E-ISSN : 2988-585X (Online)

Journal of Elektronik Sistem InformasI (JESII)

Volume 2 No 1 June 2024

DOI : 10.31848/jesii.v2i1.3418

Design Of A Monitoring System For Potential Of Hydrogen (Ph) In Fish Aquarium Water Based On Esp-32 Microcontroller

Aditya Awal Rizkia[1], Adam Husain[2]

[1,2]Department of Information System, Univ. Kebangsaan Republik Indonesia, Indonesia

Article Info

Article history:

Received June 2, 24
Revised June 23, 24
Accepted June 25, 24

Keywords:

ESP-32 Microcontroller
PH Sensor
Telegram
Waterfall
Water PH

ABSTRACT

Maintaining the quality of aquarium water is an important factor for the health and survival of fish. One important parameter in water quality is the acidity level (pH). This research aims to design and build an ESP32-based aquarium fish water pH monitoring system. The system uses pH sensors to measure water acidity levels and the ESP32 microcontroller to process and display data. The pH data is displayed on an LCD screen and can be accessed in real time through a web application. The system is also equipped with an email notification feature to give warnings when pH values are outside the normal range. Test results show that the system can measure and display the pH value with high accuracy and deliver email notifications in a timely manner. The system is expected to help fish lovers to keep their fish healthy more easily and effectively. This research designed a water pH monitoring system in an ornamental fish aquarium using a pH sensor and an ESP-32 microcontroller that can remind users through a telegram Bot message and can be seen through the LCD using the waterfall development method as a method of making tools in this study. Based on the research that has been done, the automatic pH reading system has been successfully built by being accessed via telegram and can be seen on the LCD display. pH Sensor testing has an accuracy value of 90% with testing using litmus paper comparison.

Corresponding Author:

Aditya Awal Rizkia,
Information System Department,
Faculty of Computer Science and Information Systems,
Univ. Kebangsaan Republik Indonesia.
Email: adityaa.rizkia@ukri.ac.id

1. INTRODUCTION

Maintaining optimal water quality is crucial for the health and survival of fish in aquariums. A critical parameter influencing this quality is the water's potential of hydrogen (pH). This paper proposes the design of a monitoring system utilizing an ESP-32 microcontroller to continuously track the pH level of fish aquarium water. This system aims to provide real-time data and automate maintenance by leveraging the capabilities of the ESP-32 for data acquisition, processing, and potential output through features like alerts or control mechanisms. The problem encountered in maintaining ornamental fish is the lack of regular monitoring of water pH. Many aquarium owners overlook this pH monitoring due to work commitments, household responsibilities, or when they have to leave home for extended periods. Consequently, fluctuations in water pH can affect the quality and health of ornamental fish. [1]

Several studies have been conducted to address this issue. The degree of acidity determines the quality of water because it helps the chemical processes of water. The death point of fish at acidic pH is 4 and alkaline pH is 11. The degree of acidity that is good for ensuring the life of organisms such as fish is in the range of 6.5 - 8.5 [2]. One solution developed is the use of Microcontroller-based electronic devices to automatically monitor water pH [3].

There is related research involving monitoring using a pH sensor and two pumps to flow acidic and alkaline pH solutions. The data can be accessed in real-time through an Android application [4]. Additionally, there is related research focused on creating a monitoring system using an Android smartphone. This system enables pond owners to monitor the water's pH levels in real-time. The primary aim is to simplify the care of ornamental fish and prevent pH fluctuations that could endanger the health of the fish [5]. The research object of the title is the pH monitoring system in fish aquarium water. The system is designed using the ESP-32 microcontroller. The title specifically mentions the ESC-32 as the core component of the system, but its main object is the monitoring system itself.

Traditional methods of monitoring fish aquarium water quality, particularly pH, can be time-consuming and require manual testing. This lack of real-time data makes it difficult to maintain optimal conditions. To address this challenge, this research proposes the development of a monitoring system based on the ESP-32 microcontroller. This system will provide continuous pH level readings, facilitating timely intervention and ensuring a stable environment for healthy fish. Research indicates that employing this technology can provide convenience in ornamental fish maintenance and prevent dangerous pH fluctuations. Furthermore, integrating this technology with mobile applications like Telegram enables aquarium owners to easily monitor water conditions and receive real-time notifications on their phones [6].

