Literasi Nusantara
vol.5 no. 1, November 2024 – February 2025
https://journal.citradharma.org/index.php/literasinusantara/index
ISSN 2746-8208 (Online)
ISSN 2746-3575 (Print)

Design of An Internet of Things (IoT)-Based System for Monitoring and Controlling Water and Feed in Fish Ponds

Muhammad Fajhry Amir [1]*, Sastya Hendri Wibowo [2]

[1,2] Fakultas Teknik, Universitas Muhammadiyah Bengkulu, Jalan Bali, Kampung Bali, Teluk Segara, Kp. Bali, Tlk. Segara, Kota Bengkulu, Bengkulu 38119, Indonesia

*Muhammadfajhryamir@gmail.com
DOI : *https://doi.org/10.56480/jln.v5i1.1360*

Received: December 27, 2024
Revised: January 09, 2025
Accepted: February 26, 2025

Abstract

In tilapia farming, several factors must be considered, such as water volume in the pond and feed management. Traditionally, water volume is checked manually by visually observing the pond, which lacks accuracy and time efficiency. Similarly, feed distribution is scheduled based on the feeding time for tilapia. To address these issues, an Internet of Things (IoT)-based monitoring and control system for water and feed in fish ponds is proposed. This system utilizes an Arduino connected to an ultrasonic sensor, servo motor, and relay. The ultrasonic sensor detects the water level in the pond. When the water level is low, the relay activates the water inlet pump, and when the water exceeds the limit, the outlet pump is activated. The Real-Time Clock (RTC) module schedules feeding times in the Arduino Uno program. When the feeding time is reached, the feed servo rotates 180˚ to dispense the feed. This system improves accuracy in water level monitoring and automates the feeding process, enhancing efficiency in tilapia farming.

Keywords– *Monitoring, Fish Pond, Arduino*

Literasi Nusantara. vol.5 no. 1, November 2024 – February 2025
ISSN 2746-8208 (Online) and ISSN 2746-3575 (Print)

1. Introduction

The Nile tilapia is one of the most economically valuable freshwater fish species widely cultivated in Indonesia. Known for its delicious and savory taste, Nile tilapia is highly sought after by consumers. Additionally, this fish is rich in protein and essential nutrients, making it highly beneficial for human health. Due to these qualities, Nile tilapia farming has become a profitable business sector in Indonesia, particularly in the city of Bengkulu. However, despite its economic potential, tilapia farming still faces several challenges, one of which is the fluctuation of water volume in fish ponds. Maintaining the optimal water level is crucial for the growth and survival of the fish, as inadequate or excessive water can negatively impact their health and productivity. Traditional methods of monitoring water levels, which rely on manual observation, are often inaccurate and time-consuming. This inefficiency can lead to suboptimal farming conditions and reduced yields. Therefore, there is a pressing need for an effective and efficient solution to address these challenges and enhance the productivity of Nile tilapia farming. Implementing advanced technologies, such as an Internet of Things (IoT)-based monitoring and control system, could provide a reliable way to manage water levels and feeding schedules, ultimately improving the overall efficiency and profitability of tilapia farming operations.

One effective way to optimize the productivity of Nile tilapia is by closely monitoring the water volume in the pond. Poor water volume management, whether the water level is too low or too high, can lead to a decline in both the quality and quantity of tilapia production. Insufficient water volume can stress the fish, hinder their growth, and even cause mortality, while excessive water can dilute essential nutrients and disrupt the pond's ecosystem. Given these challenges, it is crucial to implement a reliable system for monitoring and controlling the water volume in Nile tilapia ponds. This research focuses on designing an IoT-based monitoring and control system for water volume in tilapia ponds, aiming to address the shortcomings of traditional methods and improve the accuracy and efficiency of water level management. By leveraging IoT technology, this system is expected to assist fish farmers in making more informed and timely decisions regarding water volume, thereby enhancing the overall effectiveness of their operations. Furthermore, the integration of IoT in monitoring water levels can contribute to sustainable tilapia farming practices by ensuring optimal conditions for fish growth, ultimately leading to increased productivity and improved quality of Nile tilapia. This innovation not only supports the economic interests of farmers but also promotes environmental sustainability by reducing water waste and maintaining a balanced pond ecosystem.

