March - April 2020
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IoT Based Drainage Monitoring System

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Abstract

The improper way of handling the chemical waste has affected the marine life and resulted world's water supply being treated like a poisonous waste dump. This paper proposes the development of the current water quality monitoring system that suitable to be implemented in industrial area. The temperature, turbidity and pH level were measured in the real-time through sensors that send the data to the base station or monitoring room. The wireless system was used as communication tools for monitoring purpose and to enhance the efficiency in terms of flexibility and distance. Furthermore, the fundamental design of open-source electronics platform for instance Arduino microcontroller is purposed in the development of this work. Results of measurement to evaluate the reliability and effectiveness of the system are presented. It can be seen that this work can help the user to analyze the water condition in real-time and act as the last barrier for the industry to ensure the water is clean before it was being release to the river.

Keywords; *epilepsy, seizure, galvanic skin response, real-time record*

I. INTRODUCTION

About 70 per cent of the earth is cover by the water and the uses of the water exceed the usability in daily life[1]. After the world is introducing by modern equipment, the amount of clean water decreasing every year. According to saferwater.org, the amount of water contamination created by the manufacturing factory is increasing 4.5 million tons every year after World War II [2].

Water pollution refers to the uncleanness of the environment by harmful and waste materials, which bring about a significant change in the quality of the surrounding atmosphere. From the research conduct by J. Yang et al., the result collected in the industrial area provide nearly 46% to 50% of risk source in the water [3]. This paper proposed on the development of water quality monitoring at drainage that suitable to be implemented in the industrial area.

To improve the current water quality monitoring, an innovation has been introduced in this proposal. As the world has moved with the advanced technology with the internet, the water quality can be monitor from distance. The usage of the Internet of Things in one of the new technologies that was used by the industries 4.0 to help in the industrial process [4], [5] and [6].

The internet works as a communication platform from the device to the user. To improve this work, several projects have been evaluated. In paper [7], K.H Kamaludinet. al, proposed the implementation of Radio Frequency Identification (RFID) system. Wireless Sensor Network (WSN) and Internet Protocol (IP) were used in water quality monitoring. As the outcome, this system was able to sense with a maximum read of −74dBm with 100% data efficiency. Other works that have been done by Rohit K. et. al conclude the usage of Arduino

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March - April 2020
ISSN: 0193-4120 Page No. 8104 - 8110

microcontroller and General Packet Radio Service (GPRS) module for wireless data transfer [8]. The sensor only sends the data by using Short Message Service (SMS) to the end user via the GPRS module. Besides that, BT technology have also taking part in developing a project that are related to wireless. The advantage of using BT devices was not only saving cost, but it also easier in term of installation [9]. This review has helped this paper get a better understanding of the project that is going to be implemented.

Nowadays, smartphone has extended its usage by assisting human in handling their daily life. Based on the report issued by Forbes [10], 86% of people tend to use smart phone instead of websites. This paper exploits the development and analysis of the monitoring of the water quality based on Internet of Things (IoT). This work can also be monitoring using mobile application in real-time as shown in Figure 1.

This paper makes the following key contributions:

1. The development of IoT based drainage monitoring system and sensor validation.
2. The performance analysis of sensor in real-time to determine temperature, pH level of the solution and turbidity.
3. The analysis on the validation and precision of the sensors.

