UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development of Autonomous Underwater Vehicle Vision System by Using Pixy Camera

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

by

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APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment 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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ABSTRAK

Sistem visi kenderaan bawah laut autonomi dengan menggunakan kamera pixy direka untuk tujuan untuk mengesan dan menjejaki objek di bawah air. Projek ini adalah gabungan tiga elemen utama iaitu pembangunan mekanikal, elektronik dan perisian. Untuk reka bentuk mekanikal, badan AUV dipasang dan berat tambahan ditambah di bahagian atas dan bawah untuk membuat reka bentuk AUV ini mempunyai keapungan semulajadi di dalam air. Bagi bahagian elektronik, empat DC motor penembus dan dua pam bilge digunakan untuk tujuan yang bergerak. Empat motor DC untuk gerakan ke atas dan ke bawah manakala dua pam bilge untuk gerakan ke hadapan dan ke belakang. Kamera pixel dipasang di hadapan AUV untuk mengesan dan mengesan apabila mengesan kod warna di dalam air. Satu Arduino MEGA 2560 digunakan untuk mengawal pergerakan enam motor. Akhir sekali ialah reka bentuk perisian, perisian pixyMon digunakan untuk kamera pixy untuk menetapkan tandatangan imej. Perisian yang sesuai digunakan untuk membuat kod dan dimuat naik ke arduino untuk membuat AUV berfungsi dengan baik. Kedua-dua perkakasan dan perisian akan digabungkan bersama-sama

ABSTRACT

The autonomous underwater vehicle vision system by using pixy camera is designed for a purpose to detect and track the object under the water. This project is combination of three main element which is mechanical, electronic and software development. For the mechanical design, a body of an AUV is assemble and additional weight is added at top and bottom to make this design of an AUV has a natural buoyancy in the water. For the electronic part, four thruster DC motor and two bilge pump is used for the moving purpose. Four DC motor for upward and downward movement while two bilge pump for forward and backward movement. A pixy camera is mounted at the front of the AUV to detect and track when detected the color code in the water. One Arduino MEGA 2560 is used in order to control the movement of the six motor. Lastly is the software design, a pixyMon software is used for the pixy camera to assign the signature of the image. A suitable software is used to make a coding and uploaded into an arduino to make the AUV works well. Both hardware and software will be combined all together.

DEDICATION

Dedicate and appreciation for support, encouragement and understanding d to my beloved mother, father, lecturers friends and my siblings for praying and helps me in completing the final project and for my success.

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LIST OF SYMBOLS

cm	-	centimeter
mm	-	millimeter
kg	-	kilogram
V	-	volts
A	-	ampere

LIST OF ABBREVIATIONS

AUV	Autonomous Underwater Vehicle
UUV	Unmanned Underwater Vehicle
ROV	Remotely Operated Vehicle
CMUcam5 Pixy	Pixy camera

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this chapter 1, it will representing the introduction about this project. Chapter 1 will cover the project background, problem statement, objectives and work scope on conclusion of Development of Autonomous Underwater Vehicle Using Pixy Camera. Statement of the Purpose.

1.2 Project background

Over the past years ago, the Unmanned Underwater Vehicle (UUV) are known as a robot that have the efficient, cost effective and safe to use in order to carry out many underwater operation. The UUV can be classified into two art which is Autonomous Underwater Vehicles (AUV) and Remotely Operated Vehicles (ROV). The UUV familiar to the humanity today since it can replace human operation for underwater to do oceanographic researches, environment monitoring, source exploitation, maritime research and rescue. Basically, the AUV have power supply, waterproof motor and many sensor that listed to enable them since the AUV is operate manually. To make the AUV move to the target needed, it required a vision system to track and follow certain target that had been set up. For many years, all of the surface vehicles need a vision system in order to navigate their coordinate. But, vision system in underwater vehicles is relatively new and give many problem in handle it in oceans environment. Radically, camera is required for robot and the computer vision do like human vision which is interpreting the 3D world based on 2D images. Besides that, camera also use to get data and control the robot path

especially for AUV to follow and track the object that set up. The first AUV was develop at university of Washington in early 1957 and also in massachusetts institute of technology in the 1970. Both AUV developed without an embedded computer vision which means the robot was depends of the image processing that being done on desktop computer. Nowadays, the vision system on robot had been improve rapidly by using a Pixy Camera to implement the logic control directly to arduino platform. Thus, the AUV can move in oceans environment for follow and track the object smoothly and also the AUV has decision making by itself and make it more simplicity, replicability and financial viability.

