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Real Time Water Quality Monitoring in Lakes with IOT Application

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Abstract: Taking care of the water quality in lakes is crucial to keep the living things in them alive and well. It is an ecosystem that we need to maintain. A good water quality monitoring is one of the ways that we can do to maintain a healthy ecosystem for the lake. Thus, creating demands for a good monitoring system is making water quality control more efficient. This project discusses the development of water quality control in lakes through its electronic and mechanical design. This project also uses an Arduino microcontroller to design a Real Time Water Quality in Lakes with IOT Application. The IOT application that is applied in the project will make monitoring the water quality easier by making it remotely display the water condition. Future researchers can improve the design and making it more neatly.

Keywords: Water Quality, Ecosystem, IOT Application, Monitoring System

1. Introduction

With the rise in global of internet technology levels nowadays, people would like to create something different for objects or devices that are 'outside the box', this is called innovation. Innovation for objects or devices that were invented can have more functions and more attractive. This is because, our culture has been affected to be competent. Furthermore, the civilisation of the world is racing to create an innovation that would change the world to be better and more futuristic. One of the innovations of advance technology is by making a device that can make human's life easier. Nowadays, there are so many people invented new products that are really needed by industries, such as robotic arms, drones and more.

In this project, we designed a device that can monitor real time water quality in lakes. Previously, the user had to monitor water quality in lakes manually which is a tedious work for us to do. With IOT application, users are able to monitor water quality in lakes remotely.

1.1 Factors affecting the water quality monitoring process:

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1.1.1 Temperature

The increment of the temperature during the monitoring cycle, due to the change in environment from room to lake surroundings. Water temperature determines the pace of all chemical processes in a well-established system and influences fish development, reproduction, and immunity. Temperature affects the rates of biological and chemical processes. Temperature ranges are critical for the health of aquatic creatures ranging from microorganisms to fish. The oxygen content of water is affected by temperature (as temperature rises, oxygen levels fall). Weather, loss of shade stream bank vegetation, impoundments, discharge of cooling water, urban storm water, and groundwater inputs to the stream are all causes of temperature variation [1].

1.1.2 Total Dissolve Solids (TDS)

Solids in streams can be found in three forms: suspended, volatile, and dissolved. Silt, stirred-up bottom sediment, decaying plant waste, and sewage-treatment effluent are examples of suspended solids. Suspended solids cannot be filtered, whereas dissolved solids can. Several variables influence the TDS concentration in a body of water [2]. Many types of aquatic life are harmed when TDS levels are high, especially when dissolved salts are present. Animal skin is dehydrated as a result of the salts. TDS levels in lakes and streams are commonly found to be in the 50 to 250 mg/L range.

1.1.3 Turbidity

The presence of suspended materials, such as clay and silt particles from erosion or runoff, re-suspended bottom sediments, and tiny organisms in the water, causes cloudiness. The murkier the water appears and the higher the measured turbidity, the more total suspended solids there are in it. Turbidity measurements had a weaker correlation with suspended sediment concentrations (total nonfilterable residue), but they were still a good predictor for using as a water quality standard to preserve aquatic ecosystems.

2. Materials and Methods

The purpose of the methodology is to construct and develop the real time water quality monitoring system that can be monitored from mobile phone. The method used in this study were discussed in detail in the methodology.

2.1 Materials

Selection of hardware and software is crucial for executing this project as it is the requirements that is needed to complete the project. The hardware requirement for the Real Time Water Quality Monitoring in lakes with IOT application project are the device itself which consist of control circuits, actuators, and sensors. These are the list of hardware that were used:

- Temperature and humidity sensor (DHT11),
- Turbidity sensor,
- TDS sensor,
- Rechargeable 12.0 V battery,
- Solar charge panel,
- Solar panel,
- Node MCU,
- Stripboard,
- Jumper,
- and Acrylic case

These are the list of software that was used:

- AutoCAD

- Fritzing,
- and Arduino IDE.

2.2 Methods

The purpose of the methodology is to construct and develop the real time water quality monitoring system that can be monitored from mobile phone. The method used in this study were discussed in detail in the methodology.

