DESIGN AND DEVELOPMENT OF GRAPHICAL USER INTERFACE (GUI) FOR UNDERWATER VEHICLE

GOH JOEN SAM

Bachelor of Mechatronics Engineering (BEKM)
June 2012

“I hereby declared that I have read through this report entitle “**DESIGN AND DEVELOPMENT OF GRAPHICAL USER INTERFACE (GUI) FOR UNDERWATER VEHICLE**” and found that it has comply the partial fulfillment for awarding the Bachelor of Mechatronic Engineering.”

Signature	: ....
Supervisor	: Pn. Fadilah binti Abdul Azis
Date	: ....

DESIGN AND DEVELOPMENT OF GRAPHICAL USER INTERFACE (GUI) FOR UNDERWATER VEHICLE

GOH JOEN SAM

This Report is Submitted in Partial Fulfillment of Requirements for Bachelor of Mechatronic Engineering.

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

29 JUNE 2012

I declare that this report entitle “Design and development of graphical user interface (GUI) for under water vehicle” 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 tin candidature of any other degree.

Signature : ....

Name : GOH JOEN SAM

Date : ....

ACKNOWLEGEMENT

SPECIAL THANK

To Almighty GOD

To My Parent

To Pn. Fadilah binti Abdul Azis

To Mohd Shahrieel bin Mohd Aras

To Tan Chee Chien

To Mdnash Kumar

To Kong Teck Long

To my classmates

To all of my friends

&

To those who have given a valuable and helpful guidance in completing this report.

ABSTRACT

In the age of technologies, human used robots or machines to make works easier, convenient and effective. However, there is still lack of useful underwater machine for investigation or inspection of water, especially in Malaysia. Therefore, in order to have a good vision and convenient job underwater, an adjustable vision of camera with Graphical user interface (GUI) of remotely operated underwater vehicle (ROV) is created. The ROV is also been integrated with the graphical user interface (GUI) by using visual basic for the overall programming. Besides that, to make the vehicle improve it vision ability, a mechanism is design and place behind the ROV's camera to make it adjustable by itself. With the aids of these tools, it can effectively help the jobs of controlling the ROV and have a good analysis by the machine. Thus, a ROV with the abilities to capture and record the underwater condition by using computer is the main expectation in this project. Nevertheless, the ROV will be upgraded to many features that suit the requirement of commercial needs in the future.

ABSTRAK

Pada era teknologi kini, manusia sering menggunakan robot atau mesin untuk membantu mereka dalam melaksanakan kerja dengan lebih mudah, cepat dan berkesan. Walaubagaimanpun, masih terdapat kekurangan mesin atau robot yang dapat bergerak aktif untuk penyiasatan atau pemeriksaan dalam medium air, terutamanya di Malaysia. Oleh itu, untuk mempunyai sebuah mesin yang dapat melihat dengan jelas dalam air, kamera boleh laras dengan penggunaan "Graphical User Interface (GUI)" bagi sebuah mesin dalam air (ROV) telah diwujudkan. GUI yang digunakan untuk mesin ini adalah dengan mengunakan visual basic sebagai pengaturcaraan keseluruhannya. Selain itu, untuk meningkatkan keupayaan penglihatan kenderaan ini , satu mekanisma akan direka dan dipasangkan di belakang kamera untuk memberikan keupayaan bergerak sendiri tanpa bergantung kepada badan ROV tersebut. Dengan adanya bantuan alat ini, ia sudah tentu dapat membantu kerja pengawalan ROV dan dapat membuat analisi yang baik daripada kenderaan ini. Oleh itu, ROV yang berkebolehan untuk bergambar dan merakam keadaan di dalam air dengan menggunakan computer adalah misi utama projek ini. Walaubagaimanapun, ROV akan dinaiktaraf kepada banyak ciri-ciri yang sesuai dengan keperluan komersial pada semasa ke semasa.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

CHAPTER 1

INTRODUCTION

1.1 Background

Water is the major composition on earth as it covered 70% of earth surface. However, it seems difficult for human to explore the underwater nature. The major obstacle faced by the underwater vision system is the extreme loss of colour and contrast when submerged to any significant depth whereby the image quality produced is low. The ocean is currently the largest body of mass which covered seventy percent of Earth, but still remains the least explored. Modern area of research and development had discovered some equipment that can be used for the underwater application such as remotely operated underwater vehicle (ROV) and the latest invention is designing the Autonomous Underwater Vehicles (AUV). It has the potential in furthering the exploration of the deep sea.

