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Monitoring Water Quality Based on Aquaponic System Using IoT

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Abstract: The objective of this project is to develop a monitoring water quality based on an aquaponics system using Internet of Things (IoT). Arduino Mega had been used as the main microcontroller in the monitoring system. For the monitoring system, the temperature sensor, turbidity sensor, and ph sensor are used as a function to monitor the performance of the system. The function of Arduino Mega board is used to transfer data between the system devices to Blynk. Blynk is an IoT platform used to monitor the data for this project. The data recorded for turbidity is -52 until -49. The result for temperature is between 28°C to 32°C, and the result for pH is from 6 to 8. In conclusion, the developed monitoring of water quality can be applied in agriculture sectors such as aquaponics systems.

Keywords: IoT, Blynk, Arduino, Aquaponics

1. Introduction

Nowadays, agriculture is one of the other sectors that are important towards the development goals such as maintaining food security and boosting nutrition which plays a major role in transforming industries to achieve the aim. Moreover, aquaponics has become one example of an industry that combines aquaculture and hydroponic cultivation equipment [1]. This sort of agriculture benefits people all around the world by allowing them to obtain chemical-free food from the growth of organic vegetation [2].

Aquaponics is known as one of the farming aquatic organisms and hydroponics is a system that grows plants in water without the usage of soil [3]. Both the technology is used to feed the cultivated plants with the nutrient-rich water from the aquaculture as a fertilizer where it contains bacteria with the roles in nutrient conversion [4] [5]. Aquaculture should be included for the aquatic animals (e.g., fish, mussels, and crustaceans) as well as plants (e.g., micro-and macroalgae) [3]. When compared to separate fish and plant rearing systems, aquaponic systems may have a lower resource use which the plants can improve the water quality by removing ammonia, nitrites, nitrates, phosphates, and organic carbon from the fish waste [6]. The plant's effluent water can then be reintroduced to the fish without further treatment. Furthermore, the fish excrement is utilized to fertilize crops in this approach, resulting

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in the development of organic and chemical-free crops [7]. This aquaponic technique can be carried out in a small space, such as a backyard or garden, and does not necessitate a large amount of space.

This work will focus on using the Internet of Things (IoT) which has been widely used in the industries nowadays. IoT is a continuous and real-time remote sensing communication system that can be related to monitoring water quality [8]. Moreover, the IoT can be also described as a wireless sensor platform that connects a variety of smart devices, applications, sensors, systems, and connectivity throughout numerous technologies to allow them to receive and share data [9]. This platform can be used to continuously monitor the data and make necessary adjustments, leading to a healthy ecosystem that supports the growth of fish and plants [10]. The system will use Arduino as its main programming component to monitor the water quality parameters such as pH level, water temperature, and turbidity in this project.

2. Materials and Methods

Figure 1 shows the block diagram of the system process. In Figure 1, DS18B20 water-proof temperature sensor used for measuring water temperature between -55 to 125°C with ±0.5°accuracy. The turbidity sensor is used to measure the amount of light that is scattered by the suspended solids in water while the pH sensor is used to measure the acidity or alkalinity of the water. Arduino Mega is a central process unit used to connect Wi-fi and program code for water temperature sensor, pH level, and turbidity. Blynk software will be used as the data analysis monitoring for these sensors. The mobile phone will receive a notification if the condition of the water is dirty to the user.

The project interface Arduino Mega with sensors using Arduino IDE language. The coding will be uploaded into Arduino Mega and read the value in the Blynk application. The Arduino Mega connected to a Wi-Fi module allows the transfer of data output received from the sensors to the Blynk application. The mobile phone will notify warning users if the sensors detect a high turbidity reading which is more than 50.

