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VISION SYSTEM FOR AUTONOMOUS UNDERWATER VEHICLE

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MAY 2009

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VISION SYSTEM FOR AUTONOMOUS UNDERWATER VEHICLE

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This Report Is Submitted In Partial Fulfillment Of Requirements For The Degree of
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ABSTRACT

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. Therefore, this project might present the new design of vision system for autonomous underwater vehicle with the implementation of wireless camera, whereby, produce clearer image. As to obtain clearer images, several investigations will be done in order to know the appropriate distance required between the images with the camera. At the end of the project, the new design of the vision system will be well functioned and can be applied to capture clearly the underwater images and also might be used to explore the nature of underwater. This new vision system also could be used for monitoring and maintenance tasks for underwater where it is risky for the human to work in it.

ABSTRAK

Air merupakan komposisi bumi yang tersebar iaitu merangkumi 70% daripada permukaan bumi. Walaubagaimanapun, amat sukar bagi manusia untuk menerokai keindahan di dasar laut, disebabkan oleh penglihatan di dasar laut adalah kurang jelas. Hal ini dipengaruhi oleh pembiasan cahaya yang berlaku kerana perbezaan ketumpatan diantara permukaan darat dan permukaan dasar laut, sekaligus memberi kesan terhadap imej yang ingin dilihat menjadi kurang berkualiti. Oleh yang demikian, projek ini dicadangkan bagi mencipta sistem penlihatan untuk kegunaan kenderaan dasar laut khususnya kapal selam dengan mengaplikasikan *wireless camera*, supaya imej yang dihasilkan adalah lebih jelas. Dalam usaha untuk memastikan projek ini dapat menghasilkan imej dasar laut yang jelas, beberapa kajian akan dijalankan bagi memastikan jarak yang sesuai ditetapkan supaya imej yang diperolehi adalah imej yang jelas. Ciptaan ini diharapkan dapat berfungsi dengan baik seterusnya dapat digunakan untuk menerokai dasar laut atau menggunakan aplikasi ini bagi tujuan penyelenggaraan di dasar laut, dimana ianya berisiko untuk manusia bekerja di dasar laut.

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LIST OF ABBREVIATIONS AND SYMBOLS

AUV	Autonomous Underwater Vehicle
LED	Light Emitting Diode
V	Voltage
I	Ampere
R	Ohm
W	Watt
cm	Centimeter

CHAPTER 1

INTRODUCTION

1.0 Introduction

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 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 used higher cost as it design and the system's ability are quite complex. Therefore, this project had been proposed as to design more simple design of vision system for AUV with a lower cost.

1.1 Problem Statement

Development of science and technologies had given an opportunity for human to explore so many things as to fulfill the need of human daily facilities. All these gadgets and equipments were invented as to improve the quality of human life.

Basically the idea of designing the vision system for AUV is due to several factors, and the main factor is because the image that produce under the water tend to lose all the colors information in certain parts of the spectrum due to the different frequencies at ground and underwater which finally might cause the underwater image that been viewed is not clear enough. As to overcome this problem, this project had been proposed as to ensure that the submarine images can be captured clearly.

Due to the very low quality underwater images produce, therefore, this project had come to a solution by increasing the quality of the underwater images, so that the image that been obtained will less effected by the scattering light and the suspended particles in the water.

1.2 Objective

The main objectives were to design vision system for autonomous underwater vehicle using wireless camera.

1.3 Scope of Project

The project will only focused on capturing and recording clear underwater image using the wireless camera. Furthermore, the investigation of producing the appropriate distance to obtain clearer image will also be included in this project. Last but not least several comparisons between the new visions systems with the existing product will also be discuss in this project.

1.4 Methodology

As to accomplish this project in duration time of two semesters, a proper time frame should be planned so that the project is on the right track and can be done on time. The project was started by searching all the information regarding to vision system and also the information about wireless camera. All these information were collected from internet sources, thesis, articles and also journals. Duration target for gather those information is around six or seven month.

This project is preceded by designing the hardware of the project. Designing the hardware of this project included designing the waterproof casing of the camera and also constructs a simple circuit for the lens modification. Three month are provided for designing the hardware.

The next step is fabricating the project product. As for this particular project, the waterproof casing needs to fabricate. It is expected that the fabricating process will only takes two or three month to be accomplished, so that the final step which are troubleshooting can be done in the comfort time zone which about two month before the final submission of the project. Figure 1.1 shows the flow chart of the process in completing the project.

