The Application of ROV (Remotely Operated Vehicle) of the Microcontroller Submarine as a Tool to Take Sample of Water and Soil Contaminated by Waste

Muhammad Syukron[1, a)], Nuralif Mardiyah[1, b)], Wahono[2, c)], Ahmad Rosikhin[3, d)], Zamah Sari[1, e)]

[1] *Department of Computer Science, Faculty of Engineering, Universitas Muhammadiyah Malang, Jalan Raya Tlogomas No. 246, Tlogomas, Lowokwaru, Tegalgondo, Karangploso, Malang, Jawa Timur 65144, Indonesia.*
[2]*Department of Agro technology, Faculty of Agriculture and Animal Husbandry, Universitas Muhammadiyah Malang, Jalan Raya Tlogomas No. 246, Tlogomas, Lowokwaru, Tegalgondo, Karangploso, Malang, Jawa Timur 65144, Indonesia.*
[3]*Department of Physics, Institut Teknologi Bandung, Jl. Ganesha No.10, Lb. Siliwangi, Coblong, Kota Bandung, Jawa Barat 40132, Indonesia.*

[a)] Corresponding author: syukroneko@gmail.com
[b)] nuralif@umm.ac.id,
[c)] j_wahono@yahoo.com,
[d)] a.rosikhin86@yahoo.co.id,
[e)] zamahsari@umm.ac.id

Abstract. This paper describes ROV (Remotely Operated Vehicle) that can take sample of contaminated water and soil while the operator operates it on the shore or ship. User can operate ROV wirelessly. ROV is equipped with camera, robot hand, GPS, accelerometer, compass, and other devices. The ROV is aimed to help researchers to research contaminated water and soil that can be applied in and on the lake, river, and sea. The way it operates are syphoning water with mini pump and taking soil sample with robot hand. The result shows that all hardware and software can run well underwater. So that, ROV in this experiment can be used to take sample of contaminated water and soil in the place with maximum a depth of 1m. For the next experiment, this ROV will be tested in other place with a depth more than 1m. however, this ROV will continue to be refined to be maximally utilized.

INTRODUCTION

Indonesia's Environmental Status in 2012 presents worrying information about Indonesia's water, air, and sea quality. In terms of water pollution, from 411 monitoring points in 52 national strategic rivers, 75.2% monitored points showed heavily polluted status, 22.52% moderately polluted and 1.73% heavily polluted[1].

One of the polluted river is the Cikijing River. This river crosses 2 regencies namely, Sumedang Regency and Bandung Regency, Cikijing River was originally a natural river which was functioned as rice field irrigation, as well as forests, agriculture and plantations. The Cikijing River in Bandung Regency passed 4 villages, but from year 1994 to 2000 farmers and breeders suffered losses. In year 2000 to 2016, many farmers were out of business, and not a few farmers were reluctant to rent land or use their land to farm again. Based on data obtained from the Office of Agriculture and Forestry of Bandung Regency, Until year 2009 rice fields covering an area of 415 Ha or 42.2% of the total paddy field (983 Ha) in the fourth villages with a yield of around 0.50 - 0.60 tons GK / H were

Advanced Industrial Technology in Engineering Physics
AIP Conf. Proc. 2088, 020016-1–020016-9; https://doi.org/10.1063/1.5095268
Published by AIP Publishing. 978-0-7354-1818-9/$30.00

contaminated by industrial waste in the villages, so that, the productivity level of paddy fields from 1993 to 2009 slumped to 91.17%[2].

