DEVELOPMENT AUTONOMOUS SURFACE VESSEL HYDROGRAPHY SYSTEM FOR HYDROGRAPHY SURVEY AND STRUCTURE INSPECTION

W. M.Dahalan[1], A.S Mamat[1,] A.M Abdullah [1,] A.G Othman[2] N. Mohamid Salih[1,] M.R Zoolfakar [2]

[1]Marine Electrical & Engineering Section, Universiti Kuala Lumpur, Malaysian Institute of Marine Engineering, Technology Lumut, Perak, Malaysia

[2]Entrpreneur Management Section, Malaysian Spanish Institute ,Kulim Hi-Tech Park, 09000 Kulim, Kedah, Malaysia.

[3]Marine and Electrical Engineering Technology Section, Universiti Kuala Lumpur, Malaysian Institute of Marine Engineering Technology Lumut, Perak, Malaysia

Corresponding Author: wardiah@unikl.edu.my

ABSTRACT

Hydrography is the scientific method which evaluates and defines the physical characteristics of water sources and areas of land relatively close to those water bodies. For studying, it implies getting the information or information about the hydrographic information by utilizing the reverberation sounder idea. This final year project is about to development Autonomous Surface Vessel (ASV) Hydrography System for Hydrography survey and Structure Inspection. Structure inspection for this project is about to make the visual inspection such as bridge and under deck structure. Design of this project's system will fulfill the characteristics of the hydrography survey, and this system will be installed into the prototype boat. This project using the hardware system consists of Arduino Uno as the microcontroller that act as a processor for this system. Information of data that been gathered will be handled utilizing this Arduino and transmitted the information to LCD to be show.

Keywords: *Hydrography System, Autonomous Surface, Structure Inspection, Hydrography survey*

1. INTRODUCTION

At present, an Autonomous Surface Vehicle (ASV) hydrography system is about to build the system that make hydrography survey and structure inspection fitted into a small vessel with navigation and power systems enabling functions to be carried out autonomously. The hydrography system is to perform hydrography survey. Hydrography survey is the science of measuring and identifying features that affect underwater navigation, underwater construction, dredging, offshore oil drilling and associated activities. Besides, this system also able to conduct civil structure primary visual inspection such as a bridge and under deck structure. Using this hydrography system on ASV, it can reduce manpower and reduce their risk during inspection work. This hydrography system consists of variety types of hardware and sensors use to make hydrography survey, that show the system is very sophisticated to use and easy maintenance. In this project is use Lithium-Polymer battery as the main power source for this ASV hydrography system.

The ocean contributes more range area than land area in this earth's surface that may lead a lot of activity can undergoing on the ocean which can contributes to human resource. The ocean also an important medium in the industrial development of a country through maritime operation. Maritime territories have long been engines of economic development, offering natural resources and access to commerce and transportation, tourism opportunities and others. Therefore, there is a need for hydrography surveys and civil structure inspection activities to ensure that the ocean environment is maintained for maritime activities.

The problems that related to this hydrography survey collecting oceanic data, performing surveying operations, performing rescue operations or military operations in the water can be expensive and dangerous if done by humans. [1], In order to limit the to reduce the cost of doing this hydrography survey, a hydrography system build and fitted into a small boat called ASV can solve this cost problem. This is due to the costs required to produce this system survey boat are not very expensive rather it has the same features as the big boat that did the hydrography survey. It also reduces the risk and manpower to perform this hydrography survey manually, with this hydrography system fitted into ASV

boat, it is easy to control and can make inspections in areas difficult for a human body to enter this specific area such as under a bridge.

Also, the problem that can be identified is the greenhouse gases produced by ocean vehicles.[2], the mission performance is poor and little confidence can be given to the results.[3], In order to get the high performance with high quality navigation data, this hydrography system is the best system to execute this collecting ocean data task. Furthermore, monitoring and hydrologic survey in shallow water area where a survey vessel cannot access and it is dangerous for men.[4]. This hydrography system in prototype boat is one of the best system models to replace humans while reducing the risk of them doing hydrographic surveys. The aim of this research is to build the power system with power source (battery pack) on ASV to support requirements for hydrography survey and conduct civil structure, to simulate the system by running the system using a prototype boat and monitoring the marine environment using this hydrography method.

