

Automated Lobster Cultivation Monitoring System Based on Embedded System and Internet of Things: TALOPIN

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Abstract— Sea water lobster is a commodity from the sea resources that have high selling price and already encroaches international market. However, the cultivators of marine fisheries have less incentive to cultivate the sea water lobster because it is very sensitive to the environmental changes in its habitat. The environmental changes cause the decreasing appetite, vulnerable to disease, cannibalism, and lower lifespan. To prevent these problems, the researchers propose an integrated embedded system using the internet of things that can do automation process to monitor the lobster ponds. The automation system consists of temperature adjustment, pH adjustment, salinity concentration, and an automatic draining system. Beside it, this system is also equipped with a mobile application which is integrated by using internet of thing (IoT) so that the monitoring and control system of the pond can be accessed everywhere.

This research aims to test the accuracy of data from the pH sensor and temperature sensor on the prototype. The test is conducted by comparing the data from the pH sensor with litmus paper and thermometer for water temperature. Based on the test result, the researcher can conclude that the data from the pH sensor is reliable and shows the actual value of pH. While, the test for temperature sensor shows the insignificant difference with a thermometer that is only 0,9°C and 1°C. This difference is very marginal thus the system can work properly.

Keywords— *Embedded System; Internet of Things; Sea Water Lobster; Mobile Application.*

I. INTRODUCTION

Indonesia is a huge archipelagic country that has more than 60 percent of seas. Moreover, it still nature and potentially produce more sea products with higher quality like fish, roe and shellfish. On the other hand, lobster is one type of shellfishes that leading the seafood commodity in Indonesia with the high selling price. This was proven by the high export price of marine lobster in Asia and Europe market. The increasing demand on the market for marine lobster is shown by statistics of FAO and GLOBEFISH, in which in around 1980 the demand for marine lobster by Japan keep on increasing year by year up to now. Therefore, with increasing demand, there must be high quality lobster produced to get higher selling price [1].

However, people prefer simply catching the lobster continuously and selling it without considering the condition of the lobster's habitat instead of cultivating the lobster [2]. Lobster is very sensitive to the changes in its habitat situation such as pH, water temperature, oxygen, and water salinity. Those environmental changes influence the lobster's lifespan. Meanwhile, the cultivators are not sensitive toward detecting those changes and it causes the cultivation of the marine lobster to become ineffective. Moreover, there is new regulation from Indonesia Ministry of Marine and fisheries number 1/PERMEN-KP/2015 [3] which limits the minimum weight of lobster and crab that can be caught from the sea which 200 gram/each.

To solve those problems, there have been several types of research which deploy the embedded system technology. The first research was "Penyaring Air Kolam untuk

Budidaya Lobster Air Tawar Secara Otomatis Menggunakan Sistem Mikrokontroler” which aims to create an automatic draining system that is implemented to freshwater lobster ponds. This system works by using sensors to detect the clarity of water inside the pond and the data from the sensor will be processed by the automatic program in the microcontroller to circulate the water inside the pond [4].

The second research was “Sistem Pemantau Lobster Air Tawar Berbasis Jaringan Sensor Nirkabel” which aims to create a monitoring system for lobster’s habitat and send the SMS to notify the cultivators about the water parameters changes through cellular mobile phone [5].

Based on those two types of research, we can conclude that the monitoring and control for marine lobster are not done by using the internet of things so that the cultivators can’t monitor the pond condition in real time. That is why, the researchers propose an idea to create the prototype named “TALOPIN (Tambak Lobster Pintar)” that can be used to monitor and control the water’s variables in sea water lobster’s ponds by using embedded system dan internet of things. The implementation of the internet of things in this prototype aims to maximize the monitoring and control of water’s variables in the ponds through a smartphone connected to the internet network.

Embedded-system in “TALOPIN” is used to automate the system and reduce the human physical interaction [6]. The real time control is very necessary for the cultivation of marine lobster because this type of lobster is very sensitive to the changes in water’s variables in its habitat. Moreover, cultivators should adjust the condition of the pond to be as equal as possible to the real habitat of the marine lobster. While, the implementation of the internet of things in “TALOPIN” is used to do the monitoring and control for embedded system inside the lobster’s pond [7]. Another advantage of this prototype stage can be used as a learning medium to support relevant courses [8], thereby adding to the central role in the relevant laboratory [9] [10].