2.2.1 Block diagram of the system

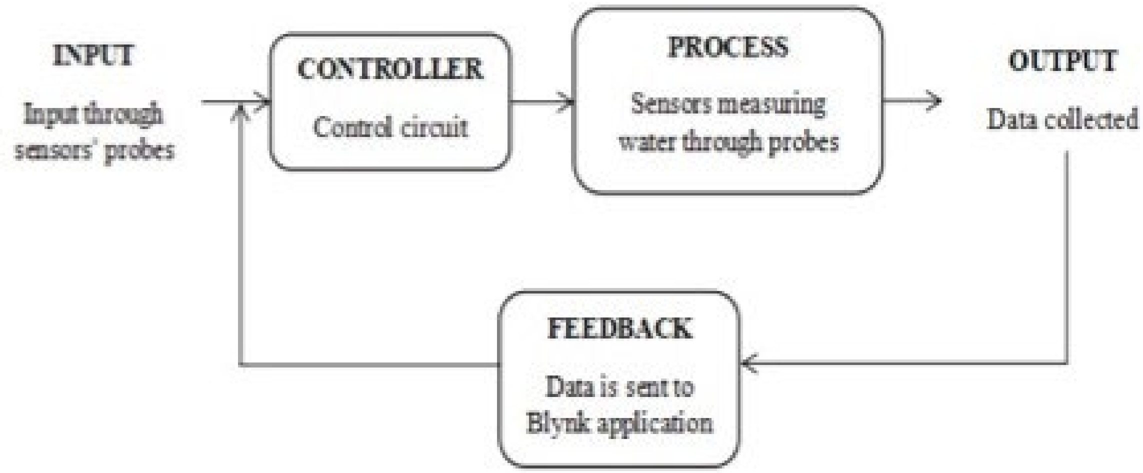

Figure 1: Block diagram of the system

Figure 1 shows the process of the Real Time Water Quality Monitoring in lakes with IOT application. The water from the lakes will flow through the water inlet then the control circuit will start to operate. The control circuit consist of Arduino and sensors that is used in this project. The actuators will collect data from the control circuit. The collected data will be sent to the user through blynk application about the water's quality condition. Then, the water will flow out through the water outlet

2.2.2 Flowchart of the project

Figure 2 shows the flowchart of the project. This flowchart demonstrates the flow of the project that starts with turning on the nodeMCU by its powersource. As soon as it turns on, the nodeMCU will connect to a WiFI connection and establish connection to Blynk application. The smart water sensors which are DHT11 sensor, TDS sensor, and Turbidity sensor will turn on. First, DHT11 sensor will measure and read data, and display data in Blynk application. Secondly, TDS sensor will measure and read, data and display data in Blynk application. Then, Turbidity sensor will measure and read data, and display data in Blynk application. When the sensors are unable measure and read data, it will go back to the nodeMCU to establish connection to Blynk application. It will go on a loop as long as nodeMCU is powered on.