Implementation vision system together with AUV would be the most efficient system created for capturing and recording underwater images. This invention had replace the conventional waterproof camera that been used before. Lots of benefits earn from this new system such as this system is ease to conduct and convenient to be use.

The application of this vision system can be widen so that the usage of the system is not only limited for exploring the underwater environment, but also can be used in education, research and rescue. However, in order to build this system, it might use higher cost as it design and the system's ability are quite complex.

1.2 Problem Statement

Human cannot work effectively in underwater yet viewing the condition inside. These problems happened when scientist needs to do inspection or research in some unknown river, police needs to do investigation under the water, marine needs to rescue people or searching item under the sea and many more.

It is happened to be lot of difficulties and inconvenient for human to do their jobs underwater when they facing the condition such as in the deep sea, toxic water, dangerous area and etc. Furthermore, the time period for human to work underwater is also limited. Moreover, there is also lack of professional diver and even if it have, the cost for the diver is expensive. Nonetheless, it was always a troublesome matter due to a lot of issues for human in any works. Hence, it will be a huge trouble in doing any jobs underwater.

Although, there are already a lot of machine such as AUV or ROV in the market which helps for underwater jobs, however the machine is all from overseas country and none of them is made in our own country, Malaysia. For sure, the price of these machines is very expensive, even for only a small size of ROV or AUV. Other than that, the function and the ability of the machine are also limited.

Last but not least, the ability of vision control and a user friendly Graphical user interface (GUI) is also a major problem for these machines. For the primitive of the underwater machine, its vision is all control by the body of the machine itself, in the other words, the vision is not flexible. Besides that, the GUI is very complicated and even some of the machine don does not use GUI. Therefore, the underwater jobs will definitely become inconvenient with such this problems assisted.

Due to lack of time, technologies and money, we decided to create a ROV instead of AUV and expecting to be able to solve the problems above. Therefore, this project had been proposed as to design a low cost vision controllable system of ROV with graphical user interface (GUI).

1.3 Project objectives

The main objective of this project is to design and develop the graphical user interface (GUI) of an underwater vehicle. The main focus of the machine is on the vision part and the GUI for the whole machine including the control of the vehicle, the control of the vision and data storing thru computer. In order to achieve the goal of this project, several knowledge such as Visual basic .Net, microcontroller communicates, solid works, design based on user request are need to be understand. In order to hit the main objective, there are also several objectives have to be taken concern:

a) To design a GUI program with useful functions and features for a remotely operated underwater vehicle (ROV).
b) To study about the communication system between the vehicle and computer by using visual basic.
c) To do the research which is vital and correlated to the underwater vision.
d) To create a mechanism to hold the camera of the ROV in order to be controllable by itself.

1.4 Scope

This project is mainly focusing on the vision part of the vehicle only. The camera of the vehicle is using the current available underwater camera, SCA0156-30M from the brand of video surveillance. Besides that, this project will only use Visual Basic to create the GUI and Micro Controller (MicroC) to control the camera movement. The GUI is based on the creativity to suit the program needs.

Limitation:

a) The depth of the water for submerging the ROV is just about 5m deep.
b) The clear vision of the vehicle under water is not more than 50inch.
c) Pool and river is the only available medium for submerging the ROV.
d) A wired connection of the camera to the PC.
e) The clearness of the water should not be less than 50%.

CHAPTER 2

LITERATURE REVIEW

2.1 Background Theory

2.1.1 History of ROV

Table 2.1: History of ROV

Years	Function
1950s	Royal navy used it to recover practice torpedoes and they named it cutlet
1960s	US Navy used it to carry out rescue operation and explore lost object from the deep ocean floor.
1970s	It is been widely used by offshore oil and gas industry to assist development of offshore oil field.
1980s	It is more essential and widely used by humans to do the job underwater which human divers could not reach.
Today	Wide range of tasks from simple examination of subsea structures, connecting pipelines and placing underwater manifolds.