This research proposes the development of a water condition monitoring system capable of operating simultaneously in real-time. The proposed system is designed by applying the SDLC waterfall model methodology and using Unified Modeling Language (UML) for comprehensive modeling and documentation. The main hardware used in this system is the ESP32, which functions as the data processing unit. To deliver the monitoring data to users, the system utilizes notifications through the Telegram application, enabling fast and efficient data transmission to end users. This research aims to provide a reliable and effective solution for continuous and real-time water condition monitoring.

2. RESEARCH METHOD

2.1. Basic Concept of Information Systems

The basic concept of information systems involves the use of information technology to collect, store, process, manage, and disseminate information within an organization or entity. It entails understanding how data and information flow through a system and how information technology can support business operations, decision-making, and organizational goals [7].

The main components of an information system include:

a. Data: Raw facts recorded and stored in a system, which can be numerical, textual, graphical, auditory, or in other forms. Data is processed and interpreted to become meaningful information.
b. Application Software: Computer programs designed to perform specific tasks within an organization.
c. Hardware: Physical components forming the infrastructure of information technology, including computers, servers, data storage devices, communication networks, and input/output devices.
d. Network: Infrastructure enabling communication and data exchange among various devices within an organization or between connected organizations. This includes local area networks (LANs), wide area networks (WANs), and wireless networks (Wi-Fi).
e. People: End users and managers of the information system. They interact with the system to input, retrieve, and process information, as well as make decisions based on the information provided by the system.

2.2. Waterfall SDLC Method

The research method used in conducting this research is to use the waterfall method as a development model for the design of a water pH monitoring system in a microcontroller-based ornamental fish aquarium. In this method there are several steps or phases. Each phase is defined by different tasks and objectives, where the overall phase describes the software life cycle until the phase is complete, but in this study only uses four phases or steps

of the waterfall method, namely analysis, design, implementation, and testing or results, this is because researchers only want to test the feasibility in terms of material and prototype monitoring systems [8] [9] [10].

The steps that must be passed sequentially in order for the process of applying this method to work properly include the following:

a. System analysis
   Is a shell of collecting information to collect complete needs and then analyze and define the needs that must be met.
b. System design
   The design stage is to make diagrams, namely use case diagrams and activity diagrams. In addition, it makes the overall system configuration of the Arduino microcontroller integrated with sensors and wifi modules and outputs. This stage will also help development to prepare hardware requirements in making the software system architecture that will be made as a whole.
c. Implementation
   implementation of the overall system design from hardware to software. The stage where the entire design is converted or built into program code and devices or tools.
d. Testing (System test)
   System testing aims to unite the entire system created. After all systems are integrated, thorough testing is carried out.

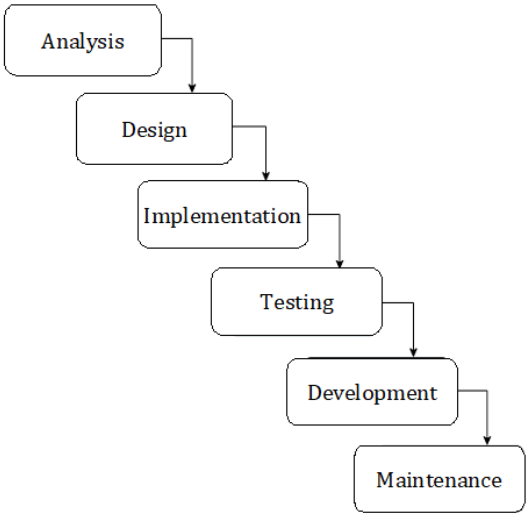

Figure 1 Method waterfall

In figure 1 an ESP32-based fish aquarium water pH monitoring system is designed and constructed using the waterfall approach. The waterfall method is a methodical, linear approach to system development. The waterfalls method in this study offers a methodical way to construct a pH monitor system. But during development, researchers must take into account the possibility that they will need to adjust to upgrades or adjustments.

2.3. ESP-32 Microcontroller

The ESP-32 microcontroller is an advanced single-chip integrated circuit that encompasses a broad spectrum of functions. It acts as the central processing unit for various electronic devices, offering features like data processing, storage, input/output handling, and operational management. Developed by Expressive Systems, this microcontroller is highly esteemed for its adaptability and efficiency across applications in areas such as home automation, IoT, robotics, and wireless communication. With built-in Wi-Fi and Bluetooth capabilities, it facilitates seamless connectivity and interaction with other devices and networks, making it a popular choice for creating cutting-edge electronic systems that are interconnected and innovative [11] [12] .

