Recent Science and Technology 17(2): 265957

Recent Science and Technology

Journal homepage: https:// www.tci-thaijo.org/index.php/rmutsvrj/index

ISSN: 3057-0786 (Online)

Research Article

Developing a Fish Tank Management System via an Online Application

Wanpracha Nuansoi, Pichet Suwanno and Supachai Maduea *

Department of Industrial, Rattaphum College, Rajamangala University of Technology Srivijaya, Rattaphum, Songkhla 90180, Thailand.

Article history:

Received: 2025-01-12
Revised: 2025-04-08
Accepted: 2025-04-11

Keywords:

fish tank;
application;
flutter

A B S T R A C T

Fish tank owners often face challenges in maintaining optimal environmental conditions due to time constraints and a lack of real-time monitoring tools. To address this, our research team developed an online fish tank management application with two key objectives: 1) to design an efficient management system and 2) to evaluate its performance. Developed using Flutter for compatibility with both Android and iOS, the system supports automatic and manual control modes. In automatic mode, users can configure pH and turbidity levels based on specific fish requirements, while manual mode allows direct control over feeding, lighting, and water filtration. The system integrates micro-controllers to gather real-time data from turbidity, pH, and temperature sensors, transmitting this information to ThingSpeak cloud for storage and analysis. The application provides graphical data visualization and facilitates remote control by sending commands through Firebase cloud to the micro-controller, which then operates connected devices via relay modules. Performance evaluations confirmed the system's reliability, with command response tests conducted over 100 trials yielding the following average latency times: 1) LED Activation: 2.86 seconds | Deactivation: 2.72 seconds; 2) Feeding System Activation: 2.61 seconds | Deactivation: 2.78 seconds; and 3) Timer-Based Feeding Operations: 2.42 seconds. This innovative system enables fish tank owners to remotely monitor and manage environmental conditions, significantly reducing maintenance time while ensuring continuous monitoring for improved aquatic life management.

1. Introduction

Keeping aquarium fish or ornamental fish is a popular hobby in Thailand. This is because ornamental fish have a variety of colors and shapes, can be kept in a limited space, and help create a refreshing atmosphere in the house. The ornamental fish business in Thailand is important both economically and culturally. Thailand is one of the world's leading ornamental fish exporters, with a global market share of approximately 7.38% and an export value of more than 700 million baht per year (Prachachat Business, 2023). The main problems that aquarium fish farmers encounter are: lack of time to take care of the fish, inconsistent feeding of the fish, deteriorating water quality, and short-lived fish due to improper care (Chen *et al*., 2023; Obma *et al*., 2023). Some water properties affect fish farming, such as acidity, alkalinity, ammonia accumulation, etc. (Ikhlaq *et al*., 2025). If aquarium fish are not managed well, the fish will easily get sick, grow slowly, and may die (Santoso and Panuntun, 2024).

Currently, there is IoT technology that can control various devices via the Internet using a single

*** Corresponding author.**

E-mail address: *supachai.m@rmutsv.ac.th*

Cite this article as:

Nuansoi, W., Suwanno, P. and Maduea, S. 2025. Developing a Fish Tank Management System via an Online Application. **Recent Science and Technology** 17(2): 265957.

mobile phone, making life more convenient. IoT technology (Phumcharoen and Ploywattanawong, 2022) defines it as an environment consisting of all things that can communicate and connect with each other through both wired and wireless communication protocols. All things have a way to identify themselves, recognize the context of their environment, and interact and work together. If IoT technology is applied to control the aquarium, it will solve the problem. There is research (Mulyana *et al*., 2023; Pangerd and Duangsai, 2023) that has developed an automatic aquarium controller using IoT. The system could feed fish, measure pH, measure temperature, control and command via the Blynk application. The highlight of these two research projects is the use of the easy-to-use Blynk application. Research (Obma *et al*., 2023) has presented the improvement of water quality and monitoring of water conditions for ornamental aquariums using IoT technology. The system has the following capabilities: measuring water temperature, measuring water pH, having a web application for using the system, and having MySQL as a database. If the temperature is high, the system will command the fan to work. If the temperature is lower than the specified value, it will send the heater to work. The highlight of this research is that it controls the water temperature. Research (Santoso and Panuntun, 2024) has presented an automatic control and monitoring system for water quality in goldfish tanks using Fuzzy Logic Controller (FLC) to control the turbidity and pH of the water in the aquarium. There is a website for viewing water quality values in real time. The highlight of this research is the use of FLC to control water quality. Research (Suranata *et al*., 2024) has presented the design of an ornamental aquarium management system using IoT technology to monitor water conditions. It is possible to track pH and water temperature through ThingsBoard. The highlight of this research is the real-time tracking of water conditions. Research (Widyati *et al*., 2025) has proposed an automatic fish feeding and temperature control system in aquariums based on IoT technology. Data is sent via MQTT protocol. It is controlled and displayed via Node-RED. The highlight is the control and command via Node-RED.

