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Performance of Lagrangian DrifteR OceanograpHy CoverageE Area (RHEA): Second Phase

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Abstract

Drifter Oceanography Coverage Area (RHEA) is a drift tracker to capture the ocean currents combined with other properties measurements. It is equipped with GPS and real-time data transmitter to obtain its geographical positions. The purpose of this research is to provide an inexpensive instruments to observe the oceanographic data. The sensors installed in this instrument are obtained from local and overseas industries. This instrument could gather data about sea surface temperature (SST), depth, salinity, currents, and acidity using the lagrangian concept. RHEA’s casing tests included a vacuum test, leakage test and buoyancy test, whereas signal test covers mobile data and satellite-based. The results showed that the stability is as expected, which is almost 1/5 of the overall height. This is to reduce the effects of wind on changes in the tool’s motion. The shaking condition was carried out by pulling the rope tied to RHEA. The slope of the tool when the pull is weak and strong ranges from 200-600 and stabilized within 2-4 seconds. The signal test was suitable for real-time and near-real-time monitoring, and was also fit for data transfer from both seawater and freshwater environments. The sensor showed a value of 4.03-4.76. For an acidity buffer of 6.86, the values indicated a range of 6.3-6.93. Seawater temperature sensors were tested by comparing them with digital temperature devices. Temperature showed that there was no difference in the value between RHEA sensor and digital temperature, which was 25.31^{0}C versus 26 ^{0}C. This research showed that the design, data transfer and data reliability can be used in seawater environment for the best result.

Keywords: Surface drifter, satellite tracking, lagrangian analysis, ocean observation

INTRODUCTION

Oceanographic data in Indonesia came entirely from both satellite and in-situ data observations. However, there is a lack of data from in-situ observations due to high cost requirements for field surveys, limited agencies that focus on marine observation as well as the complexity of ocean natural characteristics. In-situ observations using drifters in oceanographic studies are essential for education, research, stewardship, preservation and management of oceanic and biosphere systems [1-2]. A surface drifting buoy, hereafter referred to as a drifter, is an instrument that approximately follows water on ocean surface, thus providing information about ocean currents [3-4]. Drifters have a long history for a range of uses from mapping large-scale ocean currents to following oil spills [5], aiding search and rescue operations [6], tracking marine particles including marine debris [7], coastal mixing and larvae spreading [8]. The earliest drifter design sidestepped due to tracking issue and problems in identifying the start and the end of the drifters' path [9]. In the 1970s, the surface and subsurface drifters have been developed, improved and tracked in large numbers in the ocean globally [10]. Nowadays, several instruments observe almost entire oceans such as Argo floats (*see* http://www.argo.ucsd.edu), Gliders (*see* http://www.coriolis.eu.org), TAO-TRITON (*see* https://www.pmel.noaa.gov/). One of the schematic of a surf zone drifter is 1.2 meters in height plus 0.11 meters of antennae to receive GPS signals [11]. The development of a standardized, low-cost, lightweight and easily deployed drifter with a semi-rigid drogue took place under the SVP (Surface Velocity Programme), part of the Tropical Ocean Global Atmosphere (TOGA) experiment and the World Ocean Circulation Experiment (WOCE) (https://www.nodc.noaa.gov/woce) [12].

This research is not the first time, others literature work [13-15] also did the same study with different type and scale. In this paper, the lagrangian drifter with several physical-chemical instruments was combined and tested. This research presents a brief description of the drifter's GPS oceanography coverage area (RHEA); a drifter equipped with data transmission system. RHEA is a development from a GPS drifter (GERNED) [16]. It had been improved in design and sensors as well as tested in various water bodies such as rivers and shallow (<5 meters) seas.

MATERIAL AND METHODS

The drifter's design has to fit with various ocean conditions [17] such as coastal area, rough wave, and fast currents. Numerous drifters have been created by researchers [13,18-19], equipped with GPS [20] and real-time data transmitter [21]. The drag ratio between the emerged and submerged drifters' structure is usually at least 1:40, following the near-surface currents quite accurately [22].

