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Evaluation of a New Integrated Marine Instruments: RHEA (Drifter GPS Oceanography Coverage Area)

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Abstract. Marine instrumentation is used to make optimal use of natural resources in the marine sector in the form of storing oceanographic characteristics data. This research aims to evaluate a new Lagrangian instrument called RHEA, developed by the Marine Research Laboratory, Padjadjaran University. This research was conducted by examining the correction factors contained in the RHEA from the mechanical and electronic side to optimize the work and carry out appropriate validation of the oceanographic parameter data. The method used is by studying marine instrument literature and conducting a series of tests on the tool until it is ready for use at sea. The output of this research is in the form of literature on how the device works to be effective and efficient in collecting data about certain oceanographic factors. The result shows that RHEA has various functions: measuring pH, dissolved oxygen, temperature, turbidity, and salinity in real-time time. This instrument needs to be slightly modified again related to its design so that it can be more optimal when measuring oceanographic parameter data. In addition, in terms of data acquisition, it is necessary to improve the electronic components by replacing or adding several parts so that the data obtained can have high accuracy.

1. Introduction

Indonesia seas have a high level of complexity due to geography, causing periodic phenomena involving interactions between the sea and the atmosphere. With kind of interactions can cause anomalies in oceanographic phenomena. [1, 2]. To research changes in the Indonesian sea, adequate monitoring and tools are required. In 2018, the Marine Research Laboratory (MEAL) Universitas Padjadjaran with collaboration with PT Robomarine Indonesia developed RHEA instrument. RHEA is an acronym for *Drifter GPS Oceanography Coverage Area*. So far, the RHEA instrument has completed its design, physical test and data transmission test. Apart from that, the RHEA instrument has also carried out basic tests carried out on various sensors to know the precision and accuracy of the data values of the sensors used. Previous trials have shown that the design, data transfer, and validity of RHEA data can be used in marine environments, including coastal and estuarine conditions and freshwaters [3]. However, in its realization to get the value of oceanographic data that has a high level of accuracy and precision, an overall evaluation of the instrument is needed in order normal performance [4, 5]. The evaluation discussed the design of instrument shapes, power and electrical schematics sensors and oceanographic parameter data retrieval schemes [6].

The purpose of the study was to evaluate the function of the RHEA instrument so that it is optimal in observing oceanographic parameter data and knowing the value of validated oceanographic parameter data. Through this research, it is hoped that it can provide solutive information about evaluating how the RHEA instrument measures precise and accurate oceanographic data and additional literature to design similar devices in the future to be more effective and efficient in conducting surveys to obtain oceanographic data.

2. Material and Methods

The research was carried out in stages through testing instruments starting from the laboratory scale, field scale in the scope of the pond and field scale in the marine coverage. RHEA instruments must go through laboratory-scale testing to prepare for the platform's performance prior to field-scale testing. Laboratory scale testing was carried out in the working space of PT. RoboMarine Indonesia while for the scope of the pool with a minimum depth of 1.35 m to 2 m to maximize the buoyancy of the instrument.

The RHEA construction design is adapted for shallow and deep-water observations. The RHEA instrument frame design was adopted from several instruments such as *ARGO Float* and *Float Tracking* with a basic shape that resembles a mangrove propagule, which is a mangrove fruit that has germinated so that it is possible to float on the surface of the water, which represents the position of this tool when used. [7]. This design evaluation relates to the buoyancy of the instrument when it is on the water surface. As one of the *drifters,* RHEA is generally able to float and move with the ocean surface currents to investigate currents and oceanographic physical and biochemical parameters. [8, 9, 10].

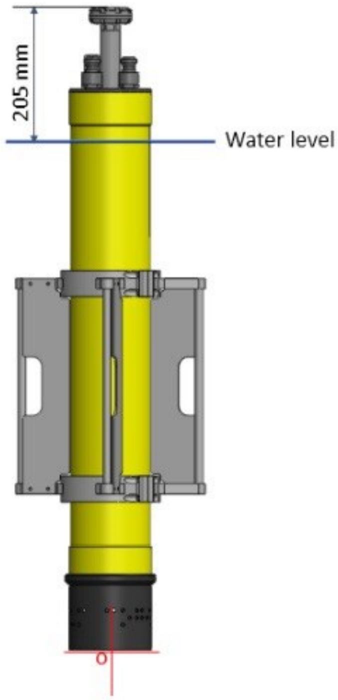

Figure 1. Position of Center of Gravity and Instrument on the Water Surface.

