Progress in Engineering Application and Technology Vol. 3 No. 2 (2022) 399-411
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PEAT

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/peat
e-ISSN : 2773-5303

Development of Fog Detector and pH Level Monitoring for Lobster's Farming

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DOI: https://doi.org/10.30880/peat.2022.03.02.040
Received 26 January 2022; Accepted 07 November 2022; Available online 10 December 2022

Abstract: Aquaculture colloquially referred to as fish breeding, is the systematic raising of aquatic animals for human consumption as a primary source of protein. Fish farming can occur in various locales, including domestic tank systems. The fogging actions conducted by health officials frequently result in problems with the tank's water quality and adversely affect the livestock's growth. The project's primary goal is to design a system that can automatically shut down water pumps and notify farmers when sensors detect smoke, develop systems capable of monitoring water pH levels via mobile phones, and discuss the impact of fogging activity on livestock by using Arduino Uno and NodeMCU ESP8266. The use of MQ-2 sensor is to detect gas concentration, and the use of pH sensor is to check the pH of water, while the use of temperature sensor is to measure the water temperature. The MQ-2 sensor can detect high gas concentrations up to 2.4 metres away from the sensor's position. The be.0 st pH ranges for lobster are 7 and 8.5, and the best temperature ranges are 23.0 °C and 31°C. Two distinct water samples were examined and found to have differing pH levels, with tap water having a pH of 6.4 to 7.5 and pesticide-contaminated water having a pH of 5.0 to 5.7. Three different test samples of water were used to achieve three independent temperature readings: cold water temperatures as low as 3.6 °C, normal water temperatures stable between 27.5 °C and 28.5 °C, and hot water temperatures as high as 67.3 °C The system in this project can be enhanced significantly by maximizing the use of Internet of Things (IoT) technology.

Keywords: Aquaculture, Water Quality, Arduino Uno, Internet of Things (IoT)

1. Introduction

Aquaculture is raising and harvesting marine species such as fish for human consumption under controlled conditions [1]. It is comparable to agriculture, except that fish are associated with the word "aqua" rather than plants or livestock. Aquaculture is another term for fish farming. Most likely, farmed

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fish is synonymous with the seafood purchased in our neighborhood grocery shop. Aquaculture may be grown practically anywhere, including coastal ocean waters, freshwater ponds, rivers, and even land-based tanks, and it is growing, particularly in Asia [2]. Animal husbandry and catch fisheries are the world's other two animal protein sources. They were, however, expanding at a considerably slower rate than aquaculture production.

Diverse water conditions are crucial for breeders in aquaculture farming because they affect both the quality of the livestock and the health of the living creature. Water quality is critical for aquatic animals because they live in water. Individual species' water quality requirements necessitate constant monitoring to maintain optimal development and survival circumstances. These include pH and temperature and dissolved oxygen and ammonia concentrations [3].

According to a study conducted in Malaysia, the country reported 130,101 dengue infections in 2019, a 60.00 % raise over 2018, and 182 deaths [4]. According to the results, Malaysia has the third-highest dengue cases and the highest fatality rate among ASEAN countries. As a result, we frequently see health authorities fogging daily to combat dengue outbreaks. Regrettably, certain parties suffer losses as a result of this fogging action. Fogging has had a considerable influence on small-scale lobster breeders in particular. This is because the smoke's chemical components will be spread across the pond, stressing the lobster and ultimately resulting in their death. This problem requires a unique solution, such as developing an automated system capable of detecting fog so that lobster breeders may quickly save their lobster. As a result, a significant financial loss to lobster breeders could be avoided.

This experiment aims to examine the effect of fogging activity on lobsters. A system capable of detecting smoke and gas will be developed to automatically shut down the water pump and send an alert message to breeders when the sensor detects an abnormal amount of smoke or gas. Additionally, a monitoring system will be developed to continuously monitor the pH and temperature of water via an LCD and the Blynk mobile application. Numerous studies have been conducted to understand better the concepts underlying the methods and components to be used in this project. Table 1 below summarizes the study's findings and includes the author's name.