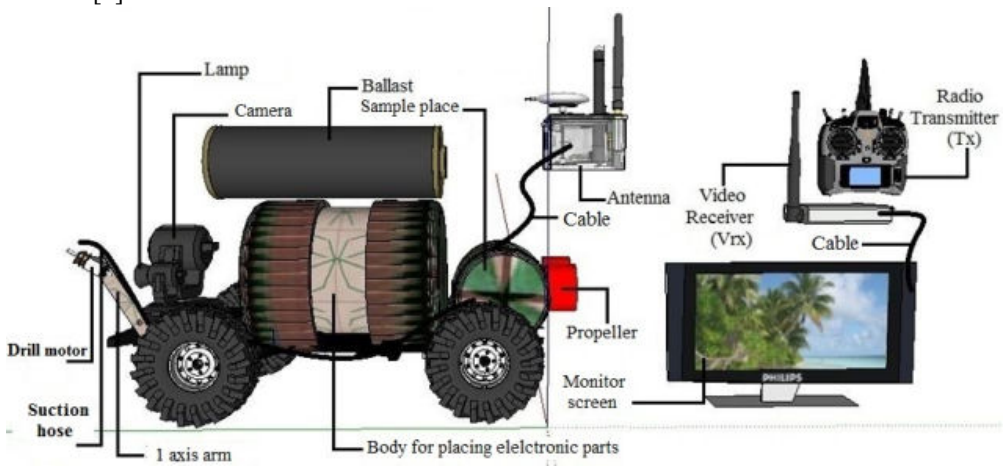

FIGURE 1. Block diagram of the ROV

To respond these issues, researcher needs to conduct a research about quality of water and soil, in order to know what are the substances of them and what decision must stakeholders take for the next. Doing a survey in contaminated place is too dangerous. It is needed special tool to support. So that, we propose a project entitled" Building a Wireless Arduino- Based Underwater Robot (ROV) as a Vehicle to Take Water and Soil Sample that Has Contaminated by Waste". ROV nowadays is used for scientific, military, and commercial applications [3, 4], such as fishery operators, archaeologists, survey rescue workers, surveillance, underwater videographers, and so on [5]. But unfortunately there has not been ROV special for taking sample of contaminated water and soil purposes.

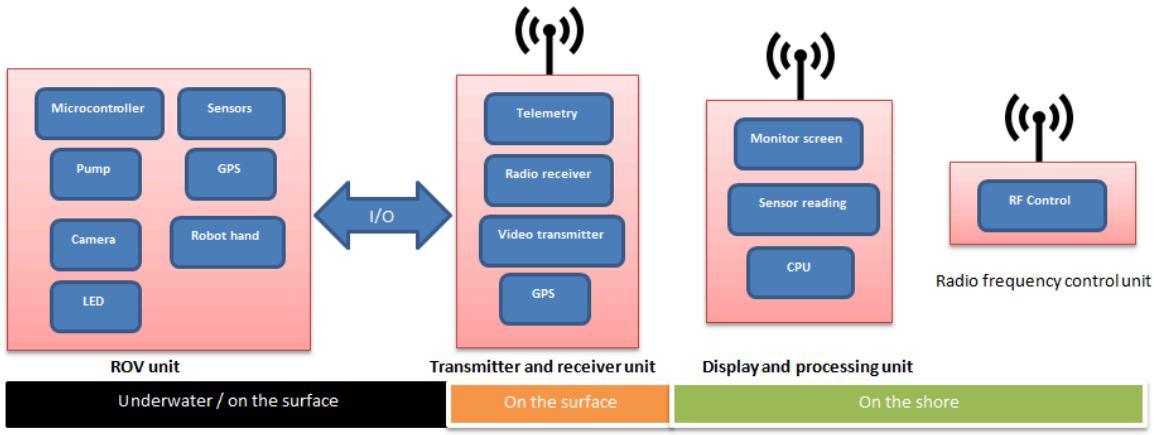

FIGURE 2. Schematic description of ROV system

ROV in this project has strengths, namely it is small, portable, and user friendly. Furthermore, user can control it wirelessly even in a narrow area as shown in figure 1. The device is equipped with a camera to allow user watches surroundings directly, GPS to know it's position and gives it a direction in particular point automatically whenever the signal is lost, sensors to detect temperature, water pressure, speed, tilt information, and lighting to light objects. This ROV can be applied in and on the lake, river, and sea. The Schematic description of ROV system is shown in figure 2.The way it operates are syphoning water with mini pump and taking soil sample with robotic hand. The

samples are used for research materials of national research institution, such as Indonesian Institute of Sciences (LIPI), Jakarta Indonesia.

METHODOLOGY

Construction of the ROV in General

This ROV consists of two main parts, namely software and hardware. SketchUp Make Software 2016 is used to design ROV, Mission Planner Software 1.3.37 is used torun APM (Ardupilot Mega) device, and Arduino Software 1.6.11 is used to run Arduino. APM is microcontroller that is used to control built-up sensors consists of GPS, speed, height, compass, and accelerometer sensor.