From the above problems and the review of related research, the research team has an idea to develop an online aquarium management system application. The system can track the status of the environment in real time, namely water temperature, water pH, and water turbidity. It can control fish feeding, water filtration, and turn on and off LED lights automatically, making the lives of fish farmers easier, especially the elderly or those with limited time. The highlight of this research is the design and development of an application that stores data on the NoSQL cloud system in real time and has a water filtration system to extend the water change time. The appropriate water environment for raising each type of fish is not the same. But in this research, it is the environment for raising goldfish. The factors are as follows: pH 7.0-8.6, water turbidity less than 5 (Ikhlaq *et al*., 2025), temperature 24-30 degrees, and red light (Noureldin *et al*., 2021). If raising other types of fish, the conditions can be adjusted as needed. The application will be developed using Flutter, which is a framework used to create a user interface for creating mobile applications that can work across platforms, both iOS and Android, at the same time. The language used in Flutter is dart, which was developed by Google. Importantly, it is open source and can be used for free (Mamoun *et al*., 2020; Kohprasert and Adsavakulchai, 2024). Data storage in the system uses the cloud system as a medium for sending and receiving data over the Internet that does not store structured data.

2. Materials and Methods

2.1 Research Scope

The system operates in two modes of operation: manual control mode and automatic mode. Users can control the feeding system, turn LED lights on and off, and view the water pH sensor, water turbidity and water temperature graphs. As for the automatic mode, the user can set the pH and turbidity of the water according to the fish raised. Once the setup is complete, the system will automatically run, and you can view the pH value, water turbidity value, and water temperature graph.

2.2 Developing a Fish Tank Management System via an Online Application using System Development Life Cycle (SDLC) in Waterfall Model.

SDLC is a process for developing and managing information systems that have clear steps, are of high quality, meet user needs, and can be maintained in the long term (Pinchunsri *et al.*, 2019). The Waterfall Model is a sequential system development process where each step must be completed before proceeding to the next step (Maulana *et al.*, 2021).

2.2.1 Requirement Analysis

From the survey on aquarium fish farming problems, it was found that the problems are caused by the need for human labor to feed, turn on and off the lights, change the water, take care of the fish, forget to feed them, and have no free time to change the water. When there is no time to change the water, the substances excreted from the fish will have ammonia and nitrite that accumulate in the water too much, causing the water to have an unsuitable value for fish farming. Another problem is the temperature in the water that is not suitable for fish farming. The temperature must be monitored and always controlled. If the temperature is not suitable, it may affect the fish, causing them to grow slowly and have pale colors.

2.2.2 System design

2.2.2.1 System Operation Flowchart

From figure 1, start the system with use the login system to sign in and the login password is incorrect, user will need to log in to the system again. If correct, it will enter the selection of the operating mode. There are 2 modes: manual control mode and automatic mode. If user select the control mode, user can control the feeding system, filter the water, and turn the light on and off. If auto mode is selected, the pH and turbidity of the water can be set. After that, user can view the water turbidity graph, pH graph, and water temperature graph.