Table 1: Summaries of previous works

Author	Project Title	Objective	Components Used	Software Used
Parak Naik (2007) [5]	Gas sensor using Arduino Uno and MQ2 sensor	to detect gas leaks that occur in the human environment such as at home, in cars, hotels and hospitals.	Arduino Uno MQ-2 sensor	-
Ngochi Renson (2000) [6]	Smoke Alarm	to detect the presence of smoke in the building, indicating the presence of a fire, and to also activate the emergency alarm.	Atmega32 MQ-2 sensor	-
M. M. Rahman (2020) [7]	Internet of Things (IoT) Based Water Quality Monitoring System	to present a basic model of a system which is low cost, less complex and to evaluate the data to compare with Water Quality Index (WQI).	Arduino Uno NodeMCU ESP8266 pH level sensor Temperature sensor Dissolved oxygen sensor Turbidity sensor	Firebase Software

V. V. Daigavane (2020) [8]	Water Quality Monitoring System Based on IOT	to develop and build an economical technology for real-time water quality monitoring in the Internet of Things (IoT).	Atmega238 ESP8266 Wi-Fi module pH level sensor Turbidity sensor Temperature sensor Flow sensor	Blynk Application Software
M. Adib (Author)	Development of Fog Detector and pH Level Monitoring for Lobster's Farming	to detect the absence of fogging smoke while simultaneously monitoring water quality.	Arduino Uno NodeMCU ESP8266 MQ-2 sensor pH sensor Temperature sensor	Blynk Application Software

2. Materials and Methods

Based on previous research, all approaches and components have been determined. This subchapter contains all of the material and methods.

2.1 Materials

The materials used in this project have been divided into three parts: microcontrollers, sensors and components as well as output components.

A. Microcontroller
- Arduino Uno: This microcontroller is used for development of Fog Detectors where it has enough pin legs to use.
- NodeMCU ESP8266: This microcontroller is used for pH Level Monitoring because this microcontroller already has an assembled Wi-Fi-module on the board. This wi-fi module will make it easier to link this microcontroller directly to a Wi-Fi network.

B. Sensors and Components
- MQ-2 Sensor: This sensor is used in this project to detect smoke. This sensor is also capable of detecting several types of gases such as Butane and Hydrogen and the operating voltage for this sensor is 5V.
- pH Sensor: This sensor is used in this project to measure the pH level of water. This sensor is an analog-type, so it requires calibration to get the right pH reading. The operating voltage for this sensor is 5V.
- DS18B20 Sensor: This sensor is a water-rinsing temperature sensor. Water temperature measurements can be taken with this sensor, which can measure temperatures between 55°C and 125°C. 3V to 5V is the operating voltage range for this sensor.
- GSM SIM900A Module: This module an open and digital cellular technology used for transmitting mobile voice and data services operate at the certain frequencies. In this project, it is used for sending an SMS to user after being triggered.
- Relay Module: The opto-type 2 channel relay is used to turn off the water pump by changing the state from normally close to normally open after being triggered.
- AC to DC Converter: This power supply unit is used in this project to convert 240VAC to the VDC value required by the component.

C. Output Components
- Water pump: This water pump is a submersible type and requires 12VDC to function.
- LCD: It is used to display reading values of pH and temperature of water.

- LED: It is used as an indicator when the system has detected a gas value that exceeds the specified threshold.

2.2 Methods

The flowchart in Figure 1 below illustrates the steps necessary to complete this project before obtaining a result. This flowchart must address numerous phases: locating and collecting data based on prior research and study, which is one of the needs of this project. The data would provide some direction and emphasize the critical nature of implementing these initiatives. Following then, the project will be designed utilizing both hardware and software. We will be writing programming code and observing the program's output in this project. If an issue exists, we must first define it by troubleshooting the programming code or the components used until the project's purpose is accomplished.