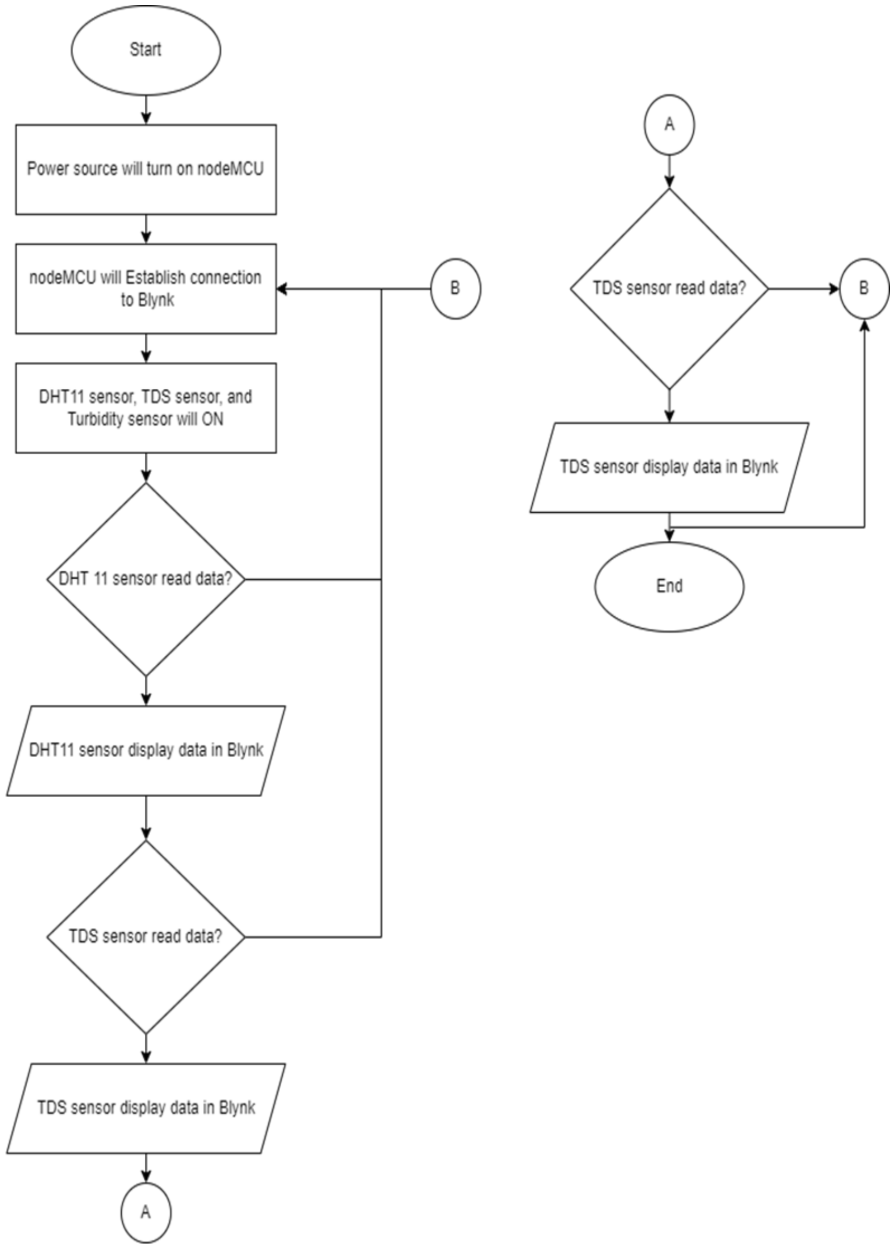

Figure 2: Flowchart of the project

2.2.3 Circuit design

Figure 3 shows the circuit design was sketched by using Fritzing software. The circuit consists, DHT11, Turbidity sensor, and TDS sensor for collecting the data for analysis, each sense the temperature, humidity, turbidity value, and TDS value respectively. NodeMCU V3 ES8266 is the model that is use in this project for interfacing with the mobile phone by using the Blynk application for the monitoring system.

