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MULTY-SENSORY CONTROL SYSTEM FOR
REMOTELY CONTROL SURFACE VESSEL

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Bachelor of Mechatronics Engineering

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"I hereby declare that I have read through this report multy-sensory control system for remotely control surface vessel and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Mechatronic)"

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MULTI-SENSORY CONTROL SYSTEM FOR REMOTELY CONTROL SURFACE VESSEL

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A report submitted in partial fulfillment of the requirements for the degree of Mechatronic Engineering

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2014

“I declare that this report entitle this report multy-sensory control system for remotely control surface vessel is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.”

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ABSTRACT

Surface vessel with wireless control provides an alternative ways to deploy ROV. The additional on multi-sensory control system makes the surface vessel more reliable for transporting ROV into the specific point before release it down into the water. This system enables the surface vessel to avoid the obstacle in front of it while waiting the operator to turn out direction of the surface vessel in case the operator can't see the obstacle in front of the surface vessel because of the distance between them are far. The first objective is for this project is to develop surface vessel enable to deploy the ROV. The second objective is to develop wireless control with suitable sensor use for navigation system. For this objective, it will be carry out by undergo the experiment which is comparison between the two types of sensor which are ultrasonic sensor and IR sensor. The third objective is about the performance of the surface vessel. There are two experiments carried out for the third objective of this project which are the different weight of the ROV or load can affect the time taken to it drops down into the water and the size of propeller is affect the speed of surface vessel.

ABSTRAK

Kapal permukaan dengan kawalan tanpa wayar memberikan suatu jalan lain untuk menggerakkan ROV. Sebagai tambahan pada kawalan sistem pelbagai pengesan ia membuatkan kapal permukaan menjadi lebih dipercayai untuk membawa ROV ke suatu titik tertentu sebelum melepaskan ia ke dalam air. Sistem ini membolehkan kapal permukaan untuk menggelak halangan yang berada dihadapannya sementara menunggu operator untuk menukar arah kapal permukaan apabila berlaku kes operator tidak perasan terdapat halangan yang berada di kapal permukaan kerana jaraknya antara mereka sudah jauh. Objektif pertama projek ini ialah untuk membina sebuah kapal permukaan yang boleh membawa ROV. objektif kedua ialah membina kawalan tanpa wayar dengan pengesan yang bersesuaian untuk digunakan pada navigasi system. Bagi objektif ini satu eksperimen dijalankan bagi membandingkan pengesan diantara pengesan Ultrasonik dan pengesan IR. Objektif ketiga mengenai prestasi kapal permukaan. Terdapat dua eksperimen dijalankan pada objektif ketiga ini iaitu perbezaan berat atau beban memberi kesan kepada masa diambil untuk ROV turun sepenuhnya kedalam air dan size kipas mempengaruhi kelajuan kapal permukaan.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

The ROV moves underwater for monitoring the underwater view. Before it goes down to the underwater, it needs a vessel to carry it to specific point before release it. Surface vessel is created for deploying the ROV. Surface vessel will moves on the water to specific point then discharge the ROV into the water. The communication used for the surface vessel is wireless communication.

The method for the surface vessel to drop the ROV is linear drop by cylinder rod. This surface did not use tugs method like a crane to drops the ROV on the water. The navigation of surface vessel not limited onto the operator control the surface vessel but the sensors that implement on the surface vessel will help the surface vessel to avoid the obstacle. Therefore, the design of surface vessel with wireless communication is meant to make works simple.

1.2 Motivation

The underwater vehicle that is used to monitoring the undersea view requires a complicated operation before it goes down to the sea. The ROV needs some medium or transportation to transport it into the water. It will be simply the work if the ROV can be carried into the destination whereby it can be discharged by operate it with wireless control. Thus, the multi sensory surface vessel with wireless control are require to help in deploying the ROV into the sea.

1.3 Problem statement

The problems of the surface vessel nowadays is requires expensive big ship to deploy the ROV. The uses of big ship need more manpower for the beginning operation which is to moves the big ship into the water from shore. Therefore, the desire to launch the surface vessel together with ROV from shore must be considered to reduce the manpower for the beginning operation.

Surface vessel with cable wire control has limit control area. The surface vessel that use the cable wire must depends on how long the cable wire is. The long wire is easily knotted. Mostly surface vessel used is not always wireless control. It's an option that we want to take to develop the wireless surface vessel. Surface vessel needs another device for navigation if the remote control operated by human did not notice there is an obstacle in front of surface vessel.