The general objective of this research is to provide a viable solution for monitoring and controlling water levels in fish ponds using Internet of Things (IoT)-based technology. By implementing an IoT system, this research aims to address the challenges faced by fish farmers in maintaining optimal water conditions, which are critical for the growth and productivity of Nile tilapia. The system is designed to offer a more efficient, accurate, and automated approach to water management, reducing the reliance on traditional, labor-intensive methods.

The specific objective of this study is to leverage advancements in IoT technology and apply them to Nile tilapia farming. This system is intended to enable fish farmers to remotely monitor and control water levels in their ponds, regardless of their location. By automating the monitoring process, farmers can save time and focus on other important tasks, thereby improving overall farm management efficiency. Additionally, the system ensures that water volume is maintained at optimal levels, which is essential for preserving the quality and quantity of the fish. With this technology, farmers can access real-time data and control water levels through their smartphones or other devices, providing convenience and flexibility. Ultimately, this research aims to empower fish farmers with a practical and innovative tool that enhances productivity, reduces manual labor, and supports sustainable aquaculture practices.

2. Method

The method employed in this research is the experimental method, which is a quantitative approach conducted in a laboratory setting with specific treatments

Literasi Nusantara. vol.5 no. 1, November 2024 – February 2025
ISSN 2746-8208 (Online) and ISSN 2746-3575 (Print)

applied. This method allows for controlled testing and observation of the system's performance under various conditions, ensuring that the results are accurate and reproducible. The experimental process begins with the design and assembly of the IoT-based monitoring and control system for water and feed in fish ponds. The first step involves creating a detailed schematic diagram of the device's circuit, which serves as a blueprint for integrating all the necessary components. The core of the system is the Arduino Uno microcontroller, which acts as the central processing unit to control and coordinate all connected devices. An ultrasonic sensor is used to measure the water level in the pond, providing real-time data to the Arduino. Based on this data, a relay module is employed to control the operation of water pumps—specifically, the inlet pump adds water when the level is too low, and the outlet pump removes excess water when the level exceeds the optimal range. For feed management, a servo motor is integrated into the system to dispense feed at scheduled times. The timing is managed by a Real-Time Clock (RTC) module, which ensures that feeding occurs at precise intervals. To enable remote monitoring and control, an IoT module (such as the ESP8266) is incorporated, allowing farmers to access real-time data and control the system via the internet. Additionally, a power supply is included to provide energy to all components, and an optional display (LCD or OLED) can be added to show real-time information, such as water levels and feeding schedules.

Once the system is assembled, the next step involves programming the Arduino to process data from the sensors and control the connected devices. The system is then tested in a controlled environment, such as a simulated or small-scale fish pond, to evaluate its accuracy, reliability, and efficiency. Data is collected on various parameters, including water level fluctuations, feed dispensing accuracy, and system response times. This testing phase is crucial for identifying any potential issues and refining the system to ensure optimal performance. After successful laboratory testing, the system can be implemented in real-world fish farming operations, where it will be further evaluated for its practicality and effectiveness. By using this experimental approach, the research aims to develop a robust and reliable IoT-based system that enhances the productivity and sustainability of Nile tilapia farming, providing farmers with an efficient tool for monitoring and controlling water and feed in their ponds.

