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IoT Based Goldfish Aquarium Water Quality Monitoring System Using SDLC Method

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Abstract

Maintaining aquarium water quality is an important factor in the care of goldfish and their aquariums, at the Gema Ornamental Fish And Aquarium store, maintenance of water quality in aquariums is still done conventionally, This study aims to implement a water quality monitoring system in goldfish aquariums based on the internet of things with automation of water changes using google assistant voice commands with integration of if this then that (IFTTT) and webhook. The method in this study uses the software development live cycle (SDLC) method with an agile development approach. This monitoring system has several functions including maintaining water quality at temperature, pH, and turbidity parameters and automating water changes. Using ESP32 Devkit as the main microcontroller and several hardware including water pumps, it is designed to monitor aquariums including the integration of the Blynk and If This Then That (IFTTT) platforms in controlling automatic water pumps via voice via google assistant. The results of this study, the monitoring system that has been created can show the water quality parameters in the goldfish aquarium which are displayed on the LCD and the blynk application, the automatic water change system with voice commands has also been successfully run to drain the aquarium water with a water height of 15cm to 10cm and refill the aquarium water.

Keywords: *Aquarium, Blynk, ESP32 Devkit, Internet Of Things, Monitoring.*

1. Introduction

Aquariums have evolved significantly in recent years, with increasingly sophisticated innovations and technologies, from initially just a glass box filled with water and fish, aquariums are now complex and sustainable ecosystems, however, maintaining aquarium water quality manually is still a challenge, especially in terms of temperature stability, pH, and water turbidity levels. A common problem faced by fish hobbyists and aquarium shop owners is the delay in detecting changes in water quality, which can be fatal to fish health, for some ornamental fish lovers, they will know more that one of the important things in ornamental fish care is maintaining water quality at all times. Because water with good quality will affect the growth and development of the fish [1], however, due to busyness or other activities and unexpected, it often becomes an obstacle when checking the water conditions in the aquarium. Therefore, there needs to be a tool that can control the aquarium water and drain the water automatically based on IoT [2], the Internet of Things (IoT) has become one of the most important technologies in recent years. As internet connectivity becomes more widespread, IoT devices will be able to communicate with each other and exchange data automatically, creating a smart and connected ecosystem [3], IoT uses cover a wide range of things, such as data sharing, remote control, and sensor reception. [4].
Observation results at the Gema Ornamental Fish and Aquarium Shop show that the water treatment process is still carried out conventionally, including measuring the temperature and pH of the water, as well as the water change process which is carried out every two days. The lack of an automatic system and real-time monitoring makes this process inefficient and at risk of reducing the quality of the aquarium environment. The quality of water as a living medium for fish greatly affects the growth and development of goldfish, therefore the quality of water must meet the needs of goldfish [5], there are several parameters that can be used as a reference to determine whether water is of good quality, namely water temperature, water pH, and water turbidity [6], as technology advances, the application of the Internet of Things (IoT) to water quality monitoring systems provides a modern solution that enables remote monitoring and control [7].
Several previous studies have developed similar systems, for example, research entitled Automatic Aquarium Drainage System Based on Temperature and Turbidity Equipped with Remote Monitoring, an automatic temperature control system in an aquarium was successfully designed and implemented for freshwater ornamental fish [8], then the research on the Design and Construction of a Water Quality Monitoring and Control System in a Goldfish Aquarium Using the Fuzzy Logic Method Based on IoT (Internet of Things), has realized the design and construction of a monitoring and control system for turbidity, temperature and pH of water in a goldfish aquarium using IoT-based fuzzy logic which can work well [9], but still limited to monitoring functions without voice-based automation features. The

weakness identified in this study is the absence of an integrated IoT system capable of monitoring water quality and automatic water changes with voice command support via Google Assistant.