2. IMPLEMENTATION OF ASV

The whole operation of this project is use Arduino as a main brain and Lithium-Polymer battery as the main power source. When the system is switch on, the ultrasonic distance sensor will start to operate which is to measure the depth of water. If the sensor system does not operate or cannot measure the water depth, it needs to recheck the sounder parameter code in Arduino software or check the connection of wire to make sure this sensor can run perfectly.

In this project, the GPS (global positioning system) will install on the Autonomous Surface Vessel prototype boat and it provide the exact location of the boat. Once the data has been collected and analyzed, using GPS it can tell at what latitude and longitude it has shallow or deep waters with the help of sonar. This system also used the camera to conduct surveillance on an area in the sea. This method is very helpful in the marine security sector. This is because the system installed in this small boat can be used as a spy that can make surveillance. When the picture or image that was taken is in not normal, the data collecting (image) can be sent to the authorities to make to ensure that they can act at that place. For example, because of this hydrographic survey, there is data (image) showing the condition under the bridge is damages or cracks under the bridge's structure.

The block diagram is to indicate on how this system work. There are have three data input which are GPS, Ultrasonic Distance Sensor (SONAR), and camera that are the main hardware for this project. The data input by the sensor ultrasonic distance sensor, (sonar) and GPS are transmitting to the microcontroller which is Arduino Uno. The microcontroller then sends the signal to the LCD display. For camera, there is no signal to the microcontroller and it will directly send the signal to the LCD display as shown in Figure 1.