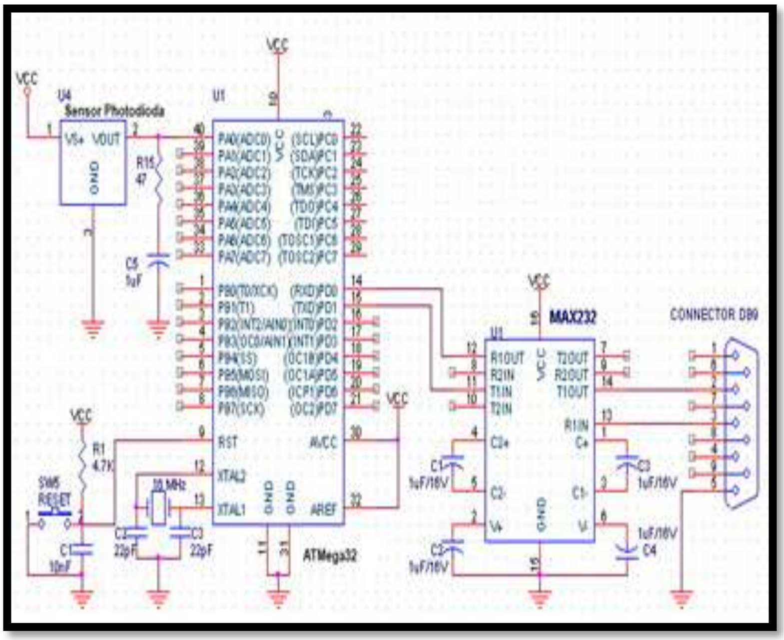

Figure 1. Tool Network Schematics

The working principle of the IoT-based monitoring and control system for water and feed in fish ponds is as follows: When the system is activated by supplying electrical power from the power supply, the ultrasonic sensor begins to operate, detecting the water volume in the fish pond in real time. The sensor continuously measures the water level and sends this data to the main module, which is the Arduino microcontroller. The Arduino processes the received data based on predefined parameters. If the water volume falls below the specified threshold, the Arduino sends a command to activate the relay module. Once the relay is activated, the inlet water pump automatically turns on to add water to the pond. Conversely, if the water volume exceeds the upper limit, the relay connected to the outlet water pump is activated, allowing excess water to be removed from the pond. This ensures that the water level remains within the optimal range for fish growth and health.

In addition to water level management, the system also automates the feeding process. The Real-Time Clock (RTC) module is programmed with

Literasi Nusantara. vol.5 no. 1, November 2024 – February 2025
ISSN 2746-8208 (Online) and ISSN 2746-3575 (Print)

specific feeding times. When the scheduled time is reached, the Arduino sends a signal to the servo motor, which rotates 180 degrees to dispense the feed into the pond. This automation eliminates the need for manual feeding and ensures that the fish are fed consistently and on time.

The system is equipped with IoT capabilities, allowing data to be transmitted to a smartphone via an internet connection. A dedicated mobile application is used to monitor the water volume in real time and control the system remotely. Through the app, users can view real-time data on water levels, manually turn the inlet and outlet water pumps on or off, and trigger the feeding mechanism if needed. This remote access provides farmers with greater flexibility and convenience, enabling them to manage their fish ponds efficiently from anywhere.

The IoT-based system integrates sensors, microcontrollers, actuators, and internet connectivity to create a fully automated and remotely accessible solution for monitoring and controlling water levels and feed distribution in fish ponds. By combining real-time data processing, automated control mechanisms, and remote accessibility, this system enhances the efficiency, accuracy, and convenience of fish farming operations, ultimately contributing to improved productivity and sustainability.

3. Result and Discussion

Based on the first stage, which is the identification of device components, the ultrasonic sensor is selected to estimate the water level in the fish pond. This sensor will detect the water height and send the data to the main module (Arduino microcontroller). The main module processes the data and sends commands to the relay module based on predefined thresholds. If the water level in the pond is below the specified limit, the relay activates the inlet water pump to add water to the pond. Conversely, if the water level exceeds the upper limit, the relay activates the outlet water pump to remove excess water. This automated process ensures that the water level in the pond remains within the optimal range, supporting the health and growth of the fish. By integrating these components, the system provides a reliable and efficient solution for maintaining proper water levels in fish ponds.

