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DESIGN AND IMPLEMENTATION OF A SHRIMP POND MONITORING SYSTEM USING INTERNET OF THINGS

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ABSTRACT

In 2020, the volume of fishery exports will reach 1.26 billion kilograms (kg) with a value of US$ 5.2 billion. Shrimp became the commodity with the most exports, namely 239.28 million kilograms with a value of US$ 2.04 billion. In 2020 shrimp aquaculture production in Indonesia reached 911.2 thousand tons, shrimp also contributed to the total export volume of fishery products by 18.95%. Vaname shrimp production is also targeted to reach 2 million tons in 2024, some of which will be for export. In an effort to achieve this target, a system is needed that is capable of monitoring and controlling shrimp ponds using the Internet of Things (IoT). Because the monitoring process that is carried out traditionally will take time and be less efficient. Therefore, it is necessary to develop a system for monitoring and controlling shrimp ponds automatically using IoT. Sensors and microcontrollers are used to read and control input and output data such as pH, temperature, salinity, turbidity, light intensity, water level, and actuators for filling and draining pumps. This system will also be equipped with an expert system to be able to perform data analysis of measured parameters. This research was carried out within 2 years. In has been carried out the development and manufacture of hardware on the monitoring and control system. In the second year, hardware and software integration will be carried out to be able to monitor, control, and analyze data as decision support and implementation in the actual system. The purpose of this research is to design and build a monitoring and control system for shrimp ponds based on the Internet of Things.

Keywords: shrimp ponds, monitoring, control, expert system.

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INTRODUCTION

According to the Indonesian Ministry of Maritime Affairs and Fisheries, vaname shrimp farming is currently the mainstay of the aquaculture sector and a priority for aquaculture development in Indonesia in the national economy. In the 2012-2018 period, the contribution of the export value of shrimp to the value of Indonesian fishery exports averaged 36.27%. This proves that the shrimp commodity has a significant role in the performance of fisheries exports in Indonesia. Apart from nationally, the production of vaname shrimp is also targeted to reach 2 million tons in 2024, some of which are for export. To realize this target, the Directorate General of Aquaculture (DJPB) and the Ministry of Maritime Affairs and Fisheries (KKP) are pushing for a breakthrough program to boost the productivity of shrimp farming. To achieve this target, of course, it must be supported from various aspects, one of which is the use of digital technology.

In an effort to ensure shrimp growth and pond profitability, pond water quality control must be carried out. The step needed to achieve this control is to carry out regular monitoring of water quality parameters. The growth and survival of shrimp are directly related to the physicochemical and biochemical parameters of pond water, so the maintenance of a healthy reservoir is very important. Monitoring of water quality in shrimp ponds is currently mostly done through manual processes. Processing is carried out by a hand-held multiparameter meter. On small farms that have a few ponds and span several acres, measurements are taken by a person walking from pond to pond or measuring site to measuring site. At each location, measurements were recorded in a notebook for analysis [1-4]. So the purpose of this research is to design and build a monitoring and control system for shrimp ponds based on the Internet of Things.

An alternative to the monitoring process that is carried out traditionally will take time, so it is necessary to develop a monitoring and control system for shrimp ponds using IoT, so that an intelligent system for shrimp ponds will be produced. This is a new paradigm in legal cultivation that takes advantage of the latest technological developments by utilizing the Internet of Things (IoT) and the use of wireless sensor networks to gain real-time monitoring capabilities [5]. Monitoring multiple parameters in real-time will help farmers to make informed decisions. So that it will produce the best utilization of resources to increase agricultural productivity and efficiently control its operations in real-time [6-14].