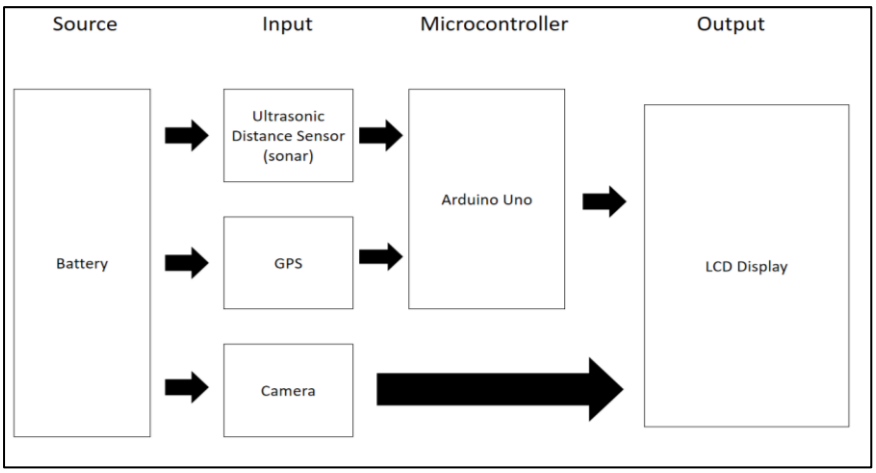

Figure 4: Basic block diagram of system

3. Preliminary Design of Hydrography System on ASV (prototype boat).

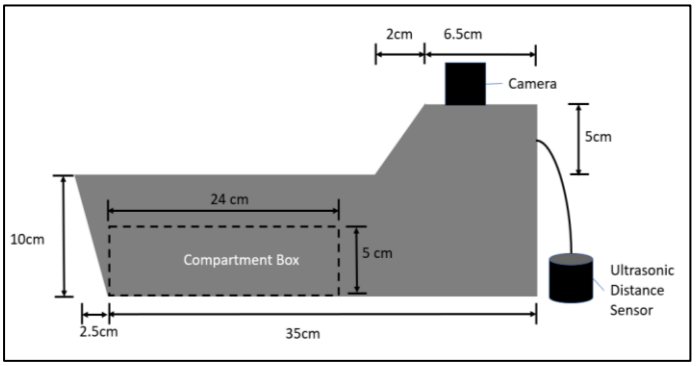

Figure 2: Side view from prototype boat

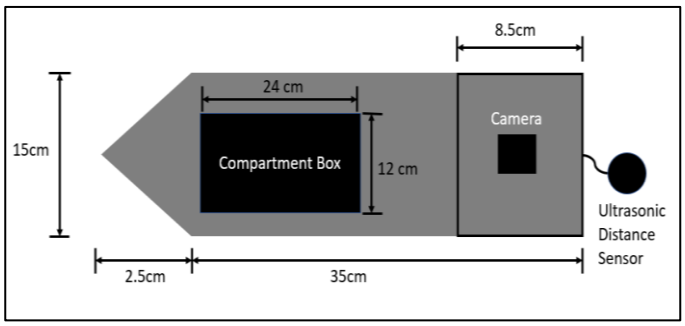

Figure 3: Top view from prototype boat

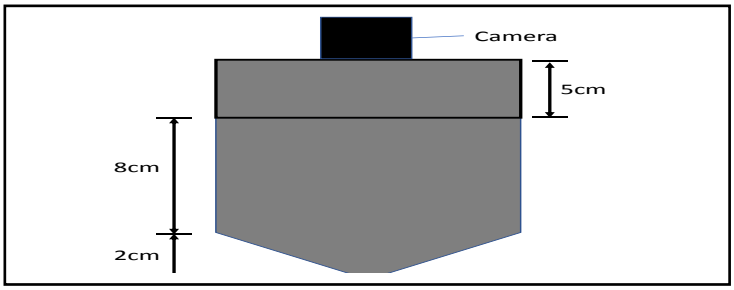

Figure 4: Front view from prototype boat

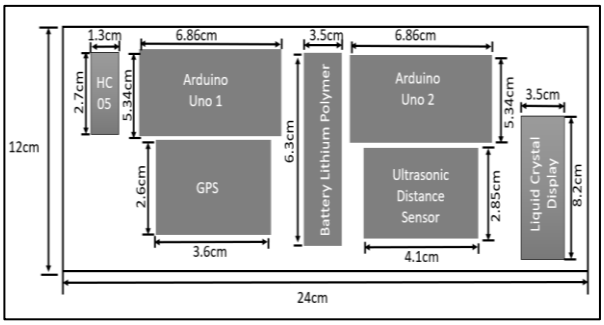

Figure 5: View from the inside of compartment box (system development)

This hydrography system is built and installed in the prototype boat. The camera is positioned high on the boat as it ensures that the view of the camera is large enough for it to record or capture the image when the boat make starting to make a survey. The camera is feature with 140 degree wide angle, so when its position is high (strategic) can perform well structure inspections such as retrieving or recording structural data under a bridge. From the side view in Figure 2, it shows that the ultrasonic distance sensor (Transducer Sensor Waterproof) is put behind (outside) located below the boat area for measuring distance water. The compartment box is in the center or middle of the prototype boat. Inside the compartment box, there are Arduino Uno, GPS-NEO6MV2 module, JSN-SR04T Ultrasonic Distance Sensor, and

Lithium-Polymer Battery. All this equipment is housed in one box, so it is easy to implement and can be integrated in one location. The prototype device construction as shown in Figure 3 to Figure 5 located at the center of the prototype, making sure all the wire is connections can easily be connected to any part of the components. Besides, with this compartment box, environmental factors such as dust and humidity can be avoided which will affect the device functionality or harm the components.

4.0 Data Analysis

The software that have been used for this project is Fritzing and Arduino IDE Software. The data will be collected using this prototype boat that has been installed with hydrographic system. There are three types of data that will be available through this system which are measurement of depth of water, overview of the area in form of footage or image and the position of the boat interpreted by longitude and latitude.

The test of this system will be carried out using a prototype boat that is place in a container filled with water. Obstacle which in this case stones will be scattered at the bottom of the container to make different water depths for testing setup. When the boat is place inside the container, JSN-SR04T will start to measure the water depth and the result will appear on liquid crystal display. To ensure that this JSN-SR04T sensor provides accurate data, result will be compared with the manual distance measurement result. During testing, real time data of latitude and longitude of the boat will be obtained from GPS Neo-6m and display on smart phone. Upon testing, the camera will be set as recording to record video around the boat. These whole sets of features will compliment to be a complete hydrographic boat system.

Basically, this GPS give the exact location of the prototype boat when doing this hydrography survey. When this prototype boat starting to make the survey and the satellite location is fixed, it will give a fixed location to track the data from this GPS neo-6m. The coordinates of the GPS device will display on a smartphone that connected using Bluetooth method. The data that come out from the smartphone's display will be in form of latitude and latitude or in NMEA sentences. This NMEA sentences is a protocol which most of GPS devices support to read longitude and latitude and other GPS data from devices. Most of computer programs that provide real-time position information understand and expect data to be in NMEA format as shown in Figure 6.

