UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF AUTONOMOUS UNDERWATER VEHICLE (AUV) ATTITUDE CONTROL 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 & Robotics) with Honours.

by

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Tajuk: DEVELOPMENT OF AUTONOMOUS UNDERWATER VEHICLE (AUV) ATTITUDE CONTROL BY USING RASPBERRY-PI

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APPROVAL

This report is submitted to the Faculty of Electric and Electronic Engineering 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 Honors. The member of the supervisory is as follow:

Signature: ……………………………………………….

Supervisor: MOHD ZAIDI BIN MOHD TUMARI

ABSTRAK

Projek ini menerangkan perkembangan Kenderaan Bawah Air Automobi (AUV) untuk sistem kawalan. Antara perubahan kaedah pemeriksaan di bawah air, menggunakan robot tenggelam berakhir popular dan lebih banyak kecekapan. Oleh itu untuk melaksanakan tugas ini, kami mencadangkan sistem kawalan dan menjelaskan kebolehcapaian sistem yang dicadangkan dalam masalah ini. Untuk reka bentuk sistem kawalan, analisis simulasi diterajui. AUV memerlukan kebolehan positif dan kebergantungan yang luar biasa untuk bergerak akibatnya dalam keadaan permukaan mana-mana yang terendam dengan matlamat pengawal PID disambungkan untuk memberikan kestabilan yang lebih besar. Berdasarkan analisa, sistem kawalan sudut disusun dan diciptakan sebagai model prototaip sistem kawalan. Eksperimen diarahkan dalam tangki ujian untuk memperlihatkan kecukupan rangka kerja yang dicadangkan. Hasilnya menunjukkan bahawa sistem yang dibangunkan adalah sangat berharga untuk mengawal sudut-sudut AUV.

ABSTRACT

This project describes development of Autonomous Underwater Vehicle (AUV) for attitude control system. Among changes inspection method of underwater, utilizing submerged robot ends up popular and more proficiency. So as to accomplish these tasks, we propose an attitude of control system and clarify the accessibility of the proposed system in this paper. For the design of the attitude control system, simulation analysis was led. The AUV needs the positive buoyant and the extraordinary dependability to move consequently in any surface condition submerged with the goal that PID controller was connected to give greater stability. Based on the analysis, a pitch angle control system was structured and created as the model of the prototype of the attitude control system. An experiment was directed in a test tank to exhibit the adequacy of the proposed framework. The outcome demonstrates that the developed system is valuable for pitch angle control of the AUV.

DEDICATION

From love, dreams and sacrifice from my whole life, I acknowledge it not enough to be proud without my father, Sofian Gan Bin Abdullah that I have learned more valuable thing from him. Thus, dedicated to my father who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, Rohana Binti Ahmad who taught me that even the biggest task can be accomplished with step by step at a time. To my teammates who support me and help to achieve this project. I never expected this far my journey to get the knowledge. A big thanks for all that always support me and believing in me. Thank you.

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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

AUV	Autonomous Underwater Vehicle
ESC	Electronic Speed Control
NOAA	National Oceanic and Atmospheric Administration
DOF	Degree Of Freedom
ROV	Remotely Operational Automobile
PID	Proportional-Integral-Derivative controller
HFR	Horizontal Front Right
VRL	Vertical Rear Left
SISO	Single-input single-output
LQ	Linear-Quadratic
IMU	Inertial Measurement Unit
LAN	Local Area Network

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this chapter 1, it explained about introduction of this project. The introduction contains the background of the project, problem statement, objective, work scope and conclusion of development of autonomous underwater vehicle (AUV) for attitude control (pitch) system.

1.2 Project Background

Recently, the investigation of underwater vehicle is currently much progressively renowned with the ascent of the ocean advancement. In especially, an enormous measure of the sea vehicle investigates, similar to the investigation of undersea pipeline, angling resources, and the mineral resources are being finished. Since people can't access the underwater condition straight, there is a raising interest of underwater automobile, which is planned to develop such vehicles with an expanded capacity moreover. Thusly, AUV were create since it mainly functions capacity to significantly help individual to achieve submerged if wish to achieve something work. AUV work with robotized, nor utilize any links for associating with vehicle move unbounded zone. At the point when contrasted with AUV which incorporate power discussion and links, when the test is unquestionably physically worked by people, the visual details of the undersea camcorder is limited, to guarantee that it needs to get a progressively great range innovation.

1.3 Problem Statement

Nowadays, Autonomous Underwater Vehicle (AUV) is very famous vehicle that were used in ocean or under water to help human to do some task. AUV is robotic device that is driven through the water using propulsion system, control by computer and of cost to make this AUV will be very expensive. After that, operation underwater certainly is one of the most challenging environments due to nonlinear disturbance like ocean wave and currents which make control and navigation very difficult to handle.

1.4 Objective Research

1. To develop an autonomous underwater vehicle (AUV) attitude control system using PID controller.
2. To design electronics, mechanicals and software of AUV.
3. To stabilize the pitch angle of AUV.