The traditional way of monitoring shrimp pond parameters is time-consuming, extra laborious, and inefficient, leading to inefficiencies. So it is necessary to develop a monitoring system and control of shrimp ponds using the Internet of Things (IoT) to automate the shrimp farming system. Sensors and microcontrollers will be used to read and control input and output data such as pH, temperature, salinity, turbidity, light intensity, water level

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and actuators for filling and draining pumps [9-17]. Then in the development of this system it is necessary to design the sensor casing so that it is not easily exposed to corrosion, so that the measurement results become more optimal. Based on the things that have been described, this research is very important to do as an effort to solve problems that exist in shrimp pond culture and has the potential to increase shrimp productivity. This system will be equipped with an Expert System so that this system is able to make predictions and as a decision support system. In this research will be carried out the development of both hardware and software that is integrated using IoT.

Based on literature searches that have been carried out by several researchers [1, 5, 6, 8, 9, 11-13, 18-21], they generally do more research on developing the hardware and sensors used. The equation with this research proposal is the development of a monitoring system using sensors and IoT. While some of the differences from the research that will be carried out are the developments of the data processing process using the Expert System which in this study will be adopted by analysis from experts to carry out decision processes or decision support. Apart from that, on the hardware side, modifications will be made to the sensor casing to make it resistant to corrosion caused by the influence of seawater. This research needs to be done because, in addition to system and scientific development, it will also solve problems that are often encountered in conventional shrimp pond management. So this research has enormous potential to be utilized by shrimp farmers who indirectly use this system to achieve efficiency both time efficiency and management of added shrimp. In addition, the results of this study have a large enough opportunity to be published in reputable international journals, simple patents, and prototypes on a laboratory scale.

MATERIAL AND METHODS

The design and development of the Internet of Things (IoT) Based Shrimp Pond Monitoring and Control System was carried out at the Electronics and Instrumentation Laboratory of the Department of Physics, Faculty of Science and Mathematics and MSTP Jepara. In this research, the hardware and software design of the Internet of Things (IoT) Based Shrimp Pond Monitoring and Control System was carried out. While the application and system trials were carried out at MSTP Jepara. The complete method used in this research is:

a) Design and implementation a hardware monitoring and control system for shrimp ponds based on the Internet of Things (IoT).
b) Integration and testing of hardware and software as a whole in the monitoring and control system for shrimp ponds based on the Internet of Things (IoT) and implementation of the actual system at MSTP Jepara.

The system designed in this research is a system capable of monitoring and controlling shrimp ponds using the Internet of Things. In addition, this system is equipped with an Expert System to be able to perform data analysis so that it can be used as a decision support system. Figure-1 is a block diagram of the monitoring and control system in shrimp ponds.

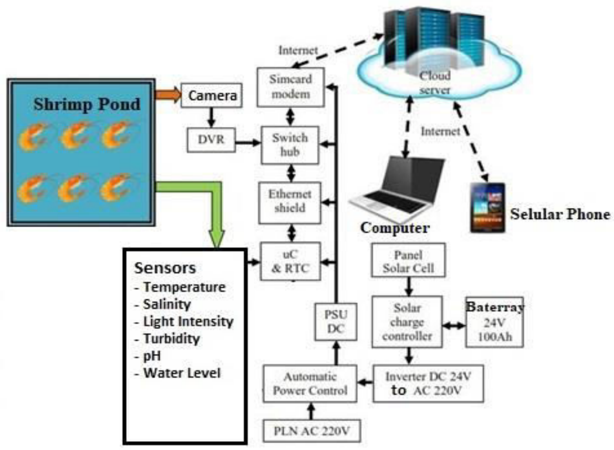

Figure-1. Block diagram of the monitoring and control system.

RESULT AND DISCUSSIONS

The shrimp pond monitoring and control system has been successfully designed and implemented. The system in general consists of a data acquisition system consisting of sensors for water temperature, salinity, light intensity, turbidity, pH, and water level. In addition, there are 2 actuators, namely pumps to supply water in the pond. Supporting equipment for shrimp pond monitoring and control systems consisting of hub switches and modems for data communication.

Sensor Testing

Sensor testing was carried out on several sensors including testing the thermocouple temperature sensor, pH sensor, light intensity sensor, and level sensor. The temperature sensor test is carried out by testing the sensor design results and the measuring instrument temperature sensor as shown in Table-1.