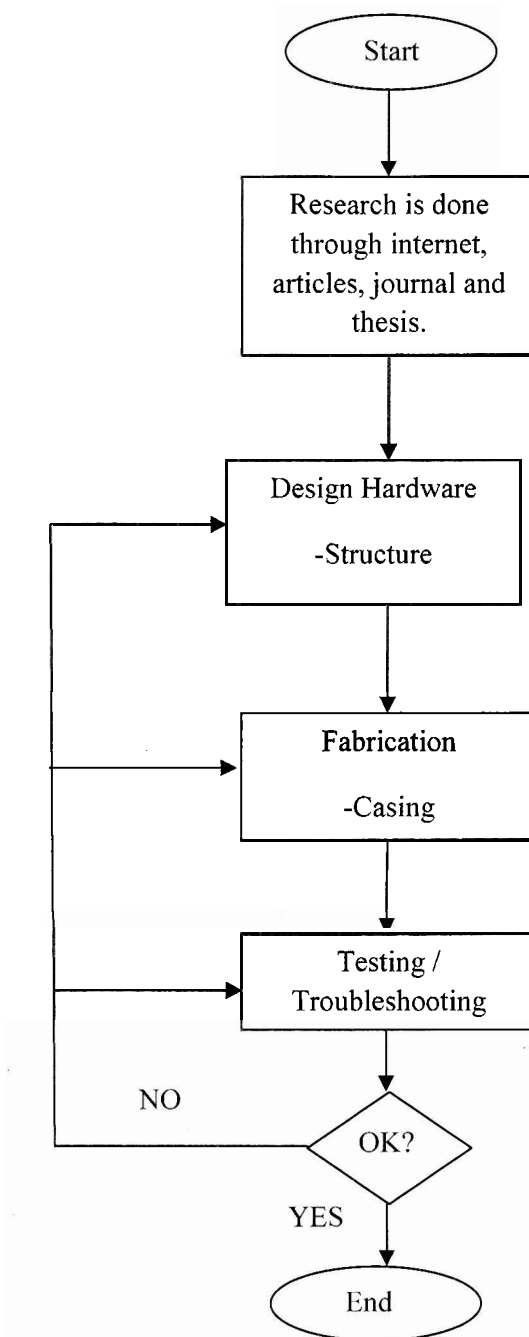


Figure 1.1: Methodology of the project

1.5 Organization of Report

The report will begin with a brief review of the introduction regarding to the Autonomous Underwater Vehicle (AUV) and yet several problem related to the limitation of underwater vision. Several important literature reviews had been quote from few resources such as thesis, journal, and as well in the reference book. Other extra information was taken from the internet. In the next chapter of this report will review the basic understanding regarding to the background of the project. Next, all the components and equipments needed for this project is highlighted in design procedure. The results of the analysis to this project will also be included in this particular report. Finally, the report will be concluded based on the overall performance throughout completing this project.

1.6 Summary

Basically in this particular chapter, the main key point that needs to be perceived is the general understanding on the objectives and scope of the project, as well to be attentive enough on the project's flow or process. Several fundamental theory related to the project is also need to be well known as it might help the reader to understand more about what will be explain in the upcoming chapter.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Literature review is most probably a basic platform of the initial part in completing this final year project. Literature review is all about gather all the theory knowledge related to the propose project. All these information might help the reader to be understand more about the project due to the theory concept that been applied to the project As for this particular project. Two main literature review are taken from the previous thesis of Vision System for Underwater Vehicles which are thesis that been written by Jack Raynolds and also Daniel Loung Huat Lim. Other extra information was taken from the internet.

2.1 Autonomous Underwater Vehicle: Vision System

The basic idea for redesigning the vision system is most probably come from researches that had been done through several previous projects which are related to the vision system for the Autonomous Underwater Vehicle (AUV). A project titled, “Autonomous Underwater Vehicle: Vision System” done by Jack Raynolds, is one of the practical inventions as it implemented high quality stereo camera together with the software system build in it as to estimate the range to objects in front of AUV and also to track features as they move relative to AUV. Figure 2.1 shows the vision system that been design by Jack Raynolds [6].

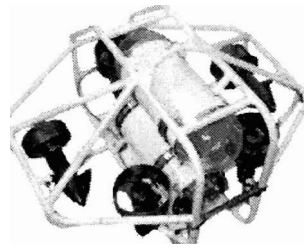


Figure 2.1: Vision System for AUV

The ability of this system is to allow the on-board camera to be used as a navigational aid for the submersible. Even though this designed is quite complicated and would give a higher cost, it is however will give wider implementation to the user such as can be control with three methods which are [6]:

- a. It can be directly control, where operator on the surface has full control on the vehicle.
- b. It is also can be semiautonomous control where the operators on the surface share control with the on board control.
- c. Autonomous control, whereby it is fully control by the on board computer.