1.5 Project Scope

In this project, the point is to create self-sufficient autonomous vehicle for attitude control system. Project scope is a rule to influence this undertaking to succeed and give simple approach to complete this task. There are few ways of design that involve in this project such as mechanical design, electronics design and software design.

1. Mechanical design

- To develop an underwater device using water proof motor, PVC tank for the robot body and the acrylic plastic that function to cover up the body. The structure of this AUV is design and draw using Solid work software before build the hardware.

2. Electronics design

- Raspberry Pi 3 B+ as microcontroller used to control and conduct the whole system and BerryIMU v2 sensor to stabilize.

-An electronic speed control or ESC is an electronic circuit that control and regulates the speed of an electric motor.

-Thruster is a transversal actuation device built or mount in of AUV to make it more maneuverable.

3. Software design

- Use software python to make coding and use to simulate the signal from sensor.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Autonomous Underwater Vehicle (AUV) are underwater robot used in underwater exploration, whether in industrial, marine, study or work. As the name AUV implies, which means the movement control of such vehicles are fully controlled by human remotely but different from controlling a vehicle on the road surface, underwater vehicle needs to consider a lot more movement possibilities, especially vertical movement whereas this movement are label as the vehicle buoyancy.

2.2 Previous Project Research

The buoyancy control is needed since the ROV was designed to be able submerge and emerge. To perform desired task, it is difficult to get the ROV to maintain and stable at a constant depth. Mohd Shahrieel Mohd Aras *et al.,* (2015) has provides this study paper. In this paper analysis, it represents the outlook and improvement of a small level underwater Remotely Operated Automobile (ROV) and modeling the depth response of the ROV using System Identification Toolbox. This task is to focus on control the vehicle using remote control for depth control. To oversee the depth, this project used PID controller to make the depth can be reached by the ROV. The focus of the controller style will have to make sure that the ROV is ordinary stable and will maintain position at the specific depth in an original underwater environment. The project design is just small scale

ROV. The capability must achieve by this ROV is to decrease under the water surface until 50m maximum. This model has been built with a depth sensor to monitor its depth through the plan and an IMU sensor to help a driver when generating the ROV which giving required details such as for example pitch and roll of the ROV. The focus for this ROV is to conduct or observe in underwater. A transfer function was obtained using identification that was used to create a controller.

The common problem for ROV control system design is including a variety of nonlinear and modelling parameter unreliability. Moreover, the problem that need to be consider including hydrodynamic nonlinear, inertial nonlinear, and problems related to the coupling between the Degrees of Freedom (DOF). Many of the researchers must ignore some unsure in the parameters to reduce the difficulty to design the controller. A Proportional-Integral-Derivative controller (PID) is the simple control technique that has been used because of the simplicity of its implementation. A PID controller for tracing has been implemented on the ROV. Figure 2.1 shows that the example of ROV with contain PID as control technique.

Figure 2.1: The example design of ROV

Thomus Thuesen Enevoldsen *et al., II (2018)* has proposed this research. This research represents about simplified modelling and recognition of an Inspection ROV. The ROV is powered by three thrusters, two rear thrusters and one upward thruster, making this an under-actuated vehicle. For the buoyancy control the ROV has adjustable ballast, allowing for positive, negative and neutral buoyancy. The vehicle is rated for 300m depths and has forward speed maximum of approximately 2.1m/s. The ROV is powered and controlled through the tether, where the software is written in C++. The current platform includes built-in PID controllers so that the user can manually tune using the Video Ray Cockpit.

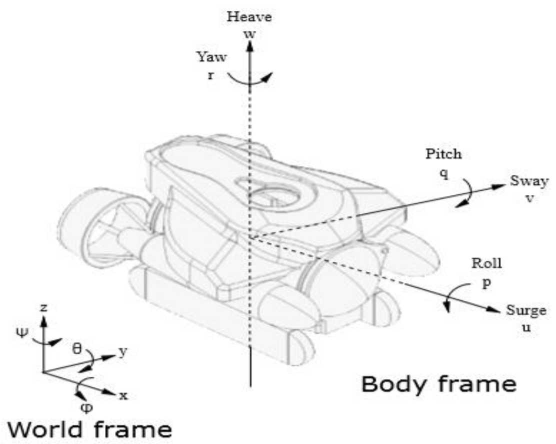

Figure 2.2: Reference frame and notations

Figure 2.2 shows that the model structure for the thrusters and drag force is obtained based on previous work from Mai et al. (2017) and Wang and Clark (2006). The quadratic formula is useful, since it simplified the process in order to identifying of the model parameters, due to the generalization of the characteristics into a linear and quadratic term. This structure is suitable for this model parameters if the operation of the actual ROV take place in a similar environment. Also, the experiment that performed later, make it happen so that the different environment parameters are identical from each other. The quadratic structure also captures the dominant linear behavior of the drag forces at lower velocity's (Wang and Clark (2006)).