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Table-1. Temperature sensor testing.

No	Sensor reading temperature (Celsius)	Gauge temperature
1	25,2	25,7
2	28,6	29,2
3	33,5	34,6
4	36,7	37,1
5	40,3	40,6
6	45,1	45,5
7	48,2	48,7
8	54,3	55,1
9	59,5	59,2
10	65,4	65,1
11	72,3	72,8
12	78,2	78,7
13	84,6	85,5
14	90,2	91,4

In Figure-2, it can be seen in the graph that the results of the design of the temperature sensor measurements and measuring instruments have an accuracy of 99%.

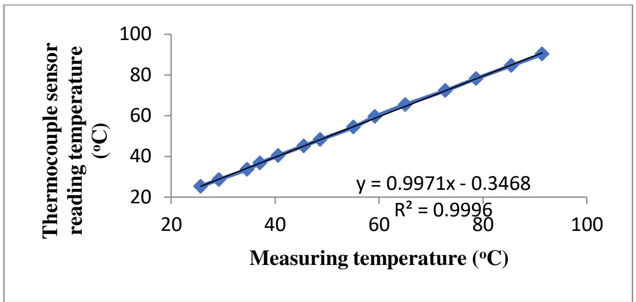

Figure-2. Graph of temperature sensor testing.

In testing the pH sensor that has been designed, a comparison is made using a standard measuring instrument; the results obtained are as shown in Table-2. Testing the pH sensor using liquid soap and vinegar, it can be seen from the test results that it shows very good results.

Table-2. PH sensor test results.

No	pH Measuring with standard	pH sensor result
1	5,16	5,31
2	5,48	5,65
3	5,76	5,84
4	6,46	6,49
5	6,77	6,57
6	6,92	6,82
7	7,47	7,53
8	7,62	7,72
9	7,84	7,95
10	7,91	8,06
11	8,11	8,29
12	8,24	8,48
13	9,47	9,58
14	9,91	10,23

In Figure-3, it can be seen in the graph that the measurement results of the designed pH sensor and measuring instrument have an accuracy of 99%.

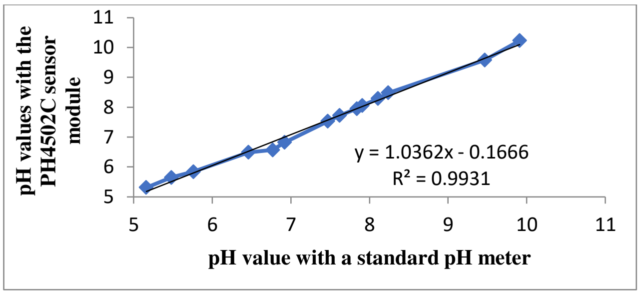

Figure-3. Graph of pH sensor testing.

In testing the light intensity sensor that has been designed, a comparison is made using a standard measuring instrument; the results obtained are as shown in Table-3. The light intensity sensor uses an LDR, voltage divider and ADC 16-bit type ADS1115.

Table-3. The results of the light intensity sensor test.

No	Standard Luxmeter (Lux)	Light Sensor Reading (Lux)
1	0	0
2	45	56
3	126	139
4	356	390
5	759	789
6	1259	1367
7	1602	1702
8	2380	2514
9	2860	2979
10	3670	3865
11	4680	4760
12	5960	6345
13	8630	9240
14	13490	12570

Figure-4 it can be seen in the graph that the results of the measurement of the light intensity sensor as a result of the design and the measuring instrument have an accuracy of 99%.