The principle of applying the theory of buoyancy to the RHEA Instrument is based on Archimedes Law [11], namely the weight factor of the instrument, buoyancy and external factors that are static and dynamic into consideration so that the stability of the device can be maintained [12]. Evaluation of this design is carried out as a non-technical factor that supports the workings of the instrument to obtain oceanographic data. The goal is how the instrument has a floating position of more than half of the part, and the top of the instrument is not covered with water so that the sensor function above the surface fully functioned.

The RHEA instrument has several parameter sensors used to convert the environmental, physical parameter values into electrical quantities so that they can be processed electronically to display the value of each measured parameter. These sensors include temperature, salinity, pH, dissolved oxygen, water level, wind speed, and turbidity. The data recorded by the sensor is in the form of the voltage value generated by the sensor. Still, the data value is not necessarily in accordance with the interval of oceanographic parameter values, so that a test data test is needed [4]. The data used in this study is primary data obtained through the measurement of oceanographic parameter sensors. The sensor then adjusted the calibration value by comparing the reading value found on the Arduino with the reading value from a conventional instrument. After validating the sensor's measurement value, the data management process is carried out after being recorded via USB. Data recording is carried out several times following the movement pattern of the instrument on the water surface [13, 14, 15].

Testing data tests include testing the usability of the oceanographic parameter sensors contained in the RHEA by integrating the data values with reading data values on conventional instruments using the same water sample. The reading of RHEA instrument data values using *RealTerm software* to obtain real-time values juxtaposed with conventional instruments such as *pH meters*, *refractometers*, *thermometers,* and *DO meters* for specific time intervals. This test is carried out so that later the difference in data values between one instrument and another can be seen from the readings of these values, initial data is obtained, which is then analyzed for the difference in values, and further steps are taken so that the difference in reading values is not too far and biased before the instrument is ready for testing at sea.

The mechanism for sending and receiving data is a component inside the instrument, namely *RockBLOCK,* which functions to send signals to Iridium's satellites. The data transmission from the satellite is then received by the Iridium Station, which then enters the server. The user can then access the data that is already on the server by subscribing to the required credit data. The operator of the telecommunications mechanism on the RHEA instrument is designing a data transmission system that is echoed from sensors and GPS (Global Positioning System) using the *RockBLOCK* satellite module as a provider with the Iridium 9062 Satellite type. This module uses this module as a telecommunication tool to automatically transfer data through programming to satellites while transferring data manually to a PC using a device *Telemetry Radio Holybro* 915 MHz 100mW and USB. To further improve the accuracy of the temporal data transmission, the telecommunications module used is integrated with the RTC module (Real Time Clock). The audit was carried out in the scope of telecommunications and data transmission, namely by comparing the validation of the duration of data submission for the two types of sending and receiving data on the RHEA instrument.

3. Results and Discussion

This research resulted in a *drifter* instrument system audit literacy called RHEA. The central part of the system being evaluated is RHEA as an instrument that measures and transmits data. The *drifter* designed in this study adopts two types of drifter designs, namely the *ARGO* model for the form and work system and *Float Tracking* with the *Davis Drifter* type for the technical operation of the instrument with several modifications to suit the needs and available materials. The distance between the top segment and the surface, for example, on ARGO is 0.367 m [16], while in this design, the distance is 0.205 m. The general cross-sectional height of ARGO is 1.1 m [17], while the RHEA has a height of 1 m. In addition, the RHEA has two pairs of *drag fins* on the main body segment with dimensions of 334 mm long and 66.5 mm wide, while the *Float Tracking* has a length of 1009.7 mm and a width of 444.5 mm. [5]. The *drag fin* used is made of mica plastic with a mesh size of 4 mm. Adjustment of dimensions and materials contained in RHEA is carried out according to the consideration that the *drifter* will be operated in shallow waters and deep waters [3].

