UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF AUTONOMOUS UNDERWATER VEHICLE DEPTH CONTROL SYSTEM BY USING RASPBERRY PI

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 and Robotics) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of **Bachelor of Electrical Engineering Technology (Robotic and Automation) with Honours**. The member of the supervisory is as follow:

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ABSTRAK

Laporan ini akan membentangkan sistem Pengembangan Autonomi untuk sistem kawalan kedalaman AUV bawah air dengan menggunakan Raspberry Pi. Kenderaan Underwater Autonomi bawah air (AUV) kebanyakannya digunakan untuk pemantauan kedalaman di bawah lautan di mana mustahil bagi manusia menyelam pada tahap yang dalam. AUV adalah kenderaan robot tanpa manusia atau sepenuhnya sensor yang menggunakan teknologi tinggi untuk membawa keupayaan baru bekerja di persekitaran bawah laut. Salah satu masalah yang dihadapi oleh AUV adalah kawalan mendalam kerana ia mungkin hilang semasa pengawasan kerana secara autonomi mengemudi di laut. Oleh itu, projek ini memberi tumpuan kepada reka bentuk dan pembangunan AUV kos rendah dengan saiz kecil dan prestasi tinggi dengan kawalan kedalamannya. Sistem AUV akan membina berdasarkan modul kamera Raspberry Pi V2 sebagai pemproses imej, BerryIMU V2 dipasang dengan sensor barometrik dan manipulasi program Raspberry Pi 3 B + untuk membolehkan pelaksanaan tugas diberikan. Sensor BerryIMU akan mengawal pengimbangan dan menyelam atau menimbulkan tindakan AUV manakala tujuan Raspberry Pi Camera adalah untuk mengenal pasti objek di hadapan dan menavigasi AUV untuk membolehkan tugas yang diberikan oleh pengguna untuk dilaksanakan. Analisis untuk projek ini adalah untuk menentukan keberkesanan projek AUV untuk mengawal kedalamannya dengan menggunakan BerryIMU V2. Sistem ini juga akan mengkaji bagaimana keadaan bacaan pengaturcaraan mempengaruhi output tugas AUV.

ABSTRACT

This report will present the Development of Autonomous system for underwater AUV depth control system by using Raspberry Pi. The underwater Autonomous Underwater Vehicle (AUV) used mostly for monitoring at the depths below the ocean where it is impossible for humans to dive on that deep level. AUV is an unmanned or fully sensors robotic vehicle that is using high technology to bring new capabilities to work in the subsea environment. One of the problems facing by AUV is the depth control since it may loss during surveillance because autonomously navigate in the sea. Thus, this project focused on the design and development of a low cost AUV with small size and high performance with its depth control. The system of the AUV will be build based Raspberry Pi Camera module V2 as an image processor, the BerryIMU V2 fitted with barometric sensor and program manipulation of Raspberry Pi 3 B+ to enable the execution of task given. The BerryIMU sensor will control the balancing and dive or rise up action of the AUV while the Raspberry Pi Camera purpose is to identify the object in front and navigate the AUV to enable the task given by the user to be executed. The analysis for this project is to determine the effectiveness of the project AUV to control its depth by using BerryIMU V2. The system also will be study on how the programming reading conditions affect the AUV task output.

DEDICATION

This report is dedicated to my beloved parents who always give the endless support to keep me moving forward and complete my studying. As my mother would always say, success is going from failure to failure with no loss of enthusiasm, so you must never give up. Their sacrifice had inspired me to work hard for the things that I aspire to achieve. I cannot find the appropriate words that could describe my appreciation for their support, love and faith in my ability to achieve my dreams.

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LIST OF SYMBOLS

D, d	-	Diameter
F	-	Force
g	-	Gravity = 9.81 m/s
I	-	Moment of inertia
1	-	Length
m	-	Mass
N	-	Rotational velocity
P	-	Pressure
Q	-	Volumetric flow-rate
r	-	Radius
T	-	Torque
Re	-	Reynold number
V	-	Velocity
w	-	Angular velocity
x	-	Displacement
z	-	Height
q	-	Angle

LIST OF ABBREVIATIONS

PCA	Principal Component Analysis
PID	Proportional, integral and derivative
Kp	Proportional gain
Ki	Integral gain
Kd	Derivative gain
ESC	Electronic Speed Control
AUV	Autonomous Underwater Vehicle

CHAPTER 1

INTRODUCTION

1.1 Introduction

An AUV stand for autonomous underwater vehicle and it is simply computer-controlled systems operating undersea. As their autonomous name suggestion, AUVs operated independently of humans. AUVs have no physical connection to their operator, who may be on shore or aboard a ship. It is rather operated by itself with self-guiding and self-powered vehicles. An AUV is differs from remotely operated vehicle (ROV) in a way that AUV it operates autonomously and no take command from its operator. The boundless functionality of modern AUVs have brought great impact to the society from operations in both offshore and onshore by commercial, government, military and academic users. Hence, AUVs can do things like exploring the sea and can search for many mystery things undersea. This development of Autonomous Underwater Vehicle (AUV) depth control system can overcome the challenges of deep-sea exploration.