Hardware consists of four main systems. First, control system. User controls device by using remote control. By using this, user can control brushless motor to make ROV go forward and backward, turn left and right, take sample, turn off and turn on LED, dive and float. Two Brushless motors are attached in behind side of ROV connected with ESC (Electronic Speed

Control). The speed of ROV can be adjusted with the help of ESC. This system is also applied in ROV hand to take sample and pump to make ROV dive and float. If pump syphon water, ROV will dive, and if pump removes water, ROV will float. Second, the body. It is built by using

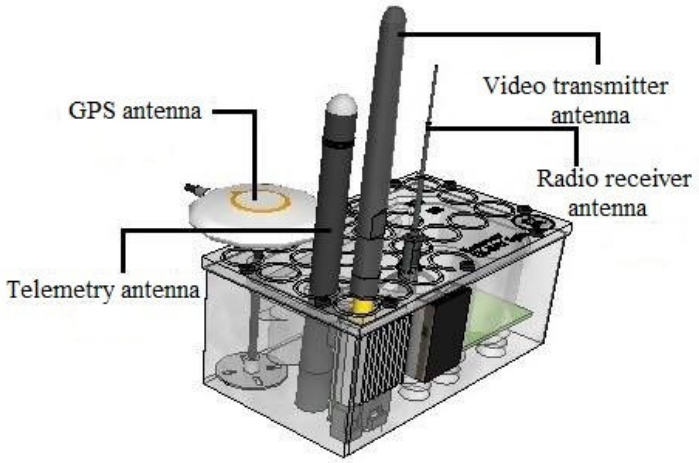

FIGURE 3. Transmitter and receiver unit

PVC pipe. Inside of it, there are 3 Arduino microcontrollers that control hardware such as LED, servo, and so on. Third, transmission part. This consists of video transmitter antenna, telemetry, radio control receiver, and GPS as shown in figure 3. The third transmission parts transmit data wirelessly via antennas. Ground station receives their radio waves and display it on monitor. Forth, it is display. The information on the monitor can be seen on Mission Planner Software as video, location, speed, compass, and accelerometer information.

Ballast System

The function of ballast system is to make the ROV dive and float. It consists of 4 parts, namely PVC tube, electric pump, balloon, and pipe as shown in figure 4. PVC tube is water resistant tube which is used to cover all 3 parts from water. Electric pump is used to syphon and

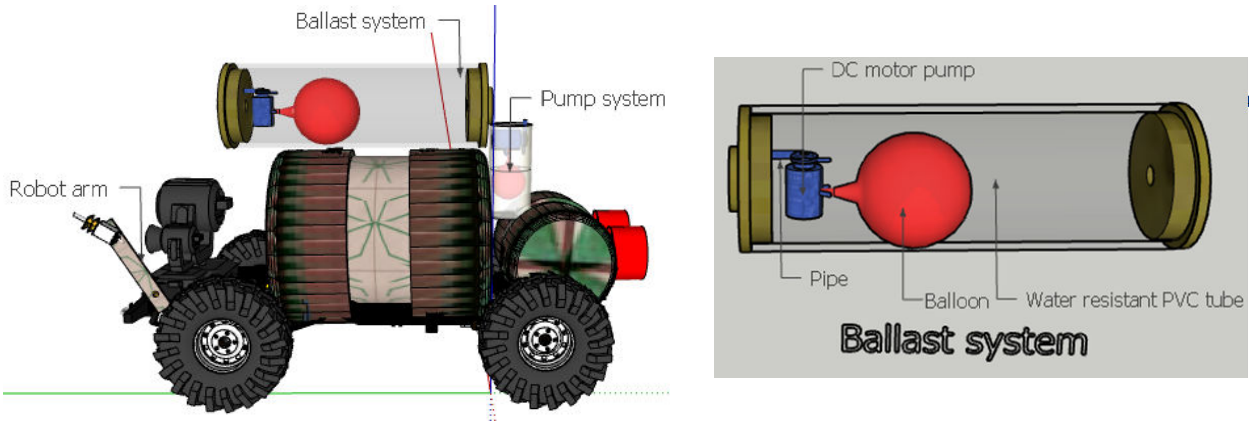

FIGURE 4. Ballast system

remove water to and from balloon. If pump syphon water, it will enter to the balloon and air between the tube and balloon is compressed. The more water enters, the more mass the ROV has, as a result, ROV dives. In opposite, if pump removes water from balloon, ROV mass decreases and air between tube and balloon is decompressed, as a result, it will float.