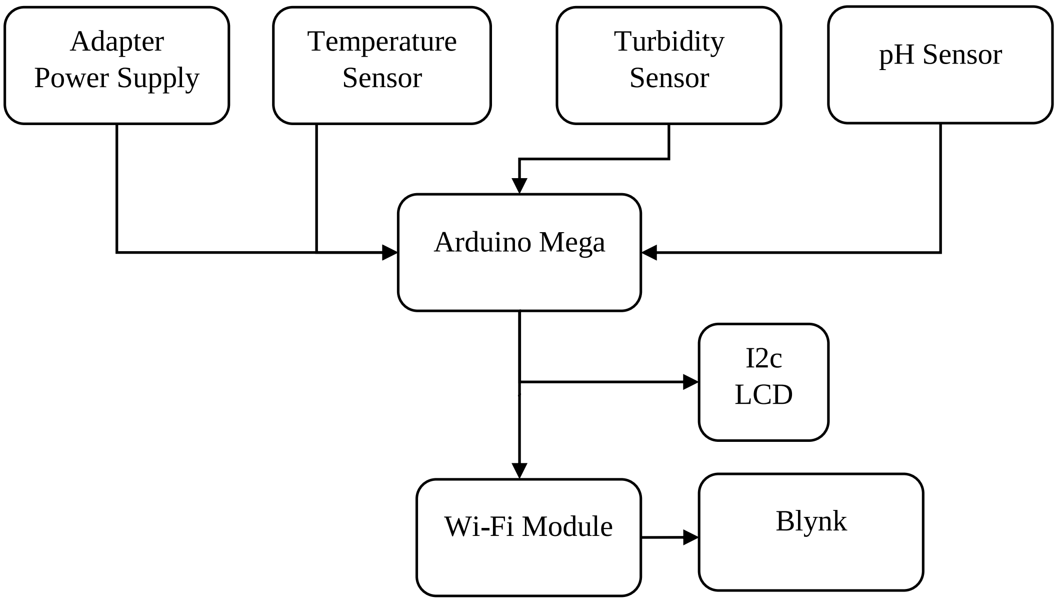

Figure 1: Block Diagram of the System Process

Figure 2 shows the hardware development for monitoring water quality system for this project. Firstly, the Arduino Mega board used as the main components for the monitoring system. There are few sensors that are used in this project which are temperature sensor, turbidity sensor, and pH sensor.

Temperature sensor, turbidity sensor, and pH sensor are used to measure the data of the system. Lastly, the Wi-Fi module Esp-01 use to replace the Arduino Mega board and take fully control of the monitoring system.

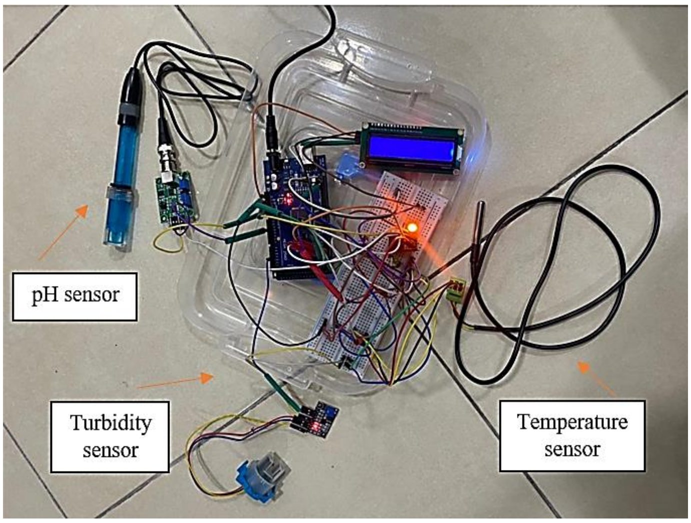

Figure 2: Hardware Development

Figure 3 shows the Blynk application monitoring the real-time data online that is connected to the internet. The Blynk was designed for the Internet of Things. The Blynk app has been developed that presents data from the sensor to the user interface. Moreover, it can display sensor data then can store the data and visualize it. After connecting to the internet, the user is able to monitor the condition of the hardware through a smartphone equipped with the Blynk application.

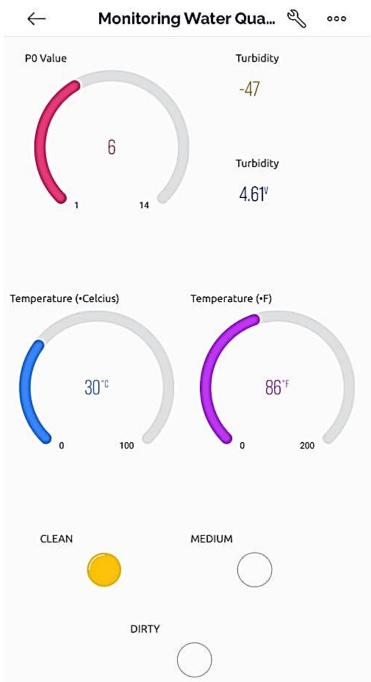

Figure 3: Blynk application monitoring

Figure 4 shows the Blynk notification notify the user when the turbidity sensor detects a higher reading in the water. To determine the condition of the water, the registered parameter by sensor is detected for pH level, water temperature and turbidity of the water. The sensors read the value and provide information to the users through Blynk application.