This study aims to design and implement a water quality monitoring system in an IoT-based goldfish aquarium using an ESP32 microcontroller used to receive and process input signals and then produce output signals according to the program, enabling the implementation of complex tasks with simple circuits [10], the DS18B20 temperature sensor is a digital temperature sensor that adopts the one-wire principle, which means it only requires one pin as a data path for its communication process [11], pH sensor is a tool used to detect the acidity and alkalinity levels of a solution [12], and turbidity sensor turbidity is a sensor used to measure the level of water quality by measuring the level of turbidity of the water [13], and automatic pump control via the Blynk IoT platform which provides an interface to control and monitor hardware in real-time via a mobile application [14], and If This Then That (IFTTT). The system was developed using the Software Development Life Cycle (SDLC) method with the Agile Development approach. The application of the Agile method allows the development of a flexible system that is responsive to user needs [15].

2. Research Methodology

The research process began with direct observation and interviews with the owner of the Gema Ornamental Fish and Aquarium Shop as a system user. Observations were made to understand the manual process of monitoring and maintaining aquarium water quality that has been carried out so far. Information from observations and interviews is used as a basis for the system design stage.

The development modeling used in this study is the Software Development Life Cycle (SDLC) which is adjusted to the Agile Development method. The development is carried out little by little and then perfected, making it easier to develop an IoT-based aquarium water quality monitoring system periodically based on input and suggestions from users. The stages in the agile development research method include requirements, design, development, testing, deployment, and review, as described and explained as follows:

Fig 1. Agile Development Methods

1. Requirement, Identification of system requirements based on observation and interview results. Requirements include temperature sensor (DS18B20), pH sensor, turbidity sensor, and ESP32 module as the main controller, and use of Blynk and IFTTT applications for monitoring and voice control.
2. Design, Design is done on IoT system architecture, system flow diagrams, and application user interfaces. The main components are designed to be integrated with each other in a modular manner.
3. Development, Hardware and software development is done using Arduino IDE, compiling program code to read sensor data, control the pump, and send data to the Blynk application in real-time.
4. Testing, Testing is carried out functionally on all sensors, ESP32 modules, network connectivity, as well as notification and voice control features via Google Assistant and IFTTT.
5. Deployment and Review, The system is tested directly in the user environment (fish shop) and a joint evaluation is carried out to assess the performance and effectiveness of the tool and determine the necessary improvements.

3. Result and Discussion

This section aims to make it easier to understand the flow of the water quality monitoring system in a goldfish aquarium based on the internet of things using the blynk application and if this then that (IFTTT) with voice control for automatic water changes.

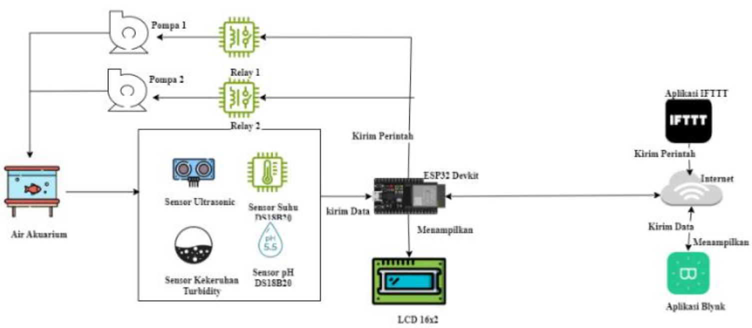


Fig 2. Monitoring System Architecture

Based on the architectural image of the monitoring system above, it can be described that the device and component systems are interconnected, starting with the ESP32 Devkit as a microcontroller that controls all connected sensors and components, the ultrasonic distance sensor functions to detect the distance of the aquarium water height, the DS18B20 temperature sensor functions to detect the temperature of the aquarium water, the PH-4502C sensor functions to detect the pH level of the aquarium water, the turbidity sensor detects the turbidity of the aquarium water, the 16x2 LCD functions to display information to users, the internet network as a connection for internet of things-based devices, the blynk application is used to monitor the use of tools and remote control, IFTTT is used for automatic water change voice control services, smartphones are used by users to be able to view information and remote control.

