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Sustainability of Water Quality Monitoring System Through Riverbank Based Internet of Things

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Abstract: Water is an essential resource for humans, ecology, health, and survival. Increased development near rivers has a negative impact on water quality, making it more difficult to provide a clean water supply. Furthermore, water pollution has resulted in a shortage of fresh water for use by consumers in their daily activities. This is taken seriously when in the absence of early detection, long-term cleaning is required to control the spread of water pollution. Water consumption contains harmful amounts of pollutants, which can pose health problems to water users and aquatic life. Therefore, in this project, a water quality monitoring system is developed to identify existing issues and issues that will arise. The implementation of IoT enables faster water quality monitoring and response times from the relevant authorities, thus enhancing the optimal warning system. The system functionality is when contamination is detected from the threshold change on the sensors data, Arduino will signal the Blynk application to send a warning notification to alert the authorities. The system correctly determined the status of the lake water by measuring a parameter that detects when tested. Experiments carried out throughout the study discovered that the proposed system has high chance that the water quality could be in bad condition due to the case study and weather.

Keywords: Water Quality, Pollution, Monitoring System, Warning Notification

1. Introduction

Water is the main source for every aspect of humans, ecosystems, health, and survival, as well as a major input to practically all sorts of production, including industrial, construction, agricultural, hydroelectric energy, transportation and for various other purposes. Due to the rapid world population and growing development, rivers help in providing 98% of the water used, and 70% of the groundwater sources are used by agriculture [1]. Increasing industrialization near the rivers results in water pollution which makes this even more challenging to prepare a clean water supply. According to the Malaysian

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Environmental Quality Report 2016, only a total of 219 (47%) of the 477 inspected rivers have been categorized as clean, with the remaining 207 (43%) being mildly polluted or 51 (10%) were polluted [2]. To improve water quality, each contamination potential must be thoroughly investigated. Water contamination has resulted in a shortage of clean water for customers to use in their daily lives [3]. When there is no earlier detection or treatment, long-term cleanup is required to stop the spread of water contamination. Water consumption contains harmful levels of contaminants, which can cause health issues for both water consumers and aquatic life [4]. For most people, the health risks of mold development caused by water damage are enough [5]. Furthermore, traditional water quality monitoring techniques are carried out manually, using river water samples. The samples are then sent to laboratories for evaluation and analysis [6][7]. These outdated approaches do not provide real-time information. Finally, in this design, a new embedded development board and a new Wi-Fi development board are used. IoT uses smart devices and the internet to provide innovative solutions to various challenges and issues [8]. The main aim behind this project is to monitor specific metrics and collect significant data from riverbanks in order to monitor water quality in real-time. According to the data analysis, contaminated water should be handled as quickly as feasible by the appropriate authorities in order to improve an optimal warning system. The Water Quality Monitoring System (WQMS) is a monitoring system that includes a number of input sensors, a microcontroller, and wireless communication.

2. Materials and Methods

In this section, there are 3 stages that lead to the project's success by acknowledging each software and hardware function.

2.1 Block Diagram

A block diagram is illustrated to aid in the most basic understanding of the system's software and hardware implementation. The relationship between input, process, and output is represented by the block and arrow. Figure 1 shows the block diagram for a water quality monitoring system with an alert system. The input of this project is a temperature sensor (DS18B20), turbidity sensor and pH level sensor. The control unit is Arduino Mega 2560 and the output is a Blynk monitoring mechanism and LCD module. ESP8266 Wi-Fi module will send data for monitoring purposes and provides notification as an alert warning.