1.3 Problem statement

Nowadays, Unmanned Underwater Vehicle had developed for many reason in order to satisfy the wishes of people. Most Autonomous Underwater Vehicle is use as a mapping, oceans survey, environment monitoring, resource exploitation, maritime search and rescue. Long time ago, the vision system on the AUV give difficulties since the robot image processing capabilities depends on desktop computer. The image processing is capture by the android platform and implement the control logic. By taking a step further than this, pixy camera is apply to underwater vehicles which means to perform a task of oceans environment monitoring easily because control logic is implemented directly to the Arduino platform. This underwater vehicles also has high cost technology and hard to handle especially for vision system. Since use a pixy camera, it is easy to use and also a low cost technology. Besides that, image sensor that being produce is large amount of data that will overload the processor which give the main problem for the robot. By using pixy camera, it will addresses that problem by pairing a microprocessor to the camera.

1.4 Objectives

a) To develop Autonomous Underwater Vehicle vision system by using Pixy Camera.
b) To design a mechanical structure, electronics structure and vision system for the AUV.
c) To implement the pixy camera to detect and track the object.

1.5 Work scope

In this project, the main aim is to develop an Autonomous Underwater Vehicle Vision System by using Pixy Camera. Project will involve in mechanical design, electronics design and control design of Autonomous Underwater Vehicles (AUV).

a) Mechanical design

To develop an Autonomous Underwater Vehicles by using waterproof motor which is attach to both side of AUV. There is cylindrical shape at the middle that protect the electronics device that control the AUV. Besides that, five motor will be used to control the speed and two for its depth. All of the component are design by using solidworks software.

b) Electronic design

This section use an arduino mega (ATMEGA2650) to control the AUV in order to track and follow the target. Arduino is separates into three section which is act as controller, another one is to control the motor driver and also connected to the Pixy Camera to control the AUV go forward, reverse, up and down based on requirement needed.

c) Software design

Arduino Integrated Development Environment (IDE) software is use in order to develop a program, make the codding and build automation. Next, this section also requirement a PixyMon software which is use to configure the Pixy Camera that connect directly to the arduino board.

1.6 Conclusion

In this chapter, it is briefly explain about the introduction of this project. Here and now, the Autonomous Underwater Vehicle is still a new technology for us. It is need more improvement and not completely discovered anymore. This AUV is develop to make it more sufficient and suitable for human being. The main reason of develop an AUV, it is can replace the human works for oceans research and discovery. Besides that, this chapter also discussed its objective and work scope in order to develop an Autonomous Underwater Vehicle Vision System by Using Pixy Camera which is use an arduino as a controller and Pixy Camera to capture the picture. This chapter will cover on development of mechanical design, electronic design and software design of Autonomous Underwater Vehicles.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Nowadays, an Autonomous underwater Vehicle is a famous robots which able to move in the oceans without any human helps. The purpose of building an AUV is to make a research for every aspect in the oceans such as mapping, military needs, commercial and oceans habitat research. Because of this AUV is fully move in automatically, it need the vision system to guide the robots moving towards the target. This vision system has been studied by many researcher to make the vision system become better than before. This chapter will discuss about the design and concept based on the latest research and article on the Autonomous Underwater Vehicle.

2.2 Previous related research

An Autonomous Underwater Vehicle (AUV) is a submerged robot which is able to move in water without need human to control the robots. Underwater vehicle is widely used in the world todays since it make human tasks become easier and safe to use. Vision system is the most important part in order to guide the robots move smoothly to reach the target. Based on previous article, there are many ways to handle the vision system by using many types of camera. (Nian *et al.*, 2013)has propose this paper. In this paper, a ROV-based system is builds in order to implement vision system by installation of optical sensors. From the resulting of swimming fish images, this underwater vision system can easily detect and track the images by helps of curve evolution and particular filtering. This method will give a much understanding about fish behaviors. Underwater vision system is affixed to a vessel or other prototype either operated by

remotely operated vehicles (ROV) and autonomous underwater vehicles (AUV) have increased gradually over many years ago. Due to the reflection of light in the water, quality of the images that produce by optical sensors may be has poor quality. The changing of optical properties of the water is caused by the environmental effect in the oceans. Consequently, the improvement of underwater imaging and image quality is indispensable to make it more suitable as the world demand.

The collection of underwater vision data based on the fish behaviours with reliability, accuracy and cost reduction. This collection of data is measured over the time depends on the system which provides recognition into fish behaviour. This fish behaviours give a balance between video quality and physical limitations includes range, resolution, frame rate and compression. Both unmanned underwater vehicle, ROV and AUV system have become a dominant robots to do a special tasks which is continuous navigation and sampling in order to achieve coincident observation over the large areas in the sea. Underwater vision system is used a VideoRay Explorer in ROV system which is includes an 8-pound submersible, control panel, seven inch LCD colour display monitor, water depth meter, auto depth feature, compass heading readout and run time meter. The design of remotely operated vehicle is shown in figure 2.1.