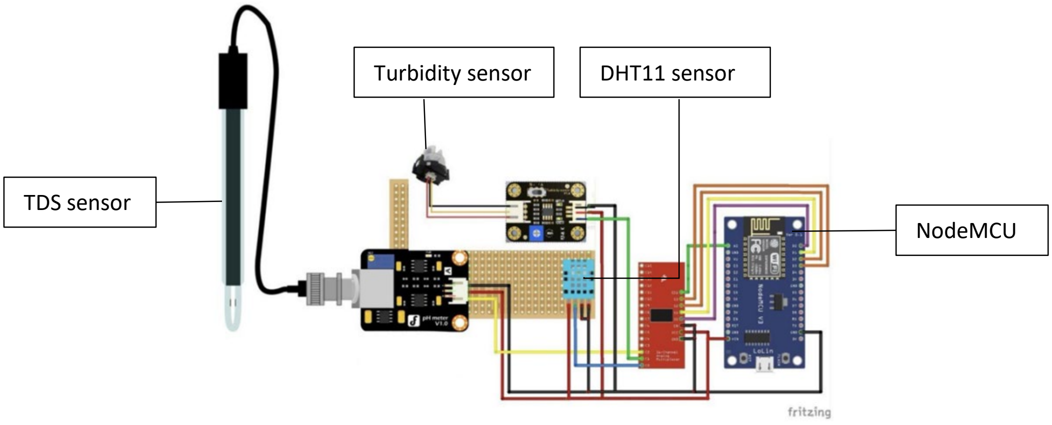

Figure 3: Circuit design using Fritzing software

2.3.4 Prototype

Figure 4 and 5 shows the main control circuit for the project. As seen in the figure below, the circuit is placed in an acrylic casing. The acrylic casing is being used to protect the main control circuit of the project. The dimension for the casing is 7x5x2 inch (LxWxH) inch. The particular purpose for using this casing was to make user easier to see the components and the connectivity of the circuit through the acrylic.

Figure 4: Acrylic casing for main control circuit (top view)

Figure 5: Acrylic casing for main control circuit (side view)

Figure 6 and Figure 7 shows the full prototype for this project. The design of the body is made to achieve the ability to float and roam on the surface of the lake. This real time water quality monitoring with IOT application is targeted for small lakes especially local ones in Malaysia. Thus, most of the components will be placed in the canoe-like body. The main control circuit is placed inside the body.

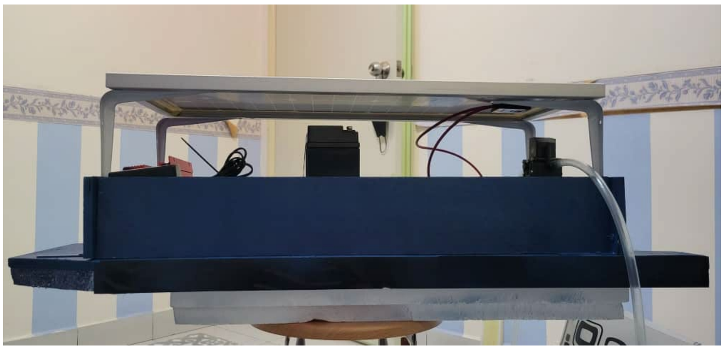

Figure 7: Side view of prototype

2.2.5 Blynk application

The monitoring system through mobile phone must have the mobile application to interface with the NodeMCU. Figure 8 shows the Blynk mobile application is applied in this project to display the data. The blynk application is interfaced with the nodeMCU to monitor the water quality parameters based on the sensors value.

Figure 8: Blynk application display

3. Results and Discussion

3.1 Results

The data were obtained from this project is by considering several factors. The table 1 shows the temperature and humidity in room environment for ten minutes. After that, the sensor is tested in Edu Hub Pagoh lake surroundings for ten minutes. The temperature and humidity are recorded for each trial in room and lake surroundings. The temperature and humidity were measured by using the sensor. The temperature was measured in Celsius (℃) unit and humidity in percentage (%). The temperature and humidity value were taken for ten minutes. During the ten minutes, the temperature and humidity value was taken for every minute as shown in the table below.

Table 1: Temperature, humidity, and time

Environment	Room		Lake	
Time [min]	Temp. [ºC]	Humidity [%]	Temp. [ºC]	Humidity [%]
1	26	69	29.3	69
2	26	69	29	77
3	27	69	28	77
4	27	70	28	88
5	26	69	28	88
6	26	69	29	83
7	27	66	29	78
8	26	67	29	88
9	27	70	30.2	77
10	27	70	30.2	88

Table 2 shows the TDS value, time, and conductivity rating of the water in Edu Hub Pagoh Lake. The capacity of a substance to hold an electric current is referred to as conductivity. The conductivity of water is commonly tested. Water without minerals or salt cannot hold an electric charge, while water with minerals and salt can. As a result, conductivity is proportional to the salt and mineral content of the water. TDS, or total dissolved solids, refers to the quantity of salt in water.