2.1.2 Fact of underwater vehicle

Plenty of work is waiting for human to be done. More than 50% of the earth's ocean is deeper than 3km and it is equivalent to the current working depth of most of the ROV technology. In other words, more than half of the ocean has never been explored. There is a big potential for human to discover any kind of raw materials in that area. In order to meet this challenge, the improvement of ROV or AUV is highly recommended. While the majority of oil & gas industry uses the ROVs to help their jobs; other applications include science, military and salvage [1].

2.1.3 Application of ROV

Table 2.2: Application of ROV

Field	Function
Science	✓ To study the behaviour of the sea. ✓ It is use to do research for the deep sea animal and even plant. ✓ Shapes and size is important to be outfitted with broadcast quality camera and high output lighting system for the application in order to make their job easier [2]. ✓ The use of Hercules ROV with hydraulic propulsion system as one of the first science ROVs to do survey and excavate ancient or modern ship wrecks [3]. ✓ Canadian Scientific submersible Facility ROPOS system is continually used Deep Ocean vents recovery and investigation to the maintenance and deployment of observatories [3].
Education	✓ SeaPerch ROV educational program is an educational tool that allows students to construct a simple, ROV [4]. ✓ To improve their knowledge in science, technology, engineering, and math skills.
Military	✓ Use ROV to replace its manned rescue systems. ✓ Mine clearing and inspection by a special type of ROV called Neutralization vehicle (MNV). ✓ It also able to track underwater enemy, patrol local harbours for national security threats and polish deep ocean floors to distinguish environmental hazards [5].
Marine	✓ Salvage operation of downed planes and sunken ships.

	✓ Sea investigation.
Oil and gas industry	✓ Fuel investigation ✓ Piping maintenance

2.1.4 Construction of ROV

Buoyancy is a necessity that can be provided by conventional R.O.V, which are built up by a large flotation pack that put on top of an aluminium chassis. Material which is normally be used for the purpose of flotation is syntactic foam. A variety of sensors have to be accommodated in order to run the system and its can be placed by fitting the compatible tool sled at the bottom of the system.

There are two separate layers in the overall system by placing two different components loads at the top and bottom according to the gravitation logics. Hence, the heavy components will be placed at the bottom while light components will be placed at the top to provide a large separation in between the canter of buoyancy and gravity in the overall system. Further illustrates, it will help to achieve a strong stability and much stiffer to do the work underwater.

To enhance full control, the thruster must be in three axes. Camera, lights and manipulators are usually built in front of the vehicle; however, it may be in the rear to help maneuvering. Next, the electrical cables must be run inside oil-filled tubing to protect them from rusting in seawater.

In fact, there are plenty of styles or designs in ROV machine, but the majority of the work class ROVs are built as described above. Unambiguously, there are very different and rare kinds of design for smaller ROVs; each of them is specially built according to their working area [1].

2.1.5 Classification of ROV

Table 2.3: Classification of ROV

Type	Size/weight	Ability
Micro	Less than 3kg	• Enter small pipeline, small cavity or sewer.
Mini	Around 15kg	• Diver alternative • Easy to carry
General	Less than 5HP	• Gripper have been installed, able to carry sonar, used on light application • Working depth less than 1000m.
Light work class	Less than 50HP	• Able to carry manipulators • Made from polymers • Working depth less than 2000m
Heavy work class	Less than 220HP	• Able to carry at least 2 manipulators. • Working depth less than 3500m.
Burial	More than 200HP	• Able to carry cable laying sled. • Working depth less than 6000m.

2.2 Vision system for underwater vehicle

The most important basic improvement is actually based on colour space conversion, chromaticity histograms, colour equalization and normalization. Basically, the colour perception of an object is depends on physical, physiological and psychological and components such as spectral composition of light, spectral reflectance of the object, transmission of the light in the medium, and the visual system of the observer. Figure 2.1illustrated the process of underwater colour modification.

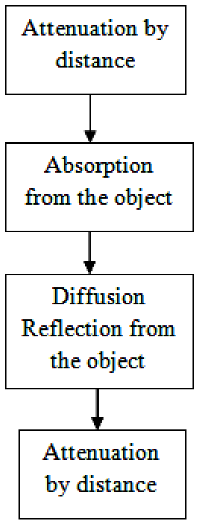

Figure 2.1: Underwater colour modification

Basically underwater imaging can be described into two terms which are passive system and active system. Passive system is the image objects that have been illuminated by some source or linked with the imaging system. For example, objects using bioluminescence or sunlight. Passive imaging is usually use for covert operations such as fish seeking or objects inspection by the Marine without being detected. However the generated source of light is use for an active system of underwater camera. An example for an active system is the underwater camera system which uses either strobe or continuous artificial illumination [6].

