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Real Time Monitoring for Smart Water Quality

Kishen Kumaar Devarajah[1], Shipun Anuar Hamzah[1]*

[1] *Faculty of Electrical and Electronic Engineering*
Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, Johor, MALAYSIA

*Corresponding Author: shipun@uthm.edu.my
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Abstract

The main purpose of this project is to develop a real time water quality monitoring system to test the water in the lakes around UTHM. Presence of contaminants such as chemicals, heavy metals and microorganisms in the water can be harmful to aquatic life and environment. By developing this system, it will help to monitor the water quality in the lakes around UTHM. The data from the system can be monitored in the Blynk platform as well. Node MCU ESP32 Microcontroller board was used as the primary computing element to control the hardware in this project. Three sensors were used to monitor the water quality which turbidity sensor, temperature sensor and pH sensor and the data from the sensors had been successfully sent to the Blynk platform with the aid of the Wi-Fi. The system was tested in three lakes around UTHM which is lake Infront FKEE, lake Infront FPTP and also Taman Universiti Lake and within 3 days observation, the system has shown the data of the monitoring system which was tested in these three lakes. This system has achieved its objective by successfully measured the water quality in the three lakes and also the system was verified as its working accurately

1. Introduction

Water is a vital resource that is essential for various aspects of human life and economic activity. In Malaysia, the abundance of water resources is due to the high annual rainfall, which averages 3,000mm and results in an estimated 900 billion cubic meters of water. This water is used for a variety of purposes, including domestic, industrial, and agricultural needs [1]. The importance of water in our daily lives cannot be overstated, as it is necessary for a wide range of activities. To ensure the safety and quality of this water, it is important to regularly monitor certain parameters such as turbidity, pH, and temperature. By doing so, we can ensure that the water we use is safe and suitable for its intended purpose [2].

The main purpose of water quality monitoring is to detect and identify any substances that could potentially harm human health or the environment and to assess their impact. There are various sources of water contamination, including both human activities such as agriculture and industry and natural phenomena such as algae blooms [3]. Water quality monitoring systems are used to regularly gather and analyze data on the quality of water in a specific location. This data is used to make informed decisions about water management, locate potential sources of pollution, and ensure that the water is safe to be used [4].

The Internet of Things (IoT) is a modern approach to real-time monitoring using wireless communication technologies, particularly relevant in the current era of industrial revolution 4.0. Wireless technologies are increasingly being used to facilitate effective personal and daily tasks. With the increasing use of wireless devices and internet of things technology, real-time observation becomes possible through the system. This proposed system is valuable because it allows researchers to obtain information more flexibly and helps to overcome challenges by enabling the convenient collection and analysis of data for monitoring water quality [5].

In this project, the three sensors (turbidity sensor, temperature sensor and pH sensor) have been used to get the water parameters value from the three lakes around UTHM. After that, the data retrieve from the sensors area sent to Blynk Platform by the Wi-Fi feature in ESP32 Board so that the users can monitor and analyze the output in the website and mobile application as well.

2. Materials and Methods

In this section, there are 3 stages that leads to the project's completion by understanding each software and hardware function.

2.1 Block Diagram

The main criteria in developing smart water quality monitoring system of this projects are input, the control unit and output. The input of the developed system is three sensors which is turbidity sensor, temperature sensor, and pH sensor. The control unit in the system is Node MCU ESP32 Microcontroller board, while the output of the system can be seen in the Blynk platform. Fig. 1 shows the block diagram of the system developed in this project.

