Designing an IoT-Based Freshwater Lobster Cultivation Monitoring Dashboard

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Abstract. Indonesian aquaculture currently has enormous potential, particularly in freshwater lobster cultivation. Freshwater lobster has a relatively high selling value because it is popular and delicious. However, many considerations must be made in crayfish cultivation, such as temperature control and water quality. The parameters of water quality have a significant impact on maintaining and increasing production. Maintenance is still done manually on a regular basis which takes a long time. As a result, in this study, the authors developed an Internet of Things (IoT)-based system to monitor water quality in lobster farming ponds using the Antares IoT platform. According to the findings, the monitoring dashboard successfully displays the temperature and dissolved water content values in real-time, can automatically set points, and displays the value of each sensor in a comparison graph. This system can help users monitor water quality in freshwater crayfish cultivation in real-time, simplifying maintenance and increasing fish productivity.

Keywords: *Antares, Freshwater Lobster, Dashboard Monitoring, Internet of Things*.

1. Introduction

Aquaculture is a significant source of income for rural communities in Indonesia. Freshwater aquaculture is currently helping to improve the food and livelihoods of rural communities. This is due to the fact that fish farming, especially freshwater fish farming, requires less space and capital to operate, making it more accessible to small-scale farmers [1]. Crayfish cultivation is one of the most popular types of freshwater aquaculture. Freshwater lobster is a type of fish that is very suitable for cultivation in Indonesia because it has a high economic value, a fast growth rate, and supportive natural environmental conditions [2].

In cultivating freshwater crayfish, the place, environment, and water quality parameters have an important role in supporting the survival and growth of freshwater crayfish. Water quality parameters must be constantly monitored and analyzed. As a result, accurate measurements of water quality parameters like pH, temperature, and dissolved oxygen (DO) must be made in real time and on a continuous basis [3]. Therefore, the current development of Internet technology can be utilized to create a monitoring system that can be controlled automatically so that it is more effective and efficient when used. One of the technological developments with the concept of

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combining internet technology and physical systems is the "internet of things". The application of IoT has been carried out in research [4] for the development of internet of things-based smarthomes by monitoring through android smartphones.

From previous research, the monitoring system for fish farming is carried out with different platforms and components. In research [5], the authors propose a water quality monitoring system for iot-based crab culture using the Raspberry Pi, temperature and pH sensors, and web-based monitoring using a node-red dashboard to display water quality parameters. While in the research phase [6], monitoring of water variables in automatic lobster cultivation was done with an embedded system using an Arduino Uno and dashboard display using the Thingspeak server. The feasibility of water in IOT-based fish ponds has been monitored using a microcontroller and the Blynk application. The results of the tests performed allow the data to be sent correctly in real-time [7]. In contrast to previous research, in this research, the dashboard design in the form of a water quality monitoring system is carried out on freshwater crayfish cultivation using an IoT platform that is connected to a website server to be accessed effectively and efficiently.

2. Theory

2.1 Freshwater Lobster

Freshwater lobster has a pretty bright prospect in the fishing sector. Besides being easy to cultivate, these animals are not susceptible to disease, are omnivorous, grow fast, and have high egg-laying power. When viewed from the technical aspect of cultivation and market potential, freshwater crayfish deserve to be widely developed in the community so that they can provide economic benefits and maintain their sustainability. The success of freshwater crayfish cultivation is strongly influenced by the availability of quality seeds. (Iskandar in [8]). In accordance with the opinion of Sukmajaya and Suharjo in [8] , who state that in their natural habitat, freshwater crayfish live and grow optimally at a temperature of 26–300 °C, optimally in dissolved oxygen (DO) ranging from 3-5 mg/l, and live at pH ranges from 6.7–7.8. [8]

2.2 Dashboard

A dashboard is a computer interface that displays a variety of charts, graphs, reports, visual indicators, and alert mechanisms that will be combined to form a dynamic and relevant information platform (Malik (2005), in [9]). According to the book Information Dashboard Design, the dashboard is used as a visual display of the most important information needed to achieve one or more goals, which are combined and arranged on a single screen so that they can be monitored at a glance [10].

2.3 Internet of Things

The "Internet of Things" (IoT) is a concept that extends the use of the internet network by integrating several machine components into a unified system that can communicate with one another [11]. In recent years, most IoT-based device architectures use the web to publish information through social networks. So, IoT can improve system tools by producing services that work together for one output [12].

