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IOT-BASED VANAME SHRIMP WATER QUALITY MONITORING PROTOTYPE USING GOOGLE SPREADSHEET

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ABSTRACT

General Background: Effective monitoring of water quality is crucial in shrimp farming, as poor conditions can lead to significant harvest failures. **Specific Background**: The integration of Internet of Things (IoT) technology provides a promising solution for continuous water quality assessment, enabling farmers to monitor conditions remotely. **Knowledge Gap**: Despite advancements in monitoring technologies, there is limited research on the practical implementation of IoT-based systems in aquaculture settings, particularly for Vannamei shrimp. **Aims:** This study aims to develop an IoT-based water quality monitoring tool using a combination of sensors and cloud-based data storage to enhance shrimp farming productivity. **Results**: The system incorporates DS18B20, pH, and conductivity sensors linked to an Arduino Uno and NodeMCU ESP8266, successfully transmitting data to Google Sheets. The TDS sensor, DS18B20 sensor, and robotic DF pH sensor demonstrated accuracies of 98.59%, 98.59%, and 94.89%, respectively, with standard deviations indicating good reliability. **Novelty**: The proposed system offers a user-friendly interface via Google Sheets, allowing real-time monitoring without geographical constraints, making it accessible for farmers. **Implications**: The findings underscore the potential of IoT technologies in aquaculture for optimizing water quality management, thereby maximizing shrimp production and minimizing economic losses due to harvest failures. This innovative approach could serve as a model for future research and application in sustainable aquaculture practices.

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INTRODUCTION

Vannamei shrimp is a type of shrimp that originates from coastal and marine waters in Latin America. Then, this shrimp is imported by countries in Asia that develop shrimp cultivation such as China, India, Thailand, Bangladesh, Vietnam, and Malaysia

[1]. In Indonesia, vannamei shrimp are obtained through importing companies and developed in hatcheries in Situbondo and Banyuwangi. Vannamei shrimp are often cultivated in ponds, along with tiger shrimp and bungee shrimp.

Vannamei shrimp has advantages, among others, immunity to diseases, short maintenance period, feed efficiency, and high level of productivity[2]. The Government of Indonesia has approved vannamei shrimp as a superior variety suitable for pond cultivation through the Decree of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia No. 41/2001.

However, vannamei shrimp cultivation is faced with several challenges, especially for shrimp farmers in ponds. Uncontrolled ecosystems and weather fluctuations cause water quality-related problems that are difficult to monitor and control properly. The lack of awareness of farmers in applying the latest technology also causes unpredictable losses in shrimp farming[3]. Although many studies have been carried out by academics related to the monitoring and control of vannamei shrimp cultivation, the expensive price of technology and the lack of counseling to farmers cause the impact of the research to not be maximized directly.

Several studies have been conducted to utilize Internet of Things (IoT) technology in monitoring the water quality of vannamei shrimp ponds[4]. The studies include the use of microcontrollers and sensors to transmit data through apps such as Telegram, Blynk, and SMS. One of the studies also includes monitoring the water quality of IoT-based ornamental shrimp aquariums.

Based on these studies, there is a need to develop an IoT-based vannamei shrimp water quality monitoring tool using Google Sheets. By using Google Sheets, users can view and analyze data and take the next steps in vannamei shrimp farming[5]. The design of this tool uses an Arduino Uno microcontroller and a NodeMCU ESP8266 for data processing and transmission to Google Sheets. The sensors used include DS18B20 for water temperature, PH SEN0161 for water pH, and conductivity sensors for water clarity. The data sent to Google Sheets can be accessed and analyzed via smartphone from anywhere and anytime.

This system is expected to help vannamei shrimp farmers in monitoring and analyzing the water quality of vannamei shrimp ponds flexibly and practically

METHODS

System Planning

System design is useful to make it easier to understand the system of tools to be made. System design consists of system architecture, block diagrams and system flowcharts.

1. **System Architecture**

   System architecture is useful for determining the basis for designing a system. (1) In the level 1 system architecture, there are sensor inputs that will be used in the field, including; DS18b20 sensor, PH meter sensor, and conductivity sensor. (2) In the level 2 system architecture, there is a microcontroller component that is useful for processing data from sensor inputs. Used Arduino Uno microcontroller and NodeMCU ESP8266. (3) In the system level 3 architecture, there is an interface in the form of google spreadsheets which is useful for monitoring and supervising data.