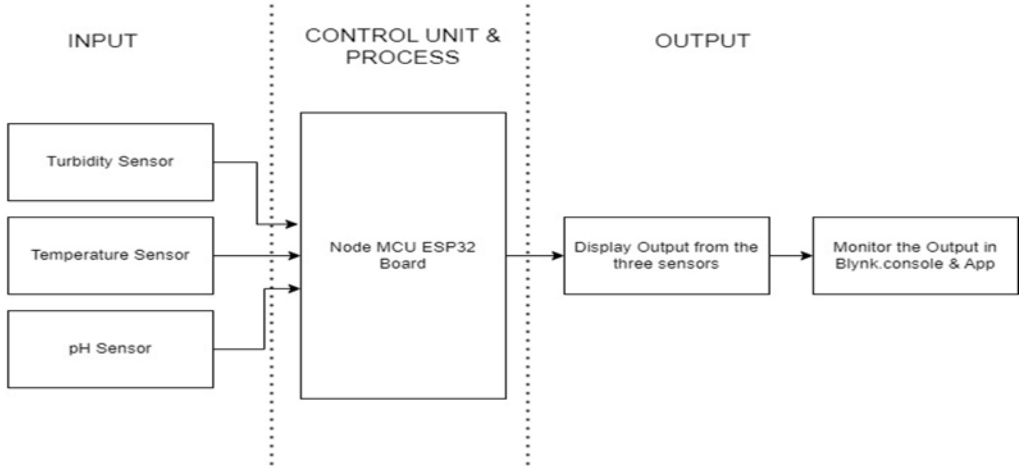

Fig. 1 *Block diagram of Real Time Monitoring System for Smart Water Quality*

2.2 Methods

The system will start working when the Node MCU ESP32 microcontroller is powered up like initialization of the three sensor which is turbidity, temperature and pH sensor and Wi-Fi connection. If the Wi-fi Network has any error, the initialization process will start again. The next process of the system is to the sensor starts working and measure the water quality by using the three sensors in three selected lakes. The sensors will measure the water parameters of the lake which is turbidity, temperature and pH again if the data is not valid. After the data validation, the real time data of the three sensors can be displayed in the Blynk Platform and it also can be monitored by the users in the platform. This system also has sleep mode which make the system get data every 15 minutes. Fig. 2 shows the process flow.

2.3 Hardware Setup

The connection of the three sensors which are TS 300B turbidity sensor, the DS18B20 temperature sensor, the PH-4502C analog pH sensor, and the main component of the project, which was the Node MCU ESP32 board. For this project, the Node MCU ESP32 board, pH, temperature, and turbidity were required to be powered by 5V by two 3.7V 18650 lithium-ion batteries arranged in series via a DC Power Jack. The two lithium batteries were charged by the TP4056 Type-C charger, which was connected to the mini solar panel, so the battery could be charged in two ways, by the solar panel and also the Type-C port. As to ease the monitoring process of this voltage value, it's displayed in the 7-Seg Voltage Display. Fig. 3 showed the Circuit design of the project and Fig. 4 showed the power supply circuit of the project and also Fig. 5 shows the lake area where the system was tested.