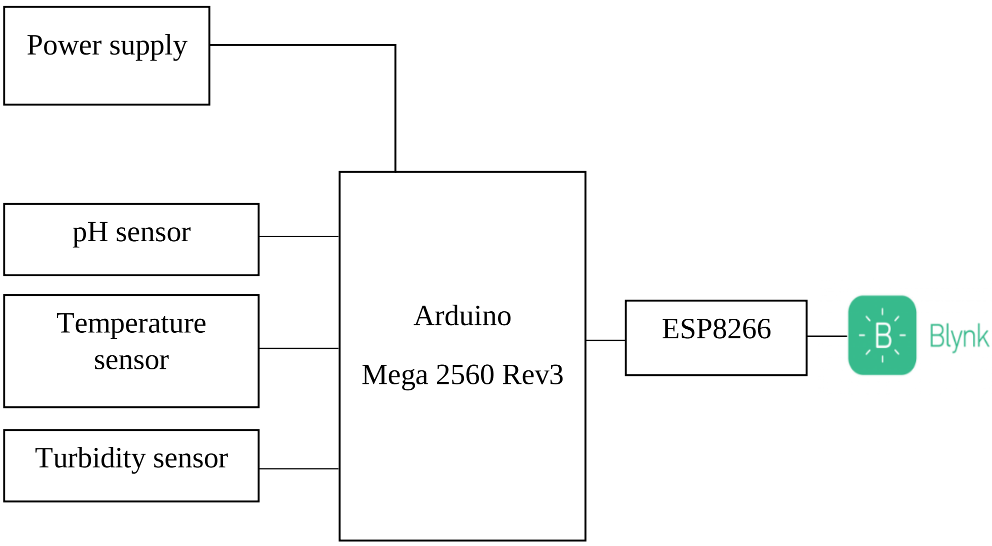


Figure 1: Block diagram of water quality monitoring system

2.2 Methods

Figures 2 shows the process flowchart for an automatic mode of the system. All the process shows incorrect order accordingly. The purpose of this flow chart is to give an overview of the steps for this project automatically.

