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IoT-based Fishpond Monitoring to Improve Water Quality

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Abstract — To address the issues of suboptimal water levels and the risk of pond water overflowing due to rainfall, a fish pond control and monitoring system utilizing Internet of Things (IoT) technology has been developed. The system monitors three primary parameters—water level, temperature, and rainfall—which are all controlled and observed through an internet-connected platform. This real-time monitoring, facilitated via a website, enables fish farmers to accurately and efficiently monitor the condition of their ponds. The system is built using a NodeMCU ESP8266 microcontroller, which is equipped with sensors to automatically collect data on the water level, temperature, and rainfall. This data is continuously updated and can be accessed online anytime, anywhere. As a result, fish farmers can quickly react to changes in pond conditions, such as adjusting water levels to prevent overflow, or maintaining optimal water temperature for fish health. The real-time feedback provided by the system also allows users to take timely actions to prevent issues that could negatively impact the fish's health or overall pond productivity.

This IoT-based fish pond monitoring and control system makes pond management more efficient and minimizes the risks posed by environmental factors such as sudden weather changes. Additionally, it helps optimize the overall productivity of fish farms by offering a reliable, automated solution that reduces the need for constant manual supervision. This leads to better management of fish ponds and enhances productivity.

Keywords: microcontroller, monitoring, NodeMCU ESP8266, website, Internet of Things.

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I. INTRODUCTION

In the fisheries industry which has a strategic role in meeting food needs in the form of animal protein, as well as supporting national food security. This sector also contributes significantly to the economy, especially in areas that make fisheries the main source of income. However, in practice, the success of fish farming is greatly influenced by factors such as water temperature, water quality, and proper feeding. The ideal water temperature for fish farming ranges from 25-30°C, which affects the metabolism as well as the growth of fish. Temperature fluctuations and deterioration in water quality, such as dissolved oxygen levels and pH, can lead to stress, disease, and stunted fish growth [1].

Internet of Things (IoT) technology is beginning to be adopted in various sectors, including fisheries, to overcome existing challenges. One of the related studies is the journal "Design and Implementation of Smart Aquaculture Monitoring and Controlling System Based on Internet of Things (IoT)" published by Surya, R.N., et al. in 2020. This study describes the use of IoT sensors connected to the cloud to monitor the condition of fish ponds in real-time [2]. In Pasaman Regency, West Sumatra, the application of this technology is very relevant because fish farmers still use manual methods that are less efficient and prone to errors [3].

Therefore, this study aims to develop an IoT-based fish pond monitoring system that can monitor pond conditions automatically and in real-time, thereby helping farmers manage pond conditions more effectively, increase productivity, and minimize risks caused by changes in weather and water quality.

II. METHOD

In the preparation of this final project, there are several stages that will be implemented, including:

A. Literature Studies

This stage involves collecting data by reviewing journals, papers, and other readings related to the tool to be developed. This process includes gathering theories about how components work that are relevant to the design of the tool.

B. System Requirements Analysis

As a first step in system development, a comprehensive analysis of the needs, both in terms of hardware and software, is required to ensure that the resulting solution is optimal and meets user expectations in accordance with the desired objectives.

1) Hardware Requirements

In the manufacture of monitoring tools, several pieces of hardware are needed to keep the system running as needed.

TABLE I
KEBUTUHAN HARDWARE

NO	Perangkat	Description
1	Server	Provide resources and store files or data
2	NodeMCU	Board Microcontroller
3	Ultrasonic Sensor	Sensors for measuring distance
4	Sensor suhu DS18B20	Sensor to measure the amount of temperature in the water
5	Sensor Hujan FC-36	Displaying weather conditions
6	BreadBoard	BreadBoard as a board to place components

2) Software Requirements

To develop this tool, software is needed as a support for the monitoring system in order to meet the expected needs. More detailed information on this can be found in the following table:

TABLE 2
SOFTWARE REQUIREMENTS

No	Sofware	Language/Platform
1	Arduino IDE	C Programming Language
2	Visual Studio Code	PHP Programming Language