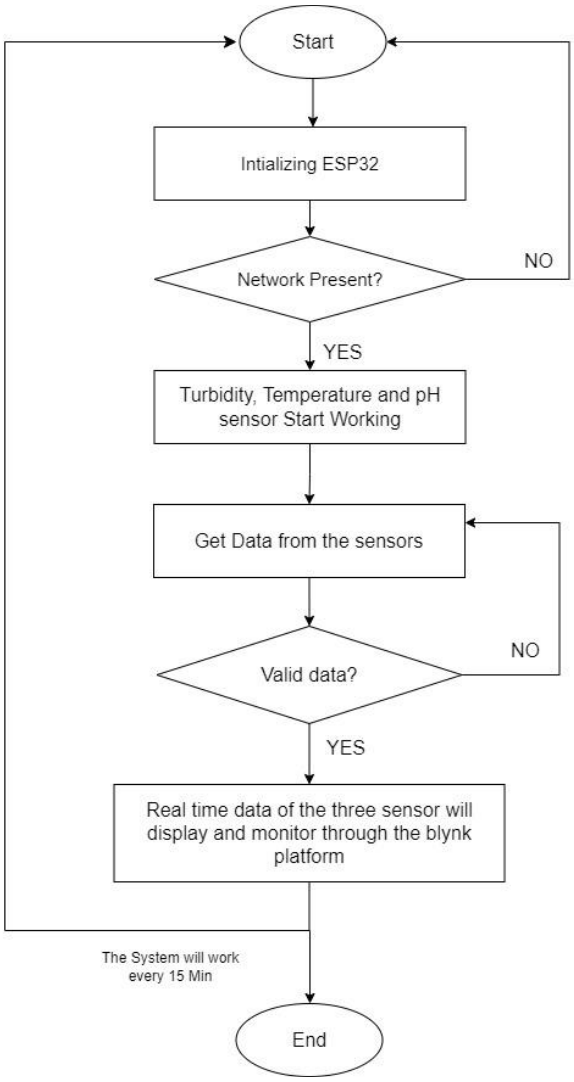

Fig. 2 *The process flow*

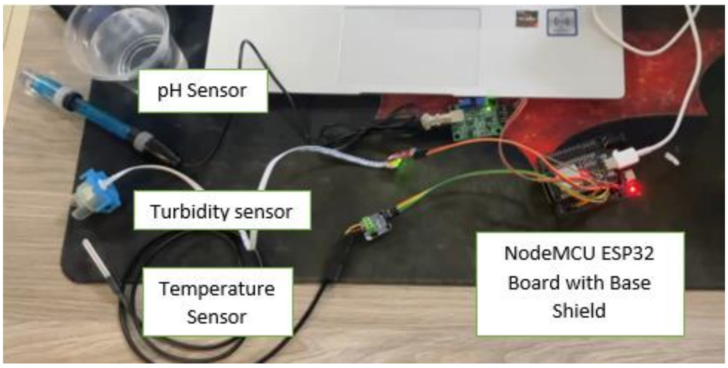

Fig. 3 *Circuit design*

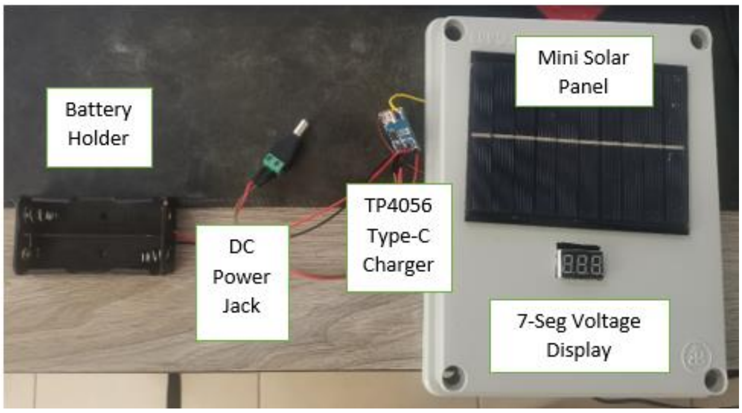

Fig. 4 *Power Supply Circuit*

Fig. 5 *Lake Area*

3. Result and Discussion

The GUI display of the result for this project are shown in Fig. 6 and Fig. 7, where the design of the GUI is simple and easy for the user to see the reading of Ph, temperature and turbidity.