The module is one of the learning sources which packed in a complete, systematic, and contain a planned learning experience tool [7]. Meanwhile, according to Anwar, learning module is material that is organized in a systematic, interesting, and covering all the materials, methods and evaluation that can be used independently to achieve the expected competencies [3]. The good and interesting module will fulfil the characteristics of a module consisting of self instructional, self contained, stand alone, adaptive, and user friendly [8]. Based on the description, it is necessary to do research of fuzzy learning module which can be used to study independently and structured based on the needs of the Electrical Engineering Education Program, Universitas Negeri Malang.

II. METHODE

The proposed method is the steps to make the automated monitoring system for lobster cultivation based on embedded system and Internet of Things (IoT). There are

designing, sensor calibrating, synchronizing, testing, and evaluating. Figure 1 shows the proposed method.

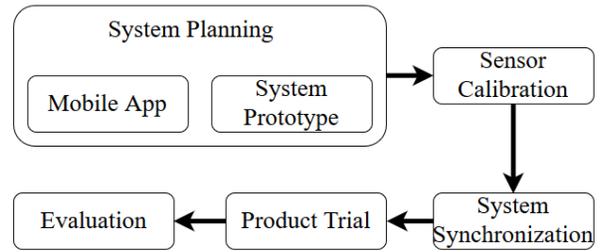


Figure 1. The Proposed Research Method

At the system planning stage, we aim at designing and making the mobile application and the system prototype. In the mobile application, the user interface has created to control the prototype of the lobster cultivation monitoring system. The design of the user interface is minimized and comforted as possible. The user interface of the monitoring system consists of a dashboard menu, lobster-tank status, active device list and sensor status. Figure 2 shows the user interface of the mobile application.

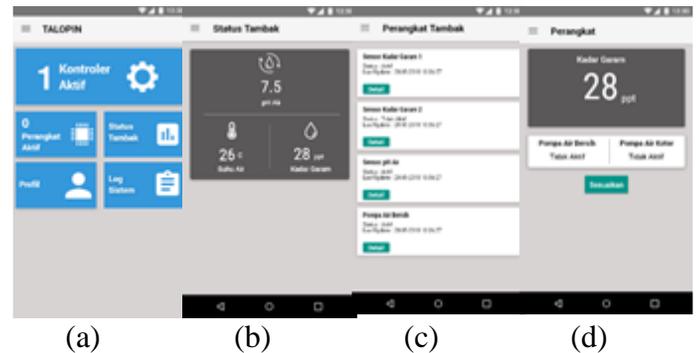


Figure 2. The User Interface Design: (a) Dashboard Menu, (b) Lobster-Tank Status, (c) Active Device List and (d) Sensor Status

The prototype of the system has been done using a PH meter sensor, salinity sensor and temperature sensor to monitor the status of lobster-tank. The water temperature of the lobster-tank has stabilized by a water heater that attaches in the tank. Also, two water pumps are used to circulate the clean salt water into the tank from dirty sea water. One motor pump drains the dirty salt water and another fills the clean salt water into the lobster-tank. The sensor and actuator have controlled by Arduino microcontroller that connects to the Raspberry pi. The Arduino has acquired the sensors data and controls the actuators also the Raspberry pi has stored the Arduino’s data to the server using internet connection. The server data is used to monitor the lobster-tank status by mobile app and bridges the command from the mobile app to the Arduino that control the actuators.

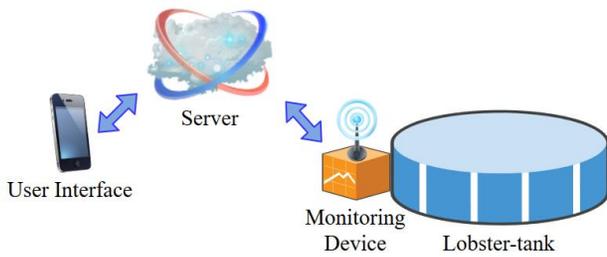


Figure 3. Automated Monitoring System Planning

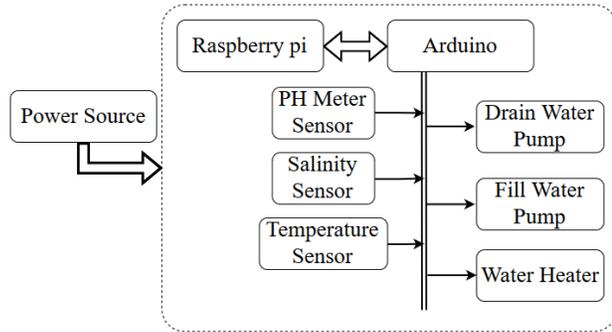


Figure 4. The system of Monitoring Device



Figure 5. Lobster-tank

The data which had been acquired from this research are qualitative and quantitative data. Qualitative data are comments, criticism and suggestions that given by validator and respondents. This data used as consideration in product revisions. While, the quantitative data is the percentage of value from the questionnaire given to the material experts, media experts, and students as the subjects of the trial. Quantitative data were analyzed to determine the percentage of feasibility from the developed module using Eq. 1.

