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Wireless Connectivity Based-IoT for Water Monitoring System in Comet Goldfish

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Abstract

The goal of a red white comet fishpond water monitoring system is to provide real-time monitoring and control of water quality parameters. Being a very adaptive freshwater fish, comet goldfish needs water conditions for optimum development and health. The water monitoring system allows fish producers to closely monitor and control important variables including temperature, turbidity, and pH. To measure these factors, the system uses a variety of sensors, including temperature, pH, and turbidity sensors. To ensure precise and dependable data collection, these sensors are placed in the water body strategically. A microcontroller, such as an ESP32, which serves as the system's central processing unit, processes and analyses the sensor which the aquarist can remotely access and view the current water quality data by using a monitoring station or cloud-based platform to receive wireless transmission of the collected data. This makes it possible for them to spot any deviations or anomalies in the water parameters and take the necessary action, such modifying the feeding schedule, managing aeration, or starting water exchange to maintain the condition of the water.

1. Introduction

In recent years, freshwater aquaculture plays an important role in the aquaculture industry. This is due to the high demand for fish, crab and even prawns. The fisheries and aquaculture sector significantly expanded in the past decades and total production, trade and consumption reached a record in 2018. In places where fisheries management is not in place, or is ineffective, the status of fish stocks is poor and deteriorating. Although 78.7% of all landings of marine fisheries come from biologically sustainable stocks, the unequal progress in fisheries management highlights the urgent need to replicate and re-adapt successful policies [1]. This results in having bad quality of fish in a big quantity.

Life on our planet is highly dependent on freshwater. Freshwater is a scarce resource and is a very small fraction of all water on the planet. While nearly 70 percent of the world is covered by water, only 2.5 percent of it is freshwater. The rest is saline seawater. Even then, just around 1.2 percent of our freshwater is easily accessible, as much of the 2.5 percent of total freshwater is trapped in glaciers and ice caps (68.7 percent) and groundwater (30.1 percent). Preserving the quality of freshwater is essential to prevent harm to human health and to the aquatic ecosystems, from which the benefits such as drinking water, food, and recreation [2].

Low power wireless connectivity does not refer to any one specific technology, but rather serves as a generic term for any network designed to communicate wirelessly with lower power than other networks such as cellular, satellite, or WiFi [3]. The use of Low power wireless connectivity consists of devices such as Bluetooth and NFC which have the benefits of low power, long range, and low cost.

1.1 Problem Statement

Water quality management is important in the aquatic environment. It is affected by different types of chemicals that originate from both natural and anthropogenic sources which were proved to be toxic to the organisms [4]. Since farmed fish are extremely sensitive to changes in factors including poisonous chemicals, pH, temperature, and gas presence, water quality control is essential in aquaculture. Low power wireless connectivity is a part of WSN (Wireless Sensor Network) which will assist in reducing power consumption, reducing cost, and increase range of the current methods for monitoring water quality that currently rely on short-range, high-power wireless technologies, which are inappropriate for sensor nodes in WSNs [5]. Therefore, to preserve the fish quality, the water quality must be regularly inspected and monitored.

As a general indicator of acidity or alkalinity, pH is correlated with the amount of hydrogen ions present in a solution. In freshwater, the fish might die if the pH value falls lower than 6.5 and if it exceeds higher than 8.5 as shown in [6]. The temperature of water also plays an important role in the quality of water. In a controlled temperature, fish can grow rapidly where the temperature must be in between 25°C -35°C [7]. If not in the right temperature, fish will grow slowly and might die. Turbidity identifies the quantity of light scattered by suspended particles in a liquid sample. Depending on the technique, the measurement is typically given in formazin nephelometric units (FNU) or nephelometric turbidity units (NTU). Turbidity is a crucial factor in many different fields and applications. It is used to `evaluate water quality and track changes in aquatic ecosystems in environmental monitoring.

Low power wireless connectivity technology will be applied based on WSN principle where data collected at the wireless sensor node will be compressed, and transmitted to the gateway directly or, if required, uses other wireless sensor nodes to forward data to the gateway [8]. The data then will be uploaded and stored in Blynk application. Lastly, the comet goldfish gets its name from a fish that was previously a light tan color with a gold belly. Traditionally, they are bright orange in color. But any goldfish's progeny can have a wide range of colors in them. Particularly comet goldfish will alter in color based on several variables, like age, food, and even the condition of the water.

1.2 Objective

This project seeks to achieve the following objectives. Firstly, the objective is to design a simple prototype for comet goldfish that measures pH, temperature, and turbidity using low-power wireless connectivity technology. The next step involves analyzing the pH, temperature, and turbidity data using the Blynk platform. Finally, the aim is to develop a user alerting product, ensuring timely notifications for aquarists in response to any variations in pH, temperature, or turbidity values.