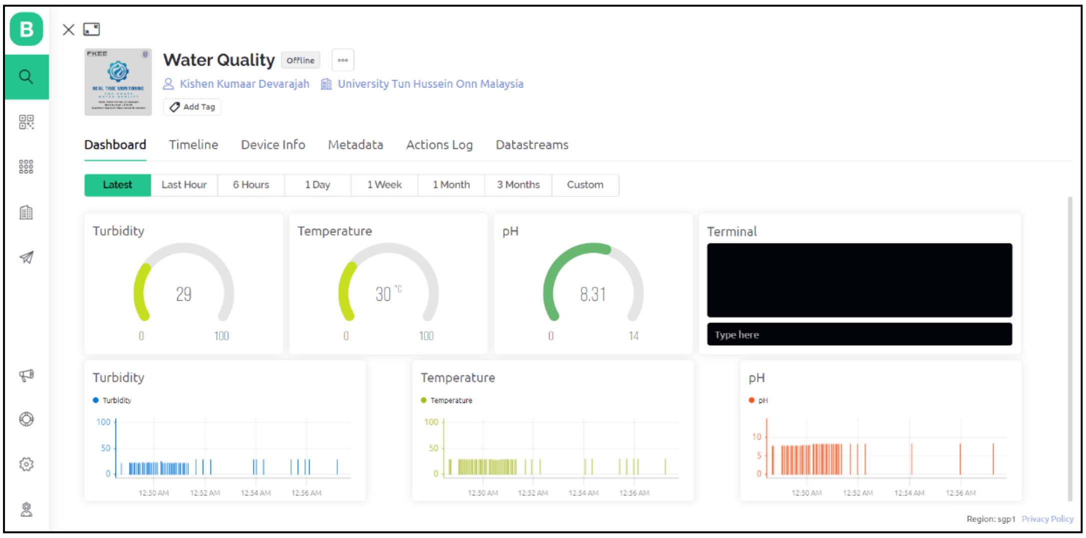

Fig. 6 *Blynk console dashboard*

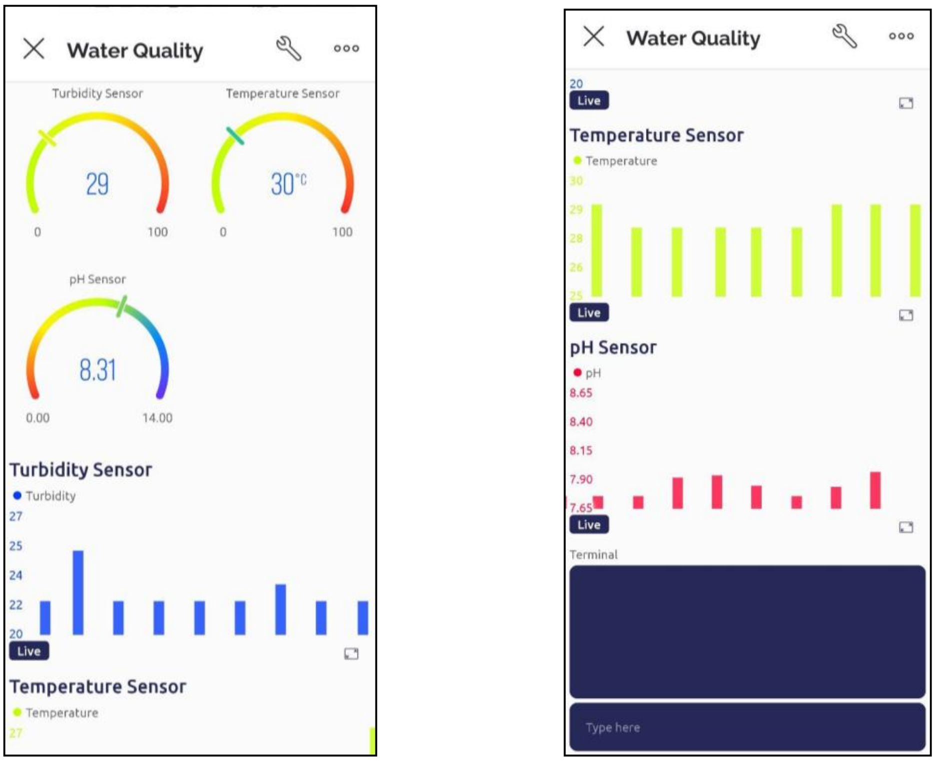

Fig. 7 *Blynk App Dashboard*

During the data collection period, three water quality parameters have been monitored which are pH, temperature, and turbidity. The system is tested in three lakes inside and also around the UTHM which is Lake A (Infront FKEE), Lake B (Infront FPTP), and also Lake C (Taman Uni Lake). The official data collection was carried out for three days which are from 1st January 2023 to 3rd January 2023 where the developed smart water quality monitoring system has been put in the side of the lake.

The water quality for the lakes referring to the pH value was tabulated in Table 1. As can be seen in this table, the pH value for all three lakes were almost similar between the range of 8.03-8.09. This is because all three lakes were fresh water lakes which are slightly alkali in nature. Also, the lakes have similar water chemistry, which could affect their pH. For example, if the lakes have similar levels of dissolved minerals or organic matter, this could contribute to similar pH values.

Table 1 *Data analysis of pH sensor*

Lake ID	pH		
	1/1/2023	2/1/2023	3/1/2023
Lake A (inform FKEE)	8.07	8.08	8.08
Lake B (Infront FPTP)	8.09	8.10	8.09
Lake C (Taman Uni Lake)	8.03	8.03	8.05

The water quality for the lakes referring to temperature value was tabulated in Table 2. The temperature value for all three lakes were almost similar between the range of 29-31. This is because all three lakes are located in close proximity to each other, and therefore experience similar weather patterns and ambient temperatures. Also, the lakes have similar water chemistry, which could affect their ability to absorb and retain heat.

Table 2 *Data analysis of temperature sensor*

Lake ID	Temperature (°C)		
	1/1/2023	2/1/2023	3/1/2023
Lake A (inform FKEE)	30	29	30
Lake B (Infront FPTP)	31	30	29
Lake C (Taman Uni Lake)	29	29	30

The water quality for the lakes referring to turbidity value was tabulated in Table 3. The turbidity in the lakes A and C have almost the similar turbidity value and this is because the lakes are located in close proximity to each other, and therefore experience similar weather patterns and ambient conditions, which could affect the turbidity of the water. While the turbidity value range Lake B which is in front FPTP was 44-50 which three times higher than Lake A and Lake C. This is because Lake B has the presence of suspended sediment in the water, such as clay, silt, or sand. These particles can be stirred up by waves, wind, or human activities such as construction or boating, and can contribute to high turbidity.

Table 3 *Data analysis of turbidity sensor*

Lake ID	Temperature (°C)		
	1/1/2023	2/1/2023	3/1/2023
Lake A (Infront FKEE)	30	29	30
Lake B (Infront FPTP)	31	30	29
Lake C (Taman Uni Lake)	29	29	30

4. Conclusion

In conclusion, this project has successfully been developed a Real Time Monitoring for Smart Water Quality. The measurement has been carried out at three lakes inside and around UTHM to monitor three water quality parameters which are pH, temperature, and turbidity This system is able to capture the data of these parameters at real-time and allow user to monitor at any time while being remotely away from the lakes around UTHM. In future, to make the IoT water quality monitoring system more effective, there are several improvements that can be made. One of the recommendations is to use machine learning algorithms for analyzing the data collected, this will enable automatic notifications when the water quality deteriorates. Another suggestion is to use floatation devices to move the system around the lake to ensure that the whole lake is covered. Additionally, incorporating additional sensors like ammonia, chlorine and dissolved oxygen sensors will help in providing a more comprehensive picture of the water quality. These improvements will provide more accurate and useful data and help to keep the lakes safe.

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Conflict of Interest

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

Author Contribution

The authors attest 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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