As for any of these control method to be control affectively, it is recommended to ensure that accurate and timely information must be produce from the sensors. Figure 2.2 shows the images that been captured using the vision system invented by Jack Raynolds [6].



Figure 2.2: Image captured.

Thorough out this project, Jack Raynolds had finally discover that the the range for the image can be captured is capable with at least 90% accuracy for a 30° from field of view and with at least 80% accuracy from 60° field view.

2.2 Design of a Vision System for An Autonomous Underwater Vehicle

'Design of a Vision System for An Autonomous Underwater Vehicle' is a project conducted by Daniel Loung Huat Lim whereby the purpose for this project is to apply the vision system for AUV for tracking and follow the underwater pipeline as this application is very popular area of research for mining organizations that pipelines on the ocean floor.

The pipeline following is fairly difficult task to achieve in natural marine environment due to frequent noise in a sub surface system. Noise is commonly occurred at submarine cause by sporadic marine growth and dynamic lighting condition.

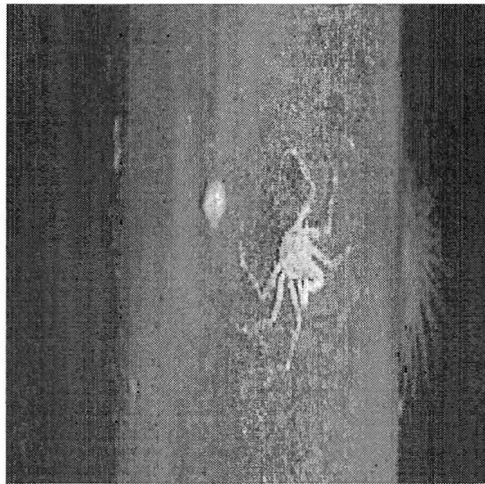


Figure 2.3: Commercial underwater pipeline [5]

Figure 2.4 shows the hardware design of the vision system. This project implemented wireless communication to allow gathering of information of important experimental data and allow remote compilation and execution of the program [5].