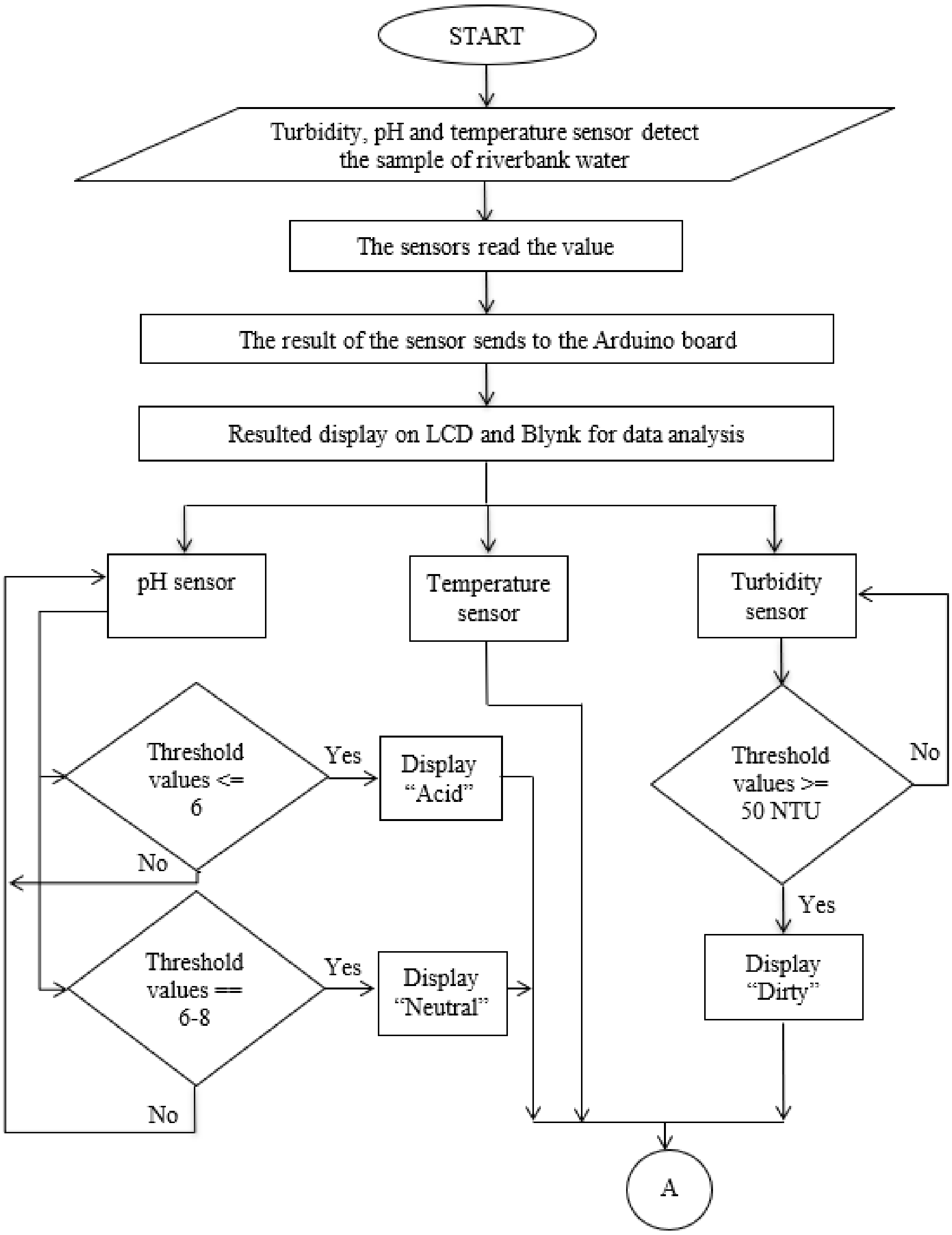


Figure 2: Process flowchart of water quality monitoring system

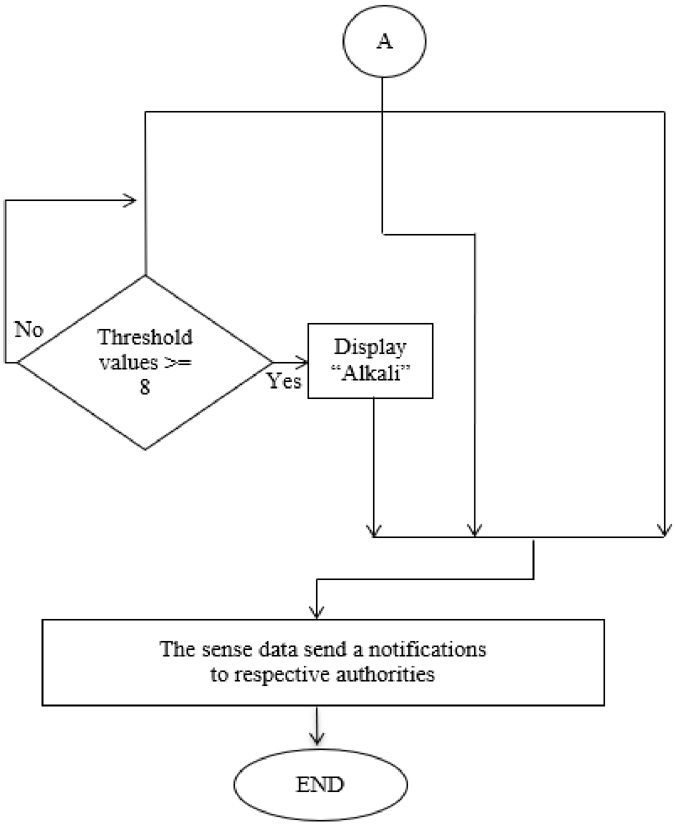


Figure 2: Process flowchart of water quality monitoring system (continued)

2.3 Schematic Diagram

All the sensors' connections are combined in this circuit diagram. Figure 3 shows the schematic diagram of this project.