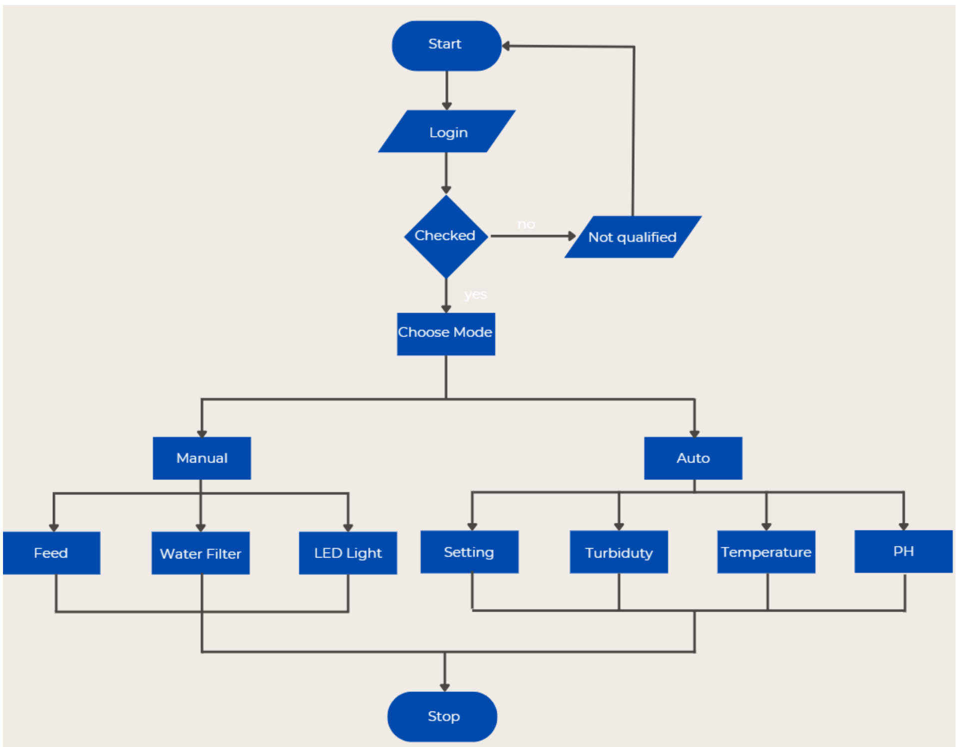


Figure 1 System Operation Flowchart

2.2.2.2 System Overview Design

From figure 2, it consists of 3 parts: application, cloud system and control part. The application receives data from the pH sensor, turbidity sensor and water temperature from ThingSpeak cloud system via the Internet to display the data on the application. The application sends data to control the on/off the water pump and LED lights to the Firebase cloud system via the Internet. The control part consists of 2 microcontrollers, Arduino Wemos and Arduino UNO. Because Arduino Wemos has only 1 analog input port, which is not enough for the turbidity sensor and pH sensor that both require analog input, and to share the load of Arduino Wemos, both boards transmit data to each other in serial. Arduino Wemos receives the pH sensor, turbidity sensor and temperature sensor values and then sends data to the ThingSpeak cloud system via the Internet and retrieves data from the Firebase cloud system (Huanthanom *et al*., 2020) to control the water pump and LED lights via relay. The working status will be notified via the Line application.

Table 1 shows the details of the devices.

Sections	Devices	Details
Input	pH Sensor	-pH measurement range: 0 to 14
		-Accuracy: ±0.1 pH at 25 °C
	Turbidity sensor	- Measuring Range: 0 – 1000 NTU
		-Accuracy: ±5% FS
	Temperature sensor	-Temperature measurement range: -55°C to +125°C
		-Accuracy: ±0.5°C in the range of -10°C to +85°C
Output	LCD	- Display 20 characters per line, 4 lines
		- Communication interface: I2C
	Relay	-4-channel relay
		-Maximum voltage and current 250V AC at 10A, 30V DC at 10A
	Pump	-Voltage: 12V DC
		-Flow rate 10L/min
	LED	-Voltage: 12V DC
	Micro servo	-Torque 1.2-1.4 kg/cm (4.8V)
		-Rotation 0-180 degrees