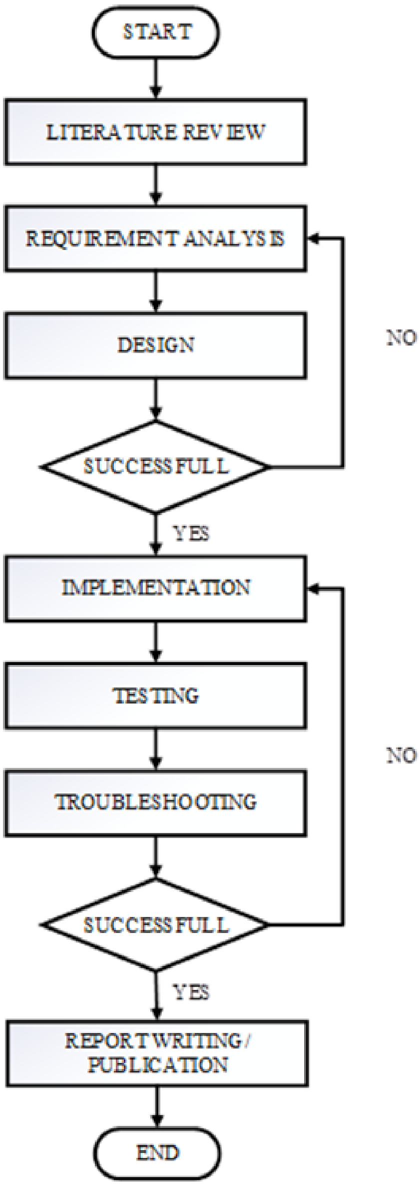
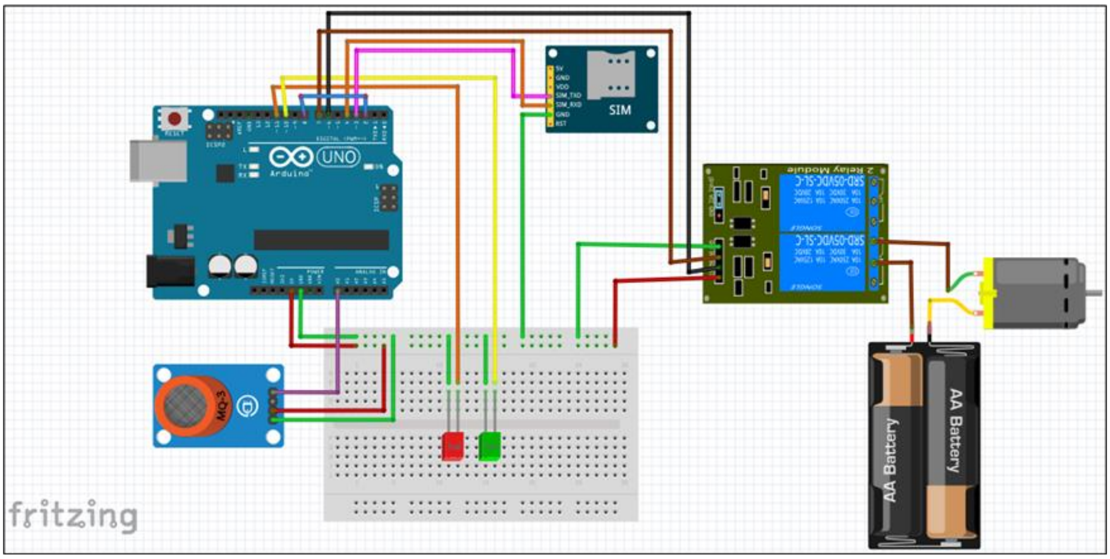
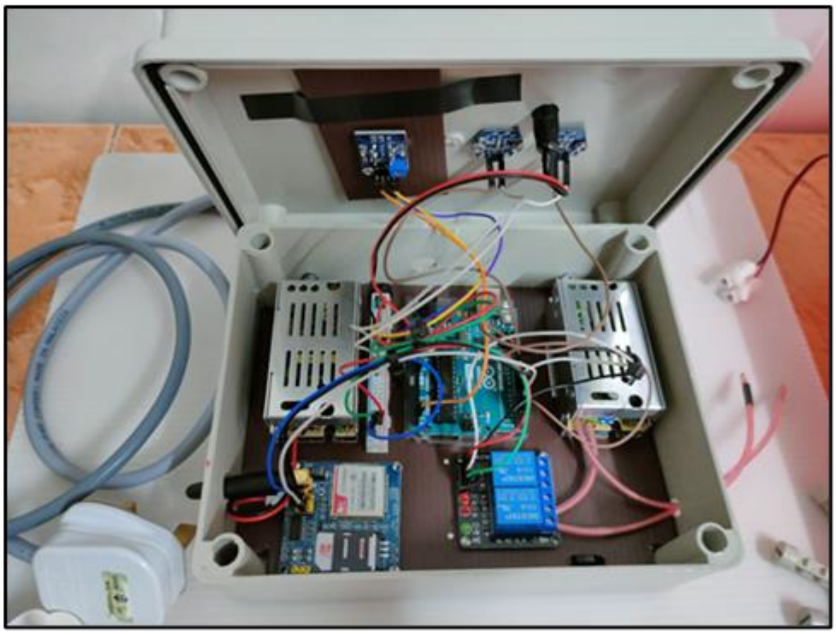