3.1. Monitoring System Flow

It is a process flow that is described through several process flows including flowcharts, use case diagrams, activity diagrams, and user interfaces. Software design can be seen as follows:

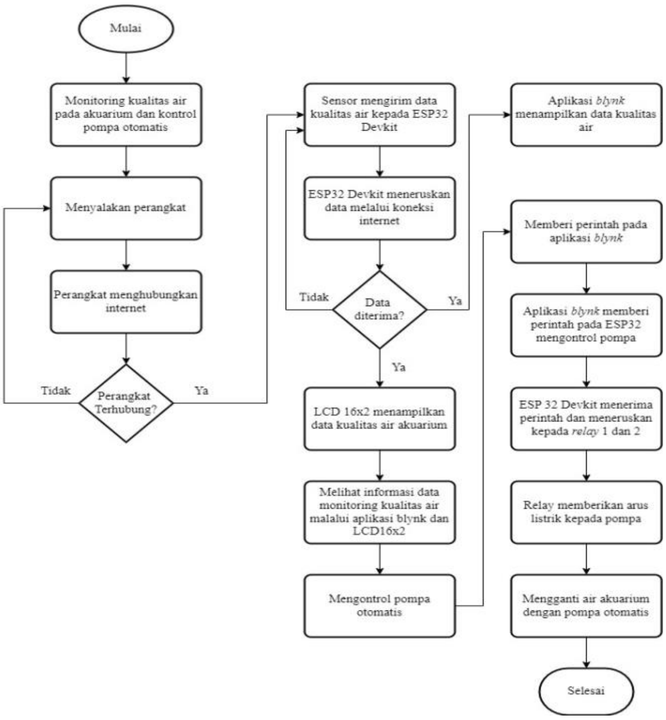


Fig 3. Monitoring System Flowchart

In Figure 3, it explains the scenario flow of the interaction of the aquarium owner with the designed system. From the device designed in the water quality monitoring system in the aquarium, the aquarium owner turns on the device, connects the device to the internet connection and if it is not connected, the user will reconnect, if connected, the user enters the blynk application, the temperature sensor detects temperature information then, the pH sensor gets pH level information, the turbidity sensor detects water turbidity, and the distance sensor detects water level information, the information is sent to the ESP32 as a microcontroller if the information data is sent then it sends the data information to the 16x2 LCD and the blynk application to be displayed if not the data information is not sent then the user turns the device back on. The blynk application receives data and displays information and sends automatic pump control commands, if this then that (IFTTT) receives voice commands through the aquarium owner with google assistant and sends control commands to the blynk application.

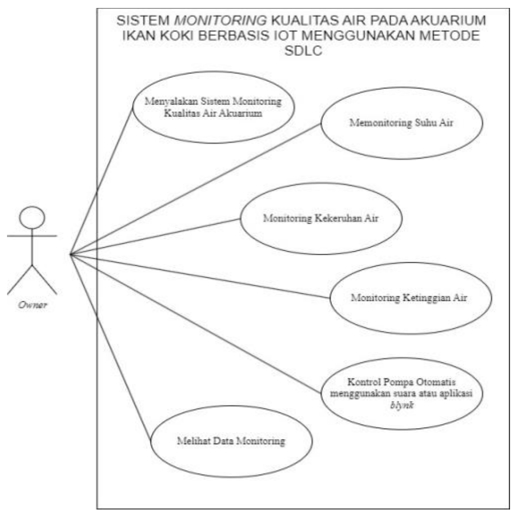
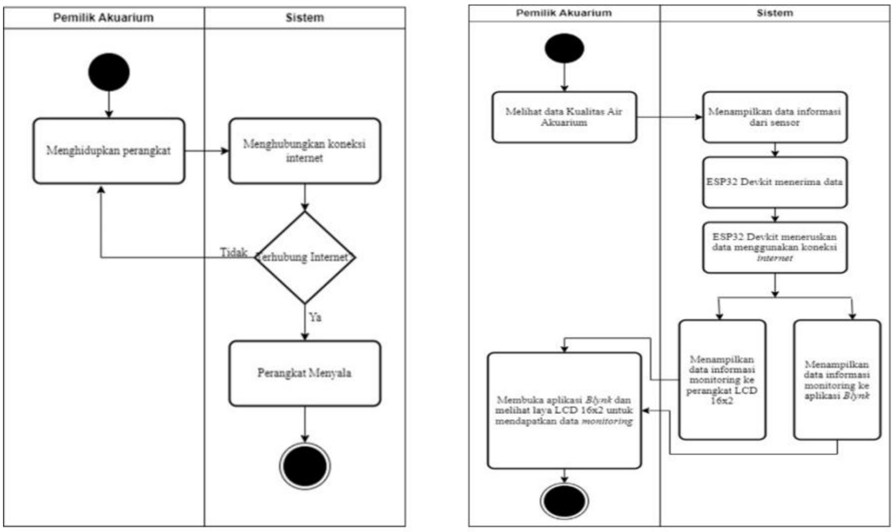