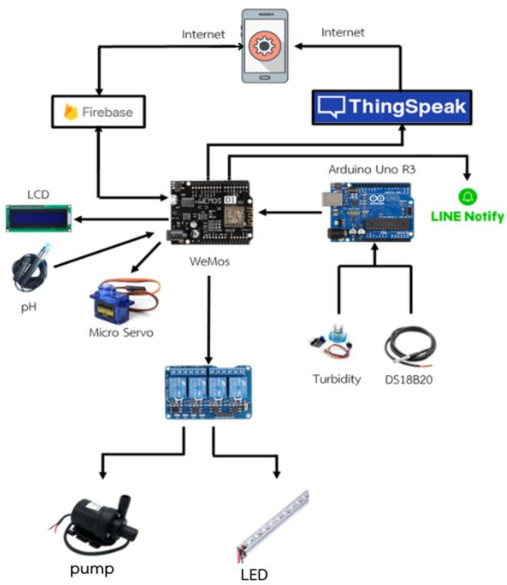


Figure 2 System Overview Design

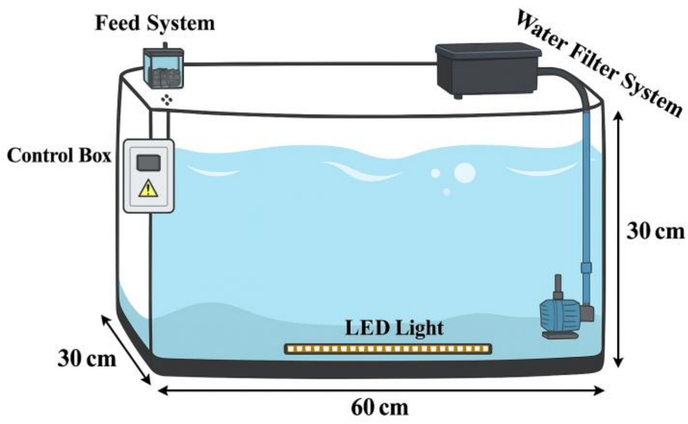


Figure 3 Fish tank structural design

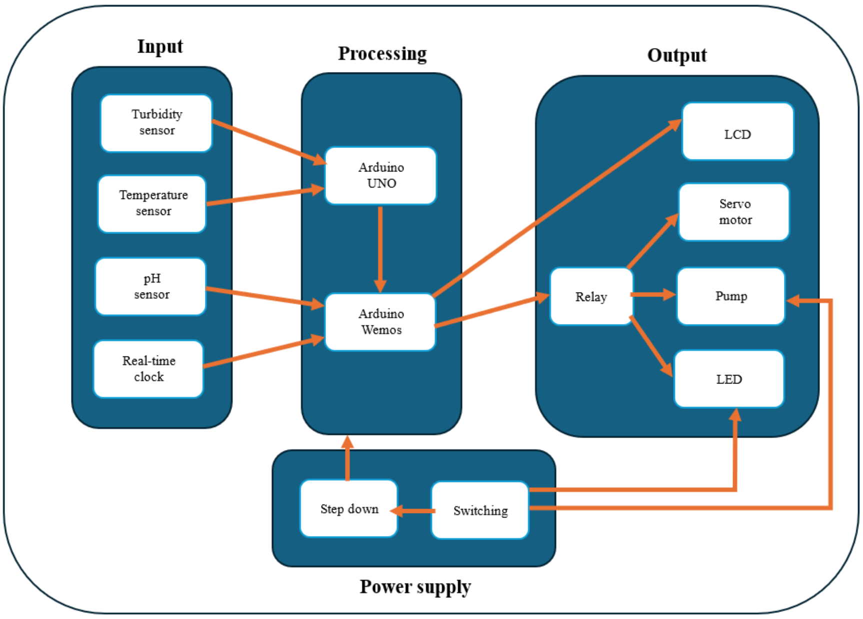


Figure 4 Hardware Design

The design of the aquarium structure consists of 4 parts: the control box is installed on the side of the aquarium, the fish feeding system is on the top left side of the aquarium, then the water filter system consists of a water pump that sucks water up to the water filter and releases water back into the aquarium, and finally the LED light is on the bottom of the aquarium, as shown in Figure 3.

2.2.2.3 Hardware Design

From figure 4, the input part consists of turbidity sensor, temperature, pH and real time clock. Next is the processing part, consisting of Arduino UNO and Arduino Wemos. The output part consists of LCD, relay, servo motor, pump and LED. The last part is the power supply part, consisting of switching power supply and step down. The power supply part is 12 Volt, connected to the step down to reduce the voltage to 5 volts to supply power to the entire circuit, except for the LED and pump, which receive 12 Volt electricity directly from switching.

2.2.2.4 Design of working conditions in automatic mode

Table 2 Working conditions in automatic mode

Conditions	Filter pump	LED lights	Feeding fish	Line notification
PH < 7	✓	✗	✗	✓
PH > 8.6	✓	✗	✗	✓
Turbidity > 5	✓	✗	✗	✓
9:00 a.m.	✗	✗	✓	✓
5:00 p.m.	✗	✓	✓	✓
Temperature > 30	✗	✗	✗	✓
temperature < 24	✗	✗	✗	✓

The experimental conditions were the same as those used in goldfish farming. When the pH value was less than 7.0, the system would turn on the filter pump. If the pH value was greater than 8.60 (Ikhlaq *et al*., 2025), the system would also turn on the filter pump. Both conditions worked to keep the pH in the appropriate range. The next condition, if the water turbidity was greater than 5 (Santoso and Panuntun, 2024), the system would turn on the filter pump to make the water clearer. Fish feeding was given at a rate of 1.8 grams, or 2% of the fish's weight (Ali *et al*., 2025), at 9:00 a.m. and 5:00 p.m. The system would feed the fish and turn on the LED lights, which stimulated the growth of goldfish and helped to darken the color of the fish. Finally, the notification section via the LINE application would notify all operating conditions.

2.2.3 System development

In the development of the application, it was developed using Flutter to develop, making it usable for both Android and iOS. The database uses Firebase Realtime Database as a medium to communicate with the hardware. It uses Arduino Wemos and Arduino Uno as microcontrollers to control and command various hardware. Wemos reads values from Firebase to command various parts and also acts to send sensor values to the Thingspeak cloud to store sensor values in the system. The application will then retrieve data from Thingspeak to display on the mobile application.

2.2.4 System Testing

After the system development is complete, the system usage is tested in the hardware section first. Then, the application is tested with the Firebase cloud system and Thingspeak cloud system. Finally, the overall system is tested. When the system is complete, the operation of various systems is tested.