Pump and Robot Arm System

Sampling system has the same parts and function as ballast system as shown in figure 5. The differences are the size is smaller and the tube material is from plastic. Electric pump is used to

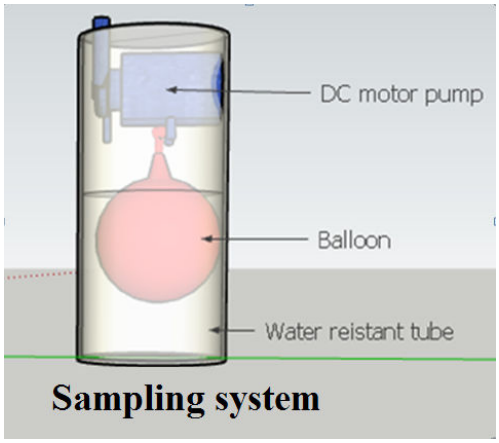

FIGURE 5. Sampling system

plastic. Electric pump is used to syphon cloudy water as sample. Sample is obtained from the movement of robot arm system. Robot arm system, as shown in figure 6 consists of 4 parts, namely servo motor, 1 axis arm, motor drill, and pipe. Servo motor is used to move arm clock

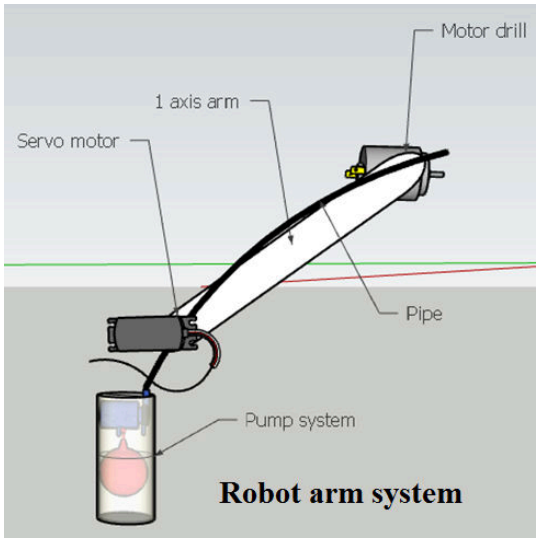

FIGURE 6. Robot arm system

wise and anti-clockwise, as a result, arm moves up and down. Motor drill is used to drill soil. And pipe is used to syphon and remove water and drilled soil to and from the sampling system.

Display System

Display system has two parts in general, namely video transmitter and video receiver as shown in figure 7. Video transmitter contains of two main parts, namely camera and video transmitter module. Camera is placed in front side of ROV to see object and robot arm is placed in front side

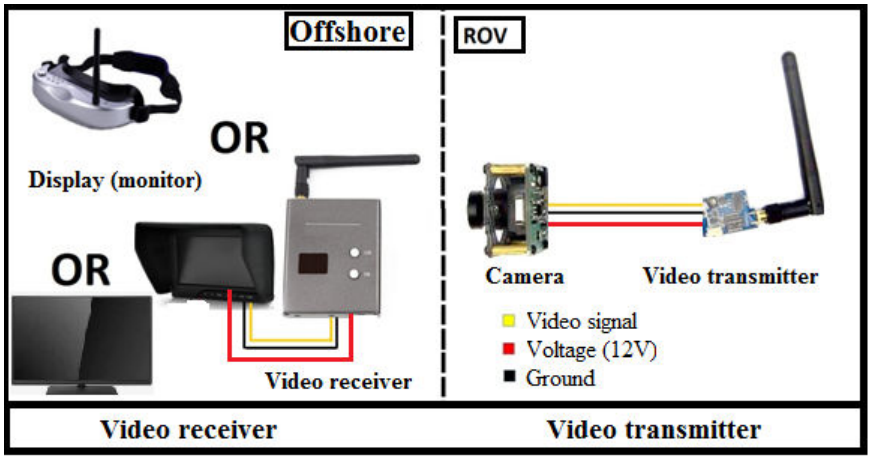

FIGURE 7. Display system topology

of ROV and beside camera can be move up and down as shown in figure 8. Video receiver contains of two main parts, namely monitor and video receiver. It is placed in offshore or in the ship. Both video transmitter and receiver are generated by 12 volt power supply. The camera