Figure 1: Flowchart of the project planning

The use of two microcontrollers in this project accelerates the development process. An Arduino Uno is used for the Fog Detector, while a NodeMCU ESP8266 is used for pH Level Monitoring. The circuit diagrams for the fog detector and pH level monitoring are shown in Figures 2 and 3, respectively creating both Fog Detector and pH Level Monitoring circuits with the Fritzing software.

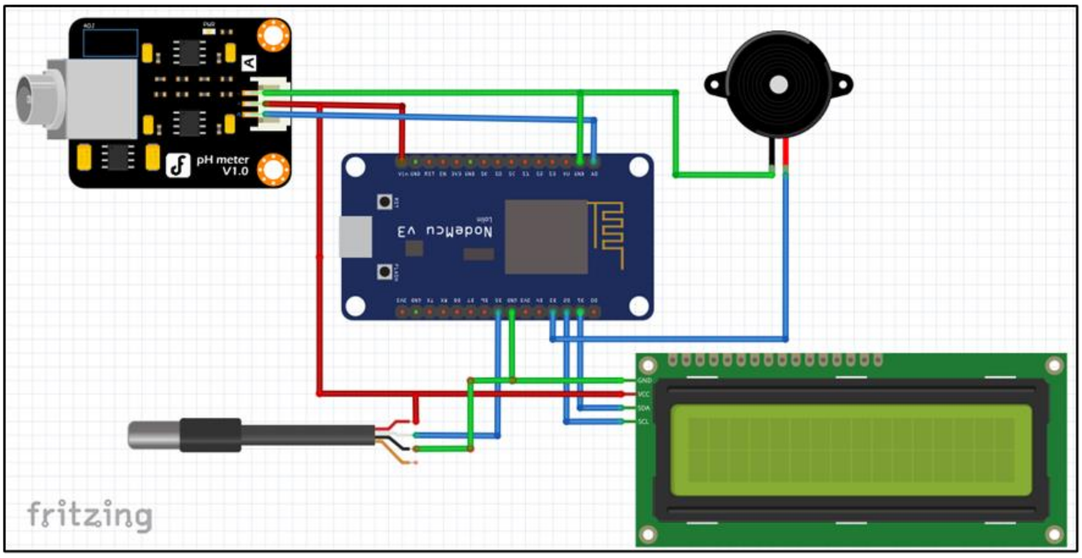


(a)