Figure 4: Blynk application notify the user

3. Results and Discussion

The result for output monitoring water quality system, at Aquaponic Site, University Tun Hussein Onn Malaysia on 5th and 6th January 2023 which are recorded from 16.00pm until 18.00pm are shown on Figure 5, 6 and 7. The parameter that has been set for this turbidity sensor are based on three condition which is clean, medium and dirty. For clean condition, the parameter is less than 20. For medium condition, the parameter is more than 20 and less than 50 while for dirty condition, the parameter is more than 50. Figure 5 shows the graph turbidity versus time that recorded at Aquaponic Site. Based on the graph in Figure 5, the data collected show that the result of the turbidity is from -52 until -49. This show that the condition of the water is in clean condition.

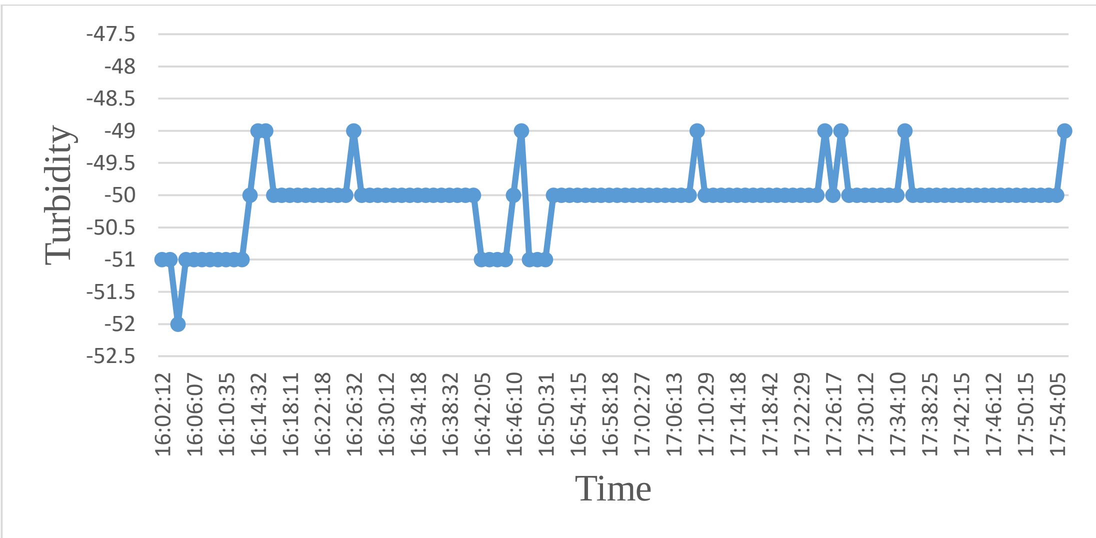

Figure 5: Graph Turbidity vs Time

Figure 6 shows the graph of temperature versus time that recorded at Aquaponic Site. The parameter that can be detected from this temperature sensor is from -55 until 125°C. Based on the data that have been collected in Figure 6, the result shows the water temperature is from 28 until 32°C. The water condition remains constant when it reaches at time 16.53pm.