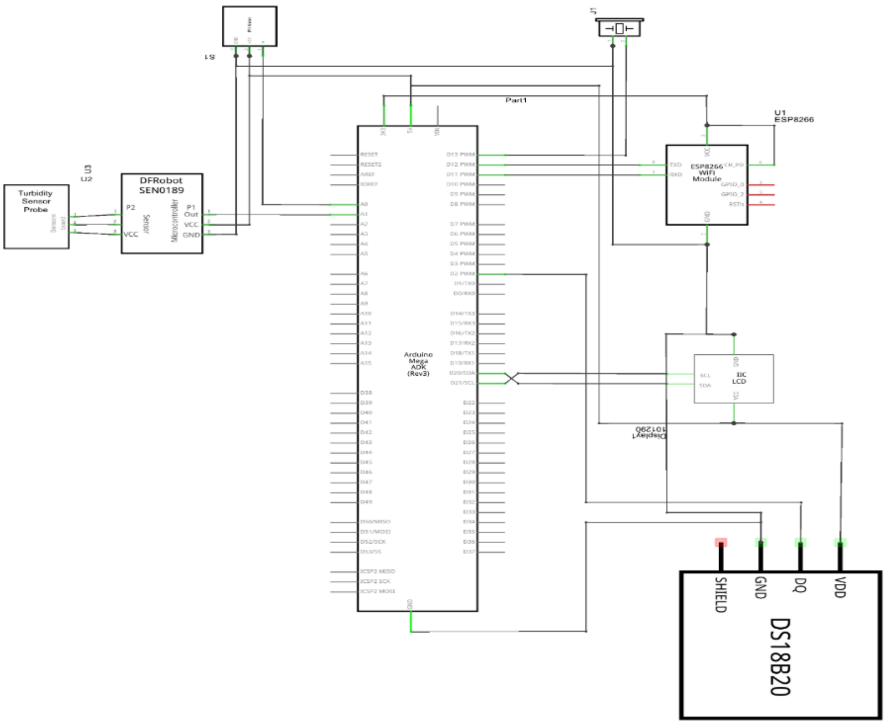


Figure 3: Schematic diagram of water quality monitoring system

3. Results and Discussion

3.1 Prototype Setup

The outputs of this project are to monitor the contaminant condition of riverbank or lake water by detecting the changes in parameter values. The turbidity sensor is used to measure water clarity or the number of particles suspended in the water. While, the temperature sensor DS18B20 measured a temperature range of -55 to +125 °C with a decent accuracy of ±5°C and the pH sensor indicates acidic fluids, neutral and alkaline conditions. If the data obtained shows the changes measurement pass the threshold value from a turbidity sensor and pH sensor, the alerting notification can be displayed through the Blynk application on a mobile phone. Then, the crucial part in the making of a water quality monitoring system using IoT is where it is going to be placed near the riverbank or lake area where the testing and obtaining of some data need to be collected continuously for a week. Figure 4 indicates the prototype of the project using PVC board and plastic materials.

Figure 4: Prototype of pet cage

3.2 Experiment 1: Sample are taken from Lake UTHM

In this experiment, the samples are taken for one week to monitor the continuity of real-time data. The water sample is collected at Lake of Universiti Tun Hussein Onn Malaysia (Figure 5) during the morning under ideal temperature conditions. The sample was tested using the prototype to obtain the data for the analysis, which the parameter of the tested sample will be used to determine the condition of water quality.

Figure 5: A case study at Lake UTHM

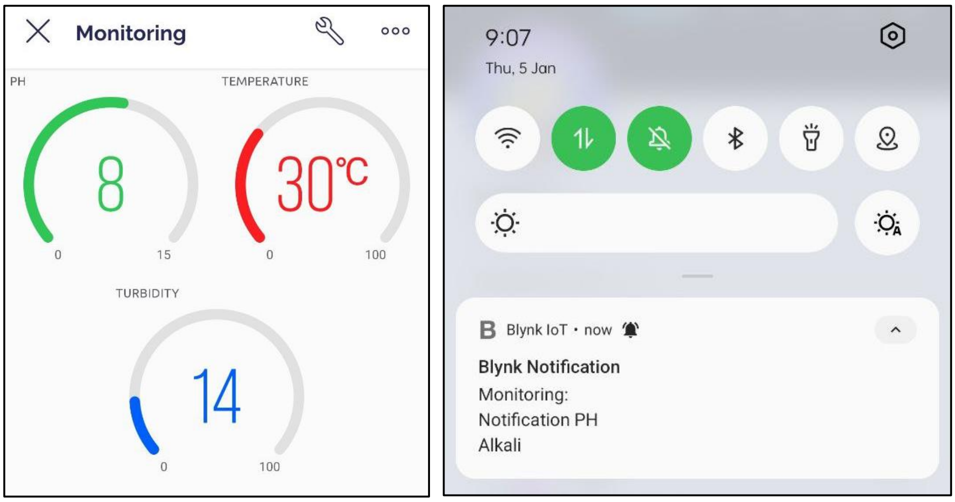
3.3 Experiment 2: Sample are taken from Sungai Felda Selancar

The samples are taken for only 3 days to monitor the continuity of real-time data at the nearest river. This river was selected to be tested due to the conditions regarding water pollutants. The water sample is collected at river Felda Selancar (Figure 6) under ideal temperature conditions around 8 a.m. to 12 p.m. The sample was tested using the prototype directly at the riverbank.