At the Sensor calibration stage, it is the step to compare and calibrate the electrical sensor with the standard measurement. The PH meter sensor is compared with universal litmus paper strip that measures from 1 to 14 PH. In the same liquid test, the sensor and litmus paper are measures and the result of measurement is compared to each other. Next, the sensor gets calibrate to the standard litmus paper strip by changing the formula in its code. This calibrate step has been done to the other sensor: salinity sensor and temperature sensor. Figure 5 shows the sensors

of the monitoring system.

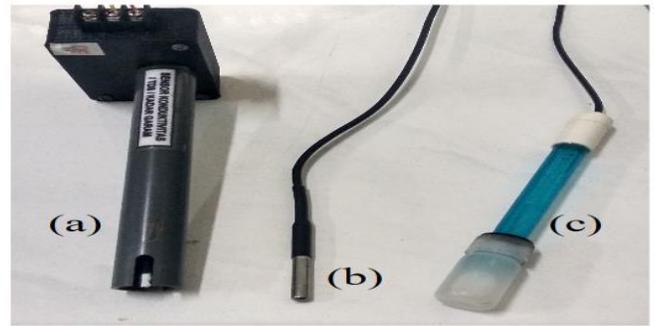


Figure 6. The Sensors of Monitoring System: (a) Salinity Sensor, (b) Temperature Sensor and (c) PH Meter Sensor

At the system synchronization stage, we synchronize the monitoring device, the server and the mobile app. In this step, the sensor and actuator data must be sent to the server via the internet. We used thingspeak.com as the server and the mobile app must synchronize with the server. It has 15 seconds update times for a single data package from the monitoring device to the mobile app.

At the product trial stage, the automated monitoring system has product trial to get the performance of the product. It takes 10 performance trials of monitoring the clean and dirty salt water. The clean salt water, in the lobster-tank, fills some artificial dirty liquid like soap water, acidic liquid and oil. From these changes of salt water quality, the system is monitoring and stabilizing the salt water quality by changing the dirty water in the lobster-tank with clean salt water in the clean salt water tank using water pumps. While changing the salt water, it still monitored by its system.

The evaluation step is to calculate the performance of the monitoring system. The evaluation using accuracy and precision as the measurement. The accuracy and precision can be calculated by Equation 1 and Equation 2.

III. RESULT

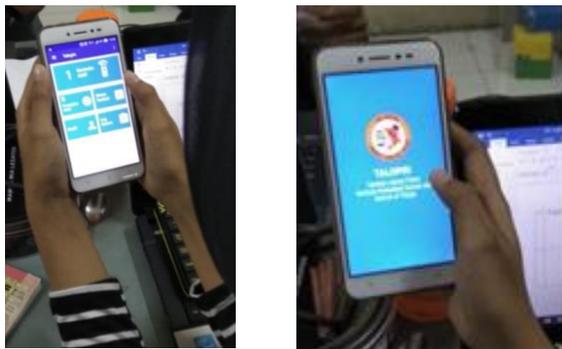
This work has been done using 80 x 40 x 40 centimeters of lobster-tank dimension with 15 centimeters of sea water level or approximately 50 liters of sea water. The monitoring system using Arduino UNO as microcontroller device to read the sensors data and to control the actuator also Raspberry pi B+ as the device to connect to the server. Our experiment using thingspeak.com as a server to bridge communication the monitoring system with the mobile app. The mobile app created by Android Studio and compatible with Android 4.0 version or above. Figure 6 shows the monitoring device and Figure 7 shows the mobile app of its controlling and monitoring.

