# IoT performance analysis on water infrastructure to support optimization of catfish cultivation

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**Abstract.** In recent years, IoT has become a reliable technology in the agricultural sector to optimize cultivation results. In the Marsudi Luhur breeder group, the harvest results were not optimal because many catfish died and gave off a bad smell. According to several references, to ensure healthy growth of catfish, continuous irrigation of the pond is required even though the flow rate is low. The location of the catfish pond is quite far from residential areas so it is not practical to monitor irrigation performance by frequently visiting the pond area. Therefore, this project aims to create an IoT-based smart farming system using the Blynk application. The system has been successfully implemented to help monitor and control solenoid performance and water flow remotely. The results show that the IoT-based smart system has performed well and has the potential to increase efficiency, comfort and productivity in managing catfish ponds.

## 1 Introduction

Currently, many catfish farmers utilize portable ponds, which are typically used for breeding and growing catfish. The Marsudi Luhur Catfish Farming Group has several ponds and faces challenges in optimizing their cultivation results. The harvests have not been optimal due to a high mortality rate and foul odor among the catfish. This is suspected to be due to poor water quality, which is detrimental to catfish development. According to several references, to ensure healthy growth of catfish, an effective aeration system is necessary [1], [2], [3], [4]. Poor health in catfish, caused by diseases, viruses, bacteria, and poor water quality, can lead to failed harvests [5], [6], [7]. The aeration system in catfish ponds needs to be monitored to maintain water quality. Therefore, innovation is required to enable monitoring at any time

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and from anywhere. The agricultural sector in Indonesia needs systemic changes to improve farmers' welfare. Implementing Smart Farming Systems using the latest technology is essential to enhance the quantity and quality of domestic harvests. Examples include Artificial Intelligence-Based Agricultural Information Systems to improve the precision and quality of agricultural products [8].

Information and Communication Systems for community economic development [9] and technology for food security[10]. Additionally, the use of drones in agriculture has revolutionized farming practices by offering significant cost savings, operational efficiency, and improved profitability for farmers. In the rapidly evolving digital era, Internet of Things (IoT) technology has become a fundamental innovation in transforming various sectors of life [11], including agriculture. One of the crucial applications of IoT is in Smart Farming practices, which utilize connected devices to enhance efficiency, productivity, and sustainability in agricultural operations [12], [13]. The use of IoT in agriculture not only stimulates technological advancement but also significantly contributes to community welfare, particularly among fish farming groups [14], [15]. By integrating IoT technology into catfish pond irrigation systems, it is expected to improve water resource management efficiency, and enhance control and monitoring of irrigation performance [16].Several IoT applications have been implemented, including manual water quality monitoring. To address this issue, an IoT-based tool for automatic water quality control needs to be applied. This tool can control and monitor the water quality of fish ponds via the web and smartphones. It can monitor temperature, pH, turbidity, rainfall, and other parameters using sensors [17]. The implementation of an IoT-based water quality system design aims to increase catfish seed production, showing that the success of catfish aquaculture can be determined by the water quality used. Although catfish can survive in poor water conditions, it negatively affects their development process [18]. The application of IoT-controlled microbubble technology in catfish ponds results in increased dissolved oxygen levels and maintains stable water pH, thereby supporting the growth of catfish and increasing production capacity [19]. One utilization of IoT advancements in aquaculture is the pond water monitoring system, which helps farmers automatically monitor water quality. The developed automation system promises to enhance the success of catfish farming [20].

## 2 Methodology

This chapter will explain the methods used to analyze the performance of IoT systems in water infrastructure for catfish farming. By utilizing IoT technology, it is expected to obtain accurate real-time data on the parameters used. This performance analysis is crucial to ensure that the implemented IoT technology impacts the quality and productivity of the farming process and provides optimal benefits. The steps taken in this research are shown in Figure 1.

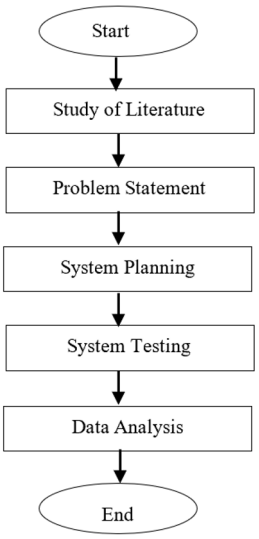


**Fig. 1.** Research Flowchart

The research began by conducting a literature study related to smart farming systems, especially for implementation in catfish ponds. The next stage is to formulate the problem faced to provide an appropriate solution. The next step is designing and manufacturing the system, namely hardware and software. The prototype was developed by utilizing solenoid components and water sensors. The software was developed using the Blynk application. Hardware implementation was carried out in 6 catfish ponds. System testing is carried out by measuring the performance of the solenoid and water sensor via the Blynk application. From this application you can also control the performance of the solenoid in real time. The results of the tool's performance are then analyzed. If the analysis provides finding information, it is necessary to take the next step.

