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The Development of Water Quality Monitoring System at Dam

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Abstract: In recent years, there has been many pollution cases reported in our country and gave a huge impact to the water supply for the residential area. Lack of remote monitoring system at dams to provide alert on contamination and water level made the situation worse. To curb this problem, new remote water quality monitoring system at dams need to be developed. This project is designed to provide a reliable and rapid early detection system at dams. It is comprise of several sensors with online data and information that can be viewed at anytime and anywhere for continuous monitoring purpose. The sensors measure three water parameters which are pH level, gas presence and water level. The gathered data will be processed by a Wi-Fi module before it is uploaded to the web server and Blynk server. It can be viewed on a webpage and Blynk application through the smartphone or computer. The implementation of Blynk in this system managed to let the users stay alert with the changes that occur at the dam by sending notification on the smartphone. A pH sensor was able to detect the changes in pH of water which is required to be between 6.5 and 7.5. An ultrasonic sensor detected the dam water level. Besides that, a gas sensor that is capable of detecting the presence of smoke or gas was introduced. In a nutshell, this project managed to detect the pH level, gas presence and water level, as well as update the gathered data into the IoT platform continuously.

Keywords: PH level, Continuous, Blynk, IoT, Gas, Smoke, NodeMCU

1.0 INTRODUCTION

Poor water distribution, ineffective usage and lack of integrated water management are several factors that can lead to water waste (Arasu et al., 2019). Hence, the invention of water quality monitoring system is vital for water management system to curb those problems from getting worse. The idea is this new water quality monitoring system used two other additional sensors beside the pH sensor. Beside measuring the pH level of the water, this new monitoring system will measure the presence of gas and level of water and targeted to be implemented at dam. Dam is built to provide sufficient water supply for human consumption, irrigation system of agriculture and industrial processes (Knight, 1990).

Implementation of IoT in this project lets the data gained from the sensors to be embedded into the server. The collected data can be view and monitor by the user without needing to go down to the investigation site each time to obtain the reading measurement. Each of the sensors is connected to a Wi-Fi module which is able to measure the water quality components like pH level, water level and gas presence continuously. The obtained data will be uploaded into the webpage and Blynk application.

2.0 DISCUSSION ON PREVIOUS WORKS

There are some previous works that used the same general concept, water quality monitoring, but implementing different approaches to obtain the results (Almaarofi et al., 2017; Cho & Lee, 2017; et al., 2021). For instance, a study carried out by (Ben-Chioma et al., 2015) was analyzed. The objective of this study was to determine the precise technique in determining the pH level of water, using either pH meter or water testing kit (test tube method) especially in clinical laboratories. The experiments were done by taking 23 different samples. The obtained results showed that pH meter gives a lower but steadily acceptable reading than the water testing kit.

On the other hand, an article published in 2018 which contains a study that was carried out by (Samsudin et al., 2018) to develop a wireless water quality monitoring system that aids in continuous water conditions measurements based on the pH and turbidity measurements. A pH sensor and turbidity sensor were used in collecting the inputs. Those two were connected to the WeMos D1 microcontroller along with the ESP8266 Wi-Fi module. The gathered data were stored in an online database platform, Ubidots and the data was displayed at a webpage, Wix. The experiment was tested at the Tasik UteM and successfully detected both pH and turbidity levels hence updating it in the Wix IoT platform.

Another previous work was carried out by (Harun et al., 2018) for pH and dissolved oxygen a real time monitoring at a fish pond. Equipment used were two temperature sensors, an Dissolved Oxygen (DO) sensor and a pH sensor, an aerator, a submersible pump to pump water from the creek and also a suction pump to extract water from the well. All those sensors were connected with a microcontroller Arduino Mega 2560. Temperature sensors that measured the water temperature, the DO sensor and pH sensor were packed together and dipped 1.5m into the water. Another sensor for atmospheric temperature measurement was left on the land, nearby the fish pond. The gathered data were then sent to the online Google spreadsheet through the ESP8266 Wi-Fi module. A 16x2 LCD is provided which allow the data to be monitored on-site.

3.0 METHODOLOGY

ESP8266 NodeMCU ESP-12E Wi-Fi module acts as the main control center. All the codes put in here. When the project is starting to function, it will initialize all the three sensors, pH, gas and ultrasonic. All those sensors will start to execute their own role in gathering the data to monitor the water quality level.

There are three states that will be detected by the pH sensor as shown in the flowchart in figure 1. The first one is if the reading value shown is below than or equal to 5, the water is considered as acidic. The second state is if the reading value shown is between 6 to 10, then the water is considered as neutral. Lastly, the third state is if the reading value shown is greater than or equal to 11, the water is considered as alkaline.