2.4 Antares

Antares is an Internet of Things (IoT) platform owned by PT Telkom Indonesia Tbk. Antares is built on two pillars: an IoT platform and IoT connectivity. Antares connects LoRa, GSM, and WiFi wireless Internet of things. When compared to other platforms, Antares has the advantage of supporting IPv6, four standard protocols such as Hypertext Transfer Protocol (HTTP), Message Queuing Telemetry Transport (MQTT), Constrained Application Protocol (CoAP), and Web Socket, and is built on a single global M2M standard [13], [14].

3. Method

3.1 System Overview

In the research on Designing an IoT-Based Freshwater Crayfish Cultivation Monitoring Dashboard it has two designs, including hardware design and software design. To fulfill these two designs, there are 3 elements, namely input, processing, and output, as shown in Figure 1.

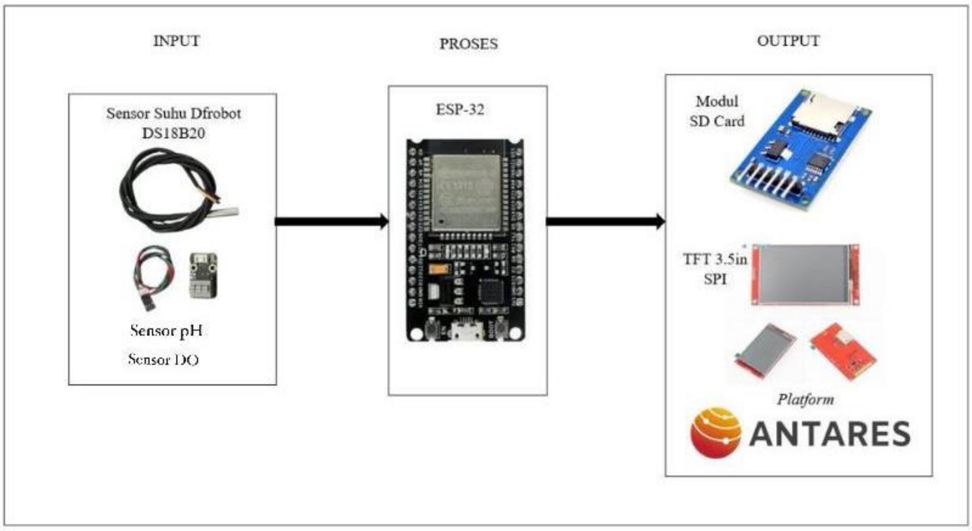

Figure 1. System General Design

The input comes from sensors used to monitor water quality. This sensor is connected to the microcontroller by using a jumper cable as a process step. Then the microcontroller will read the input data from the sensor, and it will be sent to the IoT platform via WiFi. This IoT platform can be used as a database to store data from connected IoT devices. In addition, the data is also displayed on a platform dashboard. The data that has been sent to the IoT platform will be pulled to display on a website dashboard using the PHP library. The dashboard on the website will display sensor data in real time.

3.2 Hardware design

This study's hardware design uses several components, such as a microcontroller, a temperature sensor, a DO sensor, and a pH sensor. As shown in Figure 2, the sensor components' circuit is connected to the microcontroller, and data is sent using the WiFi module.

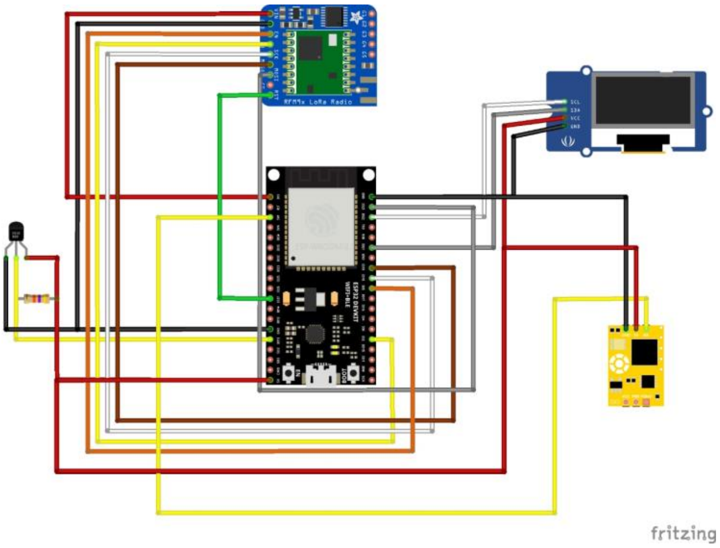

Figure 2. Design Hardware

3.3 Software Design

3.3.1 Flowchart

The flowchart diagram represents the workflow or process followed by the system as a monitoring system in retrieving data from Antares and displaying it on the main dashboard page in the form of temperature, DO, and PH data. The dashboard flowchart diagram is shown in the image below.