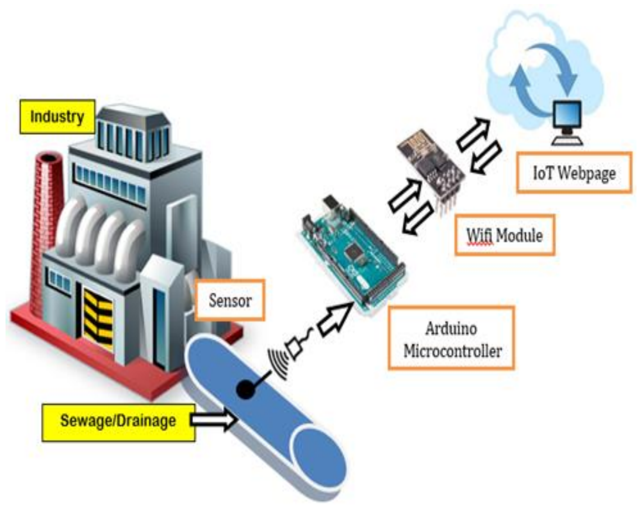

Figure 1 : Illustration of overall project design

II. METHODOLOGY & PROTOTYPE DEVELOPMENT

A. Block Diagram

Three parameters of sensor were used as the water monitoring in this work to achieve its objectives as shown in Figure 2. Temperature, turbidity and pH value of the water can be monitor from IoT webpage. The result can be accessed anywhere at any time. User can remotely monitor the sensor parameter from private website or mobile apps.

This work is needed as the last protection before the water is released to the marine life. Figure 3(i) represents the flowchart of microcontroller system while Figure 3(ii) signifies flowchart of cloud server to display output data. This flowchart shows how the process flow step-by-step and it's also offers basic overview of project movement. To add, the hardware also includes usage of Arduino UNO rev3 act as the brain of the system to evaluate the data from the input process. ESP8266 Wi-Fi module is used as communication tools to help in communicating the microcontroller to the internet.

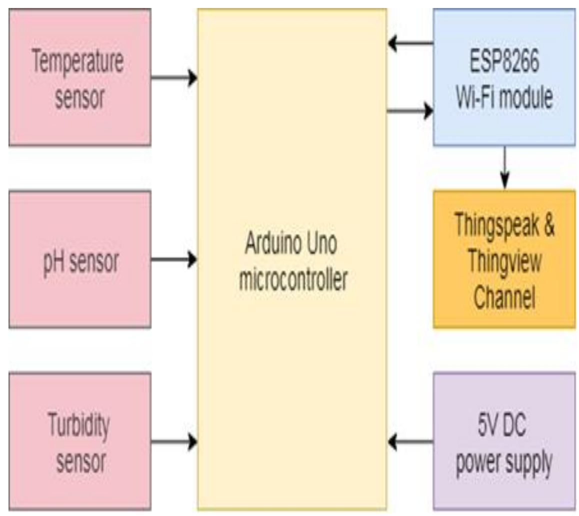

Figure 2. Figure 2 : Block diagram of the project

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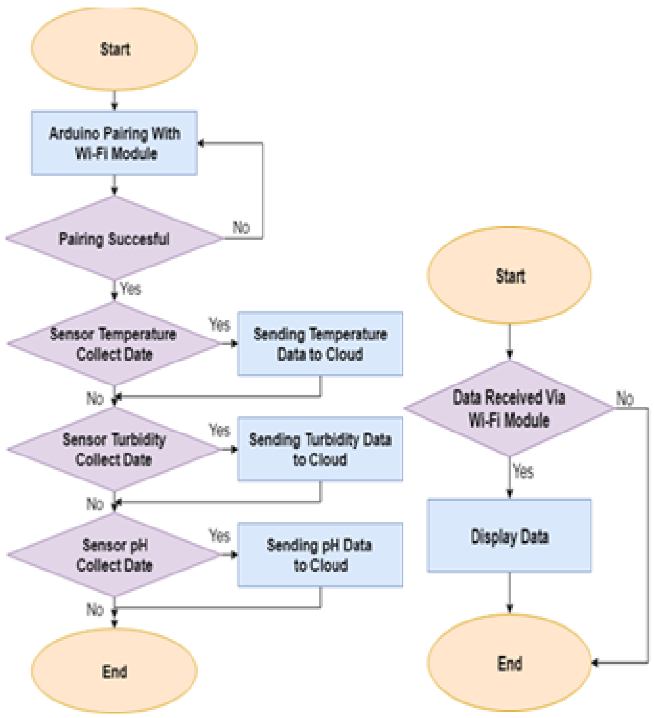
ISSN: 0193-4120 Page No. 8104 - 8110