This project is a joint-partnership between Marine Research Laboratory (MEAL) Universitas Padjadjaran and Robomarine Indonesia Company (http://www.robomarine.com). First, we evaluated the GERNED's (RHEA phase 1) existing design [16], added additional sensors and did several tests. There were several developments between GERNED and RHEA especially in the design and control system (**Table 1**).

Table 1. The differences between GERNED and RHEA

	GERNED (2017)	**RHEA** (2018)
Dimension		
Height (cm)	145	104
Diameter (cm) without blade	18	14
Weight (kg)	12	10
Design		
Blade	Lower	Middle
Rasio Tube: *blade*	1:1	2:1
System		
Data transmission	MicroSD	MicroSD and Satellite
Power	Lithium Batteries	Lithium Batteries
Sensor	Water temperature, acidity, salinity	Both water and air temperatures, acidity, salinity, humidity, pressures, and elevations
Endurance	N/A	30 days

RESULTS

Structures

Its total weight in the air is about 10 kilos. The casing is made from metal with injected molding and consisted of three sections. Iridium satellite data service is presently being used to obtain its geographical position. The drifter's battery life rate is approximately three months but it highly depends on the life span of data transmission. The RHEA (**Fig. 1***)* presented the drifter's final design. It mainly consists of a floating where a GPS unit with batteries are attached, along with an installed drogue. The external diameter of the floating is 0.35 m and the drogue consists of two interlocking square pieces with a side length of 0.42 m. The floating and drogue are connected by a 0.15 m natural rubber hose. The total height of the drifter below the water surface is ~0.60 m. The blade's design is made detachable to make it easy to be installed especially in shallow water. An additional detachable floater is needed in shallow water. The buoyant center force was at 43.3 cm and gravity at 41.9 cm from the bottom to the top, and 20.5 cm floating from the water surface. Materials that were used are fiber roving, iron, plywood, polyvinyl chloride (PVC) with diameters varying from 3, 4 and 10 inches, galvanized pole, glue, bolts, stainless steel plate, and pyloxi.

