Evolution in Electrical and Electronic Engineering Vol. 4 No. 1 (2023) 155-160
© Universiti Tun Hussein Onn Malaysia Publisher's Office

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

Development of an Intelligent System to Monitor the Canal Water Quality and Stagnation Condition

Akif Rusyaidi Azim[1], Sim Sy Yi[1]*, Md Nor Ramdon Baharom[2]

[1]Faculty of Electrical and Electronic Engineering
Universiti Tun Hussein Onn Malaysia, Johor, 86400, MALAYSIA

[2]Faculty of Engineering Technology
Universiti Tun Hussein Onn Malaysia, Johor, 84600, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/eeee.2023.04.01.018
Received 09 February 2023; Accepted 26 February 2023; Available online 30 April 2023

Abstract: This paper focused on flood and water pollution precaution systems by monitoring the canal system water quality and stagnation condition with a water conductivity probe, hc-sr04 ultrasonic sensor and, sf-y201 water flow sensor. The system will be used to monitor the canal system in Parit Raja, Johor and send an alert notification when there any abnormalities are detected. The water conductivity probe will measure water conductance. The ultrasonic sensor will measure the water level and the water flow sensor will measure the water flow rate. All of the data will be processed by ESP32 and the data can be presented through the Arduino IoT dashboard The system is tested with various tests to verify its validity. The reading from the water conductivity probe and ultrasonic sensor will be compared with an actual reading, while the water flow test will be tested with the presence of water flow in the canal system. The notification feature will be tested by manipulating the parameter conditions. For water conductivity, the percentage error shows that the system reading is fairly accurate while the water level reading is accurate. Foe the water flow rate, flow rate can be noticed through the Arduino IoT dashboard. Finally, the notification was sent to the IoT dashboard when manipulating the parameters condition. Overall, the proposed system is successful to monitor the water quality and stagnation conditions.

Keywords: Water Conductivity, Water Level, Water Flow, IoT

1. Introduction

Among the natural resources, water, without a doubt, is the most critical component in humans' daily life [1]. Due to water being a vital necessity, wastewater management must be managed appropriately. The drainage system is generally polluted due to human activity where the polluted water

*Corresponding author: sysim@uthm.edu.my

has a high level of conductance. A high value of conductance indicates a high level of salts or inorganic chemicals. Therefore, contaminated water is not fit for human consumption as it can cause sickness in humans. Next, the condition of the drainage system is usually clogged, which is the main reason for floods in urban areas. Floods in Malaysia occur due to heavy rain, and the drainage system is blocked and unable to provide a good drainage system [2]. A good monitoring device should be placed to monitor the canal's condition in order to prevent any catastrophe.

A conventional device located at Kolej Kediaman Bistari is built to measure the canal water level. The measurement device is not sufficient to prevent any disaster such as flood or water contamination from happening.

This paper promotes the expansion of the conventional device. Instead of one parameter, the prototype should monitor three parameters of the water canal. Also, a notification feature is added as an alert for any abnormalities.

The objectives of this paper are to design and develop a prototype that can monitor water conductivity, water level and water flow through IoT. Also, to verify its functionality. The prototype will be tested out in three different canal locations at Parit Raja. These locations are Kolej Kediaman Bistari, Jalan Tembikai and, Taman Universiti.

2. Materials and Methods

This section will describe the materials and methods that are proposed for developing the intelligent canal monitoring system.

2.1 Materials

Each component is tasked with a specific feature, but the combination of the component is tasked with one job which is to monitor the canal's water condition. Table 1 shows further clarification concerning the functionality of each component.

Table 1: Component functionality

	Component	Function
Input	Water Conductivity Probe	To measure the water conductivity level
	HC-SR04 Ultrasonic sensor	To monitor the water level
	SF-Y201 Water Flow Sensor	To detect the flow of water in the canal system
Process	ESP32 Microcontroller	As a controller to make sure the system is functioning [3]
Output	Arduino IoT Cloud	An IoT platform that allows to program the system and also act as General User Interface (GUI).

2.2 Methods

The related sensors are used as an input to identify the canal system condition. The heart of this project would be the ESP32. It is used to control the system functionality and decides what to do if abnormalities are detected. In this case the ESP32 is programmed to send a message to GUI if it detects the abnormalities among the three parameters monitored. For the output of this project, Arduino IoT Cloud act as GUI. The sensors' reading can be monitored on this platform. In addition, the alert message will also be sent to this platform into the messenger widget. Figure 1 shows the detailed process of those three sensors when connected with ESP32.