2.2.5 Maintenance

When the system is in use, various problems are brought to further develop and improve the system.

2.3 System Efficiency Testing

A plan was put in place to test the operation of various systems in automatic mode, namely the water filtration system, feeding system, LED lighting system, and notifications, according to the set conditions for 7 days to find the average value of pH, turbidity, and temperature. Then, the delay in ordering the operation of various systems in manual mode was tested. The test was performed by timing the time from ordering until the operation occurred 100 times to find the average value and standard deviation. The tests were as follows: average time for ordering food, average time for setting the feeding time, and average time for ordering the LED lights to turn on and off.

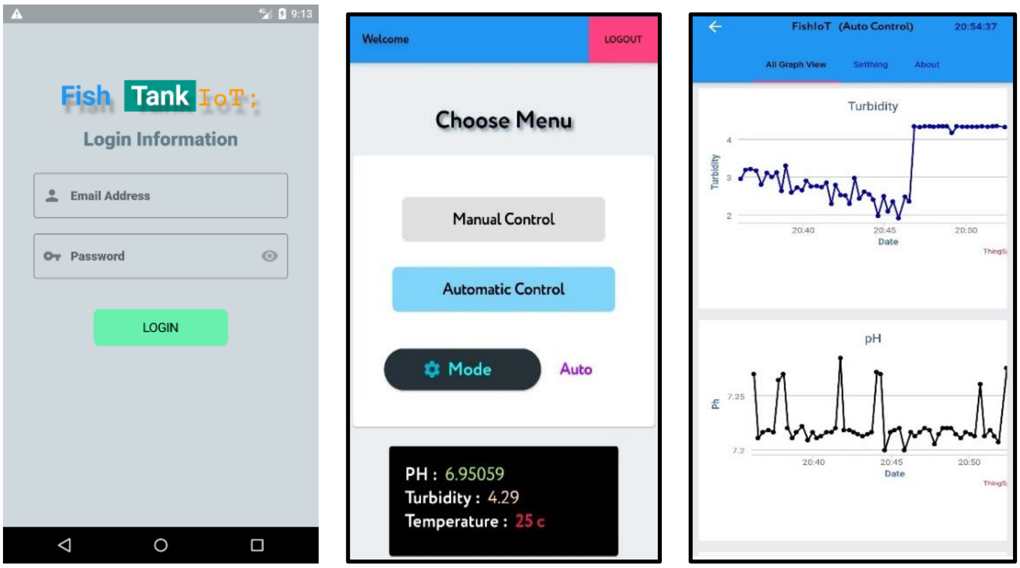
3. Results and Discussion

The development of the fish tank management system via the online application at the fish tank consists of a fish feeding system, an LED light on/ off system, a water filter system, and a notification system via the Line application. The LCD screen shows the operation of the fish tank, showing the status of the operating mode, internet connection, temperature, water turbidity and the set turbidity, water pH, and the set pH.

From figure 5a is the application to log in to the system. The user enters email and password to log in, which the system will check with the email registered in Firebase Authentication. If correct, it will go to the application page for selecting the working mode. It can select either Auto or Manual mode. On this application page, it will display the pH value, turbidity value, and water temperature as shown in figure 5b. When the working mode is selected, a graph showing the pH value, turbidity value, and water temperature can be viewed as shown in figure 5c

From figure 6, it is working in Manual mode. The user can control the operation as follows: control the LED lights to turn on and off, control the water filter, and control the fish feeding. Before controlling the operation, the system will display the status of each system. There is also a notification of the operation via the Line application, another channel for checking the operation of the fish tank.

.



a b c

Figure 5 Application login page, select operating mode, and display sensor value graph