This time, it involves the water level parameter. The ultrasonic sensor is vital for this case to measure the dam water level. It is crucial in order to know whether the water supply reserve here has been reduced or increased. There are three states that is configured for the ultrasonic sensor. The first state is if the reading value is equal to or greater than 99.7, the water level is considered increasing. While for the second state, if the reading value is between 85 and 99.6, it is considered as normal water level. Lastly is the third state. For this, if the reading value is below than or equal to 84, the water level will be considered as decreasing.

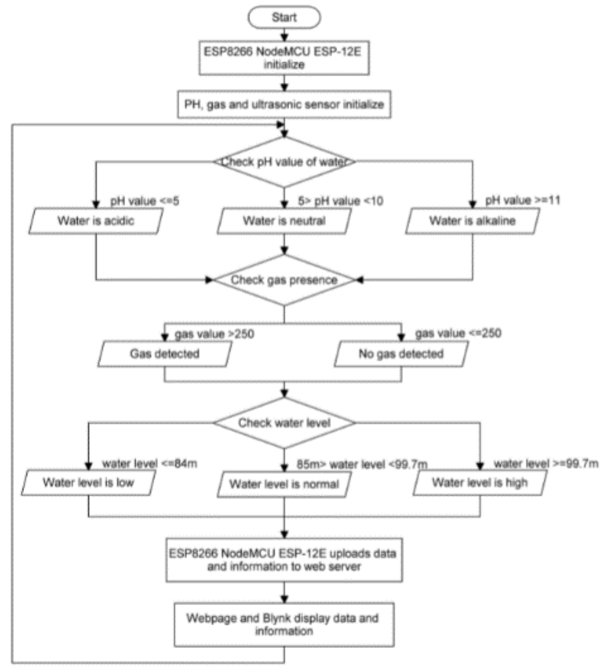


Fig. 1 Flowchart of project.

After that, all the measurement data and information from those three sensors will be gathered and processed by the Wi-Fi module, ESP8266 NodeMCU ESP-12E as shown in the block diagram in figure 2. In this part, the Wi-Fi module will upload the gathered data and information using the Wi-Fi network connection. The measurement or result will be display in a webpage and Blynk application.

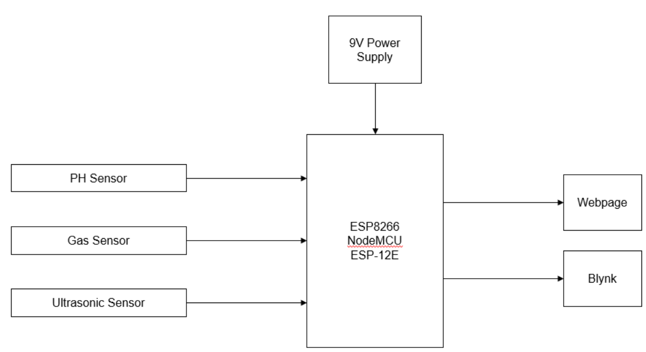


Fig. 2 Block diagram of project.

Three sensors will run the measurement of water quality parameters. The first one is pH sensor which measures the acidity, neutrality and alkalinity of the water, the second one is gas sensor that detects the presence of gas and lastly, ultrasonic sensor that will measure the dam water level. All sensors are connected to a Wi-Fi module, ESP8266 NodeMCU ESP-12E that provides the internet connection in uploading the data and information to the web server and Blynk server. The obtained result can be view or monitor through a webpage and Blynk application. A photo of the hardware is shown in figure 3.

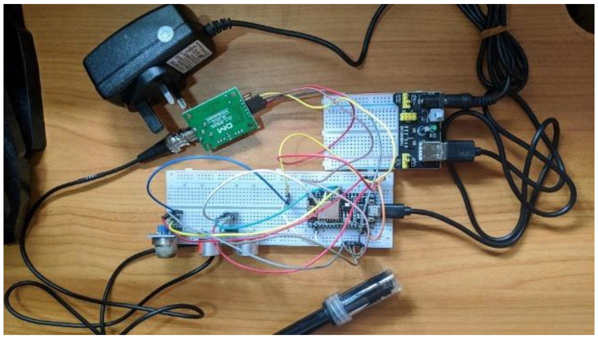
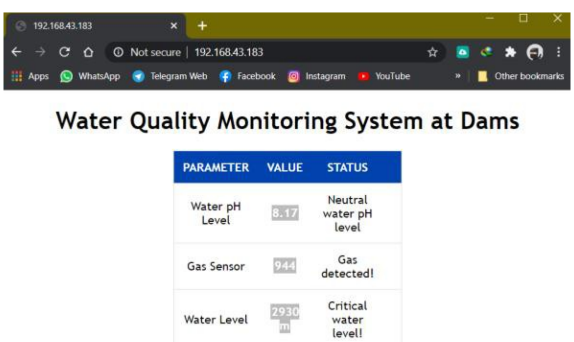


Fig. 3 Picture of circuit board

4.0 RESULTS AND DISCUSSION

The obtained results from the sensors will be processed by the ESP8266 NodeMCU ESP-12E before they will be uploaded and displayed on the webpage and Blynk application. The establishment of table in the webpage as in Figure 4 gives the user a simple way to view and monitor the generated outputs or results obtained by the sensors. For this to be made possible, the user just needs to copy out the provided URL link in the serial monitor and then, paste it in the URL space of any browser. In the constructed table, there are items shown there which are Parameter, Value and Status. The three water quality parameters will be displayed in the Parameter column. Meanwhile, values or measurements gained by each of the sensors are shown in the Value column. The last column which contains Status displays different status for each of the water quality parameters.