1.3 Scope of Study

The project focuses on several key scopes. Firstly, the primary objective is to develop a prototype that will assist aquarist by measuring pH, temperature, and turbidity values using dedicated sensors for each parameter. Next, the programming aspect involves utilizing C++, which will then be uploaded onto an Arduino platform for seamless integration with the prototype. Subsequently, the Blynk application is enlisted for data analysis, providing a user-friendly interface for aquarists to interpret and monitor the pH, temperature, and turbidity data collected by the sensors. This comprehensive approach ensures a robust system for real-time monitoring and analysis, enhancing the ability to maintain optimal water conditions for ornamental fish such as comet goldfish.

2. Materials and Method

The implementation of the Low-Power Wireless Connectivity Based-IoT for Water Monitoring System in Comet Goldfish involves key hardware components, including the ESP32 microcontroller, 4502c pH sensor, DS18B20 temperature sensor and analog turbidity sensor where each serving specific roles in real-time monitoring system. Software components encompass C++ for coding and Blynk application to analyze data and alert the user.

2.1 Block Diagram

Fig. 1 shows the block diagram of the water monitoring system in comet goldfish. The system is divided into two parts, the first of which is responsible for sensor control to guarantee that the comet goldfish have perfect water quality. This part is like an observant monitor, keeping the environment clean and healthy for ornamental fish to thrive in thanks to the monitoring of sensors that measure temperature, turbidity, and pH. The second part of the system coordinates data transfer, acting as a conduit between the aquatic environment and the aquarist. As the recipient of this data transmission, the Blynk application is essential to providing the aquarist with up-to-date information about the comet goldfish ecosystem. The Blynk app gives the aquarist more control over the present conditions by providing a thorough overview through the alert displayed in the Blynk application in specific conditions.

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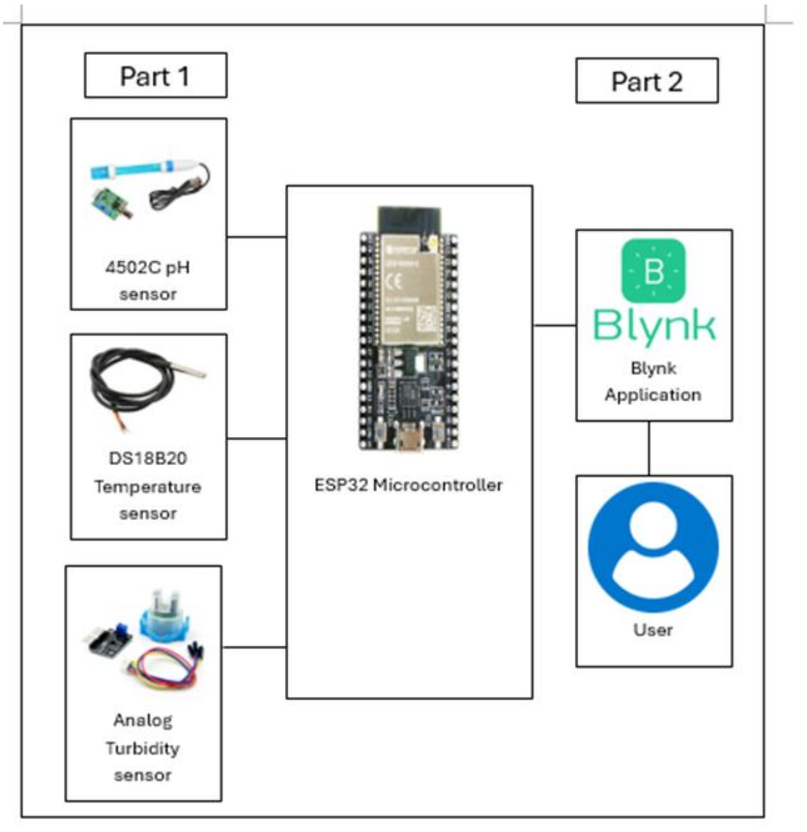


Fig 1 *Block diagram of system*

2.2 Flowchart

Fig. 2 shows the flowchart of the system. It starts when ESP32 is turned on, and the system connects to the supply. Data on the water condition will be read using the sensor to check the situation. When the water quality is in good condition, the system will keep monitoring the water but when water quality is low, Blynk will alert users where user can monitor the situation via mobile phone. Lastly, the sensor will check the quality of water again to confirm the water is in good condition.