1.4 Objectives

The objectives of this project are:

1. To develop surface vessel enable to deploy the ROV.
2. To develop the wireless remote control with suitable sensor use for navigation steering system.
3. To evaluate the performance of surface vessel on the water in terms of the time taken for the ROV slot base to move down completely by using different weight and the speed of surface vessel with different size of propeller.

1.5 Scopes and limitation

The scope of this project consists of:

1. The design of surface vessel is meant for on the water only. It moves on the water with ROV attach on it.
2. Surface vessel must carry the ROV without drops it at the wrong point.
3. The suitable sensor to use at the surface vessel for detecting obstacle in certain range.
4. The performance of surface vessel in terms of weight of ROV and the speed of motor by using difference size of propeller.

The limitation for this project is the size of surface vessel is not necessary bigger as it must follow the ROV size to attach on it. The ROV used in this project is not in the actual size. This project model the size of ROV.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Surface Vessel (SV) is designed for deploying the ROV. The communication used on the SV is wireless communication with several implanted sensors that helps it on the navigation system. This section reviews the important elements of surface vessel. The first element is the study of discharging ROV from SV, which explains the deployment configuration mounts the ROV above the SV. The second element is the detection of obstacle by sensor. The sensors use to detect object in front of it and have its detection range. Different type of sensor has different detection range. The last element is the component selection of actuator used for discharging ROV. In this element, the comparison between three types of actuator will be explained later.

2.2 THE DISCHARGING ROV METHOD BY SURFACE VESSEL

Accurate predictions of the hydrodynamic loads are important at the design stage as well as in operation, particularly during the launch and recovery phases when snatching of the

tether may occur [1]. This paper introduce about the linear dropping load by moving the shaft downward. The shaft holds the load cover slot and moves downward to the sea water. Figure below is the experiment setup by this paper. It illustrates on how the dropping load works.

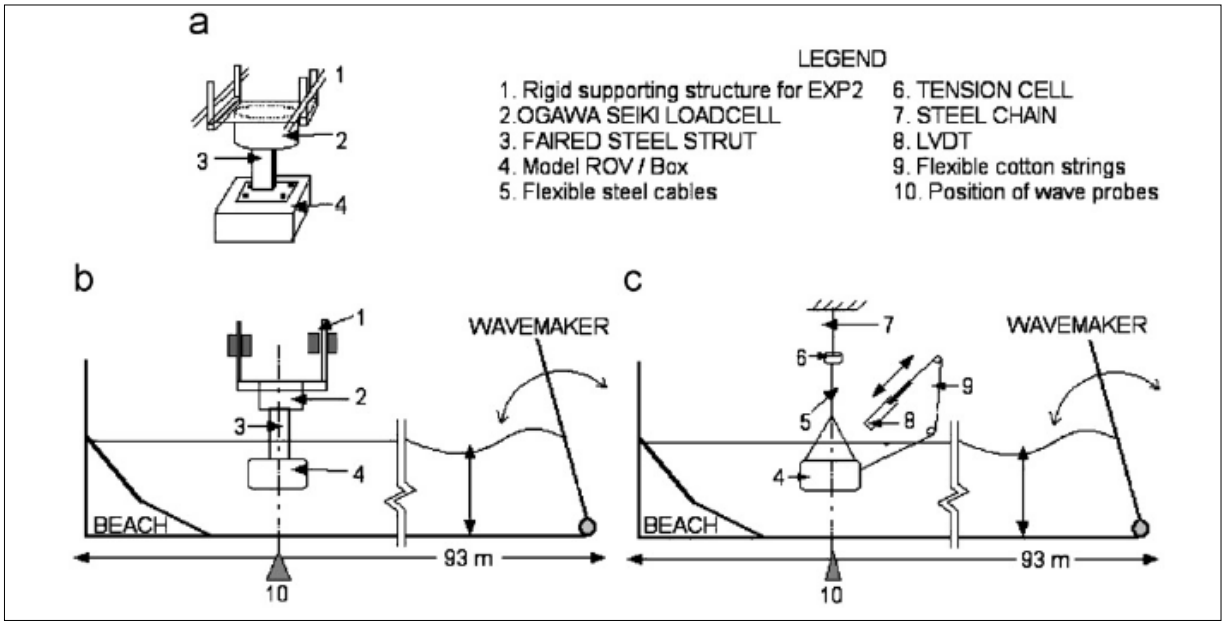

Figure 2.1 Experiment setup and the legend for discharging load [1].