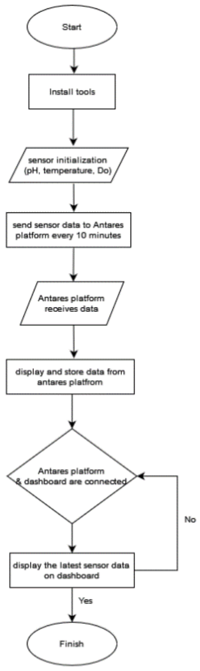

Figure 3. Flowchart System

3.3.2 Usecase Diagram

Use case diagrams are employed to represent the monitoring dashboard's process and data models. This modeling is a unified modeling language (UML), which is a Systems development design procedure. A use case diagram is shown below in Figure 4.

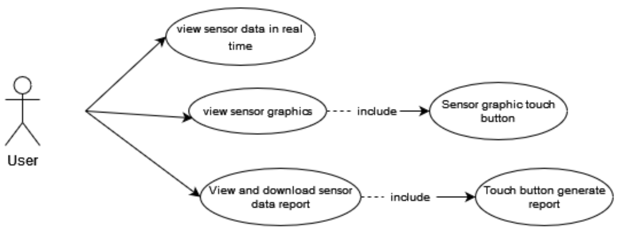

Figure 4. Usecase Diagram

4. Result

In this research, the design of hardware and software systems is based on a general description that includes input, process, and output. In addition, this design was developed based on the research that has been done. In designing this dashboard, testing is carried out, which aims to find errors in the system and ensure the system that has been built is as planned.

4.1 System Communication

The communication system was tested using the Antares IoT Platform, which functions as a database and intermediary for IoT devices. This test is done by checking the data sent by the tool on the Antares IoT Platform dashboard. Communication data will be stored and displayed in real time on the Antares platform. The display in Figures 5 and 6 depicts system communication data from sensors on the Antares IoT platform.

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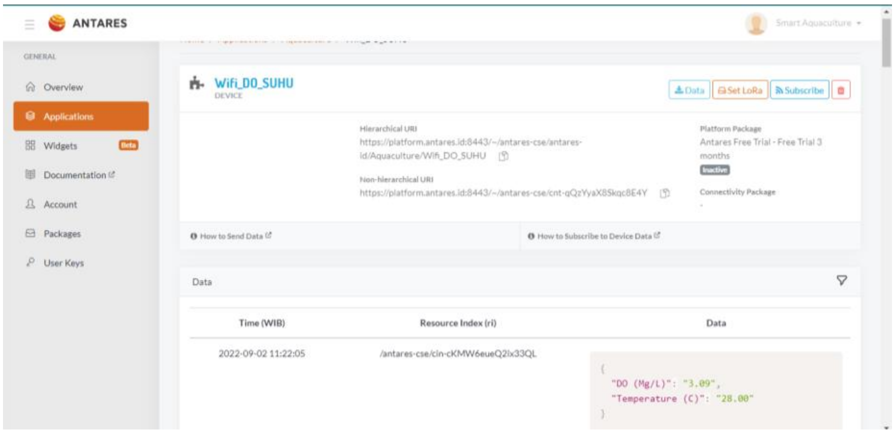

Figure 5. Sensor data DO in Antares

Figure 6. Temperature and pH sensor data in Antares

Figures 5 and 6 show that each sensor can have different inputs while still being installed on the same device, namely Wifi_DO_Suhu. So, the Antares platform can be used for multiple communications but still be stored in the same device

4.2 Dashboard Testing

This monitoring dashboard is tested using a black box test. Black box testing is software testing in terms of functional specifications that does not include testing the design and program code to determine whether the software's functions, inputs, and outputs meet the required specifications. (Sagittarius and Chalifah in AD 2020) As a result, it is hoped that monitoring sensor data on freshwater crayfish aquaculture via the Antares platform will yield appropriate results in this test. The following are the results of the tests:

Table 1. Black Box Testing Dashboard

No.	Testing	Result	Status
1.	Pressing the dashboard button on the sidebar	Main page	✓
2.	Pressing the graphic button on the sidebar	Graph data	✓
3.	Refresh the page	Get temperature sensor data, pH and DO	✓
4.	Pressing the generate report button	Get reports of all sensor data from Antares IoT platform	✓

4.3 Implementation

This implementation stage is an activity that is carried out after the design process and device testing have been carried out. This stage is carried out to determine the level of accuracy of the monitoring tool and system. The implementation of the monitoring system on this website-based dashboard is expected to be useful for users.