2.4. Telegram Bot Message

The Telegram Bot API serves as a platform interface that allows developers to create and manage bots within the Telegram ecosystem. This comprehensive tool enables various functionalities, including message exchange, command processing, multimedia content management, and user interaction facilitation. Through this interface, developers can seamlessly integrate bots into Telegram, enhancing user experiences and extending the platform's capabilities [13] [14] .

2.5. Data Collection Method

Data collection methods using literature studies (theses, theses, textbooks, journals) and other supporting information from the internet. Before conducting this research, several related research studies related to previous research were also used as references and can be used as problem formulations. literature studies can be in the form of scientific journals, books or other reference sources [15]. Literature studies can be used to answer and also ask or determine questions that have been formulated.

3. RESULT AND DISCUSSION

3.1. System Work

The design of the Potential of Hydrogen (pH) monitoring system in ornamental fish aquarium water, according to the name of this tool, is useful as a tool for monitoring the pH of water in ornamental fish aquariums, monitoring is carried out via the cellphone of the ornamental fish owner using the telegram application with the chat Bot feature in telegram which is connected or connected to the water pH monitoring tool via the Esp-32 Microcontroller.

The following is how the sensors work in the potential of hydrogen (pH) monitoring system tool in ornamental fish aquarium water made by researchers, namely:

a. Water pH sensor as a detector of the level of acidity or basicity of water as measured by a pH scale between 0 and 7. Water is said to be acidic if the pH scale number is less than 7 and is called basic if the pH scale is more than 7.
b. ESP-32 as a data processing microcontroller and Wi-Fi module used to communicate or control via the internet.
c. I2C LCD is a device that functions to display a display of quantities or numbers, so that it can be seen and known through the display on the LCD screen.
d. Telegram bot as a viewer of the pH value of aquarium water that will appear and a reminder for ornamental fish owners.

3.2. Flowchart Of the Whole System

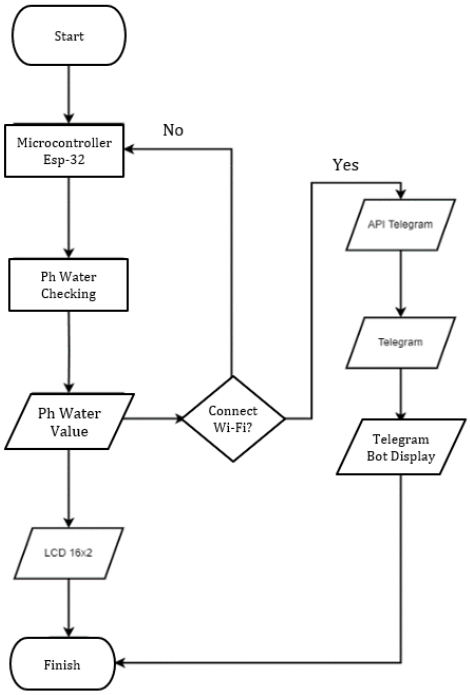

Figure 2 Flowchart of the whole system

In the tool's working system, the device is on standby when it is powered on. ESP-32 will connect to the internet and the water pH sensor will check the pH of the water. The checking results are processed by the ESP-32 microcontroller and displayed on the LCD. The pH value will be sent to the telegram application via the telegram API and displayed on the telegram bot. The data received by the telegram application will be displayed on the cell phone screen of the ornamental fish owner. I can't find the text that needs to be abbreviated. Please provide the text you want to abbreviate.

3.3. System Analysis

In the analysis phase, specifications consisting of functional and non-functional requirements are needed to establish parameters and features required by the design under development.

Functional Requirements:

a. The microcontroller used is ESP32, which will be responsible for controlling and managing the entire pH monitoring system.
b. Implementation of message notifications using a Telegram bot will enable the system to provide direct notifications to users through an integrated communication platform.
c. Utilization of the 4502 sensors for pH measurement will provide accurate and reliable data related to the acidity or alkalinity levels in water.
d. Direct transmission of pH measurement data without the intermediary of a database will ensure the availability of real-time information to users without delays caused by storage processes.