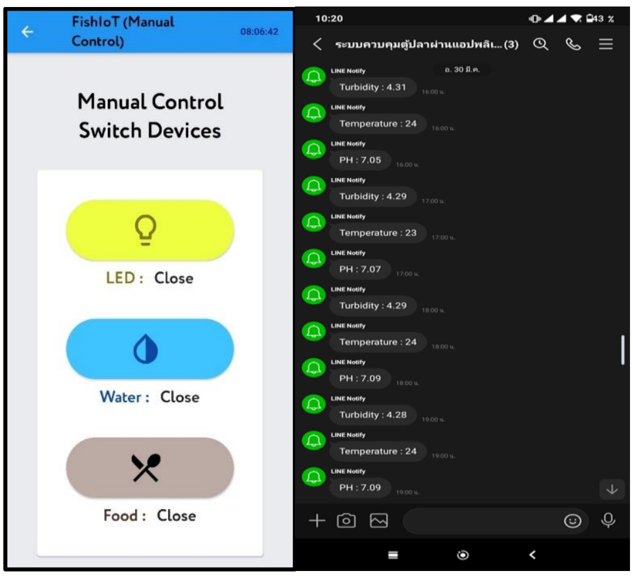


Figure 6 Working in Manual mode and notification of work via LINE application

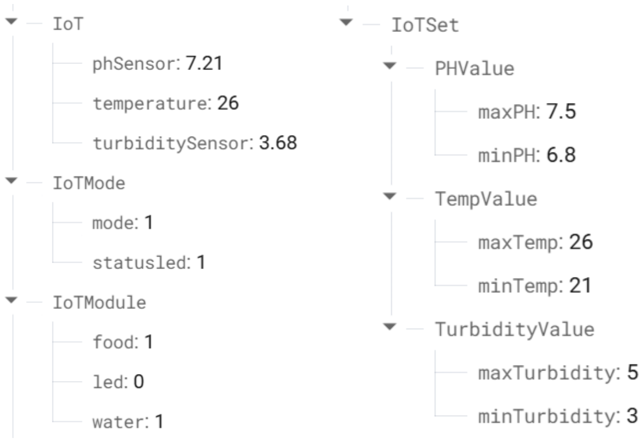


Figure 7 Storing Work Data in Firebase Cloud

Table 3 Test operation in automatic mode

Day	PH	Turbidity (NTU)	Temperature (°c)	Feeding	Water filter	LED light	Notification
1	7.45(0.08)	3.65(0.21)	25.80(0.50)	✓	✗	✓	✓
2	7.40(0.06)	3.90(0.25)	25.35(0.20)	✓	✗	✓	✓
3	7.32(0.09)	4.10(0.16)	25.12(0.27)	✓	✗	✓	✓
4	7.25(0.09)	4.40(0.24)	24.78(0.38)	✓	✗	✓	✓
5	7.08(0.17)	4.78(0.31)	25.35(0.33)	✓	✗	✓	✓
6	6.86(0.15)	4.90(0.19)	24.23(0.43)	✓	✓	✓	✓
7	7.10(0.14)	4.50(0.38)	25.55(0.37)	✓	✗	✓	✓

From figure 7, it is collecting working data in the Firebase cloud, with the following values stored: in IoT, the sensor values are stored: PH, temperature, and water turbidity. In the IoTMode section, the operation mode and status of the LED are stored. In the IoTModule section, the status of commands, feeding, turning on/off the LED lights, and filtering water are stored. Finally, in the IoTSet section, it is set in automatic mode, with settings for pH, temperature, and water turbidity in the appropriate range.

3.1 Evaluation results of the system

3.1.1 Test operation in automatic mode

The automatic mode operation was tested for 1 week, which is consistent with the research (Chen *et al.*, 2023; Pangerd and Duangsai, 2023) that tested the system for 1 week. In our research, the specified conditions for automatic mode were used, namely, if the pH is less than 7.0 or the pH is more than 8.6, the water filtration system will work. As for the turbidity of the water, if it is more than 5.00, the water filtration system will work. The feeding system and the LED light system will work according to the time. From the experimental results, all systems worked as set. On the 6th day, the pH value was less than 7.0, which is 6.86, causing the water filtration system to work. As a result, on the 7th day, the pH value increased to 7.10 and the turbidity was also good. Causing the water filtration system to stop working, this is consistent with the research of (Santoso and Panuntun, 2024). When the water filtration system is used, the pH value will improve, and the turbidity will also improve.

3.1.2 LED on/off delay test

Tested the on/off command via the application 100 times for the average latency of the command. This is consistent with the research (Pangerd and Duangsai, 2023) on automated aquarium controller with IoT, which tested the efficiency of the fish feeding system 100 times. In our research, the experimental results were recorded as a graph chart to compare the latency of the on/off. From the chart in figure 8, the blue graph is the on/off command, with an average latency of 2.86 seconds, a standard deviation of 0.26, the highest latency of 3.10 seconds, and the lowest latency of 2.10 seconds. The red graph is the off command, with an average latency of 2.72 seconds, a standard deviation of 0.31, the highest latency of 3.30 seconds, and the lowest latency of 2.31 seconds. This is consistent with the research (Romin *et al*., 2024) on the mobile application for borrowing and returning medical equipment. The medical equipment borrowing application uses the firebase cloud to store data and can link all data in real-time.