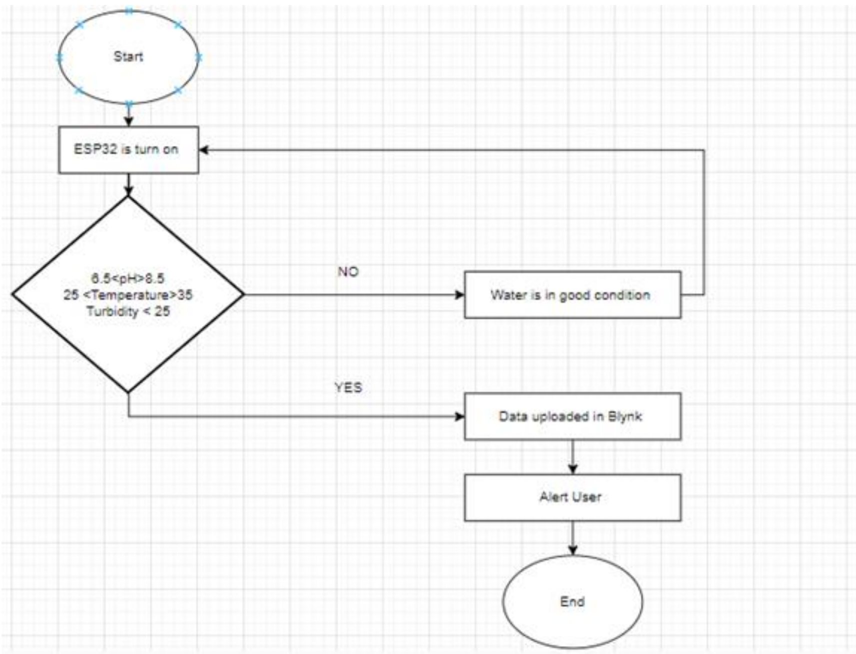


Fig 2 *Flowchart of the system*

3. Results and Discussion

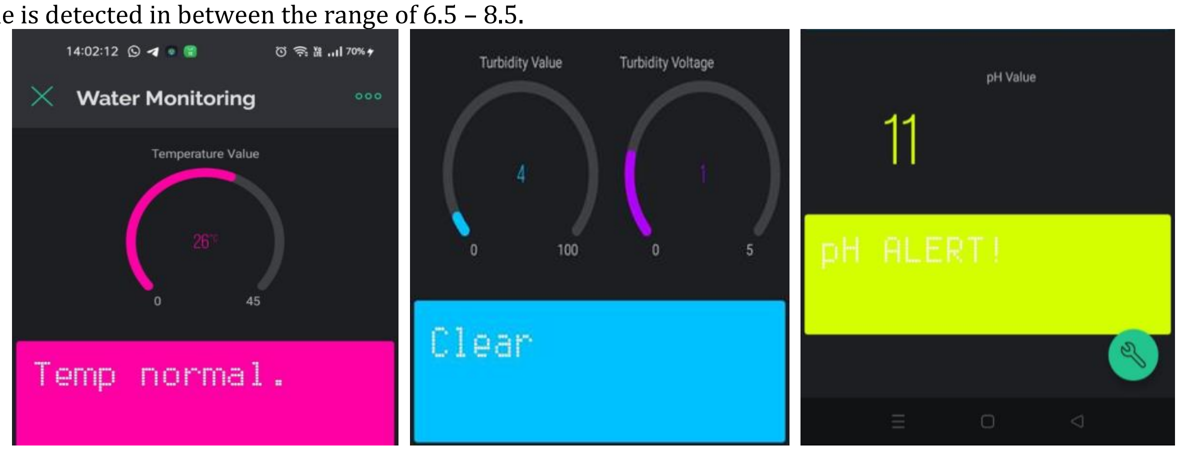
The results and discussion offer a thorough analysis of the data and its significance in relation to the research question and hypothesis, and it emphasizes the potential of water monitoring system in comet goldfish. The experiment was conducted to test the functionality of the project. The developed prototype successfully achieved the project objectives. The sensors are able to detect the parameters which are pH, temperature, and turbidity. It also successfully displayed the alert in the Blynk application which the aquarists will monitor the water condition based on the alert.

3.1 Analysis of Water Monitoring System in Comet Goldfish

Based on Figure 3(a), the value detected for DS18B20 temperature sensor shows 25°c which is an optimum temperature for comet goldfish. The value detected is in range between 25°c to 35°c where the alert will display 'Temp Normal' within the range but if the sensor detects the temperature value is lower or higher than 25°c to 35°c, the alert in the Blynk application will display 'Need Attention'.

Based on Figure 3(b), the value detected for analog turbidity sensor shows the value of 4 along with its turbidity voltage which is 1. The value for the water turbidity must be between 0 – 25 which is a healthy condition of freshwater for the comet goldfish. It will display three different alerts depending on the turbidity value detected in the water which are 'Clear', 'Cloudy' and 'Dirty'. The 'Clear' alert will be displayed when the turbidity range is between 0 – 25, the 'Cloudy' alert will be displayed when the turbidity is between 25 – 50 and lastly the 'Dirty' alert will be displayed when the turbidity exceeds more than 50.