The experiment test of this work is monitoring and stabilizing water quality in the lobster tank. The first step is to calibrate the sensors with the standard measurement. There are PH meter sensor, temperature sensor and salinity

sensor. The sensors are compared with the standard measurement and calibrate it as close as the standard measurement. Next, the sensors must be sensitive to the sea water quality changes. The monitoring and stabilizing sea water in the lobster tank determine from it. The optimal quality of sea water for lobster is 25o C to 27o C with 25 to 30 ppt of salinity and 7,4 to 8,3 PH, This is in accordance with the ideal range of sea water conditions for lobster [11]. Refer to this study, we use it to get the threshold number of sea water quality changes and stabilize it to get the optimal sea water quality. The third step is testing every single sensor to an artificial condition of sea water. There is clean sea water combines with water soap, acidic liquid (HCl) and oil. The last step is measuring the sea water using the sensor and standard measurement. Table 1 shows the result of sensor measurement and Table 2 shows the result of standard measuring instruments.



Figure 7. The Monitoring Device of TALOPIN



(a) (b)

Figure 7. The TALOPIN Monitoring App: (a) The Splash Screen and (b) The Dashboard Menu.

Table I. The Result of Sensor Measurement

No	Sensor Measurement							
	Clean Sea Water		+ HCl		+ Oil		+ Soap Water	
	PH	Temp	PH	Temp	PH	Temp	PH	Temp
1	7.16	24	4.49	25	7.76	24	8.82	24
2	6.27	25	5.76	25	8.34	24	7.96	24
3	7.4	24	6.6	25	8.54	24	8.03	24
4	7.83	24	5.83	25	8.29	24	7.16	24

5	7.64	24	5.9	25	8.44	24	6.85	24
6	6.85	24	5.73	25	8.6	24	6.76	24
7	7.45	24	5.41	25	8.9	24	6.43	24
8	6.97	24	5.89	25	8.43	24	6.82	24
9	7.43	24	5.66	25	8.51	24	7.67	24
10	7.92	24	5.81	25	8.24	24	7.56	24

Table II. The Result of Standard Measuring Instruments

No	Standard Measuring Instrument							
	Clean Sea Water		+ HCl		+ Oil		+ Soap Water	
	PH	Temp	PH	Temp	PH	Temp	PH	Temp
1	Base	25	Acid	26	Base	24	Base	24
2	Base	25	Acid	26	Base	24	Base	24
3	Base	25	Acid	26	Base	24	Base	24
4	Base	25	Acid	26	Base	24	Base	24
5	Base	25	Acid	26	Base	24	Base	24
6	Base	25	Acid	26	Base	24	Base	24
7	Base	25	Acid	26	Base	24	Base	24
8	Base	25	Acid	26	Base	24	Base	24
9	Base	25	Acid	26	Base	24	Base	24
10	Base	25	Acid	26	Base	24	Base	24

From table 1, in the column “clean sea water”, we can see the average of pH is 7.292 which means that’s alkaline and the average temperature is 24.1 °C. pH in the column “clean sea water” in table 1 has the same value with table 2. While, there is the only a small difference (0.9°C) between the temperature in table 1 and table 2. In the column “+HCL” in table 1 has the average of pH 5.708 which means that’s acid and the average temperature is 25°C. The pH in column “+HCL” table 1 has the same value with table 2. While, there is a small difference (1 °C) between the temperature in table 1 and table 2. In the column “+Oil”, we can see the average of pH is 8.405 which means that’s alkaline and the average temperature is 24°C. In the column “+Soap Water”, we can see the average of pH is 7.406 which means that’s alkaline and the average temperature is 24 °C. pH in the column “+Soap Water” in table 1 has the same value with table 2. Based on the results of the two tables above it can be concluded that the experimental results with Standard Measuring Instruments are successful because the difference in results is not too far away and it can be said that the accuracy of prototypes is approximately 90%. The results showed that air temperature, pH, DO, CO2, turbidity, ammonia and nitrite were in the range suitable for lobster cultivation [11].

IV. CONCLUSION

In this research, the researchers propose a prototype named ”TALOPIN (Tambak Lobster Pintar)” that can be used to monitor and control the water’s variables in the ponds for sea water lobster using embedded system and

internet of thing. The implementation of an embedded system uses Arduino Uno with a salinity sensor, temperature sensor, pH sensor, and water level sensor. While, the implementation of the internet of things uses Raspberry Pi which is used to process the data collected by Arduino to the thingspeak server.

Based on the experiment results, the collected data from pH sensor shows the actual pH and categorizes correctly the acid and alkaline as what litmus paper shows, while, the data collected by temperature sensor shows a very small and not significant difference with thermometer measurement results which are only 0.9 °C and 1°C. Thus, the system has been performing well..

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