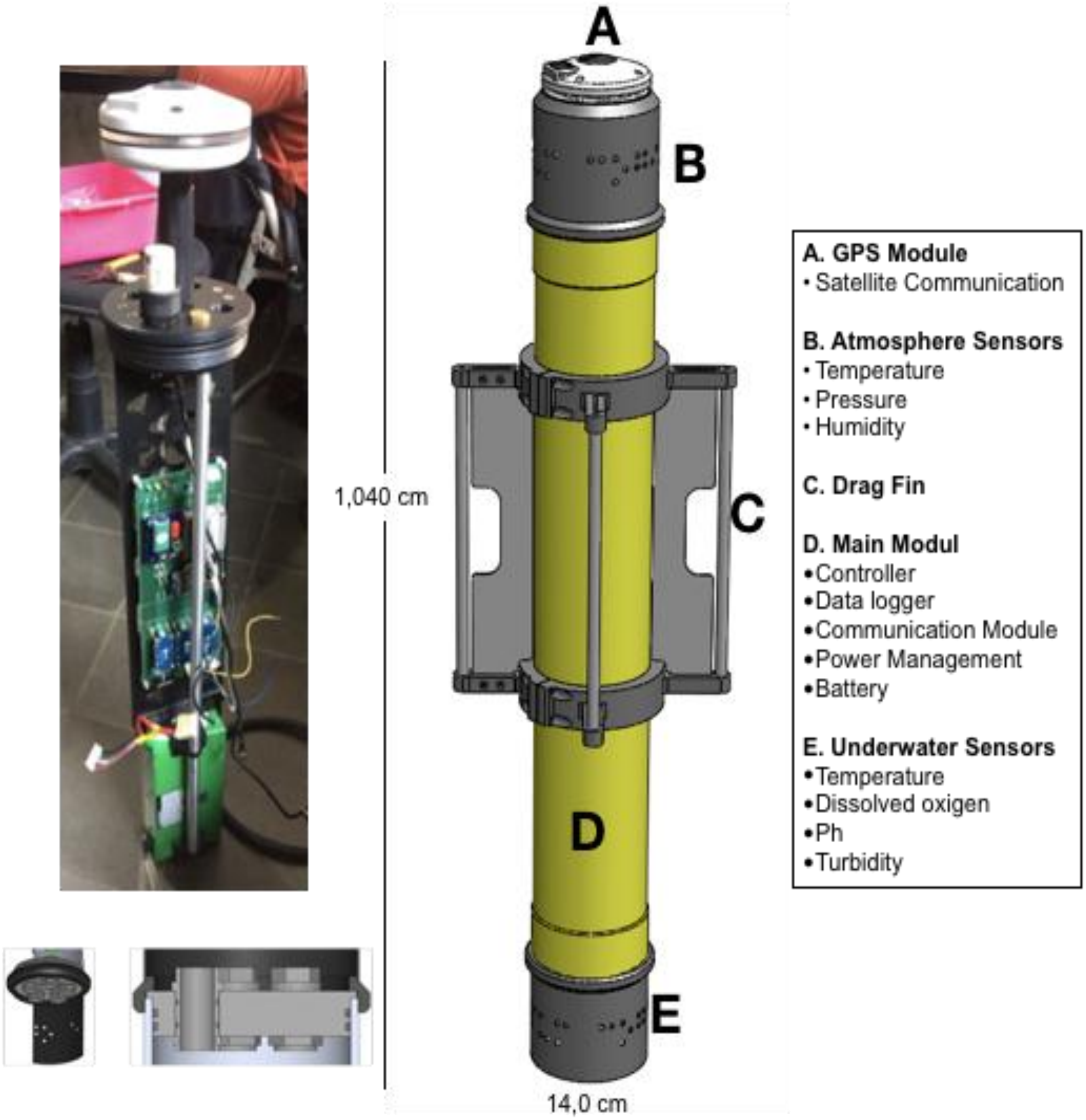

Figure 1. RHEA Design (top) sensor location, housing, and atmospheric sensor, (bottom) structure of water sensor

System and Sensors

The water sensor is below (sink) and the atmospheric sensor is above the container. They are connected to a battery and storage (Micro SD). From the storage, it will be forwarded to the satellite. RHEA was installed with RockBLOCK Iridium 9062 for data transmission to a satellite with GPS geolocation accuracy provided by ARGOS (±5km) or GPS (<1km) satellites[23]. This instrument uses satellite and from thereon, data is sent to the server and then to the user on land (land server) (**Fig. 2**).