Image processing, robot vision image analysis and machine vision is the terms that should always be stressed when discussing about image. There is usually to have common characteristics in terms of techniques and applications that been used. This shows that the techniques used and developed in these fields are very similar, or it can be known as one field with variety of names.

Those classifications are used to demonstrate the relationship between image range, camera light separation and the limiting factors in underwater image collection. For short ranges photo capturing, it need only a simple system with a good camera and controllable light beam to be able to produce good quality of pictures as underwater. If longer ranges are desired, the separation of lights and cameras will be key point to affect the quality of photo. The reason is, they present substantial advantages in that backscatter and this must be reduced substantially. [7]

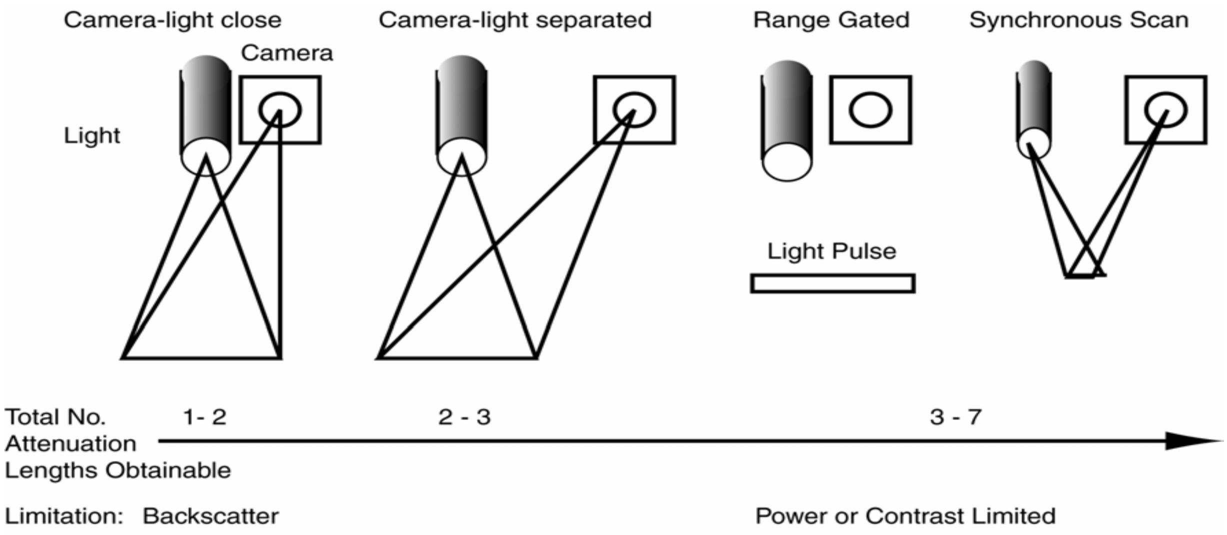

Figure 2.2: Classification System for Underwater Image Collection Systems [7]

2.3 Underwater camera mode

There are numerous kinds of marine researches are enthusiastically progressed by research institutes and universities around the world. Basically, researches about the deep-sea get a lot of attention because it is inseparably connected to various important matters such as the earth environment issue. Therefore underwater platforms like underwater vehicles (UVs) and sea-bottom stations have recently contributed. The type of UVs are classified broadly into two categories; manned underwater vehicles (MUVs) and the unmanned underwater vehicles. And moreover, the unmanned underwater vehicles are classified into remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs) [8].

Most of the MUVs and ROVs is equipped with manipulators to build and maintain underwater structures and collect various marine samples. The operators, who board on MUVs and support ships for ROVs, control them by watching the TV camera image which appears the field circumstance. And AUVs are applied not only to survey the seafloor topography and under the sub seafloor structure using acoustic sensors but also to take many camera images of the seafloor in order to make the mosaic image which is composed of them. Meanwhile, the sea-bottom stations observe not only the seafloor condition such as the crustal movement and the plate boundary earthquake but also the submarine landslide and the biology of deep-sea organism using TV cameras [9].