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Water Quality Monitoring System at Dams

PARAMETER	VALUE	STATUS
Water pH Level	8.17	Neutral water pH level
Gas Sensor	944	Gas detected!
Water Level	2930	Critical water level!

Fig. 4 Output Display.

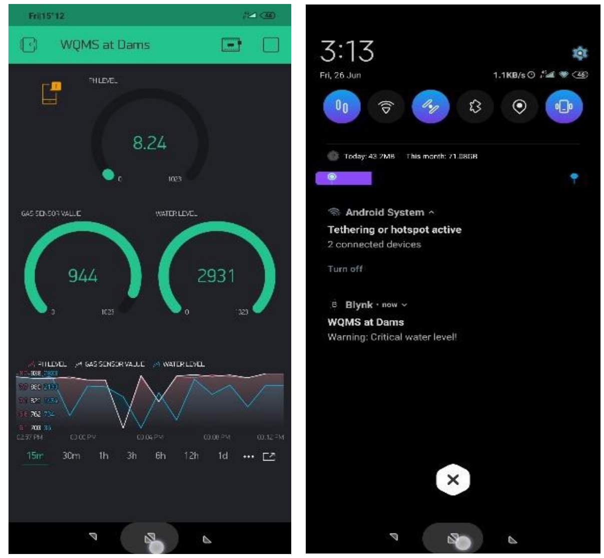

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Fig. 5 Displays at smartphone.

As shown in Figure 5 (i), three same type of gauge widgets is chosen to display the three different water quality parameters. Besides that, a widget namely SuperChart is applied to illustrate the outputs gained from the sensors. Three different colours of line graph pattern is build which represents different water quality parameters. Red line graph pattern represents the pH level, white line graph pattern indicates the gas presence and blue line graph pattern is for the water level.

Another widget is added in the application which is Notification. This widget serves sole purpose that is for the notification only. It will provide notification on the user's smartphone as in Figure 5(ii) all the time as long the Blynk application works properly in the smartphone. The user needs to allow or give permission in their smartphone main setting for the application to always function in the "background" even after the user clean their cache.

As shown in Figure 6, there is a widget named SuperChart, for user to view or monitor the graph activities. The graph is constructed based on the gathered readings and time. Red line is used to represents the pH level graph pattern. It shows high readings in the beginning before experiencing sudden drop at 3.00 p.m. Then, it rose again and had ups and downs until 4.00 p.m. Only after that, the readings became constant until the 6.00 p.m. Since pH level reading can be affected by the temperature, it can be deduced that the differences in the readings was due to temperature variations.

Fig. 6 SuperChart display.

For gas presence or gas sensor value, it is represented by the white line graph. The reading shows that the gas sensor obtained quite similar graph pattern with the pH level graph. During this experiment, a small piece of burned paper with remaining smoke is used to illustrate the real-life item that release smoke or gas. What is mean in here is that in real-life situation, there might cigarette butts that still emit the smoke or oil spill that release the gas vapor. This can be easily detected by the MQ-2 gas sensor. Based on the graph, the small piece of burned paper produced a quite high of readings in the first one hour.

Last but not least is the water level graph. Blue line graph pattern represents this water quality parameter. It experienced sudden drops and ups many times compared to the other two water quality parameters. An object is placed in front of the HC-SR04 ultrasonic sensor. The object is moved several times at different point of distances to portray the water level condition at the dam.

5.0 CONCLUSION

The developed system detects pH level, gas presence and water level hence updating the collected data into the IoT platform. This project consists of three water quality parameter sensors, a Wi-Fi module, a breadboard power supply and an AC/DC adapter. These components and devices are low cost to build, high efficiency in executing the functions and capable of analysing and updating the data anytime. Users can always be kept updated and aware with the water quality level at the dam. Furthermore, the data and information can be viewed through Wi-Fi on the smartphone or computer at anywhere and anytime.

Performance modeling in different kind environment is a vital aspect to be studied in the future as different kind of monitoring application requires different setup during the system installation. This project is suitable to be implemented for environment and ecosystem monitoring. It is a flexible system since the users can make some changes in the coding algorithm as well as the sensor planned to be used in measuring other perimeters of water quality.

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