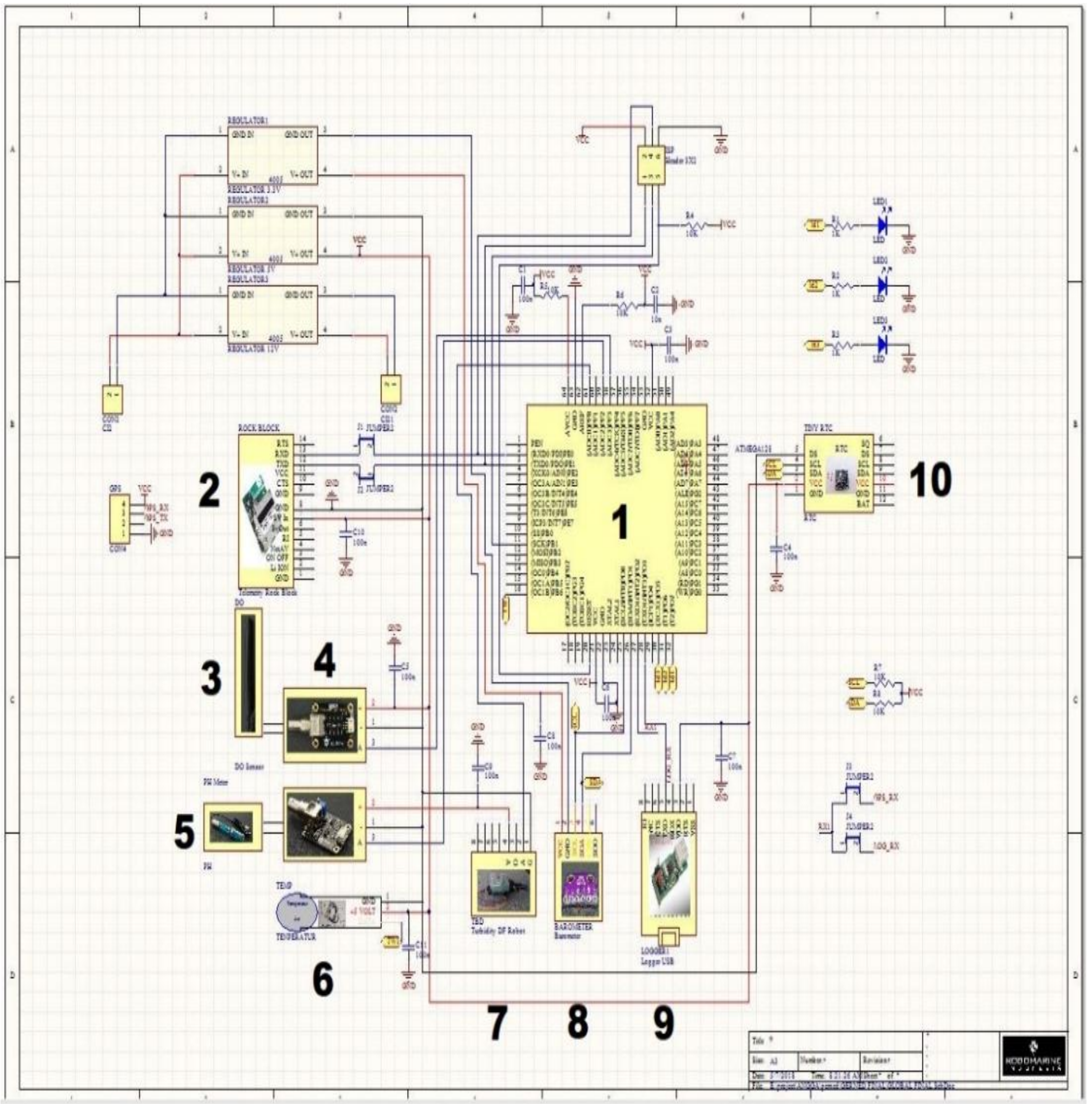

Figure 2. Electronic sketch with 1) Controller, 2) Satellite Telemetry Rock Block, 3) Dissolved Oxygen Sensor, 4) Sensor Driver, 5)PH-Meter, 6) Temperature Sensor, 7) Turbidity Sensor, 8) Barometer Sensor, 9) Data Logger, 10) RTC Module

Satellite services are used because not all seas in Indonesia have GSM signals. Data transmission can be set as required. The energy power used in RHEA is a 6800 mAh / 3.7 Volt Lithium Battery. Sensors installed in this instrument were obtained from local and overseas industries. This is to adapt to the sensors' characteristics. Sensor holes can also be replaced if there is damage during usage without having to replace the entire plate. These sensors have decent levels of accuracy (**Table 2**).

Table 2. Parameters and specification

Parameters	Range/Presition	Sensor manufacturer
Water Temperature	0°C to +70°C	DS18820
Air temperature	-40°C-85°C	Adafruit
DO	–40°C to 125°C Operation Range	TP5551/TP5552 / TP5554
pH	± 0.1pH (25 °C)	Analog pH Meter DF Robot
Humidity and Pressure	-40-+85 °C, 0...100 % rel. humidity, 300...1100 hPa	Bosch- BME280
Turbidity Sensor	Operating 5°C to 90°C	N/A
Conductivity	Accuracy 5% F.S. Temp. range 0-40 °C	DFR0300
GPS	0.25-10 MHz	U-box

Laboratory and Field Test

Various tests were carried out in a simulation pool to observed the equipment's balance when the water conditions are calm, fluctuate, and any leakage of the housing systems. The leak tested with a vacuum test in the laboratory and the second test in a pool with all sensors and loads installed inside. The tests were carried out for five hours and showed that there were no leaks. For buoyancy, it was done by decreasing the tool's height manually and giving interferences around it. In this test, the device returned to its original height (original position) and was stable (**Fig. 3**).