Figure 7. Research Sites

This research was conducted at the Cikoneng Fish Seed Center, UPTD, Ciparay District, Bandung Regency. This research site is one of the locations for fish farming in Bandung and has attractive environmental conditions for research on the quality of freshwater crayfish ponds.

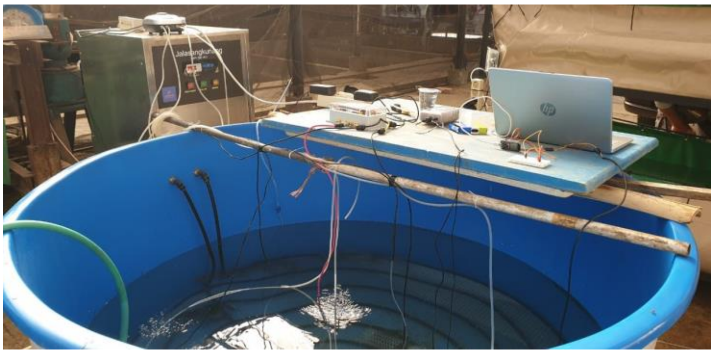

Figure 8. Monitoring Toolkit

Figure 8 is a tool design for a freshwater crayfish spawning pond that is stored at the research site. The pH sensor, temperature sensor, and DO sensor are inserted into the pond containing the lobsters. The microcontroller and relay module are stored in a box for protection. Each sensor value will be detected and read by the tool, and then there is a heater and chiller that will turn on automatically when it detects the sensor value.

The following is the dashboard view that can be accessed via https://aquaculture.brin.go.id/.

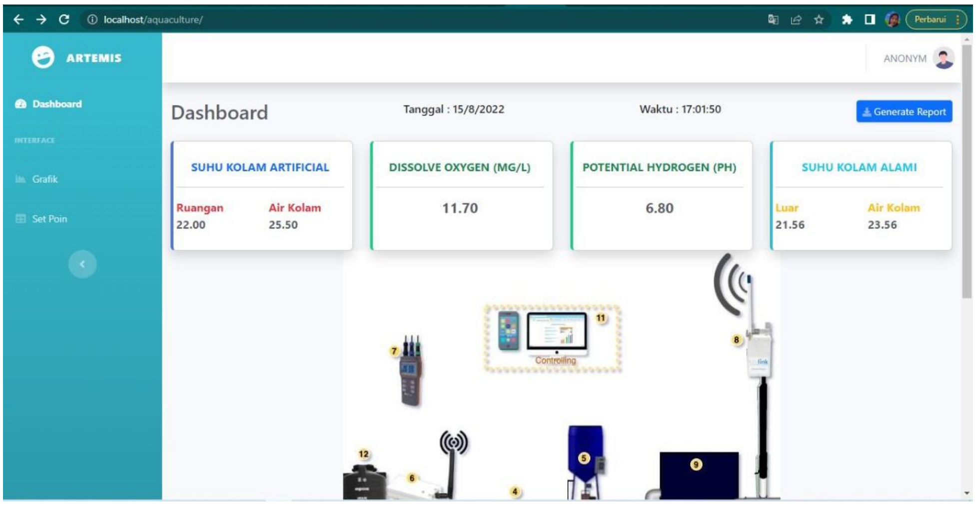

Figure 9. Dashboard Main View

The value sent from the sensor via the Antares IoT platform will be displayed in the Dashboard menu as shown above. The value displayed is the last data contained on the Antares platform. The data will change in real time if there is new data that comes in when the web page is refreshed. If no data is entered on the Antares platform, then the data will not appear as shown in the example in Figure 10. The DO sensor value does not appear because there is no incoming data.