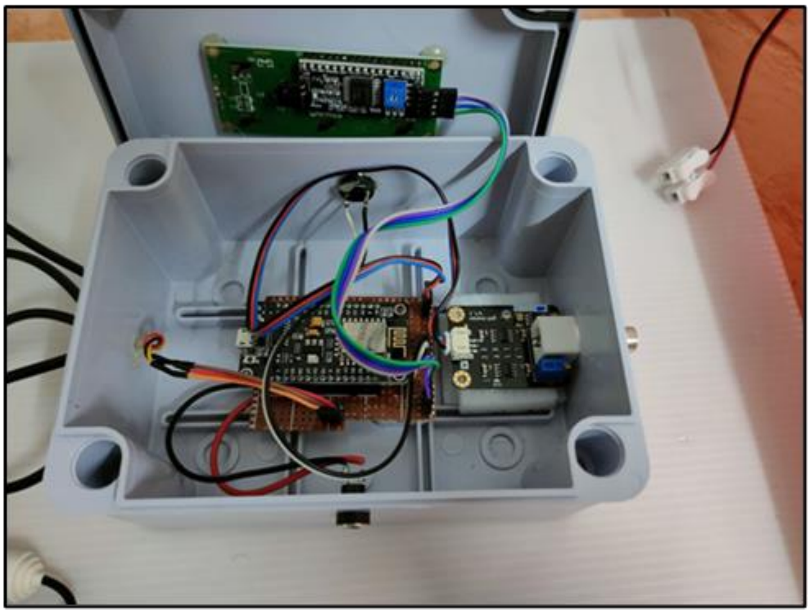


(b)

Figure 2: (a) Circuit diagram of Fog Detector; (b) Development circuit of Fog Detector



(a)



(b)

Figure 3: (a) Circuit diagram of pH Level Monitoring; (b) Development circuit of pH Level Monitoring

For Fog Detector, 9VDC is supplied to the microcontroller Arduino Uno, LED and MQ-2 sensor. The GSM SIM900A module and the water pump are powered by an AC to DC power supply unit (AC-DC Converter) by converting 240VAC to 5VDC and 12VDC respectively. The sensor used for detecting the smoke is an MQ-2 sensor, while the GSM module was used to send SMS to the user when it is triggered. For the wiring connection, the MQ-2 sensor is connected to A5 pin, green LED and red LED is connected to pin 10 and pin 11, TX and RX of the GSM SIM900A module is connected to pin 3 and pin 4, channel 1 and channel 2 of the relay module is connected to pin 6 and pin 7 of the Arduino Uno microcontroller.

Meanwhile for the pH Level Monitoring, 5VDC will be supplied to the whole system by connect the power supply to VIN pin of the NodeMCU ESP8266 via an adapter. pH level sensor and water temperature sensor are used to read the quality of the water, while ESP8266 is used as a Wi-Fi-Module, as a connection between the project and the user's interface by using Blynk application software. The Blynk software has two reading gauges: one for temperature readings and the other for pH level readings. The interface of these mobile apps can be seen in Figure 10. For the wiring connection, pH sensor is connected to pin A0, water temperature sensor is connected to pin D5, buzzer is connected to pin D3 while the LCD pin for Serial Data (SDA) and Serial Clock (SCL) is connected to pin D1 and pin D2 of the NodeMCU ESP8266 microcontroller.