However it is very difficult to understand the accurate size or accurate length and accurate area of their specified part. Such information can be measured if the underwater platforms are equipped with special acoustic devices. But they are very expensive and needs extra-large payloads/electric power to load on/activate them. Moreover, the measurement accuracy is not good. Meanwhile, if the platforms are equipped with special laser devices, such information can be measured with high accuracy. However its cost of development is high and it is very difficult to apply them because the system management in the water become complex.

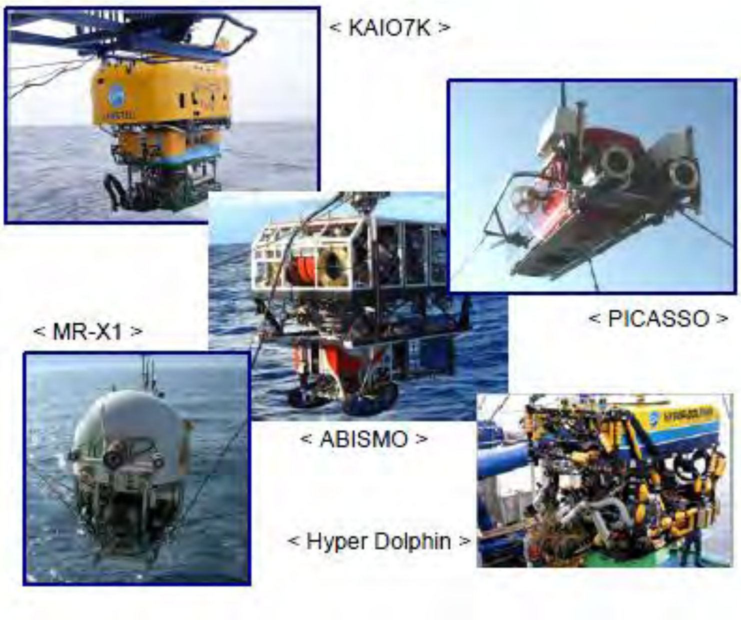

Figure 2.3: Underwater vehicles equipped with under water cameras [8]

2.4 Vision system design (control)

The vision sensing system bring the camera images as input, and outputs the pixel locations of the centroids in image coordinates of the target mooring. Besides that, the output is to identify the vision system has successfully matched a pixel group to that marker or not. The architecture is partitioned into three components: **segmentation**, **prediction, and correspondence**.

A. Segmentation

The first step in processing the input image is the segmentation subsystem of vision processing. The segmentation process for current accomplishment of the mooring-tracking application is equal to the process used in the tracing of underwater animals. The algorithms are capable of removing disturbance, and morphological gradient filter. This gradient filter is inception to extract high local gradients image regions from the output. This have successfully segment out the underwater animals from a low computational cost and fixed thresholds background. The test target used must be specially designed in the mooring tracking in order to be able to trigger the same filter in experiment [10].

B. Correspondence

Correspondence is identified by comparing each candidate pixel region, or blob, with predicted profile of markers. The comparison of blob and markers is including centroid, coordinates, area, aspect ratio, average intensity and average gradient. Multiple markers are selected for matching with the current image. First, each blob is compared to markers for best matching in term of the characteristics mentioned above. Next, best matching are elected and matches are enunciated. However, when the entire matching are not satisfied, then no match is made and that systems will shows as unavailable to the estimator and the prediction step of vision processing [11].

.

C. Prediction

The current matched blob measurements is used in the prediction step of vision processing to update the profiles related with the fiducially marker set. Weighted average of the pass profile vector and current measurement is used in the update in affecting a low pass filter on the measurements. Future implementations of this system will strongly influence by the estimator about motions of the vehicle and target to predict more perfectly the estimated changes in the blob vector, parallel to the image coordinate prediction step [11].

2.5 Graphical User Interface (GUI)

The control system consists of a sub-sea controller with inputs for cable payout amount, cable payout speed, environmental status (temperature and humidity) and outputs to control the cable payout mechanism servos drives. A PIC microcontroller was used for the controller used a PIC microcontroller as to provide digital and analogue I/0 and a serial RS-232 link to the topside control GUI software.

Doppler velocity log (DVL) of ROV will provide inputs to the GUI to measure distance along track. The distance calculated along track will use to compare the value with a file of pre-mapped waypoints. The condition of cable which needs to be pay out or not is