Figure 6: A case study at Sungai Felda Selancar

3.4 Blynk System

The Blynk platform or domain will be used to construct the IoT application. This IoT application will be designed and developed to monitor and control the sensor temperature, pH and turbidity readings. The Wi-Fi module is utilized to connect the device and the application. Figure 7 and Figure 8 illustrate a layout of the mobile IoT application for a water quality monitoring system. The profile was created in the Blynk application by using a mobile phone. There are 3-gauge meters for the temperature, pH and turbidity readings. A line chart was added for monitoring purposes. The temperature meter reading varies from 0°C to 100°C, turbidity reading is in the range 0 – 100 NTU and pH reading is from 0 – 14 pH. The chart provided was able to monitor the readings in real-time or “live”. It is helpful and easy for the user to monitor the surrounding parameter.



(a) (b)

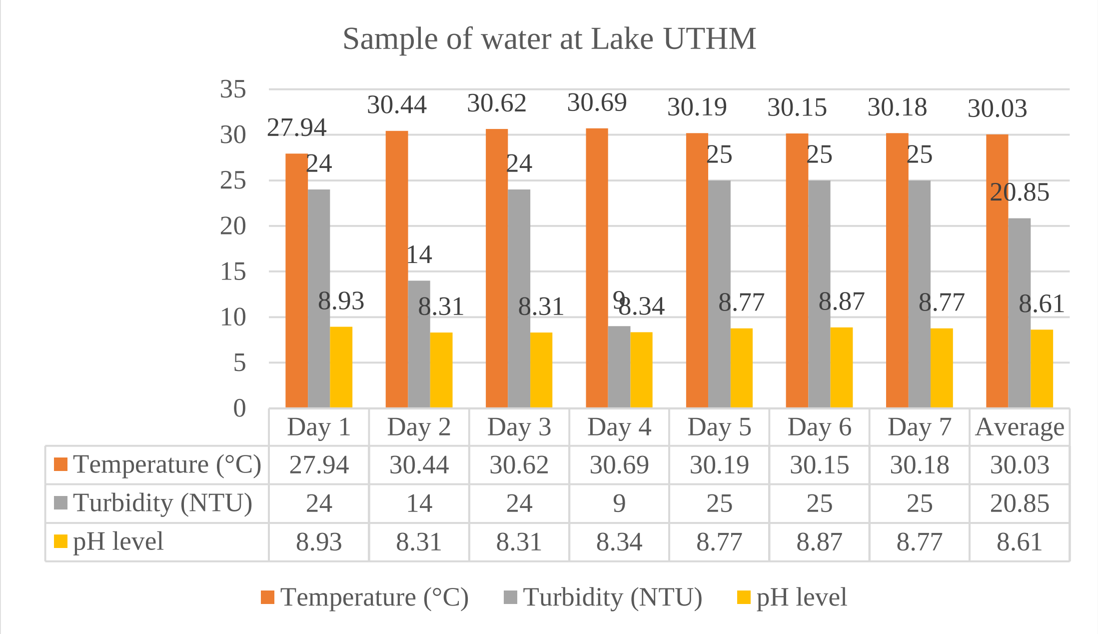
Figure 7: (a) Blynk profile of this project; (b) Notification that detected abnormal condition of water quality

(a) (b)

Figure 8: (a) Raw data for analysis: (b) Timeline for all notifications history

3.5 Data of Experiment 1

From this data shown in Figure 9 that a few samples have been collected and tested from Lake UTHM. The obtained result of the experiment indicates that the pH level of lake UTHM is alkaline water where the range is between 8.31 – 8.93, with an average is 8.61. The lake with low alkalinity could possibly be attributed to free carbon dioxide as well as the different acids and alkaline that can enter water bodies as a result of industrial wastes. The temperature measurements ranged from 27.94 to 30.69 °C producing an average of 30.03 °C. This reading could be due to the high level of sun exposure and heat evaporation after rain. Several elements that are affected by weather fluctuations and may influence water temperature were considered, including sample time and location. Hence, the turbidity of particles inside the lake is normal, which is below 50 NTU. As per research, the condition of the water inside Lake UTHM is normal