1.2 Project Background

Autonomous Underwater Vehicle (AUV) is a type of underwater robotic device which can drive through the underwater propulsion system without any human controls. It is self-piloted where it is using the feedback received from the surrounding in order to determine its actions and movement during operation.

Depth control are adaptive methods which may be used to solve the AUV buoyancy towards the disturbance and obstacle and optimization problems. They are based on the PID control system calculation. Over many generations, natural populations evolve according to the principles of natural selection and survival of the fittest. Depth control can quickly resolve the problem of its angle of error using the suitable sensor such as barometric sensor.

Therefore, if the AUV task is to explore the sea, so that we can learn many new things and new facts. However, the sea is not a friendly environment because the current and pressure will be a challenge for sea exploration. The living things in the sea also will affects the AUV system. To solve this problem, the development of Autonomous Underwater Vehicle (AUV) using depth control is a need to do this exploration. The AUV is using depth control as the main operation because to overcome those challenges, we need an automatic control especially depth as we know that the deeper the sea the higher the pressure and the current will be much more trouble for the exploration. Hence with this depth control, the stability of AUV is to maintain at the specified depth becomes easier and easy to achieve.

1.3 Problem Statement

Deep underwater exploration is one of dangerous task due to limited of human capabilities. If human can discover the underwater, many discoveries could get and learned with it. So, the underwater vehicle has been designed to overcome that problem. The problem statement with the sea exploration are the waves and current that disturbs the underwater vehicle to do the exploration. In the underwater vehicle industries, the thruster is an essential part of controlling the direction, depth, and speed of the AUV. In any case, there are some AUV that cannot be kept up at the specified depth for quite a while as a result of disturbance. Therefore, the development of Autonomous Underwater Vehicle (AUV) depth control is essential to solve this problem.

1.4 Objective

1. To develop an Autonomous Underwater Vehicle (AUV) depth control system using Raspberry Pi.
2. To design the mechanical structure, electronic circuit and control system for AUV.
3. To analyse the functionally and reliability of the AUV in the aspect of depth control.

1.5 Workscope

In this project, the aim of the design is based on three designs, which are mechanical design, electronic design, and software design.

1.5.1 Mechanical Design

- The body structure is designed to submerge in the water and the structure is almost like a submarine. All electronic devices will be inside of the autonomous underwater vehicle (AUV) body and thrusters to the left and right of the autonomous underwater vehicle (AUV).
- Six thrusters of T200 Blue Robotic is used for z-y-x axis movement.

1.5.2 Electronic Design

- One Raspberry Pi 3 B+ is used as a controller for the system and also connected to thrusters. This Raspberry Pi also will control the thrusters with using the PID control.
- One BerryIMU V2, which is fitted with barometric pressure sensor BMP280, will be used. The barometric pressure sensor is used to sense the depth of the AUV because water pressure increases with depth where the water up above weighs down on the water below.
- Four electronic speed control (ESC) is used to change the speed of an electric motor or thrusters, its route and also to perform as a dynamic brake. This device most frequently used for brushless motors basically providing an electronically produced -phase electric power low voltage source of energy for the motor.

1.5.3 Software Design

- The Raspberry Pi python software is used to program, code editor, build automation and to debug.
- The Solid Works Software is used to design the body structure of the autonomous underwater vehicle (AUV).

1.6 Conclusion

This chapter is to introduce about the project, which is the development of Autonomous Underwater Vehicle (AUV) depth control system. Sea exploration is not that simple to accomplish the objective of discovering something new. With technology and engineering innovations, the challenges of exploring the sea will make it easier and also can improve the technology due to the challenges. This development of Autonomous Underwater Vehicle (AUV) using depth control can overcome the challenges of deep-sea exploration. This chapter also discussed the objectives and work scope of this project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will discuss the literature review of development of Autonomous Underwater Vehicle (AUV) depth control and other types of AUV. Besides that, this chapter will also discuss the control system design of Autonomous Underwater Vehicle (AUV).

2.2 Development of Autonomous Underwater Vehicle (AUV)

An autonomous underwater vehicle, or AUV, is a self-propelled, unmanned, untethered underwater vehicle capable of carrying out simple activities with little or no human supervision. AUVs are often used as survey platforms to map the seafloor or characterize physical, chemical, or biological properties of the water. A large variety of AUVs are in existence, ranging from vehicles weighing tens of kilograms, to vehicles weighing thousands of kilograms. Motivations for employing AUVs range from the ability to obtain superior data quality, for example, obtaining high-resolution maps of the deep seafloor, or to establish a pervasive ocean presence, for example, using many small AUVs to observe oceanographic fields. While AUV technology development and occasional scientific use of AUVs have occurred since the 1960s, routine use of AUVs for science is a phenomenon of the last few years. Adoption of AUVs has led to increasing investment in