The results of the automated water level (water volume) monitoring in the fish pond, conducted by the ultrasonic sensor, are transmitted and displayed on both a web interface and a smartphone application. This real-time data allows farmers to monitor the water conditions in their ponds remotely and make informed decisions. The smartphone application provides a user-friendly interface where the water level data is visualized, along with options to control the system manually, such as turning the inlet and outlet water pumps on or off, and triggering the feeding mechanism if needed. Below is an example of how the monitoring results are displayed on the smartphone interface:

Figure 2. Water Condition Monitoring Display on Smartphone

At the same time, the results of the water level monitoring from the Arduino are also displayed on a web interface. This web-based platform provides an additional layer of accessibility, allowing users to monitor and control the system from any device with internet access. The web interface typically includes detailed information about the water level, pump status, and feeding schedule, along with options for manual control and configuration. Below is an example of how the monitoring and control interface appears on the web:

Literasi Nusantara. vol.5 no. 1, November 2024 – February 2025
ISSN 2746-8208 (Online) and ISSN 2746-3575 (Print)

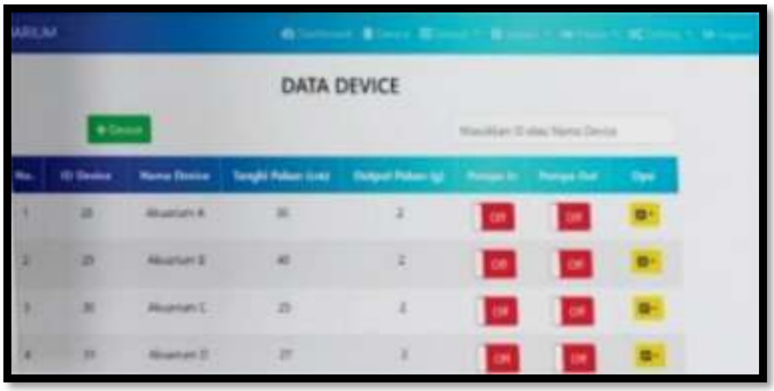

Figure 3. Devive Data Display on the Web

Water condition data will always be updated on the web and also on smartphone applications in real time. This application can also be used to obtain graphic data on water conditions.

The Internet of Things (IoT)-based Fish Pond Water and Feed Monitoring and Control System Application was created using the Arduino Idea. The creation of Internet of Things (IoT)-based fish pond water and feed monitoring and control was built using several facilities available on the Arduino Idea, namely; library, command button and others. The steps for creating this application are through the program preparation stage, application display, and program listing creation stage. The description of the stages of creating this application can be read in the following description:

Program Preparation

The program used in making the Flood Detection System application at the housing location is the android studio program with the android studio version. The appearance of the android studio on the opening menu is as seen in the following image.

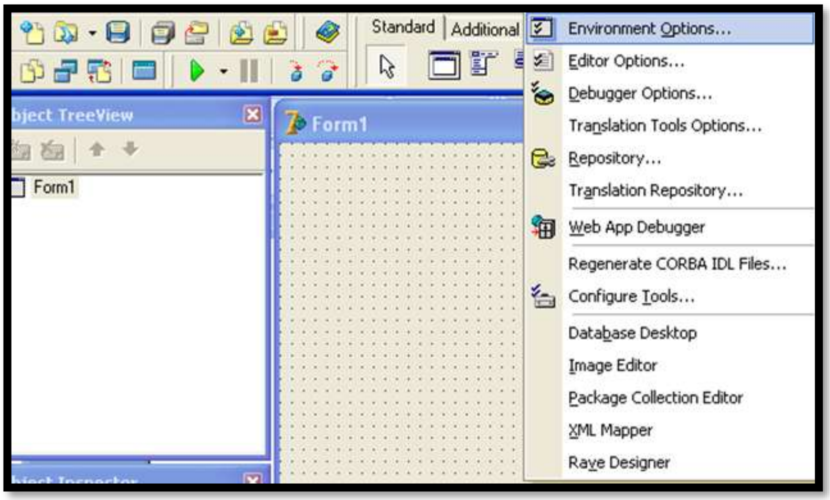

Figure 4. Program Display

In the program, there are many menus, each with its own specific function. The menus and icons used in the development of the Arduino-based Flood Detection System are those found in the general tools, which include: frame, text, label, and command button. These icons are utilized to create an intuitive and functional user interface for the system.