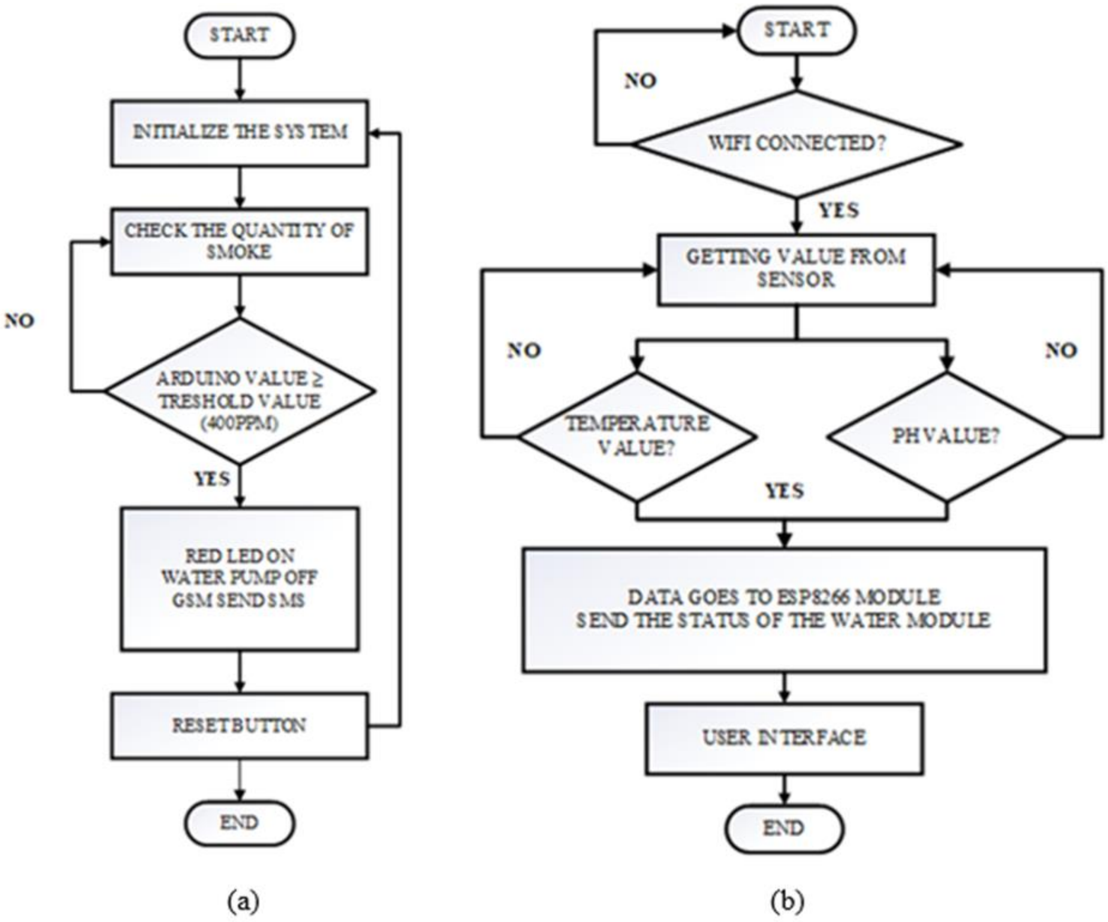


Figure 4: (a) Flowchart of Fog Detector; (b) Flowchart of pH Level Monitoring

Flowchart on the left in Figure 4(a) above shows a Fog Detector process. At the initial condition, the water pump is turned on state. When the MQ-2 sensor detects the smoke more than the threshold value, the sensor's threshold has been set to 400 parts per million (ppm), which will trigger the system. After being triggered, the red LED will turn on, indicating that the system is off and the water pump. Simultaneously, the GSM900A module will be sending an alert SMS to the user's smartphone. The system will turn on back when the reset button is pressed.

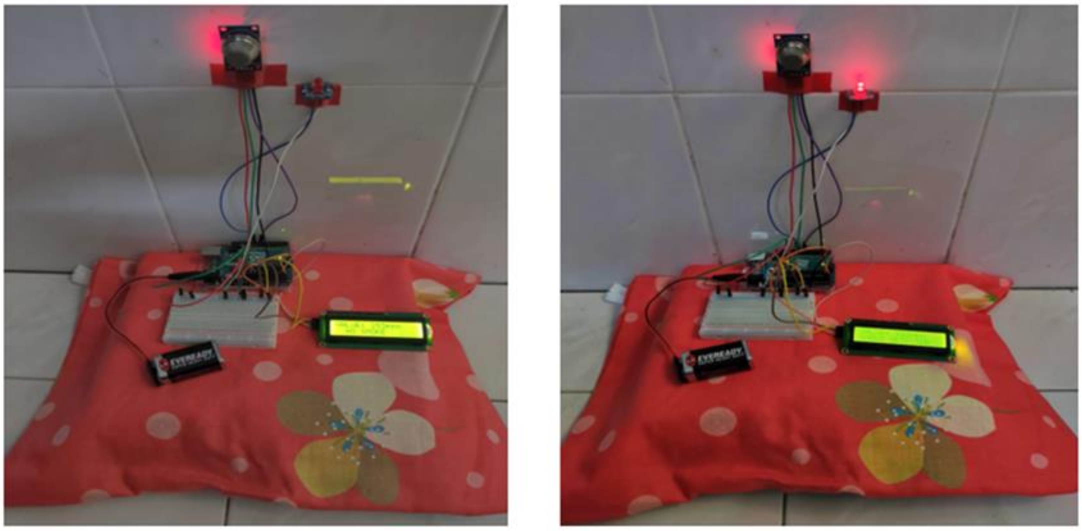
Flowchart on the right in Figure 4(b) above shows the pH Level Monitoring process. After connecting with Wi-Fi, the microcontroller will interface with the sensor and read the sensor's value. At the same time, Blynk software allows users to monitor the sensor's reading value on the apps time by time. If the microcontroller did not detect the reading from pH and temperature sensors, the microcontrollers would continuously be waiting for signals from them. As the reading has been detected, the data will then transfer to the Wi-Fi module, and the status will be uploaded to the mobile application. The respective user will get the report from the Blynk mobile application.

