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Aquarium Monitoring and Automatic Feeding System Based on Internet of Things

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Abstract. Now day ornamental fish enthusiasts are increasing, this is in line with the increasing number of people who have a hobby of keeping ornamental fish. In maintaining ornamental fish, several things must be considered to maintain the health of the fish, including water quality, changes in water temperature, and feeding. Therefore, to maintain the health of ornamental fish, a system is needed to monitor the aquarium's condition in real-time. This research aims to design a system that can monitor the aquarium's condition and provide feed automatically. Monitoring is carried out by utilizing Internet of Things (IoT) technology, which allows the information collected to be accessed in real-time through the Smart Aquarium application. The research method used in this research is analysis with a qualitative approach. The results showed that this automatic monitoring and feeding system can maintain health and reduce the risk of death of ornamental fish in the aquarium. The main concept of this system is monitoring water temperature conditions, water ph levels, and water turbidity, and doing automatic feeding. In addition, this system also has a feature that can see the current conditions in the aquarium. This system can make it easier for ornamental fish owners to monitor the conditions of the aquarium and can provide peace of mind when leaving the aquarium for some time.

Keywords: Monitoring, Aquarium, Internet of Things (IoT)

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1. Introduction

One of the drivers of the economy in Indonesia is the fishery sector, for improving the welfare of people who depend on the fishery sector, then production needs to be increased. There are 750 types of freshwater ornamental fish from 1600 types of ornamental fish traded. During the pandemic, ornamental fish commodities became popular among the people of Indonesia. Based on data from BKIPM Bandung in 2018, the number of ornamental fish that were successfully exported was 20,431,156 with an economic value of 73.3 billion rupiahs. Meanwhile, the number of exports increased to 23,317,318 for an economic value of 93.3 billion rupiahs in 2020 during the Covid-19 pandemic [1]. In maintaining ornamental fish, several things must be considered to maintain the health of the fish, including water quality, changes in water temperature, and feeding. Therefore, to maintain the health of ornamental fish, a system is needed to monitor the aquarium's condition in real-time.

In the modern era, human work can be completed properly and efficiently thanks to technological developments. Internet of Things (IoT)-based system is one of the technologies that can help human work. IoT is a system consisting of sensors or actuators connected to the internet network [2-6]. To maintain the growth and health of ornamental fish keep remains well in the aquarium, ornamental fish owners must maintain the cleanliness and quality of the water in the aquarium. In the research of Prangchumpol (2018), for the feeding is more efficient and does not pollute water quality, there is a certain dose in the feeding [2]. Another research stated that the difficulty in feeding the aquarium was due to the dense activity [2-4]. In addition, another research stated that for the growth and development of fish to be optimal, the water in the aquarium must be in good condition [5]. For the life and development of aquatic organisms, the optimal temperature range is between 24.5 - 27.5 C [6]. Not only that, a neutral pH between 7 to 8.5 is preferred because most aquatic organisms are sensitive to changes in pH [7-8]. According to Effendi (2003), the Visio logical processes in the body of aquatic organisms including fish affect the pH of the water. Metabolic rate is influenced by water temperature, the metabolic rate of fish will increase to the optimum limit if the water temperature increases and vice versa [9]. In that research's we can see the importance of monitoring water quality and feeding in keeping ornamental fish. Based on previous research, this study will combine several features such as automatic feeding that can be scheduled through the application and monitoring water conditions in the form of temperature, turbidity and pH levels in the aquarium contained in the Smart Aquarium application.

The purpose of this research is to design a system that can monitor the condition of the aquarium and provide feed automatically to make it easier for ornamental fish owners to monitor the condition of the aquarium and be able to provide peace of mind when leaving the aquarium for some time. Monitoring is carried out by utilizing Internet of Things (IoT) technology, which allows the information collected to be accessed in real-time through the Smart Aquarium application. The research method used in this research is analysis with a qualitative approach.

2. Method

The research method that we use in this research uses analysis with a qualitative approach. In system design, we use the IoT method as a means of data information in real-time by utilizing android studio software in the development of a prototyping system as a monitoring information medium. Prototyping development requires interactive communication from users. Therefore, users can provide suggestions to produce a system prototype that suits their needs. In its application, sensors, actuators, and microcontrollers are connected to the server

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via the internet network using a Wi-Fi module to carry out the monitoring system and these values will be displayed on the Smart Aquarium monitoring application.

The first step of the system prototype is to search for requirements. At this stage, user interviews and observations are carried out to obtain information about the needs that will be applied to the system. Furthermore, hardware design and checking are also carried out to find out each working component as well as develop prototype applications. After the components are inspected, a calibration procedure is carried out to ensure that the resulting values correspond to actual conditions. The development of this system will produce an initial prototype that will be used by users. After that, the user will design the prototype made. The results of the product will be used by developers to maximize the system based on suggestions given by users from the results of the initial prototype.