Fig 4. Use Case Diagram of Monitoring System

Figure 4 explains who uses the system and what users or aquarium owners can do using the system device.



(a) (b)

Fig 5. Activity Diagram (a) Turning on the Device (b) Displaying Data

Figure 5 is the flow of the aquarium owner's interaction process in turning on the aquarium water quality monitoring system device and the process of displaying data.

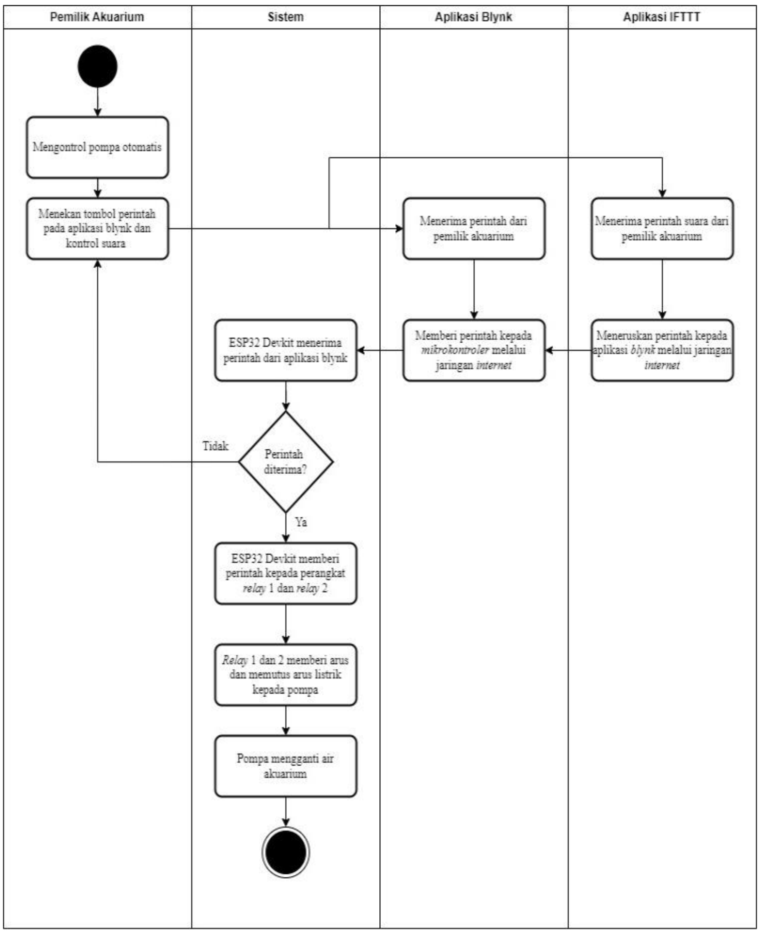


Fig 6. Automatic Pump Control Activity Diagram

Figure 6 is a description of the process flow of how the interaction between the aquarium owner and the system can control the discharge pump and the fill pump automatically.