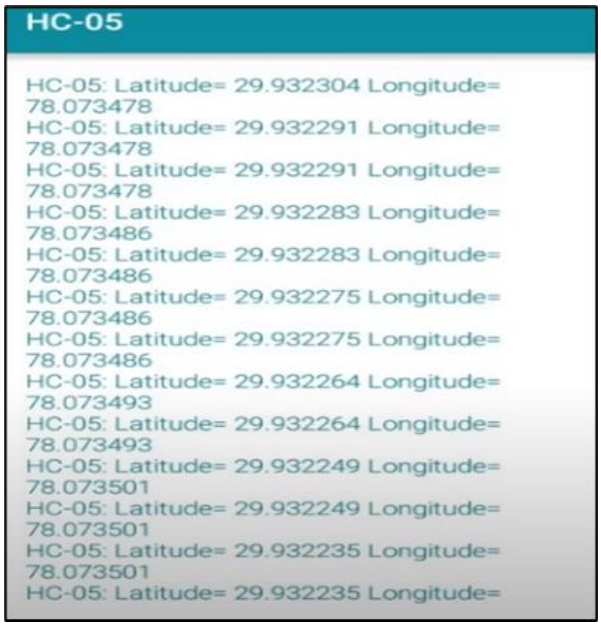

Figure 6: Data of GPS in smartphone display

The position of latitude and longitude of the prototype boat can be getting from this NMEA sentences as shown in figure below. This NMEA sentences need to be interpreted or understand to know the data about latitude and longitude. For example, $GPGLL from the NMEA sentences means it gives the data about Geographic position latitude, or longitude. Beside this NMEA sentences also provide data about where this prototype boat is heading while make a

hydrography survey as depicted in Figure 7.

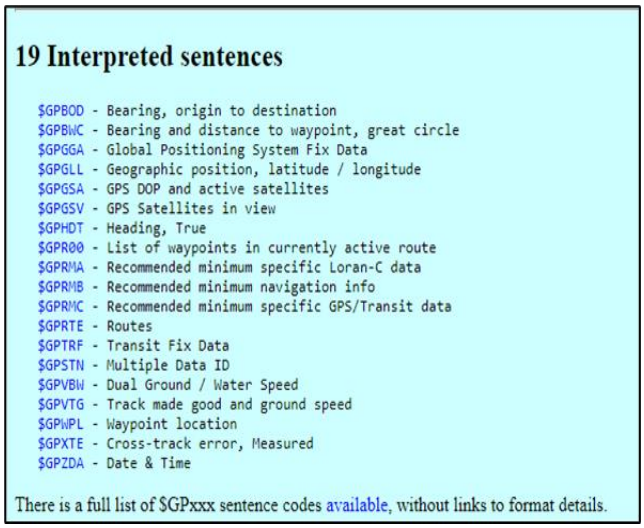

Figure 7: NMEA sentences

When the latitude and longitude of the prototype boat get, download the latitude and longitude data to GPS coordinates in map, so it will show the exact location of the boat in form of map as shown in Figure 8..