3.1. Instrument Design Evaluation

The electronics and sensors are placed on the main body segment, which is inclined close to the top part of the *drifter*. This section consists of a GPS module, a communication module and several sensor modules for surface parameters such as temperature, pressure and humidity. The communication used in this RHEA research is *Telemetry Radio Holybro 915 MHz 100mW* and USB, both data sent and communication for data configuration. Data is recorded and transmitted every 5 seconds but can be set manually via script. The upper segment consists of an *RF Telemetry antenna transceiver* as a data receiver and sender and a configuration that is connected to a laptop.

According to [18], drifter movement is able to represent the actual movement of water masses if the level of accuracy is below $1^{cm}/_{s}$ and has a drag area ratio value above 40. In this research, several components are calculated to determine the value of the *drag area ratio*, namely the RHEA surface area, drag fin, and the length of the rope used. Drag coefficient value refers to *Surface Float* [19] and then calculates the drag area value. The value of the *drag area ratio* is the comparison of the value of the *drag area* of the *drogue,* which in this research is projected by the *drag fin* with the total value of the *drag area* of the other components contained in the *drifter*. The calculation of all these components is shown in **Table 1**.

Table 1. Calculation of Drag Ratio RHEA

Component	Length (cm)	Area (cm^2)	Drag Coefficient	*Drag Area*	*Drag Area Ratio*
RHEA Surface Area	104	4882.03	1.6	7811.248	78.34
Rope Length	500		1.4	700	
Drag Fin	33.4	476260	1.4	666764	

The *drag area ratio* of RHEA is 78.34 and greater than 40. It can be concluded that the ability of RHEA to move against the movement of water masses is quite good, so this design has an accuracy below 2 $^{cm}/_{s}$ or in conditions with wind below 4 $^{cm}/_{s}$ have accuracy up to 1 $^{cm}/_{s}$ [18]. The balance of RHEA buoyancy has reached the initial goal where there are $1/4$ part is not submerged in water, but there is instability during the first *deployment* in the water column. An audit carried out to adjust the performance of RHEA was carried out by adding a weight of 0.2 Kg for the load placed on one side of the *As Rib* so that the total weight of the RHEA becomes 10.2 Kg. The following evaluation is in the upper RHEA segment on the *Close Front* section. The *Mount Sensor* is indicated to have impaired tightness after a series of *vacuum tests* have been carried out on the RHEA instrument. The condition of *Mount Rib,* which is cracked due to a decrease in strength compared to the strength of the base metal base material, is known as a *defect weld* or the weld condition that has decreased in quality.

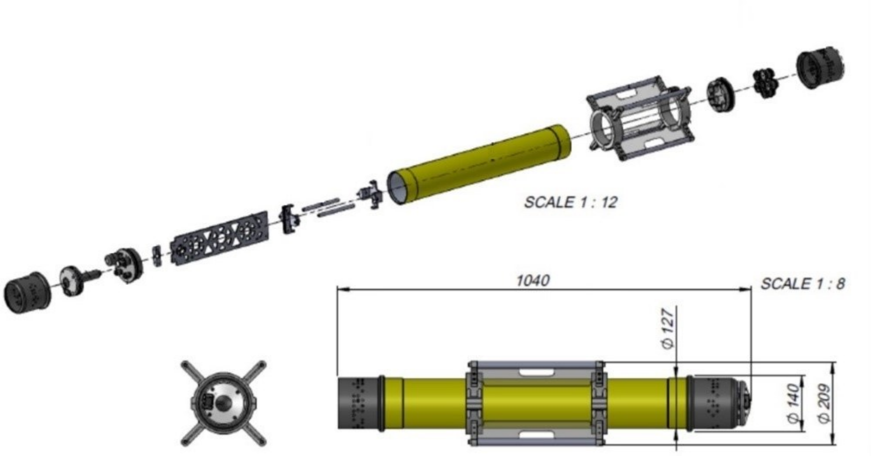

Figure 2. RHEA Component Specification

The condition of the Mount Rib needs to be replaced, and then a series of tests and inspections are carried out on the instrument. The conclusion is that what is contained in part called the O-ring, a component in the form of a soft textured ring made of natural material or synthetic rubber or plastic is suspected to be quite fragile. It is indicated that there is a leak from that point. The O-ring component serves as a barrier between each segment directly related to the RHEA main body segment.