Table 2: TDS value, time, and conductivity rating of the water in Edu Hub Pagoh Lake

Time [min]	TDS Value [ppm]	Conductivity rating
1	0	Low
2	20	Low
3	23	Low
4	102	High
5	54	Fair
6	69	Fair
7	69	Fair
8	87	High
9	34	Fair
10	33	Fair

Figure 9 shows the curve of the temperature and time for both room and lake environment. As analysed, the temperature in the room environment is quite expected as room temperature is usually around 27 °C. While in the lake environment, the temperature is quite high as the sensor is exposed to an outdoor environment. The particular reason for this circumstance is that in lake environment the sensor is exposed to the sun and that may have caused the increase in temperature.

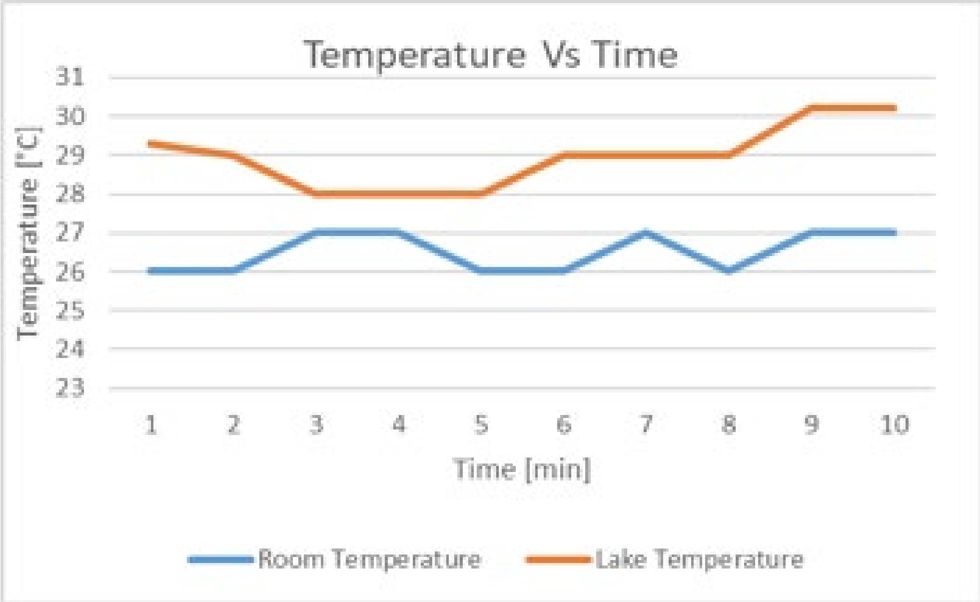

Figure 9: Temperature Vs Time

Figure 10 shows the curve of the humidity and time for both room and environment surroundings. As analysed, the humidity in room environment is less humid compared to lake environment. This is due to the condensation of water vapors that the lake produced making the environment more humid.