3. Results and Discussion

This section includes results and a discussion of this project.

3.1 Fog Detector's Testing

A preliminary experiment was conducted to determine the effectiveness of the distance between the MQ-2 sensor and the gas sprayer on the sensor's ability to detect gas. The MQ-2 sensor was set at distances of 0.4 m, 0.8 m, 1.2 m, 1.4 m, 1.6 m, 2.0 m, and 2.4 m from the gas sprayer in this study. This experiment utilized a flammable hydrocarbon gas (Aerosol can). The experimental design used to acquire the results is depicted in Figure 5.



(a) (b)

Figure 5: (a) No gas detected; (b) Gas has been detected

The reading was displayed on the LCD and recorded twice at each distance as shown in Table 2.

Table 2: The reading of gas detected at difference distance

Distance (m)	0.4m	0.8m	1.2m	1.6m	2.0m	2.4m
Concentration Value (ppm) – Reading 1	597	546	483	410	385	328
Concentration Value (ppm) – Reading 2	589	551	494	402	388	325
LED Indicator	On	On	On	On	Off	Off

The data in Table 2 above represents the readings obtained using this method. The unit for gas concentration is parts per million (ppm). The gas content in the fresh air was between 150ppm and 250ppm. This project set the concentration cutoff point at 400ppm. When the red LED light on the sensor illuminated, it indicated that it had accurately detected a gas concentration more than the threshold value.

After the experiment has been done, the development of this project was continued by adding several components such as GSM SIM900A module and also water pump. Figure 6 below shows a screenshot of an alert message received by the user on the smartphone when the system has detecting high level of gas.

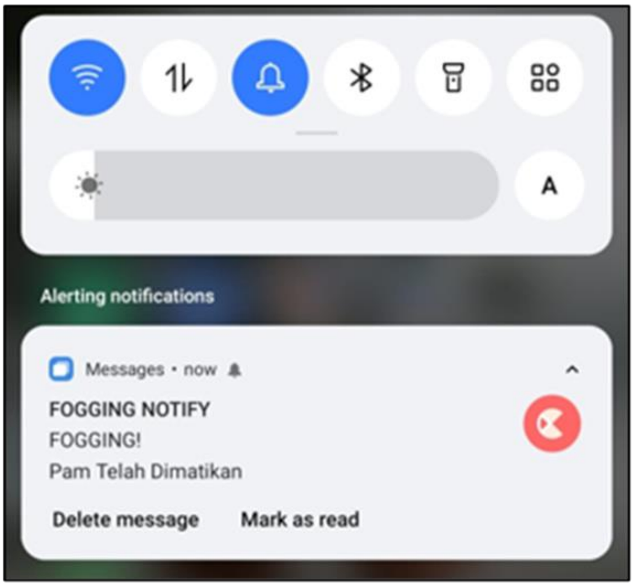
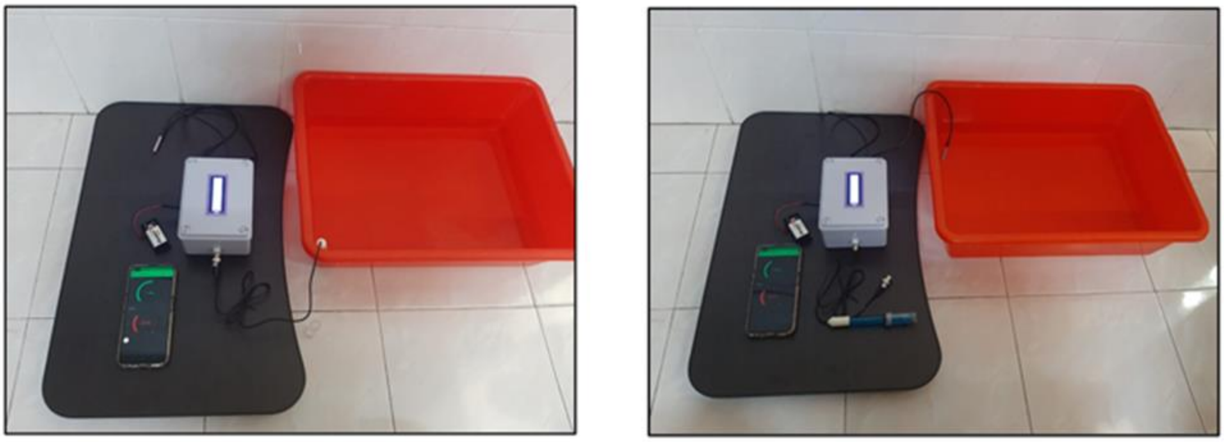