3.2. System Implementation Results

Hardware implementation is part of the system hardware components that have been used or applied to create a water quality monitoring system in an IoT-based goldfish aquarium using the SDLC method.

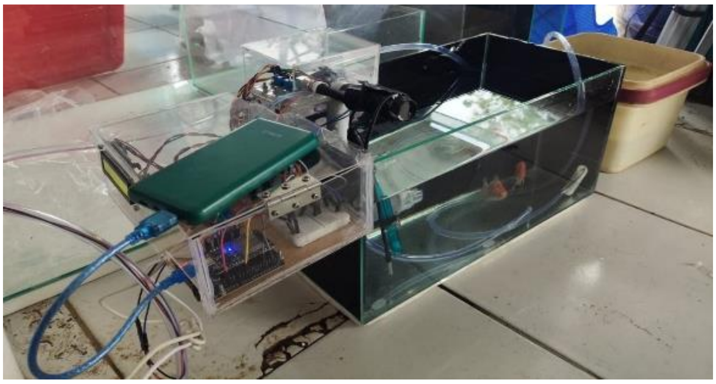


Fig 7. Implementation of Aquarium Monitoring System

The sensors read water quality parameters in real-time and send them to the cloud. The data is then displayed via a 16x2 LCD and the Blynk application on a smartphone. If one of the parameters is outside the specified threshold (eg temperature < 25°C or > 29°C, pH < 6.5 or > 9, and high turbidity), the system provides a notification, if the water turbidity threshold is turbid then the water is changed using voice control activating the drain pump to drain the water to the minimum limit (10 cm) and then refill the water to the maximum limit (15 cm).

3.3. Functional Testing Methods

Functional testing is used to ensure that hardware and software components are functioning properly and that there are no gaps as expected by the system.

Table 1: Functional Testing Results

No.	Stages	Test Scenario	Expected results	Test Results	Valid
1	Turning on the device	Connect the device to a power source.	Functions turn on and start the system	Successfully powered on and the system is ready for use	Ya
2	Internet Connection	The system device is connected to the programmed Wi-Fi.	Functions to connect with an internet connection and appears a connected display on a 16x2 LCD	Successfully connected the device to the internet.	Ya
3	Sensor Reading	The device is integrated with the aquarium sensor will read the aquarium water parameters.	Functions to read water parameter data and water level	Successfully the sensor can read the water quality parameters well	Ya
4	Replacing the LCD16x2 display	Press the button on the device for 3 seconds	Functions to replace the display on the LCD with other parameters.	Successfully replaced the display on the 16x2 LCD	Ya
5	Monitoring with smartphone	Open the Blynk application and view the monitoring data.	Functions to display sensor reading data on *the blynk application*	Successfully display data on *the blynk* application *user interface*	Ya
6	Pump control via the blynk app	Open the blynk application and press the button to empty or fill the aquarium water..	Functions to discharge and fill the water in the aquarium with a pump.	Successfully discharge water and fill the water.	Ya
7	Pump control by voice	Opening the IFTTT app activates commands, and gives voice commands with google assistant.	Functions to run voice commands with *google assistant* to control the automatic water change pump.	Successfully run automatic water change with *google assist voice control.*	Ya

4. Conclusion

Based on the results of the research, design, implementation, and testing processes that have been carried out, it can be concluded that the water quality monitoring system for temperature, pH, and turbidity parameters in goldfish aquariums has been successfully implemented using the ESP32 microcontroller. The monitoring system can measure normal temperatures at 20-30 ° C, pH 6-7 solution, ammonia acid levels or turbidity three descriptions clean, cloudy, semi-cloudy in real-time, can be designed using IoT-based applications such as blynk, Google assistant voice control features can be run on the system using the IFTTT application with webhooks, with automatic water change commands, and make it easier for aquarium owner0073.

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