Circuit Design for IoT-Based Monitoring and Control System for Water and Feed in Fish Ponds

The development of this monitoring and control system for water and feed in fish ponds is based on Internet of Things (IoT) technology. The application is designed with the primary function of monitoring and controlling water conditions in the pond. The system ensures optimal water levels and automated feeding, enhancing the efficiency and productivity of fish farming. Below is a detailed explanation of the circuit design, and a clear visual representation of the circuit can be seen in the following image:

Literasi Nusantara. vol.5 no. 1, November 2024 – February 2025
ISSN 2746-8208 (Online) and ISSN 2746-3575 (Print)

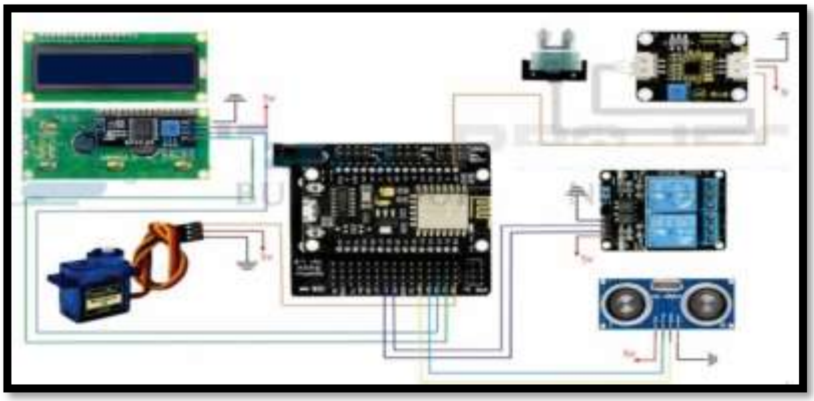

Figure 5. System Circuit View

Development of the Application Program Listing on the Computer

The program listing is written based on the desired functions of the objects displayed in the application interface. The first part of the program listing is designed to establish serial communication with the device, in this case, the Arduino. This initial program listing is placed in the form section, ensuring that it runs as soon as the application is launched. Below is the first part of the program listing:

```
void loop() {

  //Pengukuran jarak sensor ke permukaan air
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  jarak = duration*0.034/2;



  if (WiFi.status() == WL_CONNECTED) {

    http.begin(url + "key_api=" + KEY_API +"&id_device="
+ String(id_device) + "&jarak=" + String(jarak));
    int httpCode = http.GET();

    if (httpCode > 0) {
      char json[500];
      String payload = http.getString();
      payload.toCharArray(json, 500);

     DynamicJsonDocument doc(JSON_OBJECT_SIZE(5));
```

The above program listing means that when the form is opened or the application is first launched, the application will detect the serial communication path on COM Port 1, and the communication path will be opened. The settings used are as follows: baud rate (data access speed) is set to 9600 bits per second, parity is set to None, data bits are set to 8, and stop bits are set to 1. Up to this point, if the application is run and the device meets the same communication requirements as the application, the data communication process—both sending and receiving—can be carried out through the serial port on Port 1. The next part of the program listing involves assigning commands to the command buttons. The program listing for the buttons is as follows:

```
// Deserialize the JSON document
    deserializeJson(doc, json);
    String ketinggian  = doc["ketinggian"];
    String level       = doc["level"];
    String message     = doc["message"];
    String Mode        = doc["mode"];
    String relay       = doc["relay"];


    Serial.print("Response HTTP = ");
    Serial.println(httpCode);
    Serial.print("Ketinggian = ");
    Serial.print(ketinggian);
    Serial.println(" cm");
    Serial.print("Level = ");
    Serial.println(level);
    Serial.print("Message = ");
    Serial.println(message);
    Serial.print("Mode = ");
    Serial.println(Mode);
    Serial.print("Relay = ");
    Serial.println(relay);
    Serial.println("------------------------------");

     if(relay == "0"){
       digitalWrite(relayPin, LOW);
       digitalWrite(buzzer, HIGH);
       delay(100);
       digitalWrite(buzzer, LOW);
       delay(100);

     }
     else{
```

The next program listing to be created is for recording or displaying the water conditions in the pond, as follows:

Literasi Nusantara. vol.5 no. 1, November 2024 – February 2025
ISSN 2746-8208 (Online) and ISSN 2746-3575 (Print)

```
// Deserialize the JSON document
    deserializeJson(doc, json);
    String ketinggian  = doc["ketinggian"];
    String level       = doc["level"];
    String message     = doc["message"];
    String Mode        = doc["mode"];
    String relay       = doc["relay"];


     if(relay == "0"){
      digitalWrite(relayPin, LOW);
      digitalWrite(buzzer, HIGH);
      delay(100);
      digitalWrite(buzzer, LOW);
      delay(100);

     }
     else{
      digitalWrite(relayPin, HIGH);
      digitalWrite(buzzer, LOW);
     }
    delay(100);


  }
```

The program listing above functions to send characters to the Arduino, where the data will then be processed according to the function of the respective button. For the exit button, the code end is assigned, which serves to terminate or close the application. Mscomm1 is the name of the Mscomm component, which is responsible for sending or receiving data from the application. In this application, COM1 is used for communication.

Development of the Program Listing for the Device

Here, the author uses the Arduino IDE programming language. Some parts of the program listing are as follows:

Open "comb.0:1200,8,n,1" For Output As #1

Open "comb.1:1200,8,n,1" For Input As #2

The meaning of the listing above is to configure the input and output ports so that the device can communicate with the PC. This involves setting up the necessary pins on the Arduino for communication and ensuring that data can be sent and received between the device and the computer. Next:

```
//----------------LIBRARIES----------------
   #include <ArduinoJson.h>
   #include <ESP8266WiFi.h>
   #include <ESP8266HTTPClient.h>
//----------------------------------------

//Sesuaikan dengan addres i2c dan ukuran LCD yg
digunakan


const char* ssid     = "Tambak_Ikan"; //Silakan isi dengan
nama SSID
const char* password = "12345678"; //Siakan isi dengan
password

// Buat object http
```

The meaning of the listing above is to configure the hardware recognition based on the available libraries and to enable connection to the network. This step ensures that the device can identify and interact with the necessary hardware components and establish communication over a network.

Uploading the Program to the Device

As is known, there are many software tools available for flashing (uploading) the created program into the Arduino, such as ProgISP, Hyperterminal, and Khazama AVR Programmer. In this case, the author uses the ProgISP software to write the program into the Arduino. The steps are as follows:

1. Run the ProgISP application: Open the ProgISP software on your computer to begin the process of uploading the program to the Arduino. Ensure that the Arduino is properly connected to the computer via the appropriate cable (e.g., USB).

Literasi Nusantara. vol.5 no. 1, November 2024 – February 2025
ISSN 2746-8208 (Online) and ISSN 2746-3575 (Print)

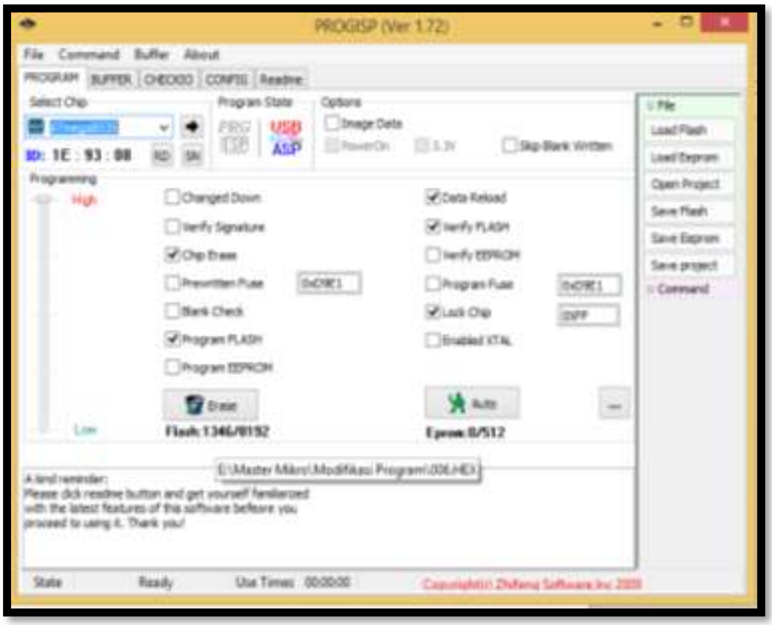

Figure 6. Initial view of ProgISP

2. Next, select the type of Arduino to be programmed in the "Select Chip" section. Choose the specific model of Arduino (e.g., Arduino Uno) from the dropdown menu or list of available chips.
3. Open the hex file (the program file created using Bascom-AVR) by clicking "Load File". Navigate to the location of the hex file on your computer and select it for uploading.
4. Then, click "Auto". The transfer process will begin automatically. Wait until the process is complete.
5. The program has now been successfully uploaded to the Arduino. Once the process is finished, the program is stored in the Arduino's memory and ready to run