Based on Figure 3(c), the value detected for the 4502 C pH sensor shows the value of 11. The value is not in optimum state because it exceeds the neutral range of pH value in freshwater which is between 6.5 – 8.5. The alert will display 'pH Alert' when it exceeds or lower than the neutral range while it will display 'pH OK' when the pH value is detected in between the range of 6.5 – 8.5.



(a) (b) (c)

Fig 3 *Water monitoring system in Blynk (a) Temperature value, (b) turbidity value and (c) pH value*

On the 25th November 2023, the procedure of data gathering for each sensor is completed between 9.00 p.m. to 11.00 p.m. with ten minutes interval in between the two hours. The data is collected after 16 hours from the procedure of changing the freshwater. During the data collection, the surrounding temperature is suitable because it's between 27°c to 30°c which is in the range of the optimum temperature for freshwater aquaculture. The DS18B20 temperature sensor detects 28°c in between from 9.00 p.m. to 9.30 p.m. while from 9.40 p.m. to 11.00 p.m., the temperature increases by one degree Celsius which is 29°c. For pH value, the data collected is between 7 – 8 which the water is in good condition. The value recorded for the pH value is same with the temperature value time stamp which in between 9.00 p.m. to 9.30 p.m., the value is 7 and increase by one for about twenty minutes which the value is 8 and decrease by one for the next one hour. A decrease in hydrogen ion concentration results in a decrease in acidity as pH rises. On the other hand, when the pH falls, the concentration of hydrogen ions rises, increasing the acidity. Next, the data collection on turbidity is also completed between the two hours where the turbidity value is constantly 9. Table 1 shows tabulated data for day 1.

On 28th November 2023, the procedure of data gathering for each sensor is completed between 1.00 p.m. to 4.00 p.m. with ten minutes interval in between the three hours. The data is collected after 11 hours from the procedure of changing the freshwater. The DS18B20 temperature sensor detects 27°c for one hour which is from 1.00 p.m. to 2.00 p.m. and increase by one degree Celsius which is 28°c from 2.10 p.m. to 3.00p.m. and increase again by one degree Celsius which is 29°c from 3.10 p.m. to 4.00p.m. respectively. The increase in temperature value might be due to the increase of the surrounding temperature. The recorded pH value is almost the same for three hours except for the first ten minutes from 1.00 p.m. to 1.10 p.m. which the value is 6 and the other two hours and fifty minutes is 7. This shows that there is no significant change in the pH reading for freshwater. Lastly, the turbidity value taken from the analog turbidity sensor shows that the value recorded for the entire three hours is 3 which is different from day 1 due to low number of fish waste which naturally occurring consequence of their metabolic activities, which include meal digestion. Fish waste is made up of several materials such as metabolic waste and undigested food particles. Table 2 consists of tabulated data for day 2.

Table 1 *Data collection for all sensors on day 1 – 25th November 2023*

Time (pm)	Temperature (°C)	pH	Turbidity
9.00	28	7	9
9.10	28	7	9
9.20	28	7	9
9.30	28	7	9
9.40	29	8	9
9.50	29	8	9
10.00	29	8	9
10.10	29	7	9
10.20	29	7	9
10.30	29	7	9
10.40	29	7	9
10.50	29	7	9
11.00	29	7	9

Table 2 *Data collection for all sensors on day 2 – 28th November 2023*

Time (pm)	Temperature (°C)	pH	Turbidity
1.00	27	6	3
1.10	27	7	3
1.20	27	7	3
1.30	27	7	3
1.40	27	7	3
1.50	27	7	3
2.00	27	7	3
2.10	28	7	3
2.20	28	7	3
2.30	28	7	3
2.40	28	7	3
2.50	28	7	3
3.00	28	7	3
3.10	29	7	3
3.20	29	7	3
3.30	29	7	3
3.40	29	7	3
3.50	29	7	3
4.00	29	7	3

4. Conclusion

A prototype has been developed integrating low power wireless connectivity technology with pH, temperature, and turbidity sensors for monitoring ornamental fish, particularly comet goldfish. This system enables real-time monitoring of critical parameters, allowing aquarists to make proactive decisions to maintain optimal health for the fish. The prototype employs a microcontroller unit with optimized power management for effective long-distance data transmission. Data is accessible through an easy-to-use interface, aiding in understanding and improving sustainable aquaculture methods. Integration with the Blynk platform enables real-time visualization and monitoring of pH, water temperature, and turbidity, facilitating quick responses to changes and historical tracking for long-term optimization. The goal is to develop a user-alerting product that provides personalized alerts via smartphone applications, email, or SMS when parameters deviate from desired thresholds, enhancing monitoring and control in freshwater aquaculture systems for comet goldfish.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the completing of the paper.

Author Contribution

The author attests to having sole responsibility for the following: planning and designing the study, data collection, analysis and interpretation of the outcomes, and paper writing.

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