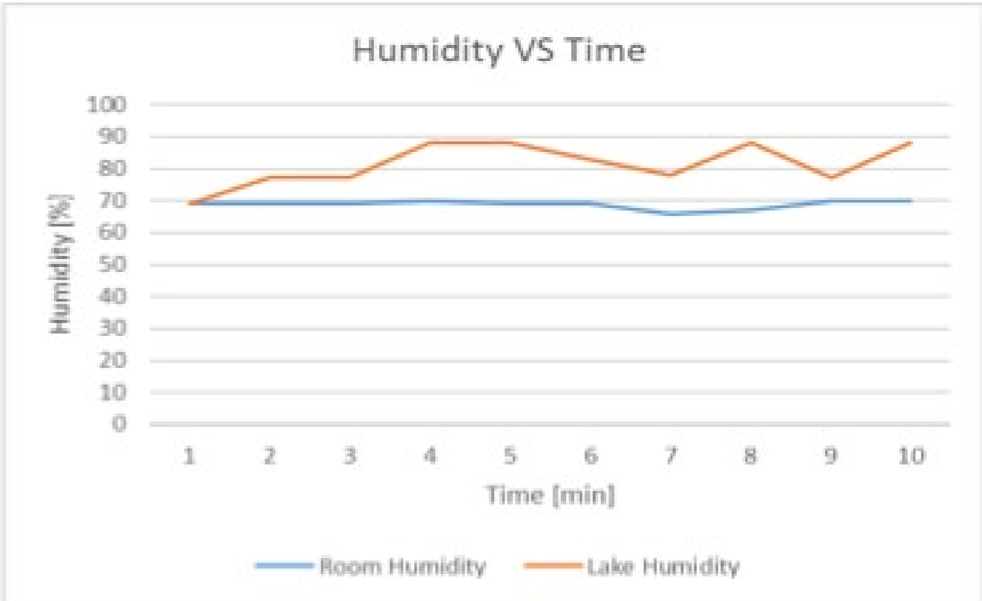

Figure 10: Humidity Vs Time

Figure 11 below the TDS value and the time taken when the sensor measured the value. Each minute shows different values but the TDS value does not exceed 500 ppm as it was taken in a lake. TDS levels more than 1000 ppm are considered dangerous. A filtration system may not be able to filter TDS adequately if the level surpasses 2000 ppm. Many types of aquatic life will get harmed when TDS levels are high, especially when dissolved salts are present. Animals' skin may become dehydrated as a result of the salts.

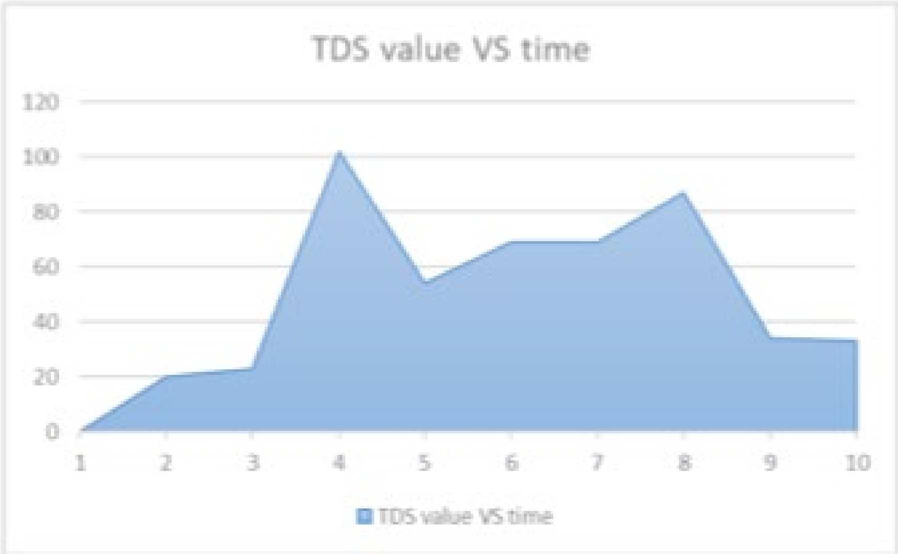

Figure 11: TDS value Vs Time

From Figure 12, it is concluded that while coding the microcontroller-based project that the equation contained in the relationship graph is only relevant if the sensor outputs 4.2 V roughly at zero turbidity (clear water), and it's only true between the 2.5 V to 4.2 V range (3,000 to 0 turbidity).