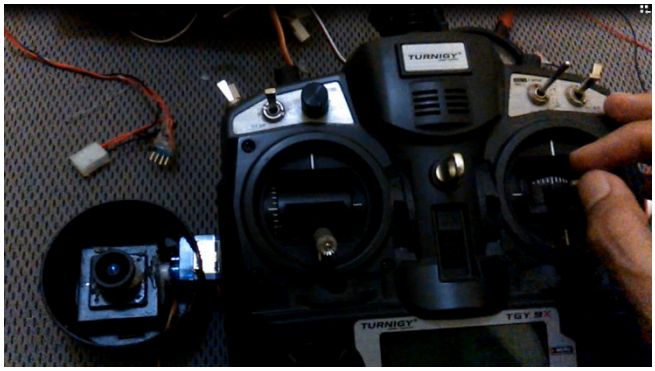

FIGURE 8. Camera movement testing

can be rotated up and down according to the remote control button movement. If the button is moved up, the camera moves up, and if the button is moved down, the camera moves down.

Due to attenuation problem, video transmitter cannot transmit radio wave well. In our research, we use 200mw of power and 5.8Ghz of frequency of video transmitter. It can only send signal maximum in 5cm of depth with 2 meters of distance. Here is the other reference of signal attenuation underwater.

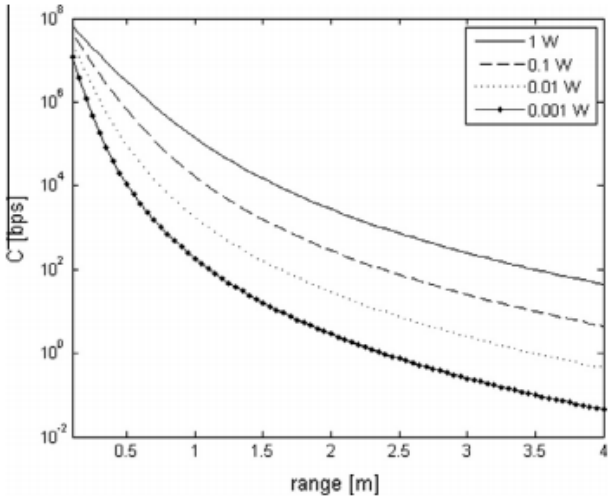

FIGURE 9. Capacity vs. range for four different transmit power values and the 100 kHz–6.35 MHz band. Channel frequency response model (10) of Sea 2 (5 m depth) is used [6].

Figure 9 shows video transmitter with 0.5m in distance can only generate 10^4 bps (10kbps) of data. If we have 0.2 watt (200mw) of power with 0.5m in distance, it may probably can only generate 20^4 bps (20kbps) of data which is not good for video display to see. To solve this problem, we use technique which is written on the contribution point.

RESULT AND DICUSSION

The ROV as shown in figure 10 has been tested in water tub with a depth of 1m. all hardware run well as shown in table 1. Camera can capture picture, transmitter can transmit, ROV can dive and float, go forward and backward, turn left and right, take sample of water and soil, and so on. All software run well too. Testing APM using Mission Planner Software is successful

Table 1. Parameters used in trying out ROV system

No	Parameter	Indication
1	Rotation of propeller A	Successful
2	Rotation of propeller B	Successful
3	Robot arm	Successful
4	Camera	Successful
5	LED	Successful
6	Clockwise and anti-clockwise of brushless rotation	Successful
7	GPS	Successful
8	Diving and submerging	Successful
9	Sample taking	Successful
10	Telemetry	Successful
11	Compass	Successful
12	Accelerometer	Successful
13	Display	Successful
14	All transmitter	Successful

to show GPS, speed, height, compass, and accelerometer data. In it's application, user can control ROV with remote control.