The other method to discharging the ROV is with using crane. Two main types of vessel regularly: used are the anchor handling or support tug, and the offshore (preferably stern) trawler [2]. In this method, the uses of hydraulics are the main part because it carries the heavy load such as ROV. Figure 2.2 shows about the crane discharging ROV.

Figure 2.2 The Stem Mounted Crane

2.3 OBSTACLE DETECTION BY SENSOR

When SV moves on the water, any obstacle lying in the path of the vehicle can give potential to damage threat. The obstacles can be avoided by the navigation plan that use the valuable information obtained to the SV. This information was provided from the inclusion data of a forward looking. Based on the paper (Martin, An, Nelson, & Smith, n.d.), sonar sensor transmits a single beam. The beam itself is deflected using phased array technique to sweep along a vertical plane [3]. The sonar sensor has following specification [4]:

Operating frequency : 650 kHz – 950 kHz
Bandwidth, Vertical : 40° at 650 kHz, 35° at 800 kHz, 30° at 950 kHz

Bandwidth, Horizontal : 3.0° at 650 kHz, 2.5° at 800 kHz, 2.0 at 950 kHz
Range setting : From 5m to 100m

Figure below explains the range of sonar sensor and its bandwidth by AUV.

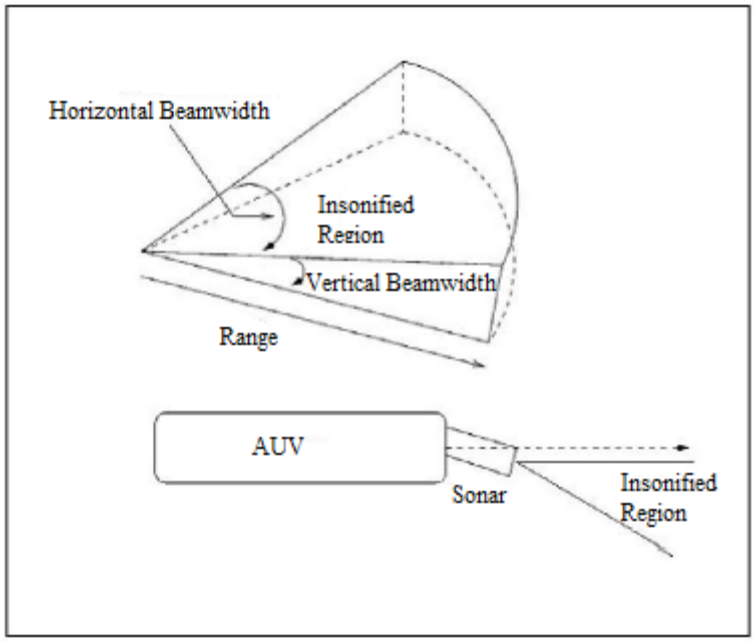

Figure 2.3 AUV with Sonar sensor and its bandwidths [6]

Another sensor that can detect the obstacle is Infrared sensor (IR). The Infrared sensor consists of one infrared LED and a pair of silicon phototransistors [5]. The phototransistor is used to detect the energy reflected by an obstacle from LED [5]. The signal returned from the sensor is dependent on the energy emitted from LED and the detectable range of the photo-transistors. The distance for the infrared sensor to detect the obstacle is less than 45 cm [5]. The infrared sensor can't detect object above than 45 cm is because were indistinguishable due to the lack of energy detected by the phototransistors. Paper (Wu, Chen, Jiang, Yu, & Yu, 2010) states that the Infrared sensor can be classified into two categories which are:

1. Un-cooled thermal infrared sensor
2. Photon infrared sensor

The un-cooled thermal infrared sensor can be function at room temperature without any expensive cryogenic cooler, which makes it suitable for many cost sensitive applications compared to the photon infrared sensor [6].

The Ultrasonic sensor (US) widely used to measure the distance because of its wide beam – width, sensitivity to specula surfaces. The Ultrasonic sensor can generate frequency sound waves of 310 kHz by range from 50 mm to 400 mm [5]. This sensor can calculate the time interval between sending and receiving the echo to determine the distance to an object [5]. Ultrasonic sensor produce mostly accurate representation of the object distance with various distance but it's difficult to face the object with round shaped. They are useful under conditions of poor lightning and transparent objects. Figure below describe the area of detection object between 2 types of sensor.