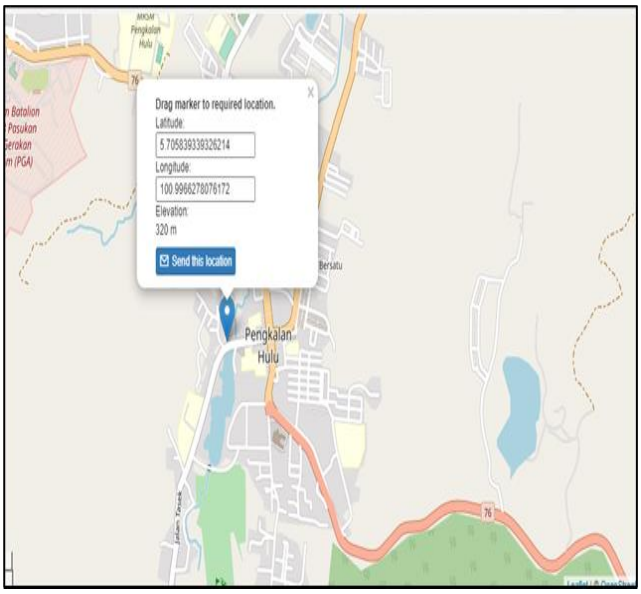

Figure 8: Location get through google maps

4.3.2 From JSN-SR04T Ultrasonic Distance Sensor

This JSN-SR04T works exactly like HC-SR04, the measurement distance is accurate about 0.5cm, the furthest distance can be measured is 4.5 meters (though it can measure up to 6.0 meters). When the prototype boat start to make the hydrography survey task, this ultrasonic sensor makes a measurement depth of the water. In Figure 9, the transducer of the JSN-SR04T is a converter energy, when the radio frequency applied to a transducer assembly so it will cause the unit to oscillate at its natural frequency. When the prototype boat start to make the hydrography survey, so the oscillation will cause acoustic waves to be transmitted in the water. The reflected acoustic energy will cause a reciprocal action at the transducer. If the reflected energy comes into contact with the transducer face natural resonant oscillations will again be produced so these oscillations will in turn cause a minute electromotive force (e.m.f.) to be created which is then processed by the receiver to produce the necessary data for display. The data measurement depth of water will get from the liquid crystal display. The unit distance of measurement can be either in centimeter or in meter. The specification of prototype is depicted in Table 1.

Figure 9: Distance data value for JSN-SR04T displayed at LCD

Table 1: Prototype specification

No	Items	Components / Part	Detail Specification
1.	Dimension	Body of the buoy	• Width : 850mm • Length : 680mm • Height : 200mm
2.	Motor	Solar Panel	• Overall : 220mm x 280mm
		Sea wave generator	• Overall : 70mm x 20mm
		2 Electric Motors	• Dimension : 40mm x 15mm • 2 Shaft : 1.5mm • Voltage : 12V
3.	Materials used for the body	PVC	• High impact strength • Corrosion resistance • Less weight • Low maintenance
4.	Primary sources	Battery	• 7.2V - 1800mAH
5.	Renewable energy	Solar energy	• Renewable energy • Do not cause pollution • Generate electricity
		Wave energy	• Renewable energy • Do not cause pollution • Generate electricity

5.0 Conclusion

A real prototype of the RC Buoy with the renewable energy sources and the PVC body had been successfully fabricated with the selected materials. It follows strictly all the designs and specifications to ensure it is able to recharge the battery for extended battery life. The performance of the completed RC Buoy has been successfully tested and analyzed to look for any weaknesses and for future enhancement. The prototype is done with an effective cost suitable with all selected materials and design needs. Using this hybrid system is effective because the hybrid system consists of more than one source of solar panels and wave of the generator are coupled together in one system, compared to a single source. The hybrid system is suitable and can be used in many areas because it does not depend on a single source to support it.

References

[1] Lindroth [formerly Tyrberg], Simon, Buoy and Generator Interaction with Ocean Waves: Studies of a Wave Energy Conversion System, 2014)

[2] Wenjie Chen, Dehong Xu, Nan Zhu, Min Chen, Frede Blaabjerg, "Control of Doubly-Fed Induction Generator to Ride-Through Recurring Grid Faults", 2016

[3] Hao Chen, Alireza Khaligh, "Hybrid Energy Storage for Unmanned Aerial Vehicle (UAV)", Science and Technology Journal, (2010).

[4] Tianze LI, "Research on New Technologies of Photoelectric Conversion Efficiency in Solar Cell", IEEE, Science and Technology Journal, (2010)

[5] Kostyantyn Sydorenko, "Flying of The UAV by the solar energy", IEEE, Science and Technology, (2012)

[6]"Hybrid Wind and Solar Electric Systems". http://energy.gov. DOE. 2 July 2012.

[7] Battery University Website. [Online]. Available: http://www.Battery university.com

[8] A. Lachichi, A. Junyent-Ferre. T. Green, Adria Junyent Ferre, "Power Converters Design For Hybrid LV AC/DC Microgrids", 2017

[9] Li, J., Cushing, S. K., Meng, F., Senty, T. R., Bristow, A. D., & Wu, N. (2015). Plasmon-induced resonance energy transfer for solar energy conversion. Nature Photonics, 9(9), 601.

[10] Sharon, H., & Reddy, K. S. (2015). A review of solar energy driven desalination technologies. Renewable and Sustainable Energy Reviews, 41, 1080-1118