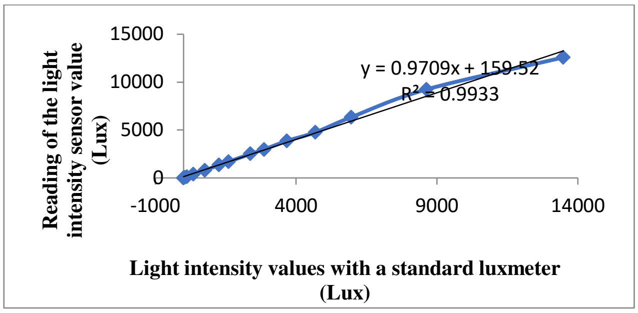

Figure-4. Graph of light intensity sensor testing.

In testing the level sensor, only low levels and high levels are obtained using logic 0 for low level (above water) and logic 1 for high level (submerged in water). Table-4 is the result of using the level sensor.

Table-4. Level sensor test results.

No	Position of the water level sensor	Digital Voltmeter (volt)	Logic
1	Above the water	0,02	0
2	Immersed in water	3,02	1

Figure-5 shows the water level sensor and its module during testing. In this test, an ordinary temperature sensor is used; it needs modification to make it resistant to sea water.

Figure-5. Level sensor testing.

The overall equipment can be realized as shown in Figure-6. In general, the equipment consists of a data acquisition system, a data processing system and a data communication system.

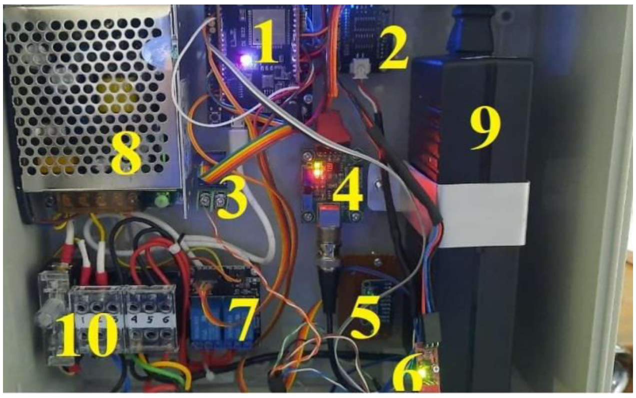

Figure-6. Shrimp pond monitoring system.

Based on Figure-6, the complete shrimp pond monitoring system consists of several components, namely:

1. Wemos ESP32 microcontroller - (supports WiFi internet network)
2. TDS sensor module
3. MAX6675 thermocouple sensor module
4. 4502C pH sensor module
5. Light intensity sensor circuit with 16-bit ADC module ADS1115
6. Turbidity sensor module
7. 5V relay module
8. Power supply 5 V / 10 Ampere
9. Power supply 12 V / 10 Ampere
10. Main terminals and fuses

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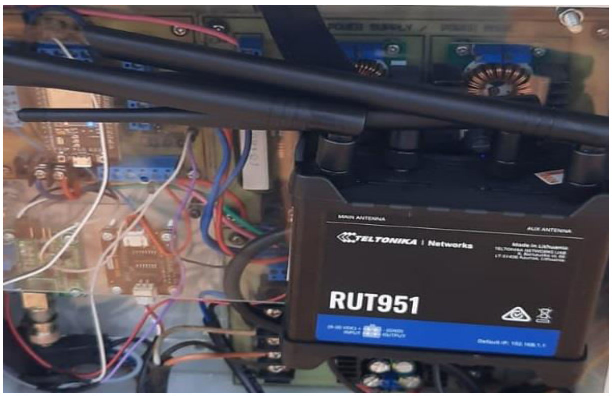

Figure-7. Data communication system using a modem.

Then testing data transmission via modem was carried out by checking the database and the application display as shown in Figure-8. It can be seen from these results that the system was able to send and read data. It can be seen that the value in the database is the same as the value in the display on the application; this proves that the data communication system is running well.