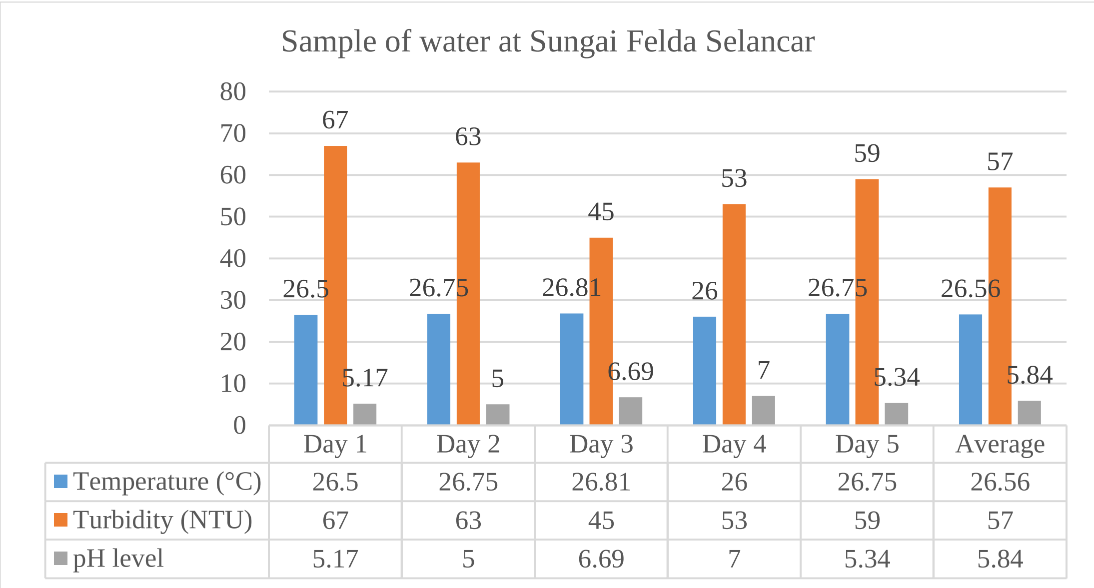


	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Average
Temperature (°C)	27.94	30.44	30.62	30.69	30.19	30.15	30.18	30.03
Turbidity (NTU)	24	14	24	9	25	25	25	20.85
pH level	8.93	8.31	8.31	8.34	8.77	8.87	8.77	8.61

Figure 9: Sample data of Lake UTHM

3.6 Data of Experiment 2

The experiment results show that the pH level of Sungai Felda Selancar is acidic water, with a range of 5 - 7 and an average of 5.84. The high pH was most likely caused by rainfall and runoffs from the local agricultural region (Palm oil plantation) and surrounding areas, and it was ascribed to the presence of high organic matter due to organic matter discharge into the river. The temperature readings yielded an average of 26.56 °C. This reading could be attributed due to raining season. Several factors, including sampling time and location, were addressed that are affected by weather fluctuations and may influence water temperature. As a result, the turbidity of particles within the river is abnormal and more than 50 NTU, which indicates the water is dirty or pollutant. According to the study, the water quality at Sungai Felda Selancar is acidic. Figure 10 shows the data analysis for average temperature, turbidity and pH reading for 5 days that has been summarized.



	Day 1	Day 2	Day 3	Day 4	Day 5	Average
Temperature (°C)	26.5	26.75	26.81	26	26.75	26.56
Turbidity (NTU)	67	63	45	53	59	57
pH level	5.17	5	6.69	7	5.34	5.84

Figure 10: Sample data of Sungai Felda Selancar

4. Conclusion

In conclusion, the purpose of this project is to implement a prototype for a water quality monitoring system with an alerting system that can work anywhere and everywhere just by depending on internet communication. This project conducted experiments in several case studies for the comparison and the continuity data sample is taken to ensure the accuracy of the sample testing is optimal. The system successfully determined the condition of the lake water by relying on the measurement of a parameter that detects when experimented. The accuracy percentage during the monitoring was 90% since the result of the water pH level was not much different around 8.1 – 8.9 pH level which is acceptable. As a result, the project has been performed to function properly in a various place condition. However, there are factors that contribute to the system's inability to the accuracy of measurement parameters, such as the microprocessor used, and sensor ability. Since the system operates in real-time, the performance of the microprocessor used is critical to avoiding lagging issues that affect the entire system. Furthermore, the accuracy of turbidity and pH sensor has influenced big factors in determining the condition of water quality due to their specific functions. Lastly, the proper cleaning of the sensor should be considered every time the sample is tested. This is to ensure that the sensor is always in good performance without effects the sensibility of the sensor.

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