Non-functional Requirements:

a. Optimal system performance is a top priority, ensuring that the system can measure and transmit data with minimal latency, thus providing users with the most current and accurate measurement results.
b. High reliability is a crucial aspect, where the system must be able to operate without significant disruptions or failures for an extended period, ensuring uninterrupted pH monitoring.
c. Precision in the operation of the system is key to generating accurate pH measurement notifications that reflect actual conditions, thereby providing certainty and reliability in system usage.

3.4. System Design

To make it easier to understand the performance of the system designed, the flow or system design is made in such a way with several system depiction methods. As in figures 2 and 3 which describe the system created.

3.4.1. Use Case Diagram System Monitoring pH

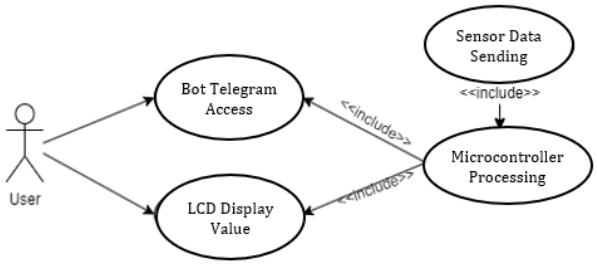

Figure 3 Use Case Diagram System Monitoring pH

Use case diagrams are used to describe how users interact with the system and the functionality of the system. This diagram describes the interaction of a system that displays the pH value of water via LCD and telegram bot. Users can access and view this information. The diagram also lists the actors or users involved in using the system. This use case diagram consists of one role which is the user.

3.4.2. Activity Diagram System Monitoring pH

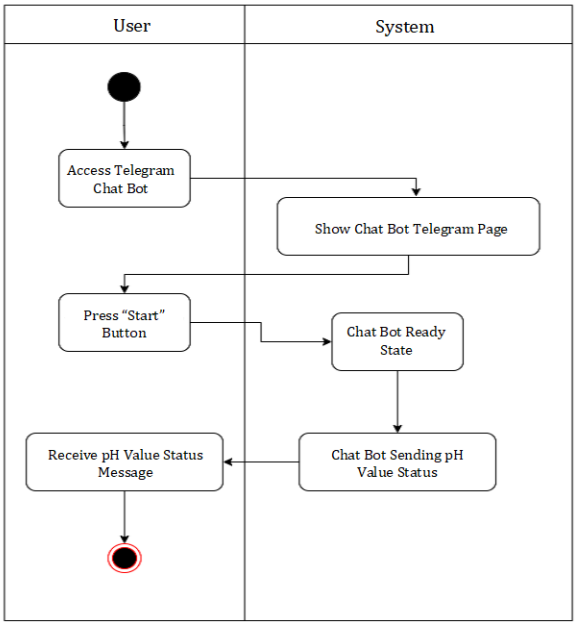

Figure 4 Telegram Bot Access Activity Diagram

The user initiates a conversation with the chatbot by sending a text message. After entering the current water pH data, the chatbot validates it. Users can monitor the pH data by sending specific commands to the chatbot. After that chatbot sending data to the user about current pH state.

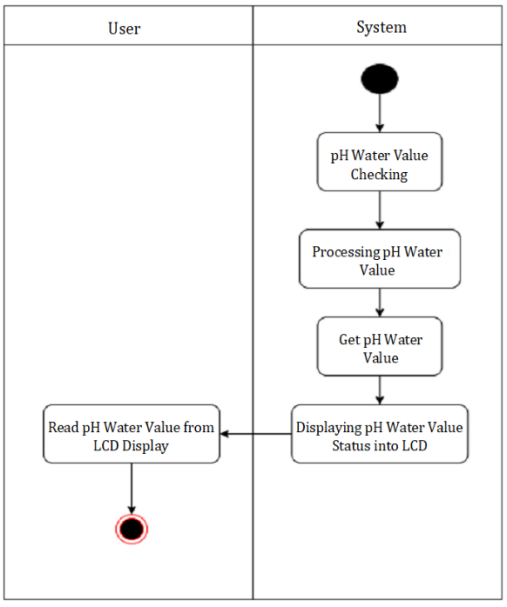

Figure 5 Activity Diagram of LCD Display

The system begins by checking the water pH value. After the check, it processes the pH value and obtains it. Next, the system displays the pH water value on the LCD screen. On the user side, there is only one action depicted: "Reading pH Water Value from the LCD Display." This indicates that after the system processes and displays the information, it is ready for user interaction.