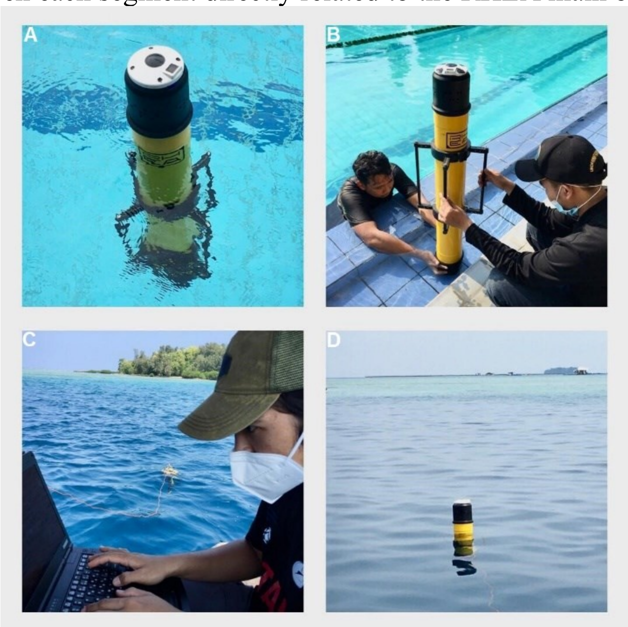

Figure 3. Activity in the Scope of the Pond and Field Scale in the Marine Coverage a) at the Pond, b) Preparation for Pond Scale Test, c) Data Acquisition Adjustment, d) at the Sea

3.2. Electronic Circuit Schematic

Electrical components are the core of the instrument power system. On RHEA instruments that use Lithium Polymer type batteries with a capacity of 20000 mAh and a voltage of 12 Volts. Battery dimensions 200 x 90 x 60 mm. Under normal use, the drifter's battery life rate is about three months, but it depends on the data transmission use [3]. To integrate the electrical system on the RHEA instrument, various modules are needed, including the Serial Hub in the form of a microcontroller that connects all the oceanographic parameter sensors contained in the RHEA. Through this research, after some tests on the pH and DO sensors on the RHEA, there was a slight disturbance in the reading of the data values because the position of the sensor was slightly shifted from its position.

The solution to overcome this problem is to add an insulator for each sensor's electrical circuit, which is constrained because the function of the insulator for the sensor is as a validator so that data reading from the sensor can function adequately [20]. As for the communication used in this RHEA research in *Telemetry Radio Holybro 915 MHz 100mW* and USB, data sent and contact for data configuration are fine.

4. Conclusion

The research results on the evaluation of the RHEA instrument show that the design, electronic scheme and telecommunication system are integral parts that must be integrated to obtain data from accurate and validated oceanographic parameter measurements for data output, especially for continuous time-series data types to be optimal. Overall, after evaluating the RHEA, which includes the buoyancy test, calculation of the drag area ratio, vacuum test, integrating the readings of oceanographic parameter values on the sensors in RHEA with reference readings from conventional instruments measuring oceanographic data, it can be concluded that RHEA can record and obtain data. Parameters continuously with data values that can be accounted for because they have been validated.