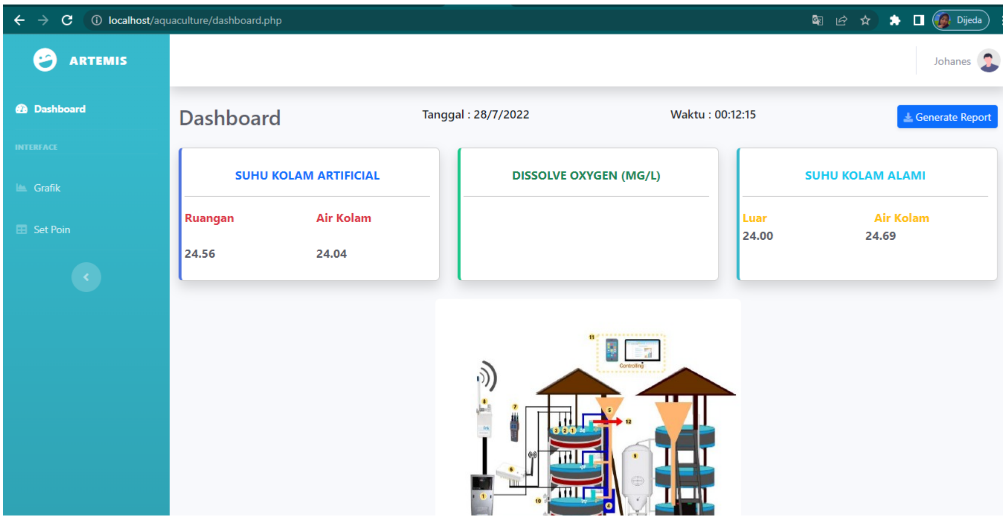

Figure 10. Dashboard not connected platform Antares

From the results of the system communication test as described in Figures 5 and 6, it can be seen that the sensor values from several different inputs can be displayed on one dashboard. When one device fails to send data values, the dashboard continues to display data from other devices.

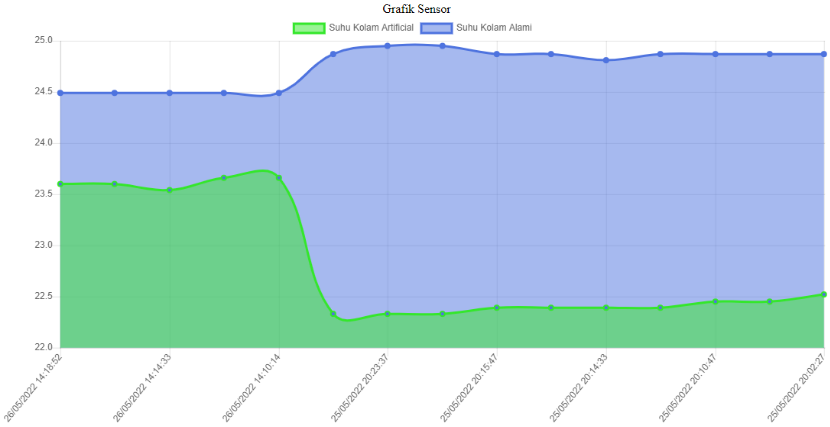

Figure 11. Temperature Sensor Graph

In Figure 11, there is a comparison of temperature sensor graphs from natural ponds and artificial ponds designed for monitoring water quality. The last 15 data points from the sensor are used.

Copy CSV Excel PDF Print

Tanggal	Waktu	Suhu Alami Kolam	Suhu Alami Luar	T
27/8/2022	01:32:04	27.00	20.50	
27/8/2022	01:21:56	27.00	20.50	
27/8/2022	01:11:48	27.00	20.50	
27/8/2022	01:01:40	27.00	20.50	
27/8/2022	00:51:31	27.00	20.50	
27/8/2022	00:41:23	27.00	21.00	
27/8/2022	00:31:15	27.00	21.00	
27/8/2022	00:21:07	27.00	21.00	
27/8/2022	00:10:58	27.00	21.00	
27/8/2022	00:00:50	27.00	21.00	

Showing 991 to 1,000 of 1,000 entries

Figure 12. Data Table Sensor

The image above shows a table with sensor data. Sensor data is information stored on the Antares platform. Sensor data can be downloaded as csv, pdf or excel files.

5. Conclusion

In this paper, the researcher proposes a water quality monitoring system for IoT-based freshwater crayfish aquaculture. This system aims to support farmers in processing freshwater crayfish by monitoring water quality regularly. This study uses a temperature sensor, pH sensor, and DO sensor as parameters to monitor water quality. Data from each sensor is sent to the IoT platform via the Arduino Uno microcontroller. Users can easily see the value of each sensor using a smartphone because the platform value will be displayed on the dashboard. This research uses an international IoT platform, namely Antares, which has been successfully integrated with a dashboard in the form of a website that has been created. The IoT-based freshwater lobster monitoring dashboard design was successfully implemented based on the test results. Data from the IoT platform is successfully connected to the monitoring dashboard. The dashboard displays the latest data variables on the Antares platform. This research can be used as a reference for developing a monitoring system in the field of aquaculture. The researchers hope to develop functional devices such as automatic water filling and temperature control in future studies so that water quality can be controlled effectively and the productivity of aquatic products can be greatly increased. Researchers believe that lobster farmers should be educated on how to keep lobsters healthy. In the future, IoT-based monitoring dashboards can be integrated with this system.

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