(i) Flowchart from Arduino Uno microcontroller (ii) flowchart from cloud server

Figure 3: Flowchart of water quality monitoring system

Initially, +5V DC is supplied to the Arduino Uno microcontroller. The system starts when the microcontroller has enough power to operate. All the sensors shared the same voltage with the Arduino Uno microcontroller. Arduino Uno are set at baud rate that are equivalent to the performance of the computer which is 115200. Since Wi-Fi module ESP8266 has input voltage that only can be turn on at 3.3V DC. Thus, the voltage input of ESP8266 Wi-Fi module which is pin 8(VCC) is connected to pin 3V3 of the Arduino board. At the same time, all the ground circuit is connected to ensure the circuit is complete and safe. The Arduino Microcontroller are paired with the Wi-Fi module to enable interconnection between the hardware to the internets. Once all the device is power on and achieves a stable connection within the network, this allow microprocessor to start reading the sensors parameter.

In this phase, the Arduino Uno microcontroller is in a ready mode. Each sensor collects all the data such as the temperature of the water, the cloudiness of the water and the acidity or alkalinity of the water. LM35 temperature sensor output pin is connected to pin A0 of Arduino Uno microcontroller. Both turbidity and pH sensor output pin are connected to pin A1 and A2 respectively. Figure 4 shows the circuit diagram for the connection of Arduino interface with the sensor and Wi-Fi module. If the sensor manages to collect all the three data, then it starts to send to IoT webpage. The result can be seen in ThinkSpeak webpage, all the result that has been collected was displayed in digital value to ease the user to understand. ThingSpeak webpage is linked with ThingView apps which enable the data to be shared and viewed using mobile application. The result displayed in ThingSpeak and ThingView were in graphical value with a delay of 15 to 60 second. Those result completes the cycle of the flowchart.

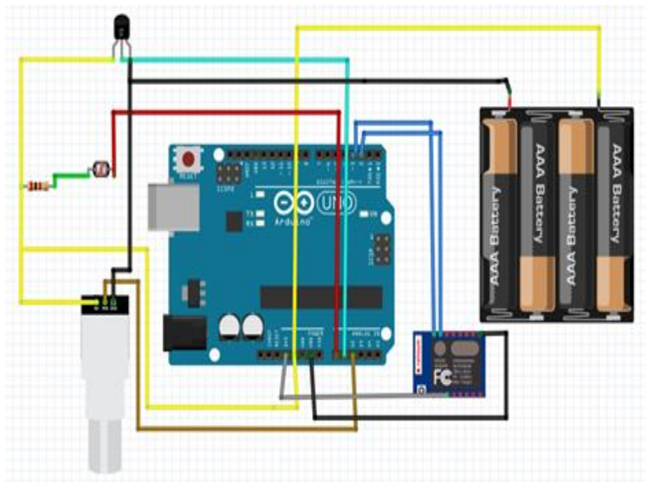


Figure 4 : Circuit diagram of the project

III. RESULTS AND DISCUSSIONS

A. The development of IoT based drainage monitoring system and sensor validation.

The outcome of the project consists of three different parameters collected from the input sensor. Result of each parameter is visualized in plots. The data is privately saved into personal account from ThingSpeak website. Additionally, the data collected from ThingSpeak account can be simultaneously shown in mobile apps thru ThingView. Figure 5

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shows the prototype of hardware development. The sensor was placed inside the container that act as the drainage while the microcontroller is situated outside the container