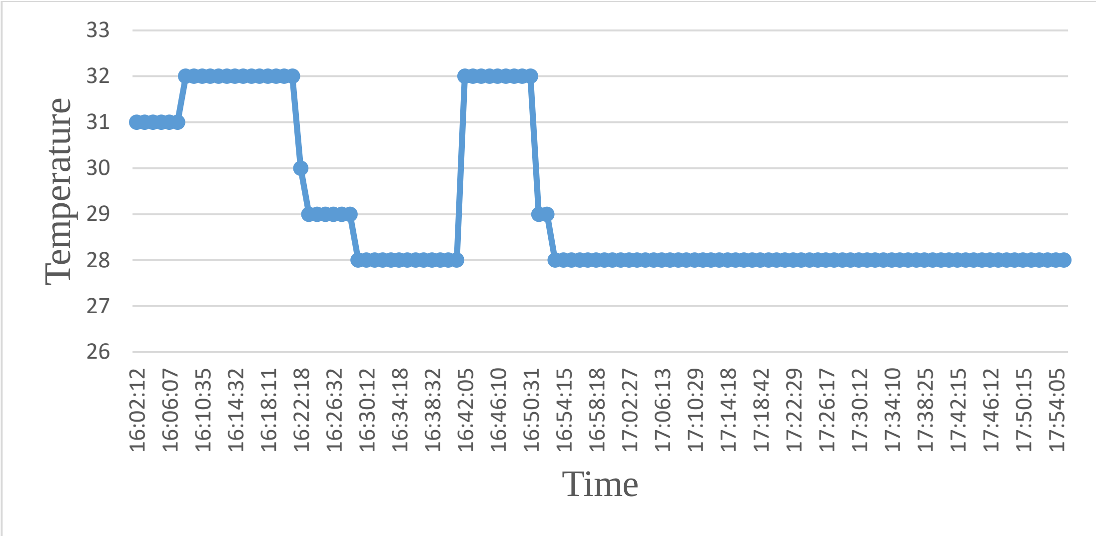

Figure 6: Graph Temperature vs Time

Next, the graph of pH versus time is presented in Figure 7. This pH is to measure of how acidic or basic of the water condition. The range can be measured from 0 - 14, with 7 being neutral. This pH function is to measure the relative amount of free hydrogen and hydroxyl ions in the water. Based on the graph in Figure 7, the data collected show that the result is from 6 to 8. In spite of the fact that the pH value ranges from 6 to 8, the result will still be neutral and in safe condition.

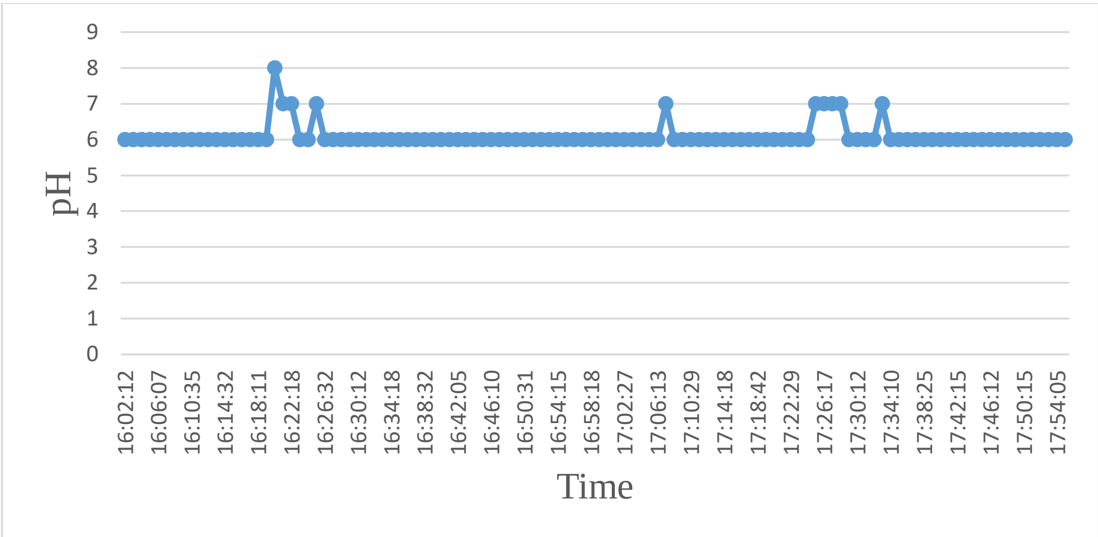

Figure 7: Graph pH vs Time

Figure 8 shows the data recorded through the Blynk platform. From this platform, the user can easily monitor the condition of the system. The yellow led will appear when the condition of the water is CLEAN. While the red led will show that the water is in DIRTY condition while the green led will show as MEDIUM condition. At the same time, the data also will appear in the Blynk application which it will show the same value as the Blynk platform.

Figure 8: Blynk Platform Interface

4. Conclusion

In conclusion, the development of the prototype for Monitoring Water Quality Based on Aquaponic System using IoT succeeded. The project's objective is successfully achieved, developing a monitoring system using IoT system that can monitor through Blynk application. Test output is done at Aquaponic Site, University Tun Hussein Onn Malaysia. For the first objective, to design a monitoring system that can be used to monitor water quality parameters which are pH level, water temperature and turbidity for aquaponic system work successfully by using Arduino Mega. For the second objective, to evaluate the performance of the system in monitoring the water quality using the IoT. In the previous chapter were discuss about the data of monitoring system performance. For the overall performance, the Monitoring Water Quality Based on Aquaponic System using IoT show that it is easily to be used by the consumer to monitor the condition of the system.

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