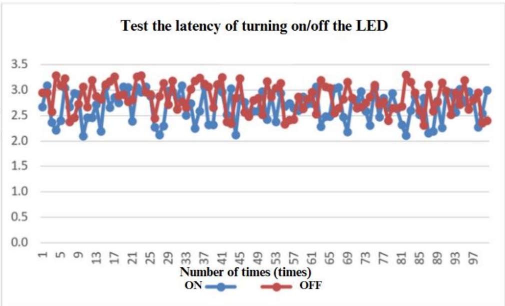


Figure 8 Graph showing the LED on/off delay test

3.1.3 Testing the delay of the opening/closing of the feeding system

Test the on/off command via the application 100 times. Record the experimental results as a graph chart to compare the delay of the on/off. From figure 9, the blue graph is the on/off command. The average delay is 2.61 seconds, with a standard deviation of 0.30. The maximum delay is 3.20 seconds, and the minimum delay is 2.11 seconds. The red graph is the off/on command. The average delay is 2.78 seconds, with a standard deviation of 0.32. The maximum delay is 3.28 seconds, and the minimum delay is 2.30 seconds. The factor affecting the delay in the system command depends on the speed of the internet. If the internet has high speed, it will result in a high speed of commands, resulting in reduced latency.

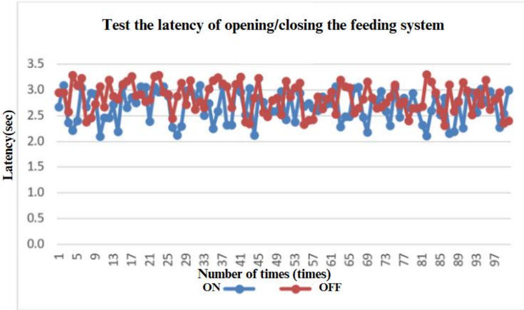


Figure 9 Graph showing the feeding system on/off delay test

3.1.4 Testing the delay of the feeding system on/off timer

From figure 10, test the timing to turn on/off the feeding system by sending values from the application to Firebase. Then Wemos retrieves the values and compares them. When it matches the set time, turn it on/off as ordered. Test 100 times and record the experimental results. The average delay is 2.42 seconds with a standard deviation of 0.25. The maximum delay is 2.90 seconds, and the minimum delay is 1.90 seconds.

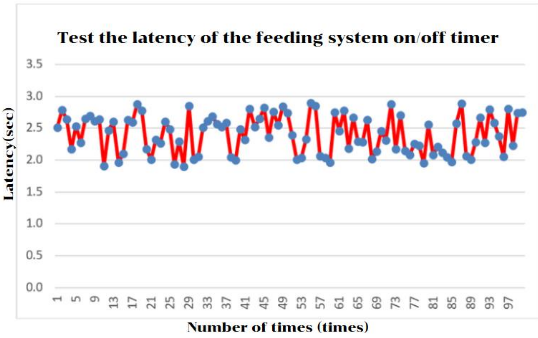


Figure 10 The graph shows the test time of the feeding system on/off timer

4. Conclusion

The development of the online fish tank management system application could work in 2 modes: manual mode and automatic mode. In the manual mode, it can control the on/off LED lights, change water, and feed. In the automatic mode, it can set the temperature, turbidity, and pH value. The application development uses Flutter, which can be used on both Android and iOS operating systems. It stores data in 2 cloud systems: Firebase cloud, which stores command data and immediate data, which are temperature sensor values, water turbidity, and water pH values. The Thingspeak cloud system stores sensor values similar to the Firebase cloud, but it is non-immediate data. This data is displayed as a graph in the application. In terms of hardware, Arduino Wemos and Arduino UNO are used as microcontrollers working together. Wemos read values and sends them to the Firebase cloud and sends sensor values to the Thingspeak cloud, which then processes and commands the various parts. In terms of performance testing the test of 100 times of command delay, the test result of the delay of LED on/off command has an average of 2.86 and 2.72 seconds, respectively. The test result of the delay of the feeding system on/off command has an average of 2.61 and 2.78 seconds, respectively. And the test result of the delay of setting the time to turn on/off the feeding system has an average of 2.42 seconds. The development of this system is beneficial to aquarium fish farmers in reducing the time spent on care, control, and monitoring via online systems, resulting in farmers' income, reducing costs, and increasing profits, moving towards precision agriculture.

5. Acknowledgments

This research was successfully completed. We would like to thank the Research Review Committee, Rattaphum College, Rajamangala University of Technology Srivijaya, and research assistants Mr. Somnuek Hantawanno and Mr. Narongsak Yeemareb. Finally, the research team would like to thank Rajamangala University of Technology Srivijaya for providing the budget and income to support this research.

6. References

Ali, Z., Sher, N., Muhammad, I., Nayab, G.E., Alouffi, A., Almutairi, M.M., Khan, I. and Ali, A. 2025. The combined effect of cadmium and copper induces bioaccumulation, and toxicity and disrupts the antioxidant enzymatic activities of goldfish (Carassius auratus). **Toxicology Reports** 14: 101972.