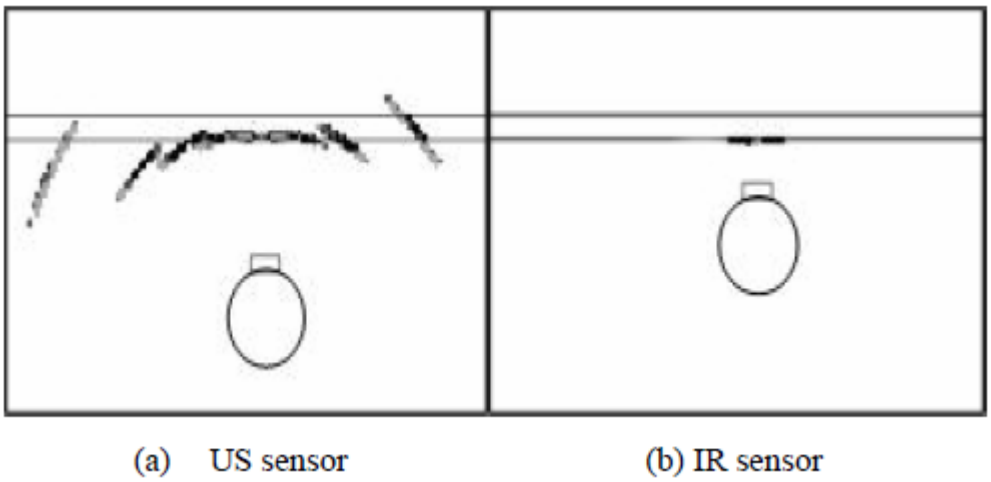

Figure 2.4 Distance data from the flat surface [5]

Ultrasonic sensor is high resolution compare to the infrared sensor [4]. This paper states that accuracy percentage for ultrasonic sensor is higher than infrared sensor which are about 90% to 97% compare to the infrared sensor which is 92% to 95% accuracy percent. This paper also state that the standard error for ultrasonic sensor is lower range than the standard error for infrared sensor.

2.4 ACTUATORS FOR DISCHARGING ROV

2.4.1 TYPES OF ACTUATORS

Pneumatic cylinder has several advantages which are easy maintenance, convenient assemblage, clean operating condition, higher reliability and lower cost [7]. In addition, pneumatic cylinders are light weight and can be readily installed using common compressed air supplies [8]. The pneumatic cylinder also has the limitations which are:

1. Relatively low accuracy

   – As pneumatic systems are powered by the force provided by compressed air, their operation is subject to the volume of the compressed air. As the volume of air may change when compressed or heated, the supply of air to the system may not be accurate, causing a decrease in the overall accuracy of the system.

2. Low loading

   – The cylinders of pneumatic components are not very large. Therefore, a pneumatic system cannot drive loads that are too heavy.

3. Processing required before use

   – Compressed air must be processed before use to ensure the absence of water vapor or dust. Otherwise, the moving parts of the pneumatic components may wear out quickly due to friction.

4. Inconsistent moving speed

   – The air can easily be compressed which resulted the moving speeds of the pistons are relatively inconsistent.

5. Noise

   – Noise will be produced when compressed air is released from the pneumatic components.

The hydraulic cylinders use an incompressible fluid so the force applied at one point is transferred to another point. Based on paper (Huang & Cao, 2011), hydraulic cylinders have following superiority [9]:

- Realizing step less speed regulating in large field.
- Each component of fluid drive can be arranged conveniently and neatly in requirement.
- Easy operating, convenient controlling and easy to realize automation and remote control.
- Working substance generally uses mineral oil, and can self-lubricating compared with motion surface.

Meanwhile the disadvantages of hydraulic cylinder are stated from paper (Zhao, Chen, & Chen, 2009) are [10]:

1. Unstable hydraulic oil behavior

   – The compressibility of the hydraulic fluid and the working temperature change lead to oil density variation, which is an important inaccuracy sources.

2. Hydraulic system leakage

   – In the high pressure, all hydraulic system exist certain leakage. This can cause the position keeping capacity of cylinder to lose, and other serious consequences.