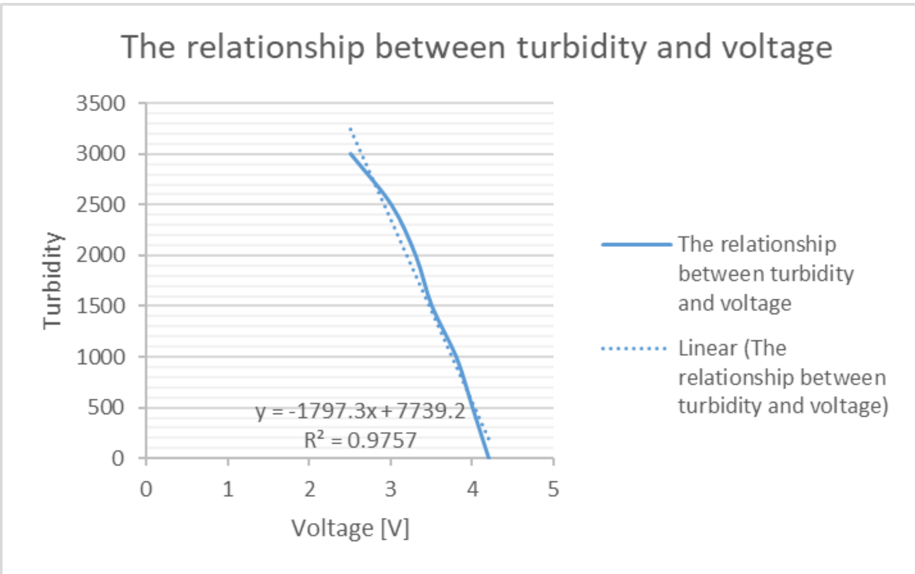

Figure 12: The relationship between turbidity and voltage

3.2 Discussion

The results that was obtained in the lake environment has met the specification for local lakes in Malaysia. The National Lake Water Quality Criteria and Standards (NLWQS) for Malaysian lake are used as a reference for specification of quality water required information in making judgements as to the fitness of lake water for human protection, recreational purposes, and ecosystem health for the diversity or protection of aquatic life [12].

4. Conclusion

The real time water quality monitoring with IOT application has been developed. The system was driven by using the nodeMCU programmed by Arduino IDE C language. The system consists of three main sensors which are TDS sensor, DHT sensor, and turbidity sensor. The data were collected and analysed by considering the measured values by the sensors in ten minutes. In conclusion, water quality monitoring is essential as aquatic life depends on the quality of the water. With this project, water quality monitoring is made easy as now user can check through their own mobile phone using the blynk application.

Acknowledgement

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References

[1] F. R. Spellman, E. Drinan, The drinking water handbook, 2nd edn, ISBN: 978-1-4398-6690-0 (2012)

[2] APHA (American Public Health Association). Standards methods for the examination of water and wastewater, 21st edn. American Public Health Association, Washington DC (2005).

[3] L[15] Fritzing, "Electronics made easy," Fritzing, [Online] https://fritzing.org/learning/get-started

[4] Blynk, "How Blynk Works," Blynk, [Online]. https://docs.blynk.cc/

[5] Walton N R G 1989 Electrical Conductivity and total dissolved solids—What is their precise relationship? Desalination **72** 275–292

[6] Sathish Pasika, Sai Teja Gandla,,Smart water quality monitoring system with cost-effective using IoT, Heliyon, Volume 6, Issue 7 (2020). https://www.sciencedirect.com/science/article/pii/S2405844020309403

[7] IoT Application in River Monitoring: Methods and Challenges by Saharuddin, H., Rahman, T., Elijah, O., and Khairudin, F. (2019).

[8] Smart Sensor Device for Detection of Water Quality as Anticipation of Disaster Environment Pollution by Taufiqurrahman., Tamam, N., Putra, D., and Harsono, T. (2016).

[9] Cho Zin Myint, Lenin Gopal, Yan Lin Aun (2012). Reconfigurable smart water quality monitoring system in an IoT environment, ICIS (2017), pp. 435-440.

[10] Niel Andre Cloete, Reza Malekian, Lakshmi Nair (2014). Design of smart sensors for real-time water quality monitoring. Department of electrical, Electronic and Computer Engineering, University of Pretoria, Pretoria, South Africa IEEE J., 13 (2014), pp. 1-16.

[11] A.J. Whittle, M. Allen, A. Preis, M. Iqbal (2013.) Sensor Networks for Monitoring and Control of Water Distribution Systems. Coventry University, Coventry, UK (2013) MIT article.

[12] Z. Sharip, Suratman, Saim, Noordin, Normaliza, Majizat, Akashah, Fauzi, Mohd, & Ibrahim, Zelina. National Lake Water Quality Criteria and Standards (2016).