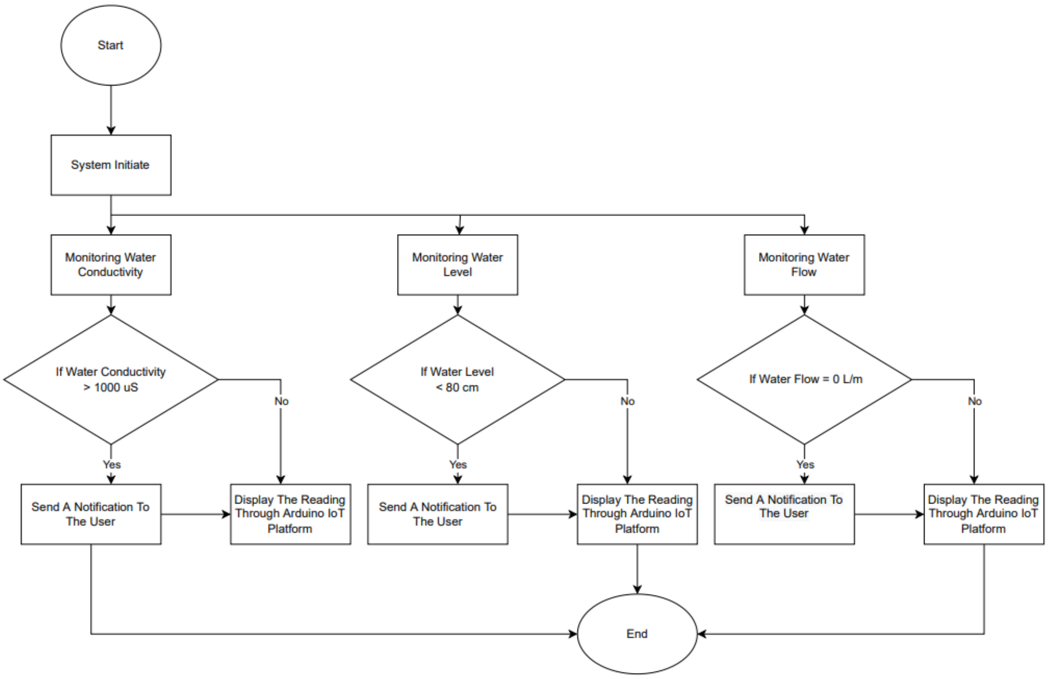

Figure 1: System flowchart

2.3 Equations

The water conductivity can be obtained by identifying the resistance of the water [4]. In theory conductance is inversely proportional to resistance:

$$Conductance = \frac{1}{Resistance} \quad Eq.1$$

The formula in Eq 1 is used in programming the ESP32 to measure the water conductivity. Also, the water level used a mathematical equation to obtain the water surface's distance from the ultrasonic sensor. The equation are as follows:

$$Distance = \frac{Time \times Speed\ of\ Sound}{2} \quad Eq.2$$

The distance can be determined by the time taken for the sound wave to return to the sensor and the speed of the sound transmitted to the water surface [5].

3. Results and Discussion

This section will present the data obtained after running a few tests on the prototype. Each sensor undergoes a different test to verify its functionality. Short-range and long-range tests are conducted for the ultrasonic sensor. Water conductivity test result will be compared with the result obtained from Dissolved Oxygen (DO) meter. Next, the flow rate sensor undergoes a real-life practice test. Lastly, the condition of the parameter is manipulated to test out the notification feature.

3.1 Water conductivity level test result

The water conductivity test is conducted by using six water samples. Three of these are gathered from the real canal system in Parit Raja which is Kolej Kediaman Bistari, Jalan Tembikai and, Taman Universiti. The other three water samples are tap water, drinking water and distilled water. The samples are labelled A, B, C, D, E and, F respectively. The reading obtained from the water conductivity probe is then compared with the reading from DO meter. Table 2 shows the result of the test.

Table 2: Water conductivity test result

Water sample	Average DO meter conductivity reading (µS)	Average Project probe conductivity reading (µS)	Percentage Error (%)
A	359.09	302.76	15.69
B	529.48	486.88	8.05
C	960.08	897.48	6.52
D	120.94	86.12	17.04
E	115.25	54.48	15.78
F	11.30	0.00	Invalid

The result above shows the average reading obtained from the DO meter and conductivity probe. Each sample is measured three times to get a stable reading. The readings are then compared by using percentage error. The percentage error for this test is relatively large indicating that the conductivity probe is not accurate. In addition, the percentage error for sample F is invalid because the conductivity probe could not pick up a low level of conductivity hence the reading is 0 µS. The inaccuracy is caused by the probe not having a fixed distance between the positive and negative probe unlike the DO meter.

3.2 Water level test result

The data obtained from the sensor was compared with an actual measurement of the water level height using a measurement tape. The water level was measured from the sensor to the surface of the water. Table 3 and 4 show the result for short-range and long-range test respectively.