(4) The microcontroller sends data to google spreadsheets through the internet network connected to the device

2. Block Diagram

The block diagram of a system is useful for determining the basis of design, it is explained that the input device block in the form of a conductivity sensor, PH sensor and temperature sensor DS18B20 will send data to the microcontroller block which will process the data. The data will be sent to the output block where it will be received and stored by the server and database. The data will be sent again to google sheets to be displayed and the data will be acquired.

3. Flowchart

A program flowchart depicts the flow of a program's run. Flowchat program for IoT-Based Vannamei Shrimp Water Quality Monitoring Prototype Using Google Spreadsheet starts from Arduino Uno initializing the sensor input. Next, data readings are carried out on the sensor. The read data will be processed by the Arduino Uno and will be sent to the NodeMCU via serial communication. In the NodeMCU Microcontroller, serial communication is initialized and connectivity is carried out on WiFi[6]. The data obtained from the Arduino Uno will be sent to the google sheets database and then will be displayed on the google sheets.

4. Google Sheets Planning

Google Sheets design is done by opening the Google Sheets page first. Next, give the file name that we will create and write the program script in the script editor. Next, create a page with Publish as a web application and next, copy and paste the page that has been created on the Arduino program. After everything is done, upload the program and a test will be carried out.

5. Overall Hardware Design of Water Quality Monitoring System

In the NodeMCU circuit with Arduino Uno, serial communication can be carried out through cross-connected RX TX pins. There is a reset button to reset the program on the microcontroller. The DS18b20 sensor is connected to a 5-volt source voltage as a voltage suumber and is connected to pin 5 of the Arduino to transmit the temperature measurement output[7]. There is a PH sensor connected to a 5-volt voltage source and an A4 pin as an analog data output from the water ph measurement. The conductivity sensor is supplied with a voltage supply of 5 volts and connected with an analog pin A5 for water conductivity readings.

RESULT AND DISSCUSION

Testing

The purpose of this test is to take data from the readings of the sensors used such as the DS18b20 sensor, TDS sensor and PH meter sensor. A test of sending data to google sheets was also carried out. This test is divided into 2 types, namely software and hardware testing. Software testing includes program testing, google sheets testing and data transmission testing[8]. In the hardware test, the measurement results of several sensors were tested with standard sensors used in the field previously. The data that has been obtained will be used as an evaluation for future development and research purposes.

1. Pengujian Sensor TDS (Total Dissolved Solid)

Table 1. TDS sensor testing

Testing to	TDS Meter (PPM)	TDS (PPM)	Deviation (PPM)	Accuracy (%)	Standard Deviation
1	501	507.79	6.79	98.66%	TDS (PPM)
2	501	508.04	7.04	98.61%	
3	501	507.79	6.79	98.66%	0.448
4	501	507.55	6.55	98.71%	TDS Meter (PPM)
5	501	508.28	7.28	98.57%	
6	501	508.04	7.04	98.61%	
7	501	508.28	7.28	98.57%	0
8	501	509.01	8.01	98.43%	
9	501	508.28	7.28	98.57%	
10	501	508.77	7.77	98.47%	
	Average		7.183	98.59%	

The test was carried out 10 times and the results were obtained that the salt content test in water solution with a TDS sensor had an accuracy percentage of 98.59% compared to the TDS meter [9]. From the results of the sandart deviation calculation, it was found that the TDS sensor has a standard deviation of 0.448. It can be concluded that the TDS sensor has moderate accuracy and overall the TDS sensor testing is going well and optimally.