## 2.1 Hardware Design

In designing the IoT-based irrigation system for catfish ponds, the first step is to plan the use of appropriate hardware and sensors to automatically monitor and control pond conditions, as shown in Figure 2.

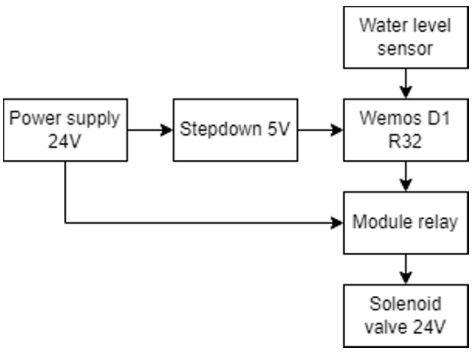


**Fig. 2.** Hardware Design Block Diagram

This process begins by selecting a stable and reliable power supply to support the overall system operation. The next step is to use a 5V step-down converter to reduce the electrical voltage to a safe level for use by microcontrollers and other IoT devices. Then, a water level sensor is installed inside the pond to measure the water level in real-time. Information from this sensor will be sent to the Wemos D1 R32, a WiFi-based microcontroller, which is responsible for controlling the system based on the received data. The Wemos D1 R32 will connect to the internet via a WiFi network, allowing users to monitor and control the catfish pond remotely through a mobile application or web platform. When the water level reaches a certain threshold, the Wemos D1 R32 will use information from the water level sensor to activate the relay module. The relay module will control a 24V solenoid valve connected to the water source, opening or closing the water flow as needed. This ensures that the water level in the pond remains optimal for catfish growth and health. By utilizing IoT technology, the catfish pond irrigation system can be automatically regulated based on actual conditions, minimizing manual intervention and improving operational efficiency.

## 2.2 Software Design

In software design, through a comprehensive software design process, from monitoring pond conditions to taking necessary actions automatically or as per user instructions. The steps of software design are illustrated in Figure 3.

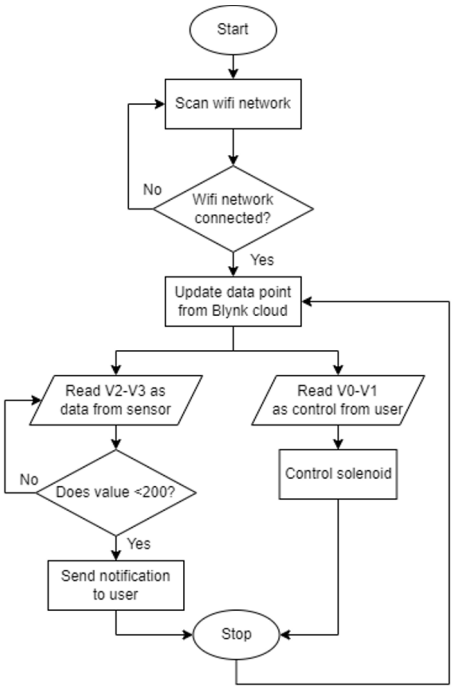


**Fig.3** Software Design Flowchart

The first step in designing the irrigation system software is to scan the WiFi network. This process aims to ensure that the IoT devices can connect to the available WiFi networks in their vicinity. After successfully establishing a WiFi connection, the system will proceed to the next step. Subsequently, upon successfully connecting to the WiFi network, the system will fetch the latest data from the Blynk Cloud. This data includes real-time information about

the catfish pond conditions, such as water level and solenoid valve status. By regularly updating data from the Blynk Cloud, the system can ensure that the received information is always accurate and up-to-date. After updating the data from the Blynk Cloud, the system will read sensor values from pins V2 and V3. These sensors are responsible for measuring water quality or water flow rate in the pond. If the value read from the sensors is less than 200, indicating that the water flow in the pond is disrupted or absent, the system will send a notification to the user. This notification aims to inform the user that there is an issue with the water flow in the catfish pond and it needs to be addressed promptly. On the other hand, the system will also read user input values sent through pins V0 and V1. This input could be commands to manually turn the solenoid valve on or off. Based on these input values, the system will control the solenoid valve, ensuring that the water flow in the pond can be adjusted according to the user's needs. Thus, the software of this IoT-based catfish pond irrigation system allows users to efficiently and effectively monitor and control pond conditions, both in terms of monitoring and regulating water flow.