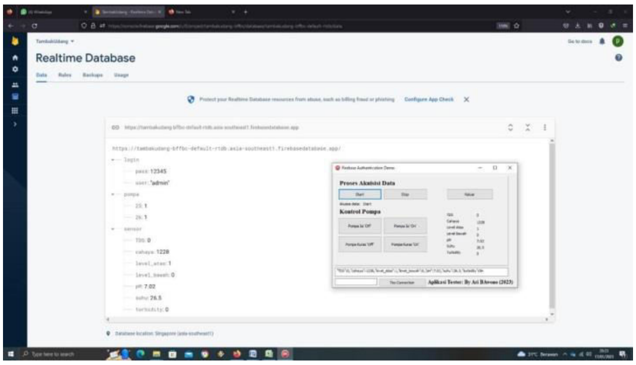

Figure-8. Communication data test results.

System Implementation

After testing the sensors, they are implemented in shrimp ponds which can be used to monitor the condition of shrimp ponds. The system has been implemented at the MSTP Jepara Shrimp Farm, by installing several sensors and data communication systems as well as monitoring system software using Android. Figure-3.9 shows the system that has been implemented in the Shrimp Pond at MSTP Jepara. The system is equipped with sensors, a modem for data communication, a data acquisition system, a power supply system using solar cells, and a monitoring system using Android.

Figure-9. System implementation in the Jepara MSTP shrimp pond.

Meanwhile, the Android-based monitoring system as shown in Figure-3.10, the monitoring system is able to monitor the condition of parameters in water and the environment, such as temperature, water level, pH and light intensity which can be monitored directly or via Google Spreadsheet. It can be seen from the results of testing the system individually and that the entire system has worked well. The system can carry out real-time monitoring as shown in Figure-3 and Figure-10, monitoring using an Android-based cell phone and monitoring results recapping using Google Spreadsheet has gone well. The sensor measurement results when compared with standard measuring instruments have an average accuracy of 99%. The calibration model of the sensor used refers to research [5, 12-13].

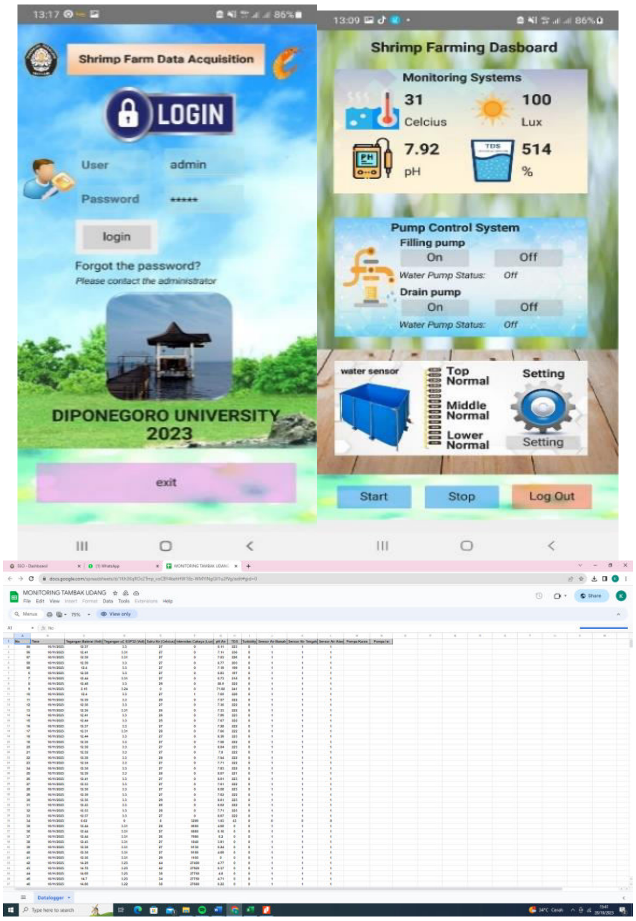

Figure-10. Monitoring system via. Android and Google Spreadsheet.

CONCLUSIONS

From the research that has been done, it can be concluded that the system can work well with data accuracy from sensors reaching an average of 99%. The data communication system has been able to work well; this is evidenced by the value in the database equal to the value in the shrimp pond monitoring and control system application.

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