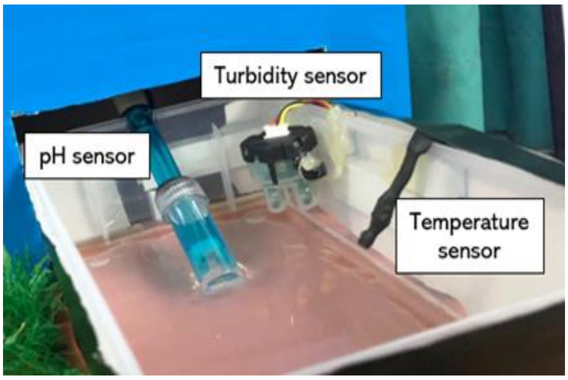


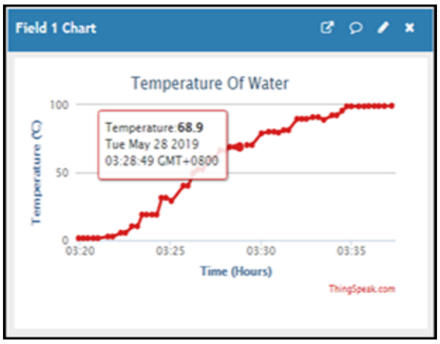
Figure 5 : Sensor configuration

Temperature sensor, pH sensor and turbidity sensor have their own unit, thus it need to be converted into degree Celsius (^{0}C) for temperature, pH level for pH sensor and NTU for turbidity sensor. Arduino Uno microcontroller are loaded with a complete coding based on C language to ensure the integration between the sensor and desire output is produced. To determine the effectiveness of this product development, some parameter assumptions has been chosen during this process.

Firstly, temperature sensor is tested by using normal tap water. Starting from freezing temperature until the boiling point of the tap water. The temperature sensor is dipped when the conventional glass thermometer show increasing in temperature value. The second sensor used in this paper is pH sensor. The sensor measured the concentration of the hydrogen ion in the liquid and convert the value into output voltage. the sensor was tested by using different concentration of liquid at room temperature. The solution that are used are near to required pH level ranging from 1 until 14. Turbidity sensor is the third parameter that produce analog output in this development. Thus, the output voltage of different cloudiness of the solution at room temperature was collected. The sensor is test by using 10 different cloudiness of solution to assure the sensor accuracy.

B. The performance analysis of sensor in real-time

A several test was conducted in order to determine temperature sensor; difference temperature of the water can produce voltage ranging from -0.75V until 2.5V. The voltage is increasing as the temperature of the water increase. As a result, the overall output product demonstration for temperature parameter are shown in Figure 6(i) in ThingSpeak account on field 1 chart. Following, Figure 6(ii) shows the value displayed on ThingView mobile apps. The result can be monitor in real-time with delay within 15 second interval. Thus, it can produce nearly 20 output data for every 5 minutes interval. Moreover, ThingView apps copied the latest result from ThingSpeak and displayed in the application as shown in figure below.



(i) Thingspeak webpage

(ii) ThingView mobile apps

Figure 6 : Temperature of water displayed via Thingspeakchanel and ThingView apps

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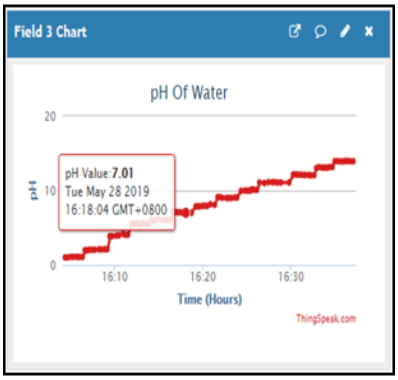
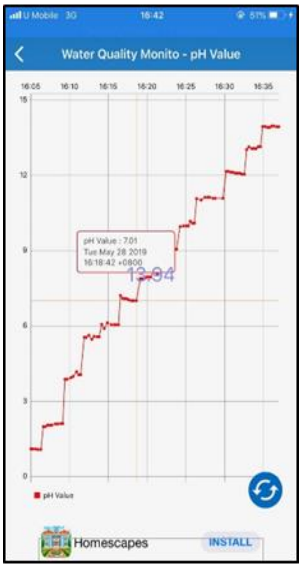
In field 3 chart from ThingSpeak channel, the result of pH level of the solution was displayed. Figure 7(i) show the line graph of the solution after being tested from most acidic to the most alkaline. The parameter was collected by the sensor and displayed on ThingSpeak webpage. pH sensor was dipped into 14 different solution to show the accuracy of system. The output voltage of the solution that are more acidic is less than 3.5 volts while alkaline solution is higher than neutral is around 3.6 until 4.9 volts pH value Next, the result was displayed simultaneously at ThingView apps based on Figure 7(ii). The result of ThingView is identical to the characteristic from ThingSpeak webpage as its shared the same API key.