## 3 Results and discussion

After implementing the planned hardware in the IoT-based catfish pond irrigation system, a series of tests is conducted to evaluate the performance and reliability of each component. The results of these tests provide valuable insights into how effectively the system can manage pond irrigation and meet the needs of the catfish.

### 3.1 Power Supply Testing

Testing on the selected power supply aims to ensure that the provided voltage meets the specifications required by each device. Data on voltage stability and power consumption are shown in Table 1.

**Table 1.** Power Supply Test Results

| **Test Type** | **Time (s)** | **Testing Results** |
|---|---|---|
| Voltage Stability | | Output Voltage (V) |
| | 5 | 5.00 |
| | 10 | 5.01 |
| | 15 | 4.99 |
| | 20 | 5.00 |
| | 25 | 4.98 |
| Power Consumption During Operation | | Input Current (A) |
| | 5 | 1.2 |
| | 10 | 1.3 |
| | 15 | 1.2 |
| | 20 | 1.1 |
| | 25 | 1.3 |

Based on Table 1, the measured output voltage and input current during the stability testing and power consumption during operation indicate that the power supply is capable of providing sufficient power for all system components.

### 3.2 5V Step Down Testing

Next, testing the 5V step-down converter involves evaluating its ability to convert electrical voltage to a safe and stable level for use by microcontrollers and other sensors. The 5V step-down testing is illustrated in Table 2.

**Table 2.** Step down test results

| No. | Test Type | Output Voltage (V) | Voltage Stability (V) |
|---|---|---|---|
| 1 | Electrical Voltage Conversion to 5 V | 5.00 | Stable |
| | | 5.01 | Stable |
| | | 4.99 | Stable |
| | | 5.00 | Stable |
| | | 4.98 | Stable |

From Table 2, the measurement results of the output voltage under stable conditions demonstrate that the 5V step-down converter functions effectively in supporting the overall system operation.

### 3.3 Water Sensor Testing

The next testing focuses on the sensor used in the system, namely the water level sensor for measuring the water level in the pond. The testing involves calibrating this water level sensor and checking the accuracy of readings as well as responsiveness to changes in pond conditions. The results of the water sensor testing are shown in Table 3.

**Table 3.** Water Sensor Testing Results

| **Sensor Value** | **Water Flow Conditions** | **Notification** |
|---|---|---|
| 2000 | Hard | No Notifications |
| 1800 | Hard | No Notifications |
| 1504 | Hard | No Notifications |
| 1488 | Hard | No Notifications |
| 1200 | Moderate | No Notifications |
| 1000 | Moderate | No Notifications |
| 800 | Moderate | No Notifications |
| 600 | Small | No Notifications |
| 500 | Small | No Notifications |
| 400 | Small | No Notifications |
| 200 | Very Little | Notifications |

From Table 3, it is shown that when the sensor input is ≤200, there is a response to send a notification to the user indicating that the water flow is very low or there is no water flow, prompting action. These results indicate that the water sensor can function effectively within the system.

### 3.4 Wifi Connection Testing

WiFi connection testing involves measuring the distance between the IoT devices and the internet network to ensure stability and data transmission speed. This is important to ensure that the system can consistently connect to the cloud platform and send data in a timely manner. The results of the WiFi connection testing are shown in Table 4.

**Table 4.** WiFi Connection Testing Results

| No. | Distance (m) | Connection Stability | Information |
|---|---|---|---|
| 1 | 5 | Stable | Connected |
| 2 | 10 | Stable | Connected |
| 3 | 15 | Stable | Connected |
| 4 | 20 | Stable | Connected |
| 5 | 25 | Stable | Connected |

Based on Table 4, the results of the WiFi connection testing within the range of 5 – 25 meters demonstrate that the WiFi connection remains stable during the testing, and the device can connect well. Thus, it can be ensured that the system consistently connects to the cloud platform and can send data in a timely manner.

