UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE DEVELOPMENT OF ACTIVE BUOY CHARGING STATION FOR REMOTELY OPERATED UNDERWATER VEHICLE (ROV) USING SOLAR POWER

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

by

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I hereby, declared this report entitled "The Development of Active Buoy Charging Station for Remotely Operated Underwater Vehicle (ROV) using Solar Power" is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment 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:

………………………………

(Mr. Mohd Zaidi Bin Mohd Tumari)

ABSTRAK

Stesen boya pengecasan aktif direka dalam projek ini untuk tujuan mengecas kenderaan dalam air kawalan jauh (ROV). Sistem boya dikawal oleh UNO mikropengawal Arduino UNO. Tujahan ini menyediakan akses kepada gerakan untuk boya. Panel solar membekalkan tenaga untuk menyimpan dalam simpanan bateri. Oleh itu, bateri boleh digunakan untuk pengecasan ROV. GPS akan menyediakan lokasi boya aktif dan boya akan bergerak ke ROV untuk mengecas bateri ROV. Pengekodan dibina dalam perisian Arduino dan dipasang kepada perkakasan untuk penyelakuan. Akhir sekali, perkakasan dan perisian digabungkan semua bersama-sama untuk menguji dan menyelesaikan masalah ralat. Hasil yang diharapkan dicapai bahawa sistem boya aktif akan bergerak ke arah ROV dengan menggunakan modul GPS. Sistem ini boleh sendiri pengecasan-dengan menggunakan panel solar dan menghantar tenaga kepada ROV.

ABSTRACT

The active buoy charging station are designed in this project for the purpose that use to charge the remotely operated underwater vehicle (ROV). The buoy system is controlled by the Arduino UNO microcontroller. The thrusters provides the motion for the buoy. The solar panel provides the energy to store in the battery storage. Therefore, the battery can be used for ROV charging. GPS will provide the location of the active buoy and it will move to the ROV to charge the battery of the ROV. The coding are constructed in the Arduino software and installed to the hardware for the simulation. Lastly, the hardware and software combined all together to test and troubleshoot the error. The expected result is achieved that the active buoy system will move towards the ROV by using the GPS module. The system can self-charging by using solar panels and transmit the energy to the ROV.

DEDICATION

To my beloved parents, whose motivate and inspire me all the ways since the beginning of my studies. They sacrifice their priorities and make efforts for me to be here today. Their love, dream and sacrifice are great source to encourage and strengthen me throughout my life. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to achieve my dreams.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ROV	**Remotely Operated underwater Vehicle**
GPS	**Global Positioning System**
SAR	**Specific Absorption Rate**
FFT	**Fast Fourier Transform**
SD	**Secure Digital**
OS-IS	**Ocean Seismic-Integrated Solution**
AGI	**Assist in Gravitation and Instrimentation**
INGV	**Istituto Nazionale di Geofisica e Vulcanologia**
ISPRA	**Istituto Superiore per la Protezione e la Ricerca Ambientale**
DICCA	**Dipartimento di Ingegneria Civile,Chimica e Ambientale**
AUV	**Autonomous Underwater Vehicle**
LAN	**Local Area Network**
PAM	**Passive-Acoustic Monitoring**
RAOS	**Real-time Acoustic Observing System**
PC	**Personal Computer**
ASV	**Autonomous Surface Vehicle**
LBL	**Long Base Line**
KB	**Kilobit**
SRAM	**Static Random Access Memory**
EEPROM	**Eletrically Erasable Programmable Read-Only Memory**
USB	**Universal Serial Bus**
PWM	**Pulse Width Modulation**
TX	**Transmitter**
RX	**Receiver**
DC	**Direct Current**
AC	**Alternating Current**
RPM	**Revolutions per Minute**
LCD	**Liquid-Crystal Display**
IO	**Input and Ouput**
ADC	**Analog to Digital Converter**

RS	**Register Serial**

CHAPTER 1
INTRODUCTION

1.0 Introduction

In this chapter, it delivers an introduction about this project. The introduction mainly describes about the background, problem statement, objective, scope and thesis outline of the project given which is the development of active buoy charging station for remotely operated underwater vehicle (ROV) using solar power**.**