3.5. Hardware Design

To enhance comprehension of the operational effectiveness of the devised tool or hardware, it is essential to delve into the intricacies of its flow and design. By thoroughly examining the interplay of components, functionality, and architecture, we can gain valuable insights into its overall performance.

3.5.1. Blok Diagram

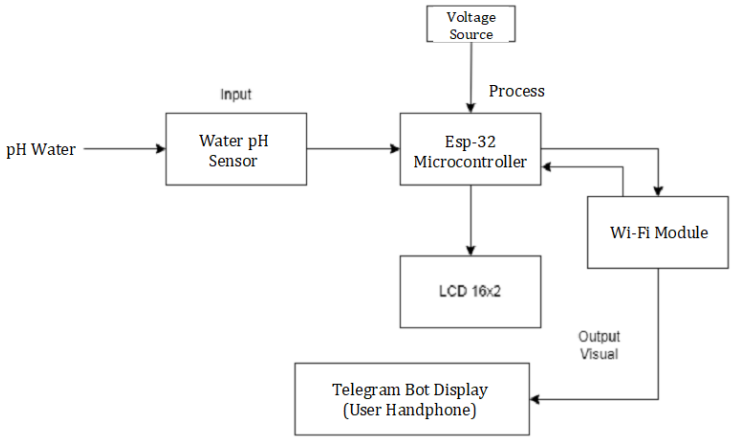

Figure 6 Block Diagram

The system block diagram shows the input and output configuration of the system. In this design, the input comes from a pH 4502 sensor that detects the acid-base degree of the solution with an analog output. The input is processed by the microcontroller for data processing from the sensor. The pH data is sent to the LDC and Bot telegram through the Wi-Fi module on the microcontroller. The microcontroller used: Esp-Wroom-32 (Esp-32).

3.5.2. Architectural Drawings of the Tool Set

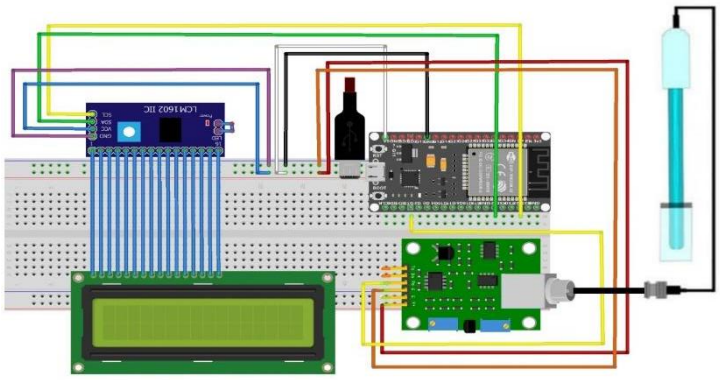

Figure 7 Hardware Schema

Based on the figure above, the overall hardware configuration is described from the input/output pins used and connected to the microcontroller system. In making the pH monitoring tool for ornamental fish aquarium water, it is explained with the following pins and wiring:

a. Micro USB as a supply or voltage giver to the ESP-32 microcontroller
b. White and black pin-coloured cables (Gnd and 5v) are connected to the breadboard to provide more pins (Gnd and 5v)
c. On the water pH sensor, the red and orange pins (Gnd and 5v) are connected to the pins (Gnd and 5v) on the breadboard, to get electricity supply

d. On the water pH sensor, the yellow-coloured cable Pin (Po) is connected to pin (G15) on the microcontroller for pH sensor input -4502C.
e. On the 16×2 LCD, all pins are connected to the I2C module to convert the pins on the 16×2 LCD to only four pins that are used.
f. On the I2C module, the purple and blue pins (Gnd and Vcc) are connected to the pins (Gnd and 5v) on the breadboard, to get electricity supply.
g. And the yellow and green coloured wires pin (SDA, SCL) for the output pin to the 16x2 LCD which is connected to the pin (G21, G22) on the breadboard.

3.6. System Implementation

So, after the required equipment has been collected, the implementation of the tool assembly is carried out by researchers following the architecture that has been made.

3.6.1. Display Page of The Water Ph Monitoring Message

In designing the display page of the water pH monitoring message using messages from telegram bots, the page or display displays the pH value of aquarium water by providing the level and value of acidity or pH of water in ornamental fish aquariums.