Table 3: Short-range test result

Measured Value (Cm)	Sensor Value (Cm)	Percentage Error (%)
2.000	2.363	18.15
4.000	4.267	6.68
6.000	5.865	2.25
8.000	8.092	1.15
10.000	9.095	9.05
12.000	11.832	1.40
14.000	14.240	1.71
16.000	15.266	4.59
18.000	18.139	0.77
20.000	19.703	1.48

Table 4: Long-range test result

Measured Value (Cm)	Sensor Value (Cm)	Percentage Error (%)
20.000	19.091	4.54
40.000	37.519	6.20
60.000	55.930	6.78
80.000	75.905	5.11
100.000	95.710	4.29
120.000	116.647	2.79
140.000	135.286	3.37
160.000	154.547	3.41
180.000	174.454	3.08
200.000	194.684	2.66

The purposes of this test are to verify the capabilities of the sensor to measure short-range and long-range measurements. From the table above, the percentage error is used to identify how big of the difference is between the two measurements. Overall, the percentage error is in the range of 5% which is good for the accuracy test.

3.3 Water flow test result

The SF-Y201 water flow sensor is dipped into the canal stream. The purpose of this test is to verify the sensor's functionality and capability. Table 5 shows the result obtained after the sensor is dipped into three different locations.

Table 5: Water flow test result

Location	Water flow rate (L/m)
Kolej Kediaman Bistari	0.647
Jalan Tembikai	0
Taman Universiti	0.266

The result shows that the sensor does pick up the flow rate of the canal in L/m. Kolej Kediaman Bistari and Taman Universiti canal system have water flowing hence the reading. Jalan Tembikai canal shows 0 L/m. This shows that there is no water flowing in the canal. This is due to the canal being clogged by trash.

3.4 Notification feature

To test out the notification feature is tested out by manipulating the parameter conditions. The sensor is placed near the surface of the water. The water flow sensor is dipped into a bucket of water which has no flow and the water conductivity probe is dipped into a high conductivity solution which is a salt solution. Figure 2 shows the messenger widget sending the message regarding the abnormality's detection.

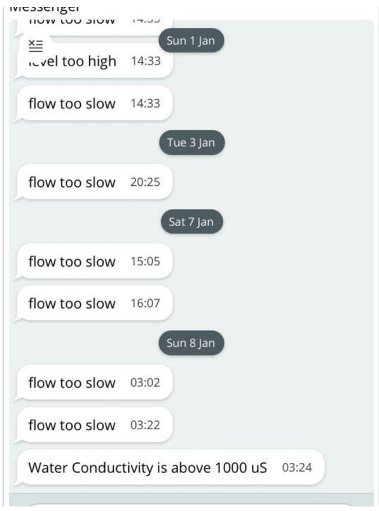

Figure 2: Messenger Widget

4. Conclusion

The system focused on an intelligent canal monitoring system which is controlled by ESP32. The three sensors monitor the canal water conductivity, level and flow and if abnormalities detected it will be supposed to send a message to the GUI. Overall, after running the test on the prototype, the sensors can monitor the canal condition. The test shows that the ultrasonic sensor is accurate, and water flow sensor can detect the flow in the canal stream. However, the water conductivity probe shows the conductivity level but it is not that accurate. In the future, a few adjustments can be made by improving the accuracy of the water conductivity probe or adding other sensors to monitor other parameters. For example, a pH sensor could be used to monitor the pH level of the water. For now, the prototype is sufficient to replace the conventional device at Kolej Kediaman Bistari canal.

Acknowledgement

This research was made possible by the guidance from Dr. Sim Sy Yi and Assoc. Prof. Dr. Md Nor Ramdon Bin Baharom. The authors would also like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] H. K. Mandal and Research, “Influence of Wastewater PH on Turbidity,” *Int. J. Environ. Res. Dev.*, vol. 4, no. 2, pp. 105–114, 2015.

[2] N. Weng Chan, “Increasing flood risk in Malaysia: Causes and solutions,” *Disaster Prev. Manag. An Int. J.*, vol. 6, no. 2, pp. 72–86, 1997, doi: 10.1108/09653569710164035.

[3] M. Babiuch, P. Foltynek, and P. Smutny, “Using the ESP32 microcontroller for data processing,” *Proc. 2019 20th Int. Carpathian Control Conf. ICCC 2019*, no. May 2019, 2019, doi: 10.1109/CarpathianCC.2019.8765944.

[4] Mohammad Almohsin, “Water Conductivity,” no. 1645, pp. 1–76, 2000.

[5] K. G. Panda, D. Agrawal, A. Nshimiyimana, and A. Hossain, “Effects of environment on accuracy of ultrasonic sensor operates in millimetre range,” *Perspect. Sci.*, vol. 8, pp. 574–576, 2016, doi: 10.1016/j.pisc.2016.06.024.