C. Block Diagram

A block diagram is a simple visual representation that shows the cause-and-effect relationship between inputs and outputs in a system. Block diagrams for control systems generally include elements such as inputs, processes, and outputs. The following is a block diagram for the design of an IoT-based fish pond monitoring tool:

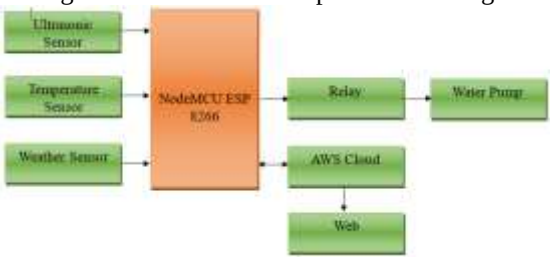


Figure 1 Block Diagram

In making this fish pond monitoring system, rain sensors and ultrasonic sensors will be used as inputs. Rain sensors function to detect the amount of rainfall, while ultrasonic sensors will measure the water level in fish ponds. The data obtained from the two sensors will be processed by NodeMCU, and the monitoring results will be sent to the website for display.

1) System Topology

Below is the topology of the design of an IoT-based fish pond control and monitoring system:

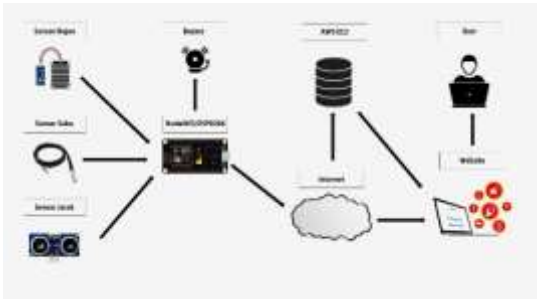


Figure 2 System Topology

Based on the visualization of the system topology shown in Figure 2, it can be seen that the NodeMCU will ESP8266 receive data from rain sensors, temperature sensors, and ultrasonic sensors. This data will be processed and forwarded to the buzzer as a notification of rain, as well as sent to the internet for further processing. Data connected to the internet network is then processed in AWS EC2 to be stored and displayed through a website that can be accessed directly by the user.

2) Flowchart

Based on the visualization of the system topology shown in Figure 2, it can be seen that the NodeMCU will ESP8266 receive data from rain sensors, temperature sensors, and ultrasonic sensors. This data will be processed and forwarded to the buzzer as a notification of rain, as well as sent to the internet for further processing. Data connected to the internet network is then processed in AWS EC2 to be stored and displayed through a website that can be accessed directly by the user.

Figure 3 Flowchart

The application starts by connecting the NodeMCU to a Wi-Fi network and using ultrasonic sensors to capture river water level data. The data is then sent to the Amazon Web Service (AWS) platform. Data stored in AWS is then accessed through APIs to be displayed on the website dashboard.

3) Hardware Planning

a) HC-SH06 Ultrasonic Sensor Series

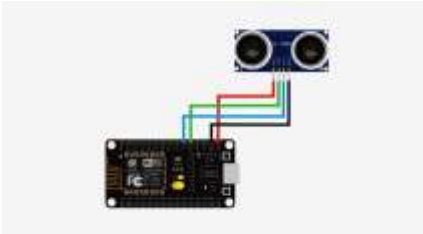


Figure 4 Ultrasonic Sensor Network

TABLE 3
ULTRASONIC SENSOR PIN

No	Node MCU	HC-SR04 Sensor
1	VIN	VCC
2	D8	Trig
3	D7	Echo
4	GND	GND

b) DS18B20 Temperarure Sensor Range

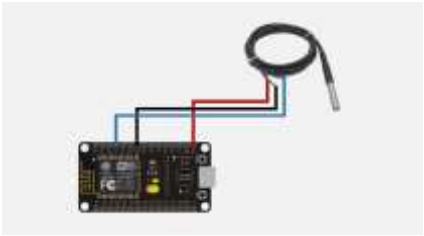


Figure 5 Temperature sensor Network

TABLE 4
TEMPERATURE SENSOR PIN

No	Node MCU	Temperature Sensor Ds18B20
1	3V3	VCC (Red)
2	GND	GND (Black)
3	D3	Data (Blue Yellow)