3. Results and Discussion

3.1. System Planning

The monitoring and automatic feeding system for aquariums consist of tools and applications. The tool is designed based on the need for monitoring and automatic feeding of the aquarium. The tool in this system consists of several sensors to monitor the current conditions, namely the water temperature sensor which functions to measure the temperature level in the water, the pH sensor which functions to measure the acidity level in the water, and the turbidity sensor which functions to determine the level of turbidity of the water in the aquarium. Not only that but the system is also equipped with an actuator in the form of a servo motor which functions to perform feeding automatically by opening/closing the feed container valve. The system workflow is shown in Figure 1.

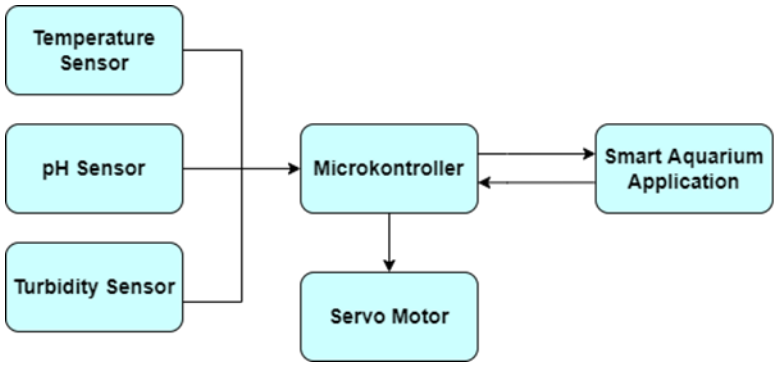

Figure 1. System workflow

Figure 1 shows the workflow of the system where the temperature sensor, pH sensor, and turbidity sensor will collect data from the aquarium, then the data obtained will be processed by the microcontroller and the results will be sent to the Smart Aquarium application. In addition, the application can also send commands to feed automatically, the command is sent from the application to the microcontroller and then the microcontroller will drive the servo motor to open/close the feed valve. The system utilizes Internet of Things (IoT) technology which allows sending data to applications in real-time. The Smart Aquarium application is designed to be able to monitor conditions in the aquarium and also regulate automatic feeding which can provide convenience for aquarium owners. The menu structure of the Smart Aquarium application is shown in Figure 2.

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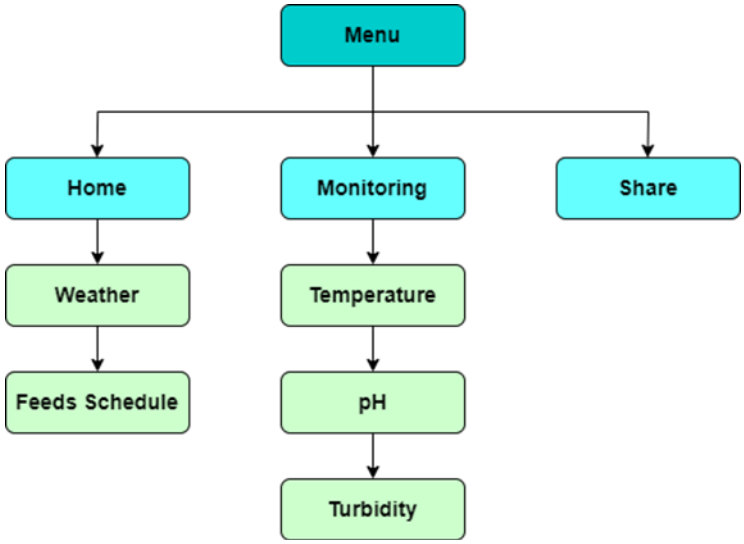

Figure 2. Menu Structure of the Smart Aquarium application

Figure 2 shows the menu structure of the Smart Aquarium application. The Home menu contains weather information and automatic feeding schedule settings. The Monitoring menu displays the current condition of the aquarium containing the water temperature level, the pH level of the water, and the level of water turbidity. Then there is the Share menu which functions to share monitoring data.

3.2. Application Prototype Development

When the application is first opened by the user, it will display the logo and name of the application "SMART AQUARIUM" which has been designed by the developer, which can be seen in Figure 3.