### 3.5 Display Testing

The Blynk application interface is designed to provide comprehensive monitoring of the catfish pond irrigation system's performance in real-time. Within the application, there are two main components displayed: solenoid control and water level sensor values. The Blynk application interface is shown in Figure 4.

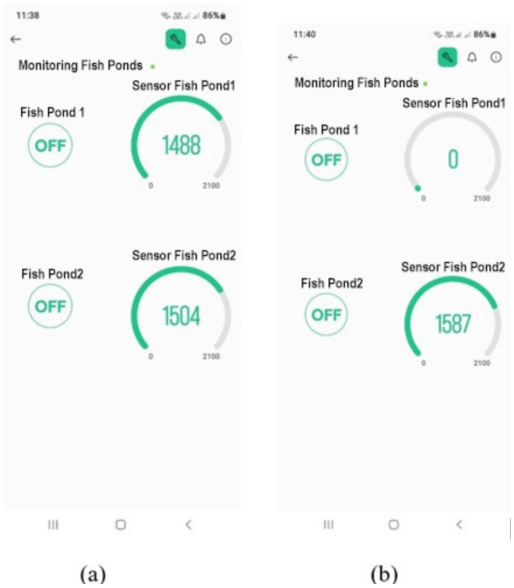


**Fig.4** Display on the Blynk Application

From Figure 3, the solenoid control is represented by the "On/Off" button, allowing users to manually control the solenoid valve. When the "On" button is pressed, the solenoid valve will be activated, allowing water to flow into the pond. Conversely, if the "Off" button is pressed, the solenoid valve will be deactivated, stopping the flow of water into the pond. This display provides users with the ability to perform manual interventions if needed, for example, in emergency situations or for testing purposes. The display testing results for solenoid performance are shown in Table 5.

**Table 5.** Solenoid Performance Testing Results on the blynk application

| No. | Date | Time | Solenoid Status on Blynk | Solenoid Performance |
|---|---|---|---|---|
| 1 | 24-04-2024 | 08.00 | On | active |
| 2 | 24-04-2024 | 10.00 | Off | active |
| 3 | 24-04-2024 | 12.00 | On | active |
| 4 | 24-04-2024 | 14.00 | On | active |
| 5 | 24-04-2024 | 16.00 | Off | active |

Table 5 presents recorded data from user testing using the Blynk application to remotely control the solenoid. Users can track and analyze the performance of the IoT-based catfish pond irrigation system.

In addition to solenoid control, the application interface also displays the water level sensor values in numerical form. This information allows users to monitor the water level in the pond in real-time. The water level sensor values are periodically updated and clearly presented in the application, enabling users to see if the water level in the pond is within the desired range or if there are any changes that need attention. If the water level sensor value is ≤200, a notification will be provided as shown in Figure 4.

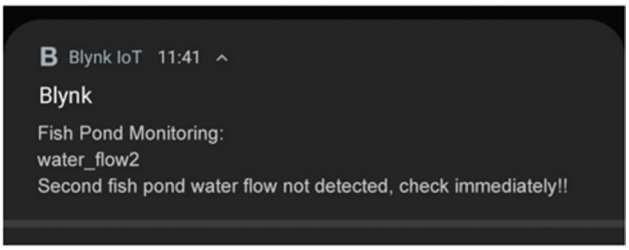


**Fig. 5.** Display of notifications to users

With the combination of manually accessible solenoid control and real-time monitoring of water level sensor values, users can ensure that the IoT-based catfish pond irrigation system functions optimally and according to their needs. The Blynk application provides users with the ability to interact directly with the system and monitor the catfish pond conditions easily and efficiently.

## 4 Conclusions

Based on the testing results conducted on the IoT-based catfish pond irrigation system, the following conclusions can be drawn:

1. The Hardware Performance consisting of the power supply, 5V step-down converter, and sensors such as the water level sensor have been tested and proven to function well in supporting the overall system operation. This indicates that the selected hardware

components can provide sufficient power and accurate readings of the pond environment conditions.

2. WiFi connection stability through testing between IoT devices and the internet network shows that the connection has good stability at various distances.
3. The quality of water level sensor measurements indicates that these sensors provide consistent and responsive readings, allowing the system to monitor pond conditions effectively.
4. The system has been successfully implemented to send notifications to users, if water flow stops or if sensor values reach a certain threshold. This enables users to respond to issues quickly and take necessary actions to maintain pond conditions.

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