c) FC-36 Rain Sensor Series

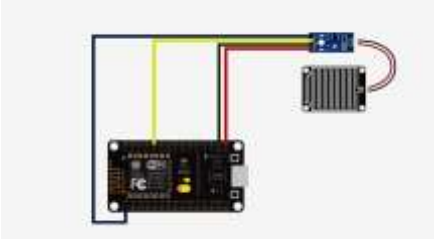


Figure 6 Rain Sensor Netrowk

TABLE 5
RAIN SENSOR PIN

No	Node MCU	Fc-36 Rain Sensor
1	3V3	VCC
2	GND	GND
3	A1	A0
4	D4	D4

4) NodeMCU Module Connection Program Design

The purpose of this design is to connect the NodeMCU module ESP8266 with the WiFi network, thus allowing the NodeMCU ESP8266 access the internet. To connect the NodeMCU module ESP8266 with WiFi, you need to add the following script in the Arduino IDE:

```
String ssid = "Nama SSID WIFI";
const char password = "Password WIFI";
```

5) Website Display Design Design

This display design is designed to provide real-time information to users in obtaining data in the field. The information can be accessed through the website. Here is the design of the web display that will be created:

Figure 7 Login Display Design Design

The image above shows the design of the login display to access the fish pond monitoring website. The information displayed on the website page includes two types, namely water level information and weather information, which are presented in the form of values and statuses. Water level values are displayed in the form of numbers that are converted to statuses such as low, normal, and high. Meanwhile, weather information shows the status of rain or not rain.

Figure 8 Website Display Design Design

6) Program Creation

At this stage, attention is focused on developing programs that are in accordance with the design of the tools that have been prepared beforehand.

a) Creating a Server on Amazon Web Service (AWS)

Here are the steps to create a server in Amazon Web Service:

Step 1: Log in to your AWS Console account by entering your username and password, after logging in please click EC2.

Step 2: At this stage, there is an option to select the Amazon Machine Image (AMI) to use. Recommended to choose Ubuntu Server 20.04 LTS (HVM), SSD Volume Type 64-bit (x86)

Step 3: In the Agency Type section, select Type t2.small.

Step 4: In the Key Pair section, add the name of the Key Pair and select the desired type along with the key file format. This key is used to log in to the server.

Step 5: In the Add Tags section, click Next: Firewall (security group).

Step 6: In the Summary section, click Launch Instance.

Step 7: The server view that has been created, to make sure the server is ready to use, can be accessed via the IP address 172.31.93.2

Step 8: The following is what the Apache2 Ubuntu Default Page looks like.

b) Creating Elastics IPs on Amazon Web Service

Elastic IP is used to connect ESP8622 NodeMCU modules with AWS. The purpose of its use is so that the IP used is static and does not change during the implementation of the tool. Here are the steps to create an Elastic IP on Amazon Web Service

c) Installation of phpMyAdmin on Ubuntu

Installing phpMyAdmin on Ubuntu requires the following steps:

Step 1 : Update the server or update the repository on Ubuntu with the following command:

sudo apt-get update

Step 2: Next, perform the installation of Apache on Ubuntu using the following command:

sudo apt-get install apache2

Aftrer the Apache installation process is complete, it can be seen whether the installation was successful or not, by opening the IP server with the command:

http://IP-54.86.249.2

Step 3 3: Install MySQL which functions to manage SQL databases. To start the installation process, the following command is used:

sudo apt-get install mysql-serve

Once the MySQL installation process is complete, the next step is to ensure a successful installation by logging into MySQL using the following command:

mysql -u root -p

Next , enter the password for the login process to MySQL.

To exit MySQL, you can enter the exit command and press ENTER:

mysql> exit;

Step 4: Next is the PHP installation process. To install PHP by entering the following command:

sudo apt-get install php php-mysql libapache2-mod-php php-cli php-cgi php-gd mysql-server mysql-client zip -y

To ensure that the PHP installation process is successful, it can be checked with the following three steps:

1. Log in to the HTML directory on the web server using the following command:

cd /var/www/html

2. Next by creating a PHP file using the following command:

touch info.php

3. After completing creating the PHP info file, then enter the PHP info file using the following command:

nano info.php

Next, copy and paste the code below by right-clicking:

Then save by clicking CTRL+X and then pressing y and ENTER.