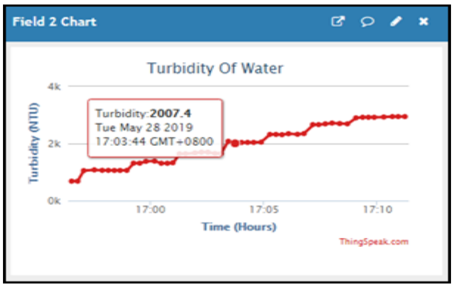
(i) Thingspeak webpage



(ii) ThingView mobile apps

Figure 7: pH value displayed via Thingspeakchanel and ThingView apps.

Lastly, third result that was displayed in ThingSpeak channel and ThingView apps is turbidity of the water. The data is showed as shown in Figure 8(i) from website page of ThingSpeak on field 2 chart. The value from the figure below is referring from the test have been assigned to turbidity sensor which is being tested by using 10 different cloudiness of solution. Output voltage produce is equal to 2.53 volts with a difference of 1.97 volts compared to initial value when the sensor is dip at the most turbid solution. In the other hand, Figure 8(ii) shows the same outcome in mobile apps via ThingView. It can be concluded that as the turbidity of the solution increase, the reading of the NTU in the channel is increasing. However, the output voltage of the turbidity measurement is decrease as the cloudiness of a liquid is increase. The output voltage produce is at low because of the physical characteristic of the sensor.



(i) Thingspeak webpage

(ii) ThingView mobile apps

Figure 8 : Turbidity reading of the water displayed via Thingspeakchanel and ThingView apps

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March - April 2020
ISSN: 0193-4120 Page No. 8104 - 8110

C. Analysis on The Precision of Product

The ability of the sensor to read the data precisely is necessary in this work. Each parameter was tested using a specific tool that act as control of this project. The accuracy of the sensor can be computed using equation 1 below.

$$percent\ error, \% = \left|\left(\frac{sensor\ reading}{actual\ reading} \times 100\right) - 100\right| \ldots \text{Eq. 1}$$

Firstly, the temperature of the water was tested in normal tap water with temperature of 25^0C. However, ThingSpeak account shows the water temperature of 26.2^0C when LM35 temperature sensor being dip inside the water. By using the formula above, the percentage error of the sensor is equal to ±4.8%. A sensor produces an error that is less than ten percent from its actual value.]. Thus, it can be concluded that when the sensor detects any changes in temperature of the water or a solution, it can provide a result with 95.2% accuracy.

Next, the result of pH sensor can be verified by using buffer solution with pH level of 4.00. In this development, the pH sensor senses the buffer solution higher than the actual value. The result from ThingSpeak channel displayed 4.08. After substituting the value in the equation 1, percentage error produce for this sensor is approximate to ±2.0%. It can be concluded that, the pH sensor has an accuracy that are equal to 98% during monitoring the quality of the water.

Third parameter in this development is turbidity sensor. Based on the result produce at normal tap water that are equivalent to 10 NTU. The value displayed at ThingSpeak channel is higher than the actual value. ThingSpeak channel 3 shows value of 10.3 NTU. The percentage error of the sensor is ±3%. Thus, turbidity sensor has an exactness of 97% when analyzing a sample. Since the operating voltage of the sensor are from positive 2.5 until 4.5 volts, hence it rejects turbidity value that is more than 3000 NTU. In short, the highest turbidity point is equal to the lowest output voltage of the sensor produced.

IV. CONCLUSION

This project had successfully claimed its first objective which is to monitor the quality of the water from cloud server which is ThingSpeak and ThingView by using ESP8266 Wi-Fi module. The result can be viewed in graphical value with the mismatch that is less than 60 seconds. Secondly, the sensors are fully integrated with the Arduino Uno microcontroller to check the water quality. According to the result obtained, it can be concluded that the error produce is less than 10 percent on each parameter. Finally, the result is presented in software and mobile apps in plots type. This development involved the usage of internet can give a lot of beneficial to the user such as can view the result from anywhere at any time.

It can be seen that this work has impact not only it can be better than conventional water monitoring device for water checking, but it can be considered as the best solution for the industries to guarantee the water is clean and nontoxic to before it being release to the waterway or ocean. Moreover, in this modern era, technology keeps improving with so many researches that have been conducted. Thus, it can help human to have a better life.

V. ACKNOWLEDGMENT

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March - April 2020
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