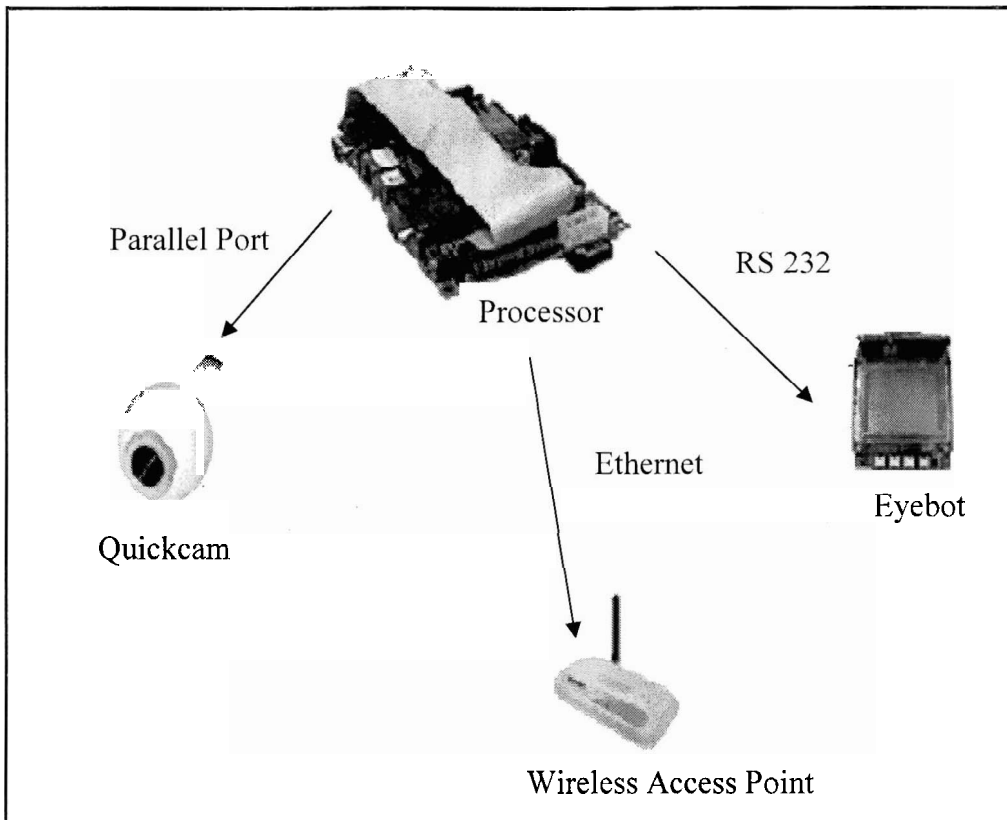


Figure 2.4: Hardware and its interconnection

Through this project, it had been discover that with the implementation Gaussian Filter the system can track the clear view of image. Figure 2.5 and 2.6 shows the result of tracking the underwater pipes [5].

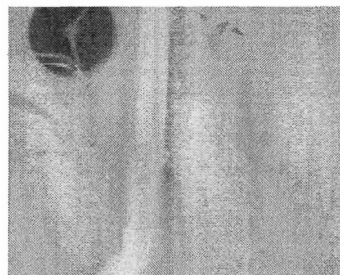


Figure 2.5: Image before process



Figure 2.6: image after process.

2.3 Wireless Camera

Seems that this project involve with the application of the wireless camera, it is therefore important to know the basic knowledge related to the wireless camera. The basic idea of the camera concept is discovered by Mo Ti from China where he noted that the reflected light rays of an illuminated object passing through a small dark enclosure result in an inverted with the exact image of the object.

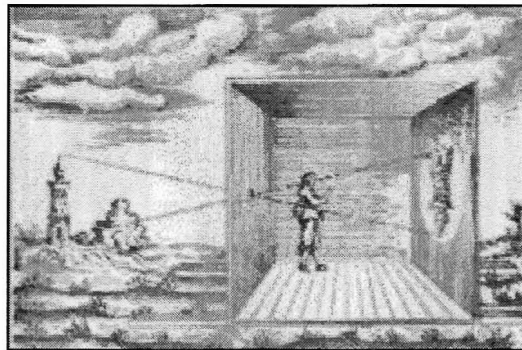


Figure 2.7: Camera concept [8]

The first camera was invented is Obscura Camera which only a box with a hole in one sides of it. The light will pass through the hole and strike a specific part of the back wall. However, with the development of science and technology, the invention of the camera is being upgraded with special features, but the concept of the camera is remaining the same. Figure 2.8 shows the development of the camera.

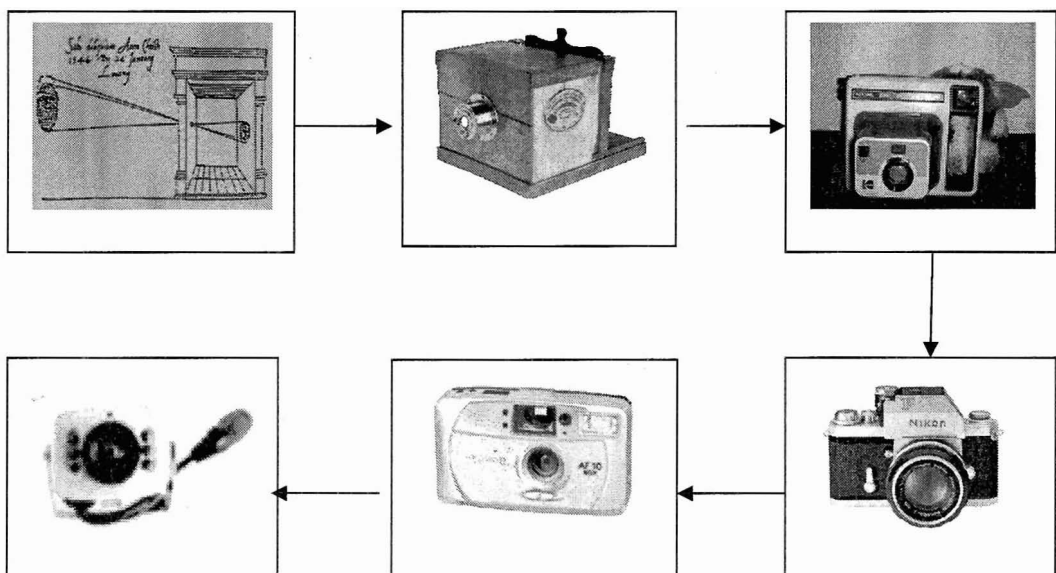


Figure 2.8: Development of camera