4. Perform IP Server access by entering the following command in a web browser and to check if the PHP installation was successful or not.

Figure 9 Server IP Access

Step 5: Install phpMyAdmin. To start the installation process, use the following command in the terminal:

sudo apt-get install phpmyadmin

Next is to choose the type of web server. The default option is apache2. Press ENTER to select. Then press the Tab key to move to the OK button. Press the ENTER key to continue.

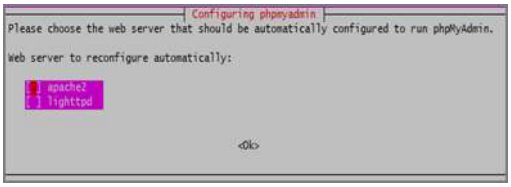


Figure 10 Choosing a Web Server Type

Next to configure the phpMyAdmin database with dbconfig-common. Select Yes and click ENTER.

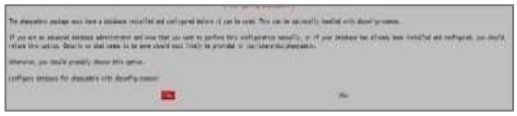


Figure 11 phpMyAdmin Configuration

Then you will be asked to create a new password for phpMyAdmin login.

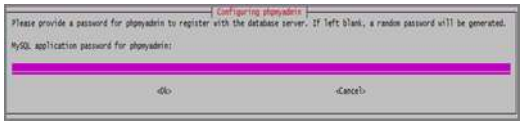


Figure 12 Password phpMyAdmin

Finally, confirm the password. Make sure the password is the same as the one entered earlier.

To make sure the phpMyAdmin installation process is successful, go to our website URL with the following format:http://54.86.249.27//phpmyadmin

The phpMyAdmin installation process has been successful. To log in to phpMyAdmin, use the "root" username and password you created during the phpMyAdmin installation process.

d) Creating a Database in phpMyAdmin

Step 1: Log in to phpMyAdmin and create a "colamikan" database.

Figure 13 Welcome to phpMyAdmin

Step 2: And then create a user table and a sensor table consisting of water temperature, altitude and weather..

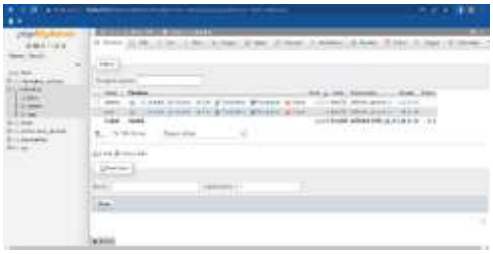


Figure 14 Creating a Database in phpMyAdmin

III. RESULTS AND DISCUSSION

Device testing is the final stage in the process of making IoT-based fish pond monitoring tools. Through testing, it can be ascertained whether the device designed and built works properly and meets expectations. The purpose of these tests and measurements is to ensure that each circuit block in the system is operating as expected. The results of these tests and measurements are then used as data that will be further analyzed. From these results, data was obtained about the tools that had been made, which would then be analyzed, both in terms of data, damage, and errors in the operation of the device.

A. Field Test Results

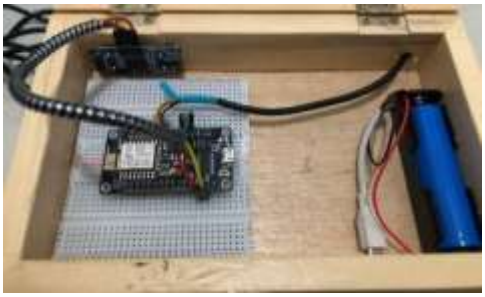


Figure 15 Field Testing

As seen in Figure 4.35, the testing stage is carried out directly in the fish pond to monitor pH, temperature, and water levels. This test lasts for 30 minutes with data logging every 5 minutes. The results of the data readings from the test can be viewed on a web dashboard that can be accessed via a laptop or smartphone using http://54.86.249.27/kolamikan IP address.