Figure 8 Display of Water pH Monitoring Message Page on Telegram Bot

3.6.2. Hardware Design Implementation

In the monitoring system built, the pH measurement of water uses a water pH sensor installed or connected to the ESP-32 microcontroller board. To determine the pH value of water in the aquarium, an LCD is used to determine the pH value of water that has been dipped in water.

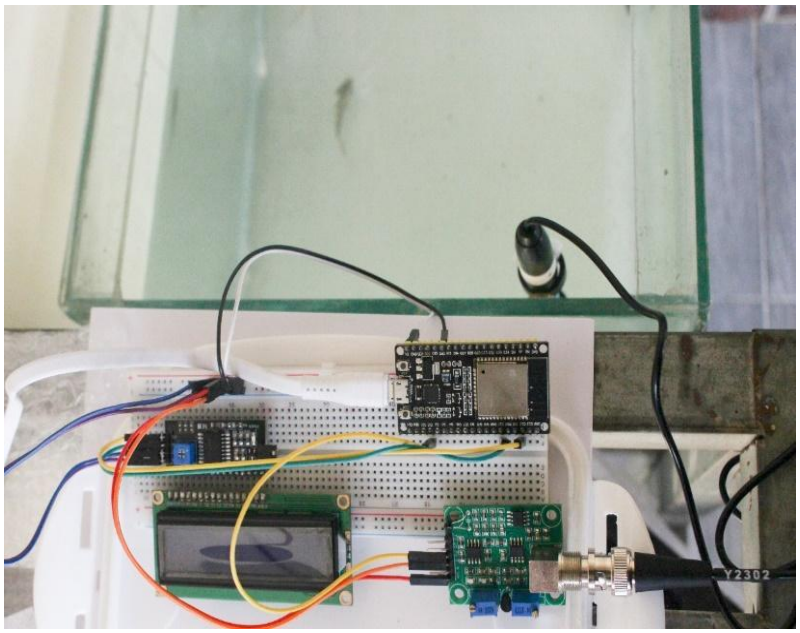

Figure 9 Ornamental Fish Aquarium Water pH Monitoring System

3.6.3. Testing with Aquarium Water Samples

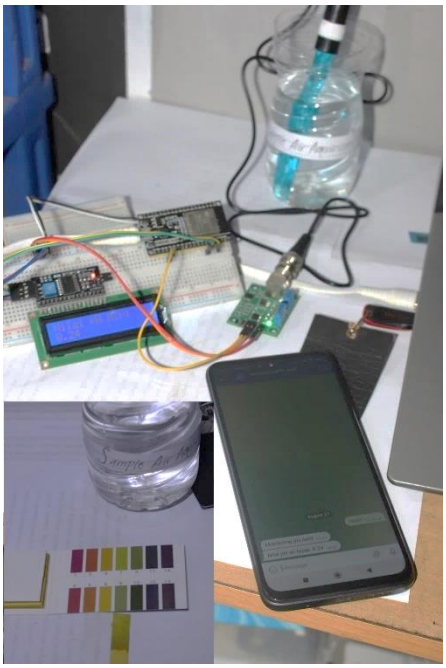

Figure 10 Testing with Aquarium Water Samples

In this sampling test, testing was carried out for 4 days by combining all of the above system circuits into one which aims to see the system working as expected. And testing was also carried out by taking two samples of ornamental fish aquarium water and carried out as many as 4 days in the morning and evening to test the accuracy in reading the pH value of this ESP-32 microcontroller-based ornamental fish aquarium water by comparing using litmus paper measuring the degree of acidity of water.

The test results of the Potential of Hydrogen (pH) Monitoring System in Ornamental Fish Aquarium Water Based on ESP-32 Microcontroller. Testing the pH sensor using aquarium water displays the pH value well, the

results of the value displayed on the LCD and on the telegram chatbot display also bring up the same value. Has an average accuracy value on the water pH sensor of 90%.

4. CONCLUSION

Based on the results of the analysis, assembly and design and testing of the system that has been carried out, the following conclusions can be drawn:

1. The pH Monitoring System in Ornamental Fish Aquarium Water uses ESP-32 and a pH sensor. Other components are 12C LCD, breadboard, jumper cables, and USB cables. Programming the tool with Arduino IDE using telegram for notification and online value display makes it easier for ornamental fish owners in aquariums to monitor pH levels automatically according to the needs of pet fish.
2. Testing of Potential of Hydrogen (pH) Monitoring System using ESP-32 Microcontroller in Ornamental Fish Aquarium Water shows good results. The pH sensor is tested with aquarium water and displays the same pH value on the LCD and telegram chatbot. The water pH sensor has an average accuracy of 90%.