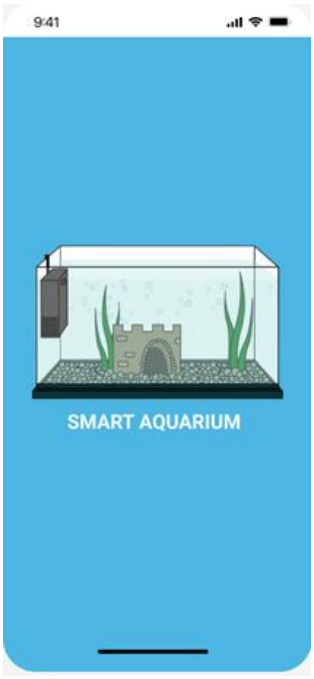

Figure 3. Welcome Page Smart Aquarium

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After displaying the welcome page in Figure 3. Next, the user will be presented with the main page or the home menu. On the Home menu, there is a weather widget that displays the day, date, year, hour, temperature, and the user's location which can later be used as a comparison with existing conditions. On the Home menu, there is also an option to choose the time for automatic feeding, as for how to create an automatic feeding schedule by pressing the add logo to add additional hours. The following display of application design on the home menu can be seen in Figure 4.

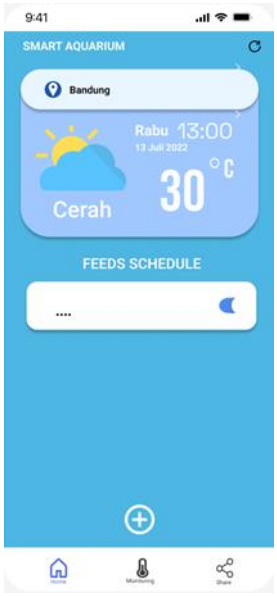

Figure 4. Smart Aquarium Application Home page

In the Monitoring menu, 3 widgets will display the temperature, the pH, and the water turbidity level in the aquarium equipped with a refresh feature in the upper right corner. The following display of application design on the Monitoring menu can be seen in Figure 5.

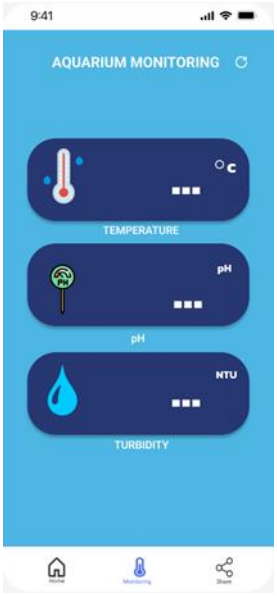

Figure 5. Smart Aquarium Application Monitoring page

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3.3. Prototype System Testing

After the system and application prototypes have been creat, the initial stage of system testing is carried out in the context of discussions between developers and users. System testing through application in the form of automatic feeding and monitoring of the conditions of the aquarium. Figure 6 shows the home page for adding an automatic feeding schedule by clicking on the add logo and it will display a customizable clock.

Figure 6. Feeds Schedule for Home page

On this page can only store a maximum of 4 feeding times which can be disabled and adjusted. After the schedule is set, the system will provide feed according to a predetermined schedule [2]. Further testing for monitoring can be seen in Figure 7.

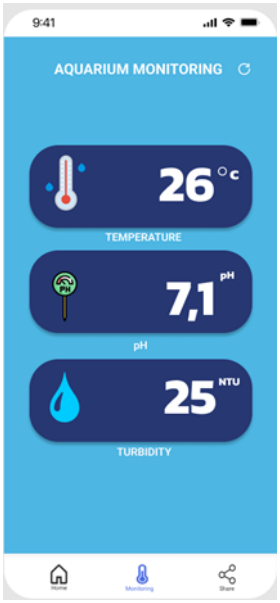

Figure 7. Aquarium Monitoring Test

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Figure 7 displays the aquarium condition monitoring page. On this page, the monitoring data will be updated automatically following changes in the data obtained by the sensor that occurs in the aquarium. It can be seen in the temperature section showing a temperature of 26°C which indicates the water temperature in the aquarium is at a normal level because the water temperature for ornamental fish in the aquarium must always be in the range of 24.5 - 27.5°C [6]. Furthermore, it can be seen in the pH section that the pH level of the water is 7.1 which indicates the pH of the water in the aquarium is at a neutral level because the optimal water pH conditions for fish maintenance range from 7 to 8.5 [7-8]. Then in the turbidity section, it can be seen that the turbidity level in the aquarium is 25 NTU, this level is still considered ideal for fish because the ideal turbidity level of water is in the range of 0-25 NTU [10-14]. In the last section, there is a Share menu which is useful for sharing monitoring data.

The prototype of the Smart Aquarium system and application was developed to help ornamental fish owners to monitor and automatically feed their ornamental fish aquariums. This system performs real-time monitoring and scheduled feeding. This research produces a prototype system that can provide convenience for aquarium owners in knowing the conditions of the aquarium.

4. Conclusion

This monitoring system is designed to be an interactive system model for ornamental fish aquarium owners. Information related to the condition of the aquarium can be found in this system through the Smart Aquarium application in the form of water temperature, water pH, and water turbidity. Not only that, but the system can also perform automatic feeding which can be scheduled through the application. With this system, it is hoped that the health of fish in the aquarium can be maintained optimally.

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