B. Web Services Testing Results

At this stage, tests are carried out on web services for cloud-based fish pond monitoring to ensure that the web system can function properly in receiving data from the tested device.

1) Login Page View

The first page accessed before heading to the main web page is the login page. On this page, users must enter a username and password, both of which are set as "admin".

Figure 16 Login Page

2) Display on the Home Page

Figure Figure 17 Home Page

On the home page, users can view information on the results of monitoring temperature, weather, and water level in real-time. In addition, users can also access information about the average data of fish pond monitoring every day.

3) Data Page View

The test results of the water level and temperature can be viewed on the sensor data menu on the web page. There, the monitoring data will be displayed in detail based on the results obtained from the sensor device.

Figure 18 Monitoring Data

4) Logout Process

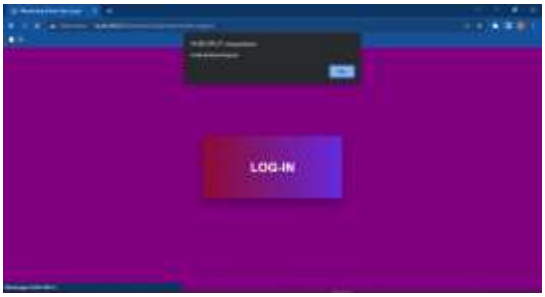


Figure 19 Logout Process

C. System Testing Discussion

After testing the IoT-based fish pond monitoring system, the results were obtained that the ultrasonic sensor, DS18B20 temperature sensor, and FC-37 rain sensor function well in reading water level, water temperature, and weather conditions.

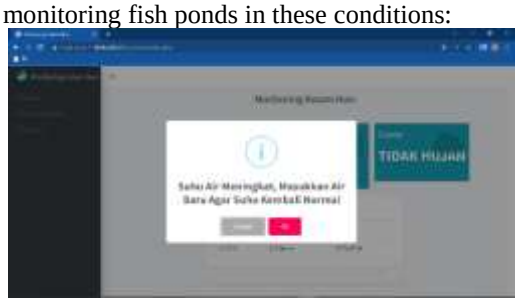
1) Safe Water Height and Ideal Water Temperature

This is a normal condition in the fish pond monitoring system. These conditions allow fish to live well because of the ideal water temperature and safe water level. The following are the results of monitoring the safe pond water level and the ideal temperature for fish survival.

Figure 20 Safe Water Level and Ideal Water Temperature

2) Safe Water Height and Non-Ideal Water Temperature

In these conditions, the increase in the water temperature of the fish pond is caused by too high light intensity. Temperatures that are too high can reduce the appetite of fish. In certain situations, the water temperature will return to normal when it rains or the water in the pond is changed. The following are the results of monitoring fish ponds in these conditions:



Gambar 21 Ketinggian Air Aman dan Suhu Air Tidak Ideal

3) Unsafe Water Heights, and Ideal Water Temperatures

This is a bad condition for fish growth, where the high water in the pond has the potential to cause overflow which can cause fish to come out of the pond. In these conditions, the sensor will detect the height and temperature of the pool water, which is then displayed on the website. A notification will appear on the webpage when unsafe water level conditions and non-ideal temperatures are detected.

Figure 22 Unsafe Water Level and Ideal Water Temperature

IV. CONCLUSION

Based on the results of testing the IoT-based fish pond monitoring device, it can be concluded that several important factors need to be considered during the device's construction. The placement of the device should be carefully chosen, positioned in the right location and in a calm area of the pond water, so the device can provide accurate information regarding water discharge increases, abnormal temperature changes, and rainfall in the fish pond area. The ability of the monitoring tool to send notifications when the temperature or water level exceeds or falls below normal limits has proven effective in preventing potential fish growth failure.

From the series of experiments conducted, the system was tested 10 times with a success rate of 95%. These tests revealed that the water temperature and pH were within the expected range, corresponding to the necessary parameters for red tilapia farming. This proves that the designed device works effectively in sending notifications related to temperature, pH, and water levels, which in turn helps optimize the pond conditions for successful fish farming.

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