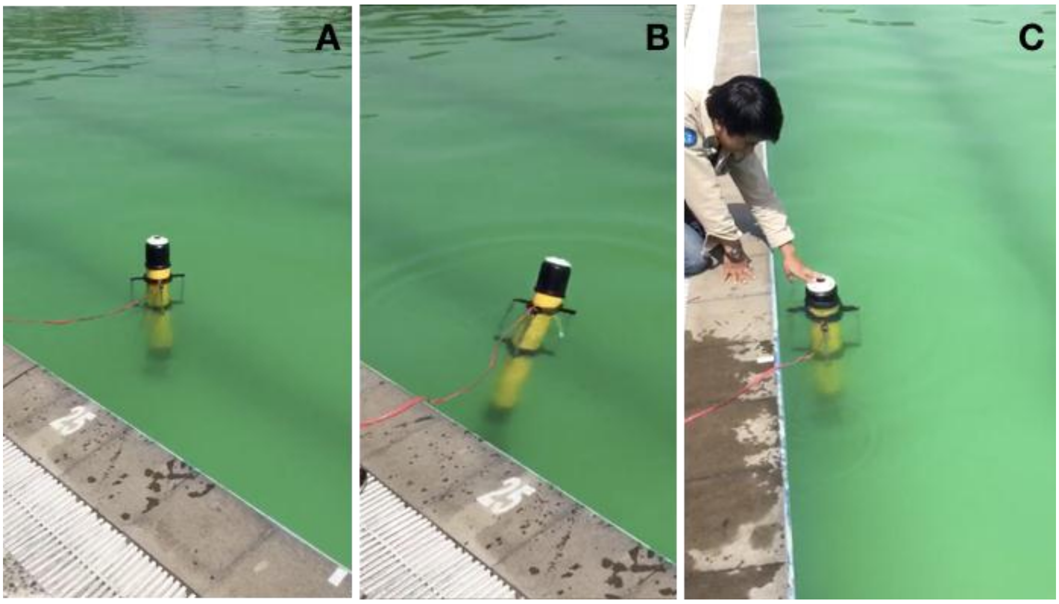

Figure 3. Buoyancy test with different treatment a) calm condition, b) the instrument pulled out, c) push and release

DISCUSSION

RHEA has completed its design, physical test and data transmission test. The field test also showed a satisfying result and can be applied for seacurrent monitoring and measurement. Basic tests were carried out on various sensors. This is useful for the precision of the sensors used. In this case, all sensors have been tested and can be used with a decent level of precision. First, the test was done to sensors. Acidity sensor was tested in buffer solutions of 4.01 and 6.86. The time used was 300 minutes. The sensor showed a value from 4.03 to 4.76. For the buffer pH of 6.86, the values indicated a range from 6.3 to 6.93. Seawater temperature sensors were tested by comparing them with digital temperature devices. Temperature showed that there was no difference in the value between the RHEA sensor and digital temperature, which was 25.31^0C versus $26\ ^0$C.

The stability was also as expected, which is almost 1/5 of the overall height. This is to reduce the wind effects on changes in the tool's motion [24]. The shaking condition was carried out by pulling the rope tied to RHEA. The slope of the tool when the pull was weak and strong ranged from 200-600 and stabilized within 2-4 seconds.

Further research is expected by adding a module that is useful so that this tool can go down into water bodies to its most extent. The required sensor is a depth sensor emitted from the device. This is very useful to monitor Indonesian water bodies or others with very different characteristics. Therefore, measurements are no longer set from the computer but this tool can measure the water's depth itself. As we know, Indonesian seas in the west are shallow whereas the east are deep. Water mass transfer can occur from the east to the west or vice versa [25]. The next project is an oceanographic database development (see http://podc.fpik.unpad.ac.id), which will be used for all oceanographic data including those from RHEA.

CONCLUSION

This research showed that the design, data transfer and data reliability can be used in ocean environment include coastal and estuarine condition. It is also could use in the freshwater area. RHEA could also measure water quality with real-time and near real time monitoring that send to phone directly or send the data into the memory card.

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