress report of Underwater ROV project including suggestion for further improvement of this project.

CHAPTER II

BACKGROUND OF STUDIES

Despite their size and functions, all ROV shares generic building blocks which consist of major common components. The difference is only how the manufacturers manipulate these components in designing their own ROV. Usually, work class ROV are constructed using a same design while smaller ROV are freely designed to fit its mission.

2.1 Basic Components

Despite their classes and mission objectives, all ROV are build with consideration of the following matters. These followings matters can be describe as the basic component of a ROV.

2.1.1 Frame and Housing

This is the most important part of the ROV, the frame provides a solid platform for attaching necessary mechanical, electrical, data acquisition and propulsion components. The concept of choosing the best material for the frame is to give maximum strength to the structure with minimum weight. It is very important for the weight to be offset with buoyancy of the ROV which will keep it balanced