1.1 Background

A buoy defines as a float moored in water to mark a location, warn of danger, or indicate a navigational channel. The first buoy existed in 13^{th} century, it used to guide the ship to avoid obstacles and provides safety purpose on oceans. After a few centuries, the buoy becomes more modern to carry out different types of function. There are some buoy still carry out the safety purpose, but got improvement about adding the GPS which can monitor by the satellite and gives a coordinates for location. Other than that, the buoy also used in marine navigation to discover the marine life in the oceans. This may help to study the marine biology. Lastly, the buoy also used in climate prediction, it will collect the data to the controller and helps to predict the climate or can detect the sudden changes in the oceans to avoid natural disaster.

1.2 Problem Statement

An active buoy is a floating device that can have many purposes. It mainly uses for sea mark, oceanographic research, climate prediction and for safety purpose. Nowadays, most of the buoy is used to collect data on the sea and it is less for using to charge Remotely Operated Vehicles (ROV). Weather of a particular place is important for some of the occupation such as fisherman, diver and sea transportation. The information can be collected and interpret to prevent from danger. Remotely Operated Vehicles is submerge all the time inside the underwater. It will stop functioning when battery drained. Thus, active buoy is used to ensure the ROV operated all the time by providing energy to ROV when battery is low.

1.3 Objectives of Research

1. To develop an active buoy charging station by using solar power.
2. To design the mechanical structure, electronic circuit and control of the buoy.
3. To implement the GPS module for localization of the buoy.

1.4 Scope of Research

A working scope that is a guideline that ensures that the project accomplished to the objectives that provides an easy way to finish the project. There are a few ways of design that conduct in this project.

1. Mechanical design

   -To design an active buoy that consist of a tube that provides a base for floating and the solar panel is used to charge the lead-acid battery that provides the storage of electricity.
   -To develop an active buoy consists of waterproof thruster for the motion of the buoy.

2. Electronic design

   -Arduino Uno use to control the whole system and the GPS shield provides location and send to the buoy and user.

3. Software design

   -Arduino programming and GPS module programming are used in this project.

1.5 Thesis Outline

The structure and design of the thesis are as follows:

Chapter 1 – Introduction: This part is briefly explained about the introduction of the whole project through the problem statements, objectives, scopes of the project.

Chapter 2– Literature Review: This part provides a reference of the previous researchers and the existing project that how to give a guideline and details to do the project.

Chapter 3 – Methodology: This section clarifies about the technique of this project, which describe the working scope and method to build up the project and furthermore approach taken with a goal to finish the project which the equipment parts and programming will be highlighted.

Chapter 4 – Result and Discussion: This chapter will consider about the desired result of the movement of the active buoy.

Chapter 5 – Conclusion and Recommendation: This chapter will write a conclusion about the whole project and future expectations that can be done for the future project.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter will discuss about the concept and method on previous related projects in related books, journals and website.

2.1 Previous Project Research

Active buoy is a real time communication tool on the sea via satellite telecommunication for collecting meteorological and oceanographic data from remote ocean areas to help and understand the global weather, climate and marine life.

Huang et al (2013) proposed this research paper. In this paper, an economical, low cost, flexible and high accuracy GPS was introduced that purpose to check the wave parameter which are delivered from SAR picture reversal. Tide data is removed by wavelet transform, wind wave data is used to calculate the spectrum by Fast Fourier Transform (FFT). In the experiment, GPS buoy will show its performance to monitor the wind wave. The outcomes of this experiment are compared with the data calculated using the SAR method in which the data can reach the satisfaction and acceptable accuracy.

The design of this experiment, to make the buoy flexible to monitor the wave parameter and more economic in the sea area. It is using a cheap balata as the base of the buoy and filling with plastic sheet inside the balata, the GPS receiver is fixed on the center that show in Figure 2.1.

Figure 2.1: Structure of the buoy

The GPS receiver is waterproof so it can resist the sea water from overlapping the buoy. The buoy will not submerge easily because the balata is a rubber tire which can float on the sea surface. Besides that, this simple GPS buoy collects the data and transfer it by Bluetooth device in the hand phone and then the data will be transferred using an SD card to the computer and proceed it using Matlab to calculate the wave parameters. The advantages of the GPS buoy is it can afford, low operating cost for small private sectors and easy to be used for monitoring the sea areas that use in interest. Figure 2.2 shows the method of data transfer from the buoy to the computer.