ACKNOWLEDGEMENTS

I want to express my sincere thanks to everyone who has contributed to the completion of this research. I am particularly grateful to my parents for their constant encouragement and to my supervisor for their invaluable guidance. The support and assistance from my colleagues, friends, and peers have also been greatly appreciated. This project's accomplishment is the result of the combined efforts of all involved, and I am truly thankful for each contribution, regardless of its size.

References

[1] A. Mardiyono, A. A. Suhandana and M. Y. B. Rasyiidin, "Sistem Peringatan Kualitas Air dengan Teknologi IoT Berbasis Cloud pada Akuarium Air Tawar," *Jurnal Teknlogi Informatika dan Komputer MH. Thamrin,* vol. 8, no. 1, p. 54, 2022.

[2] M. Nasrullah, D. N. Ramadan and A. Hartaman, "Water level and pH control in Koi fish cultivation," *e-Proceeding of Applied Science,* vol. 7, p. 3198, 2021.

[3] F. Fauziah, "Monitoring Tingkat Kekeruhan Air Pada Aquarium Budidaya Ikan Cupang," *JUISIK,* vol. 1, no. 3, pp. 65-66, 2021.

[4] A. Rahayuningtyas, D. Sagita and N. D. Susanti, "Rancang bangun sistem monitoring dan kontrol pH air untuk budidaya ikan lele," *Agrointek,* vol. 17, no. 1, p. 98, 2023.

[5] T. Pangaribowo and Khoerudin, "Sistem Monitoring Kualitas Air Pada Kolam Ikan Melalui Pengukuran kadar pH Berbasis Android," *Jurnal Teknologi Elektro, Universitas Mercu Buana,* vol. 9, no. 2, p. 1, 2018.

[6] D. Lestari, E. Yuniarti and Y. D. Sari, "Sistem Monitoring Kualitas Air dan Pakan Otomatis Pada Akuarium Ikan Mas Koki Terintegrasi IoT," *BEES: Bulletin of Electrical and Electronics Engineering,* vol. 4, p. 104, 2023.

[7] Z. Setiawan, R. C. S. Hariyono, R. Fitriyanto, I. K. Phan and D. Suprayitno, Pengantar Sistem Informasi: Konsep Dasar dan Aplikasi Praktis, Jambi: PT. Sonpedia Publishing Indonesia, 2024.

[8] M. Fitria Nur Hasanah and M. Rahmania Sri Untari, BUKU AJAR REKAYASA PERANGKAT LUNAK, Sidoarjo: UMSIDA PRESS, 2020.

[9] M. A. Subandri and Danuri, "Early Warning System of Water Quality Changes In Fishponds," *JURNAL TEKNOLOGI DAN OPEN SOURCE,* vol. 6, no. 1, p. 56, 2023.

[10] V. H. C. Putra, M. Hendayun and P. Yustianto, "EARLY WARNING SYSTEM AND MONITORING OF RIVER WATER QUALITY BASED ON INTERNET OF THINGS," *DEVOTION,* vol. 3, no. 1, pp. 43-44, 2021.

[11] F. P. G. Márquez, Fausto Pedro García Márquez, London: BoD – Books on Demand, 2021.

[12] A. A. Sneineh and A. A. Shabaneh, "Design of a smart hydroponics monitoring system using an ESP32 microcontroller and the Internet of Things," *MethodsX,* vol. 11, p. 2, 2023.

[13] "Bots: An introduction for developers," Telegram Messenger LLP, [Online]. Available: https://core.telegram.org/bots. [Accessed 20 May 2024].

[14] A. D. Mulyanto, "Pemanfaatan Bot Telegram Untuk Media," *MATICS : Jurnal Ilmu Komputer dan Teknologi Informasi,* vol. 12, pp. 49-50, 2020.

[15] M. N. Adlini, A. H. Dinda, S. Yulinda, O. Chotimah and S. J. Merliyana, "METODE PENELITIAN KUALITATIF STUDI PUSTAKA," *EDUMASPUL,* vol. 6, no. 1, 2022.