Testing Results

Testing was conducted by evaluating the system's ability to detect water conditions (water volume) in the fish pond. This involved connecting the sensor, which is linked to the Arduino, to serve as the input. The testing process utilized the device connected to a computer, and the monitoring results were displayed in real-time on both a smartphone application and a web interface. The system's operation was controlled using the application on the computer.

The sensor was installed in the fish pond to detect water volume, while the regulation of water inflow and outflow was managed using two water pumps—one installed at the water inlet and the other at the water outlet. The results of the water condition (volume) monitoring can be seen in the following image:

Figure 7. Status Display on Smartphone

From a series of tests conducted, this detection device has been proven to function according to its design. It effectively detects the water conditions (water volume) in the fish pond. When the water level exceeds the predetermined threshold, the Arduino sends a command to the relay to activate the outlet water pump. Conversely, when the water level falls below the set threshold, the Arduino sends a command to the relay to activate the inlet water pump. The water conditions in the pond are displayed in real-time on both the smartphone application and the website, providing users with accurate and up-to-date information for monitoring and control.

4. Conclusion

In conclusion, several key points can be summarized as follows: (1) The IoT-based monitoring and control system for water and feed in fish ponds functions effectively, providing significant assistance to fish farmers in monitoring their ponds, particularly the water conditions. Fish farmers can access

Literasi Nusantara. vol.5 no. 1, November 2024 – February 2025
ISSN 2746-8208 (Online) and ISSN 2746-3575 (Print)

real-time information about the water conditions from anywhere using the smartphone application. (2) The IoT-based monitoring and control system for water and feed in fish ponds utilizes two water pumps, which are used to regulate the inflow and outflow of water. These pumps operate automatically based on the data detected by the sensors, ensuring optimal water levels in the pond. This system enhances the efficiency and convenience of fish farming operations, allowing for better management of water resources and improved productivity.

References

Audrilia, Meri, and Arief Budiman. 2020. “Perancangan Sistem Informasi Manajemen Bengkel Berbasis Web (Studi Kasus: Bengkel Anugrah).” *Jurnal Madani: Ilmu Pengetahuan, Teknologi, Dan Humaniora 3*(1):1–12.

Desmira, Desmira. 2023. “Penerapaan Sensor Proximity Dan Photoelectric Sensor Untuk Mengetahui Perbandingan Kwalitas Benang Yang Baik Pada Mesin Rieter E7/5-A.” *PROSISKO: Jurnal Pengembangan Riset Dan Observasi Sistem Komputer 10*(2):212–16.

Fitriana, Sarirah. 2022. “Rancang Bangun Sistem Monitoring Persediaan Barang Pada SP Part Lampung Berbasis Web.” *Jurnal Ilmu Data 2*(5).

Jatnika, Hendra. 2021. “Monitoring Kualitas Air Berbasis Smart System Untuk Ketersediaan Air Bersih Desa Ciaruteun Ilir, Kec. Cibungbulang, Kab. Bogor.” Kilat 10(1):89–100.

Kurniawan, Fikri. 2022. “Rancang Bangun Keamanan Rel Kereta Api Berbasis Arduino Dengan Sensor Infrared.” *Jurnal Portal Data 2*(3).

Mulyana, Jajang, Rifki Burhanudin Baharsah, Arif Budimansyah Purba, and Cepi Indra Grahana. 2023. “JM Penerapan Teknologi Internet Of Think (IoT) Untuk Smart Green House Berbasis Web Server Dan Android Controller.” *Jurnal Inovasi Pengembangan Aplikasi Dan Keamanan Informasi Nusantara 1*(1):45–54.