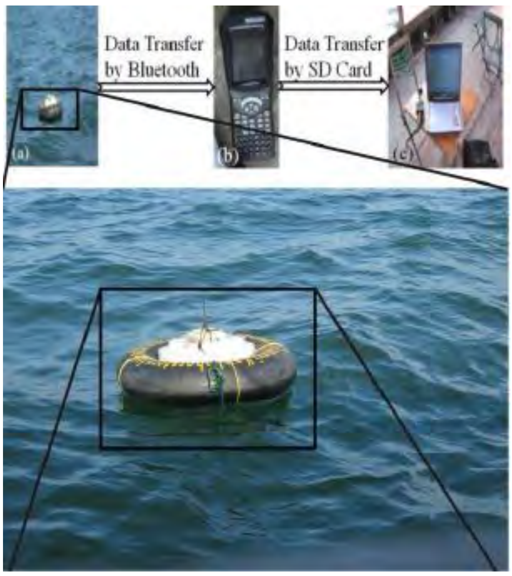

Figure 2.2: Method of the data transferred

This buoy is to study the tropical marine monsoon climate that located in Beihai city, Guangxi province, China at latitude of 21.39 °N through 21.41°N, a longitude of 109.11°E through 109.13. °E. The area of study is around 24km^2. The plenteous fishery resources area, the average temperature is 21.9℃, the minimum temperature is at 2℃, the maximum temperature is 37.1℃, the normal daylight 2009 hours, the average rainfall 1670 mm, the primary meteorological disaster is a hurricane, 10 level tropical storm achieves 6 times in consistently.

Tahara et al (2013) proposed this research paper. This paper study about the calculated wave values using by Fast Fourier Transform (FFT) method comparing with the satellite data. The safety moored buoy system is used to collect the valuable data that analysis from a tension gauge and an accelerometer and calculated by Fast Fourier Transform (FFT) method. A logging system is used for operation and accessed on the buoy system.

According to this research paper, three batteries are used in the logging system and the battery capacity is 66Ah and voltage 7.8V. It's an operation period of 13.4 months. Therefore, this logger is a super low power consumption type of buoy. Moreover, the data is stored in SD card on the logging system have total data volume was about 1.47G bytes, after 13.4 months the data were 5680. The data acquisition rate was 97%. After collecting data from these buoy system analyses of the data confirmed that the equipment operated safely and acquired data for one year in an environment of about 0°C and the data were validated using the acquired data. Figure 2.3 shows the logging system that stored the information.

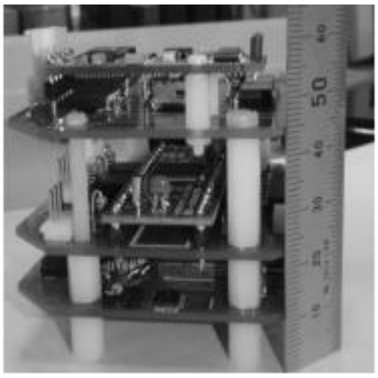

Figure 2.3 Logging system

Joe et al (2014) composed this journal. In this journal, wave's powered energy is sources of energy that generates the robotic buoy system for long term operation. They made a new prototype of buoy system that consists of propulsion system and power generation system. They adopt the wave glide platform to hold the position of the buoy and built-up a flip type self-rectifying wave turbine system. They also created a new modelling equations for the proposed system and simulated in numerical software. The buoy system is tested for the energy harvesting power and the station keep ability. This new buoy system provides a sufficient energy to operate on the sea surface and can collect the observation data with a good precision and high accuracy.

The focus on this project is station-keeping without mooring, survivability and power generation for long-term operation. The propulsion system is a solution that helps the buoy for station keeping without mooring and continuous patrol around a certain place. This system consists of the wave glide that provides the buoy driving forward without using any energy and optimized rudder help to control the direction of the buoy.