2. DS18b20 Sensor Testing

Table 2. Testing of the DS18b20 sensor and thermometer

Testing to	Thermo (C)	DS18b20 (C)	Deviation (C)	Accuracy (%)	Standard Deviation
1	30	29.5	0.5	98.33%	DS18b20 (C)
2	30	29.44	0.56	98.13%	
3	30	29.44	0.56	98.13%	0.053
4	30	29.44	0.56	98.13%	Thermometer (C)
5	30	29.37	0.63	97.90%	
6	30	29.44	0.56	98.13%	
7	30	29.37	0.63	97.90%	0
8	30	29.44	0.56	98.13%	
9	30	29.31	0.69	97.70%	
10	30	29.44	0.56	98.13%	
	Average		0.583	98.06%	

The test was carried out 10 times, and the results were obtained that the water temperature test with the DS18b20 sensor had an accuracy percentage of 98.59% compared to the Thermometer[10]. From the results of the sandart deviation calculation, it was found that the DS18b20 has a standard deviation of 0.053. It can be concluded that the sensor has good accuracy and overall the DS18b20 test went well and optimally.

3. Robotic DF pH Sensor Testing

Table 3. Testing of robotic DF pH sensors and pH meters

Testing to	pH mtr	pH mtr DF robot	Deviation	Accuracy (%)	Standard Deviation
1	6.50	6.50	0.00	100.00%	pH mtr DF robot
2	6.50	6.55	0.05	99.24%	
3	6.50	6.55	0.05	99.24%	0.0258
4	6.50	6.50	0.00	100.00%	PH mtr
5	6.50	6.55	0.05	99.24%	
7	6.50	6.50	0.00	100.00%	0
8	6.50	6.55	0.05	99.24%	
9	6.50	6.55	0.05	99.24%	
10	6.50	6.50	0.00	100.00%	
	Average		0.03	94.89%	0.05

The test was carried out 10 times and the results were obtained that the water acidity test with the robot DF pH sensor had an accuracy percentage of 94.89% compared to the pH meter[11]. From the results of the sandart deviation calculation, it was found that the robotic DF pH sensor has a standard deviation of 0.258[12]. It can be concluded that the sensor has good accuracy and overall the testing of the robot's DF pH sensor is running well and optimally.

Discussion

From the above test, it is found that the TDS sensor test has an accuracy percentage of 98.59% compared to the TDS meter[13]. From the results of the sandart deviation calculation, it was found that the TDS sensor has a standard deviation of 0.448. It can be concluded that the TDS sensor has moderate accuracy and overall the TDS sensor testing is going well and optimally. Meanwhile, the DS18b20 sensor test has an accuracy percentage of 98.59% compared to the Thermometer. From the results of the sandart deviation calculation, it was found that the DS18b20 has a standard deviation of 0.053. It can be concluded that the sensor has good accuracy and overall the DS18b20 test went well and optimally. In testing, the robot's DF pH sensor has an accuracy percentage of 94.89% compared to the pH meter[14]. From the results of the sandart deviation calculation, it was found that the robot's DF pH sensor has a standard deviation of 0.258. It can be concluded that the sensor has good accuracy and overall the testing of the robot's DF pH sensor is running well and optimally. Based on the Arduino IDE monitor Serial display. It can be concluded that the data transmission from the Arduino

Uno to the NodeMCU has been successful. The data format displayed is in accordance with the design that has been set. In addition, WiFi connection testing has also been successful. This success is evident from the device's connection to a WiFi network that can be viewed through the serial monitor display on the Arduino IDE[15]. Based on the table view in Google Sheets, it can be confirmed that the data submission process has gone according to the plan that has been set.

CONCLUSION

In conclusion, **Fundamental Finding**, this study successfully developed an IoT-based water quality monitoring tool for shrimp ponds, utilizing sensors such as the TDS, DS18B20, and robotic DF pH sensor, which demonstrated high accuracy levels of 98.59%, 98.59%, and 94.89%, respectively. The system effectively transmits data to Google Sheets, allowing for real-time monitoring and efficient management of water quality by shrimp cultivators. **Implication**, the implementation of this monitoring tool can significantly enhance shrimp farming productivity by enabling farmers to make informed decisions based on accurate water quality data, thus minimizing crop failures and maximizing production outcomes. **Limitation**, however, the study's findings are constrained by the specific environmental conditions and sensor calibration used during testing, which may not generalize to all aquaculture settings. **Further Research** is warranted to explore the scalability of this system across different shrimp farming environments and to integrate additional parameters such as dissolved oxygen and ammonia levels to provide a more comprehensive assessment of water quality.

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