References

[1] Purba, N.P., Pranowo, W.S., 2015. Deskripsi Karakteristik Massa Air dan Sirkulasi Laut. Unpad Press 1.
[2] Yulihastin, E., Febrianti, N., 2018. Impacts of El Nino and IOD on the Indonesian Climate.
[3] Purba, N.P., Faizal, I., Mulyani, P.., Prayogo, N., Prasetyo, T., Khan, A.M.A., 2019. Performance of lagriangan drifter oceanography coverage area (RHEA): second phase. Int. J. Ocean. Oceanogr. 13, 353–361.
[4] Jones, D.O.B., Gates, A.R., Huvenne, V.A.I., Phillips, A.B., Bett, B.J., 2019. Autonomous marine environmental monitoring: Application in decommissioned oil fields. Sci. Total Environ. 668, 835–853.
[5] Lumpkin, R., Özgökmen, T., Centurioni, L., 2017. Advances in the Application of Surface Drifters. Ann. Rev. Mar. Sci. 9, 59–81.
[6] Moscetta, Pompeo, Sanfilippo, L., Savino, E., Moscetta, Pietro, Allabashi, R., Gunatilaka, A., 2009. Instrumentation for continuous monitoring in marine environments. MTS/IEEE Biloxi - Mar. Technol. Our Futur. Glob. Local Challenges, Ocean. 2009.
[7] Purba, N.P., A. Harahap, S., Prihadi, D.J., Faizal, I., Mulyani, P.G., Fitriadi, C.A., Pangestu, I.F., Atmoko, P.D., Alfath, A., Sitio, J.T., 2017. Pengembangan Instrumen Lagrangian Gps Drifter Combined (Gerned) Untuk Observasi Laut. J. Kelaut. Nas. 12, 109.
[8] Gerin, R., Zennaro, M., Rainone, M., Pietrosemoli, E., Poulain, P.-M., Crise, A., 2018. On the design of a sustainable ocean drifter for developing countries. EAI Endorsed Trans. Internet Things 4, 155483.
[9] Jönsson, B.F., Döös, K., Myrberg, K., Lundberg, P.A., 2011. A Lagrangian-trajectory study of a gradually mixed estuary. Cont. Shelf Res. 31, 1811–1817.
[10] Qin, X., Menviel, L., Sen Gupta, A., van Sebille, E., 2016. Iron sources and pathways into the Pacific Equatorial Undercurrent. Geophys. Res. Lett. 43, 9843–9851.
[11] Mohazzab, P., 2017. Archimedes' Principle Revisited. J. Appl. Math. Phys. 05, 836–843.
[12] Subbaraya, S., Breitenmoser, A., Molchanov, A., Muller, J., Oberg, C., Caron, D.A., Sukhatme, G.S., 2016. Circling the Seas: Design of Lagrangian Drifters for Ocean Monitoring. IEEE Robot. Autom. Mag. 23, 42–53.
[13] Molcard, A., Piterbarg, L.I., Griffa, A., Özgökmen, T.M., Mariano, A.J., 2003. Assimilation of d rifter observations for the reconstruction of the Eulerian circulation field. J. Geophys. Res. Ocean. 108.

[14] Rypina, I.I., Kirincich, A.R., Limeburner, R., Udovydchenkov, I.A., 2014. Eulerian and Lagrangian correspondence of high-frequency radar and surface drifter data: Effects of radar resolution and flow components. J. Atmos. Ocean. Technol. 31, 945–966.
[15] Spencer, D., Lemckert, C.J., Yu, Y., Gustafson, J., Lee, S.Y., Zhang, H., 2014. Quantifying dispersion in an estuary: A Lagrangian drifter approach. J. Coast. Res. 70, 29–34.
[16] Roemmich, D., Johnson, G.C., Riser, S., Davis, R., Gilson, J., Owens, W.B., Garzoli, S.L., Schmid, C., Ignaszewski, M., 2009. The Argo Program: Observing the global ocean with profiling floats. Oceanography 22, 34–43.
[17] Alderson, S.G., Killworth, P.D., 2005. A preoperational scheme for calculating sea surface height by Bernoulli inverse of argo float data in the North Atlantic. J. Atmos. Ocean. Technol. 22, 1416–1422.
[18] Niiler, P.P., Paduan, J.D., 1995. Wind-driven motions in the northeast Pacific as measured by Lagrangian drifters. J. Phys. Oceanogr.
[19] Sybrandy, A.L., Niiler, P.P., Martin, C., Scuba, W., Charpentier, E., Meldrum, D.T., 2009. Global Drifter Programme: Barometer Drifter Design Reference, DBCP Report No.4, Rev 2.2.
[20] Anderson, C.W., Kitchin, D.A., Decker, K.S., 2002. Oceanographic Sensor System Development 23, 415–427.

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