Besides that, the buoy also consists of a Power Take-off system that supply to the long term observation stationary. The energy is used is wave energy and this energy is extracted from the flip-type wind turbine system. The wind turbine system will move on two different stages which is a vertical and horizontal stage. The turbine at the buoy will get the potential energy as the waves pass over in vertical stage. While in horizontal stage, the turbine will move up and down to create a drag force and convert as a torque by the flip wings. Figure 2.4 shows the prototypes of Wind Turbine System.

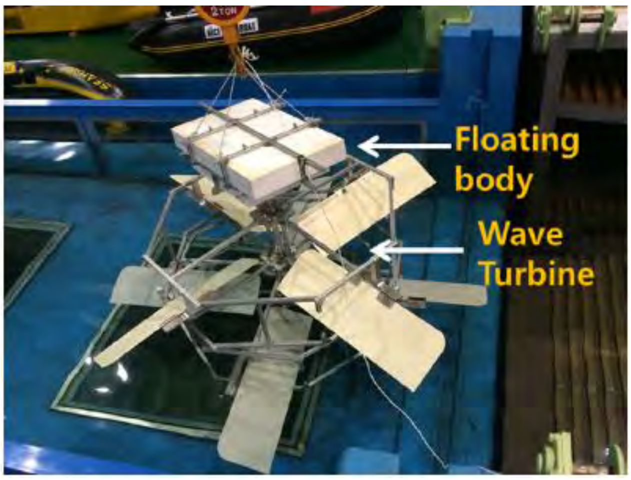

Figure 2.4: Prototypes of Wind Turbine System

L. Iafolla et al (2015) proposed this research paper. In this paper is discussed about the enhancement of safety conditions and to decrease the risks by the development of a coupled monitoring and forecast system of the sea-state outside the main harbors of the Northern Tyrrhenian and Ligurian Seas. The ocean and wind estimates are accessed by using a numerical model specifically implemented for this project and the monitoring system is made of measuring stations installed on the coast near the harbor areas.

According to this paper, the OS-IS monitoring system is a high sensitivity accelerometer (provided by AGI) and specifically developed algorithms that evaluates the sea waves by processing the micro-seismic signals. With this method, we can measure the power spectrum of sea waves (not directional) from which we can evaluate the most important parameters like: significant wave's height (Hs), mean period (Tm), peak period (Tp). This system installed on a regular building and it is easy to install, maintain and protected from environment. The data analysis compared to the buoy ISPRA it shows a good correlation (>90%) and a lower limit in the measurement of the Hs (from 0.2 to 0.4 m). Figure 2.5 shows that the OS-IS system that collects data from each measurement station and transfer to the server through internet connection. While in Figure 2.6 shows that the data logger is collected in three different stations and it transfer the data through internet connection to the central server and compare the data collected by the buoy INGV and ISPRA.

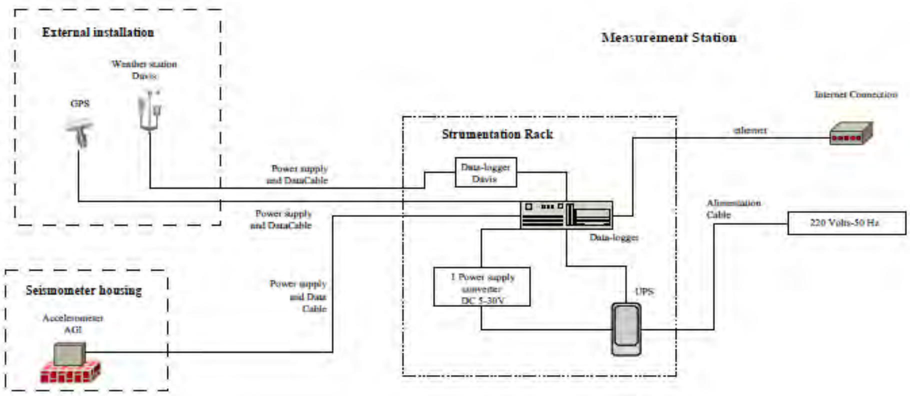

Figure 2.5: Each measurement station is multi-parametric including the accelerometer, which is the core of OS-IS, a weather station and a GPS to synchronize the data from other stations. The Data logger stores and sends the collected data through an internet connection to the server.