FIGURE 10. The prototype of ROV device

Picture can be captured clearly and sample taking is easy because user only need to watch monitor to control. Controlling system can be used wirelessly. So that, user can use remote control easily to control ROV without any worrying about the number of cables that will make user inconvenience to operate. The sample of contaminated water is filtered by filter paper to

FIGURE 11. The sample of contaminated water before (left) and after (right) filtering process.

sort between water and soil. Water and soil as shown in figure 11 which has been separated can be used as sample to send for research material of eligible institution, such as The Indonesian Institute of Sciences (LIPI).

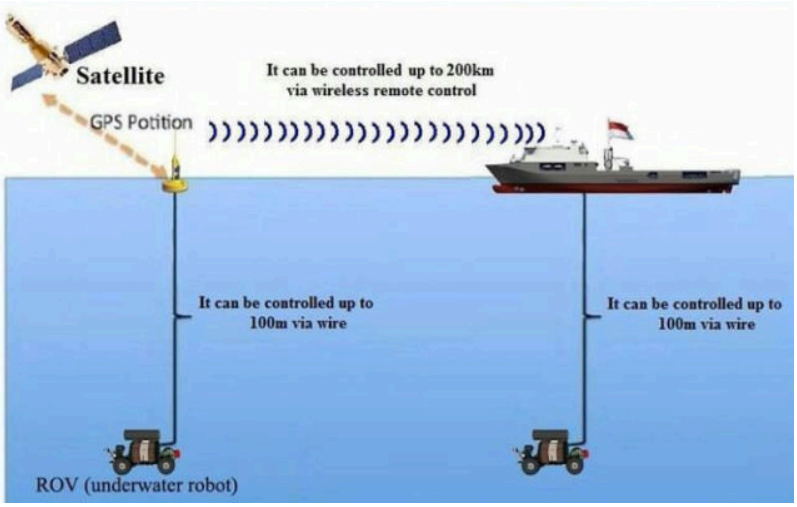

FIGURE 12. Wireless communication is conducted wirelessly in the air

CONTRIBUTION

Radio wave cannot be transmitted well underwater due to attenuation issue. There are four main ROV parts that use radio signal, namely telemetry, video transmitter, remote control receiver, and GPS. To solve this problem, we use technique, namely placing all transmitters and receiver which are attached directly to the ROV on the surface of water as shown in figure 12. It does help because it becomes radio wave transmission in the air. So, user can control it from long distance up to hundreds of kilometers without any water attenuation problem depends on what type of transmitter is used.

CONCLUSIONS

An experimental about the application of ROV (Remotely Operated Vehicle) is presented, the result shows that all hardware and software ROV can run well. So that, ROV in this experiment can be used to take sample of contaminated water and soil in the place with maximum a depth of 1m. For the next experiment, this ROV will be tested in other place with a depth more than 1m. however, this ROV will continue to be refined to be maximally utilized.

REFERENCES

1. Ministry of Environment, Indonesian Environmental Status (Jakarta: KLH, 2012), pp. 35-38
2. Indonesian Journal of Environmental Law, Volume 03 Issue 01 July 2016, pp. 119-120
3. N. E. Leonard, D. A. Paley, F. Lekien, R. Sepulchre, D. M. Fratantoni, and R. E. Davis, "Collective motion, sensor networks, and ocean sampling," Proc. IEEE, vol. 95, no. 1, pp. 48–74, Jan. 2007.
4. "Underwater Vehicles and National Needs," National Academy Press, National Research Council, Washington, DC, 1996.
5. Subramanian, Akshay & Rao, Guru Prasanna & Jayabarathi, R &, ramkumar &, sudarsan. (2014). Semi Autonomous Underwater Surveillance Robot. International Journal of Electronic and Electrical Engineering. 7. 13-18.
6. A. Zoksimovski et al., Underwater electromagnetic communications using conduction – Channel characterization, Ad Hoc Netw. (2015), http://dx.doi.org/10.1016/j.adhoc.2015.01.017