Chen, P., Song, Q., Hong, K., Liu, W., Xiao, W. and Chen, S. 2023. Design of integrated smart aquarium, pp. 3122-3125. *In* **2023 China Automation Congress (CAC).** IEEE, Penghu, Taiwan.

Huanthanom, C. , Saladkaew, N. and Chunwiphat, S. 2020. A Development of New E-commerce Platform for Product Preordering. **The Journal of Industrial Technology** 16(1): 1-14. (in Thai)

Ikhlaq, A., Kanwal, M., Rizvi, O.S., Ramzan, N., Akram, A., Qazi, U.Y., Qi, F., Ul Hassan, S. and Javaid, R. 2025. Decontamination of fish aquarium wastewater by ozonation catalyzed by multi-metal loaded activated carbons for sustainable aquaculture. **Process Safety and Environmental Protection** 193: 374-384.

Kohprasert, W. and Adsavakulchai, S. 2024. Moblie Applcation Platform for Tour Guide Recommendation. **Rom Yoong Thong Journal** 2(3): 16-36. (in Thai)

Mamoun, R., Nasor, M. and Abulikailik, S.H. 2020. Design and development of mobile healthcare application prototype using Flutter, pp. 1-6. *In* **2020 International Conference on Computer, Control, Electrical, and Electronics Engineering (ICCCEEE).** IEEE, Khartoum, Sudan.

Maulana, F.I., Susanto, V., Shilo, P., Gunawan, J., Pangestu, G. and Budi Raharja, D.R. 2021. Design and Development of Website Dr. Changkitchen Diet Catering Using SDLC Waterfall Model, pp. 75-79. *In* **Proceedings of the 6th International Conference on Sustainable Information Engineering and Technology (SIET '21).** ACM, Malang Indonesia.

Mulyana, E., Dzikrirrahman, M., Ridwan, A.M., Halim, I. A., Yulianti, A.Y. and Hilmi, F. 2023. Goldfish aquarium automation and monitoring based on Internet of Things, pp. 1-6. *In* **2023 9th International Conference on Wireless and Telematics (ICWT).** IEEE, Solo, Indonesia.

Noureldin, S.M., Diab, A.M., Salah, A.S. and Mohamed, R.A. 2021. Effect of different monochromatic

LED light colors on growth performance, behavior, immune-physiological responses of goldfish, Carassius auratus. **Aquaculture** 538: 736532.

Obma, J., Promsangming, P., Angkawisittpan., N., Nuan-on, A. and Sonasang, S. 2023. Water quality improvement for ornamental fish tank using IoT technology. **Journal of Engineering and Innovation** 16(1): 26-33. (in Thai)

Pangerd, S. and Duangsai, S. 2023. Automated aquarium controller with IoT. **UTK Research Journal** 17(1): 60-68. (in Thai)

Phumcharoen, J. and Ploywattanawong, L. 2022. The IoT Technology for Control the Earthworm Culture Environment. **KKU Research Journal (Graduate Studies)** 22(1): 145-155. (in Thai)

Pinchunsri, P., Chantaradara, T., Choisang, Y., Khosinprasurt, T. and Buasan, D. 2019. Development of information program for assets management at a private university in Nakhon Pathom Province. **Christian University Journal** 25(2): 79-91. (in Thai)

Prachachat Business. 2023. **Revealing the list of 5 beautiful fish species that bring in good income, are exported and are famous all over the world.** Available Source: https://www.prachachat.net/economy/news-1441890, December 27, 2024.

Romin, P., Jinda, Y., Kamolwet., P. Channawon, S. and Sammaphan, U. 2024. Medical Equipment Loan Mobile Application. **Journal of Applied Research and Development by ECTI Association** 4(3): 1-10. (in Thai)

Santoso, B. and Panuntun, W.D. 2024. Goldfish aquarium water quality control and monitoring system using fuzzy logic controller (FLC). **Multitek Indonesia: Jurnal Ilmiah** 18(2): 96-104.

Suranata, I.W.A., Paramartha, I.G.N.D., Wiguna, I.K.A., Gama, A.W.O., Indrawan, G. and Divayana, D.G.H. 2024. IoT design of ornamental fish aquarium management could monitor water conditions, pp. 189-194. *In* **2024 4th International Conference of Science and Information Technology in Smart Administration (ICSINTESA).** IEEE, Balikpapan, Indonesia.

Widyati, M.A.S., Anshori, Y., Lamasitudju, C.A.R., Laila, R. and Joefrie, Y.Y. 2025. Automatic fish feeding and temperature control system for aquariums based on Internet of Things (IoT). **Journal of Applied Informatics and Computing** 9(1): 146-152.