Figure 6: A screenshot of the alert message

3.2 pH Level Monitoring's Testing

The experimental setup depicted in Figure 7 below was used to get data on the pH level and the water temperature. The pH level is determined by examining two samples of water: tap water and water contaminated with pesticides. Then, the experiment determines the water temperature level by examining three degrees of water temperature: hot water, cool water, and cold water. Both containers for the samples were filled to the same level of 4 liters of water, and all of these experiments were conducted indoors.



(a) (b)

Figure 7: (a) pH sensor testing; (b) Water temperature testing

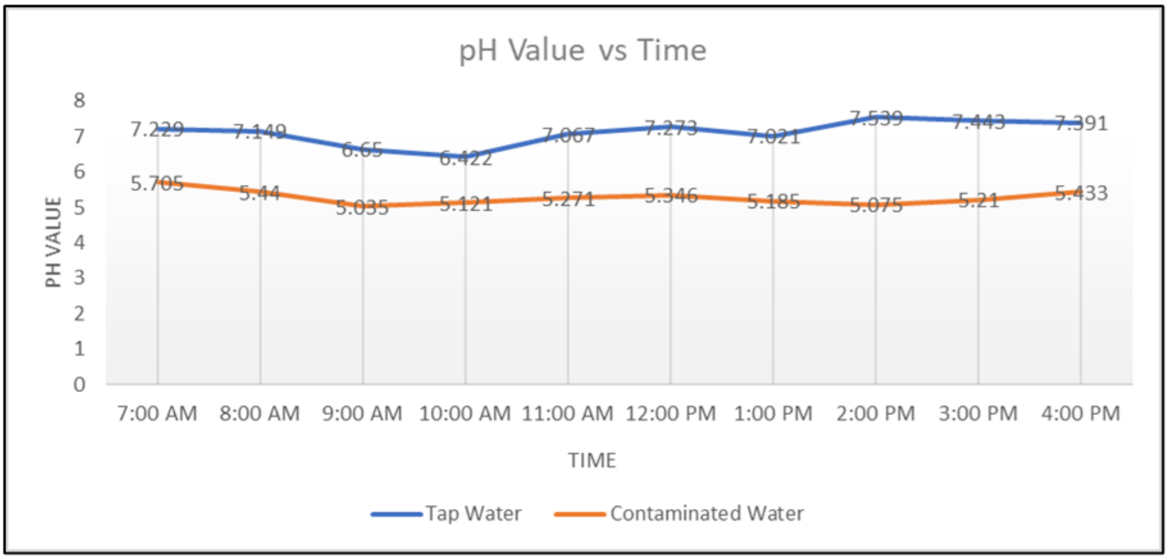


Figure 8: Graph of pH Value vs Time

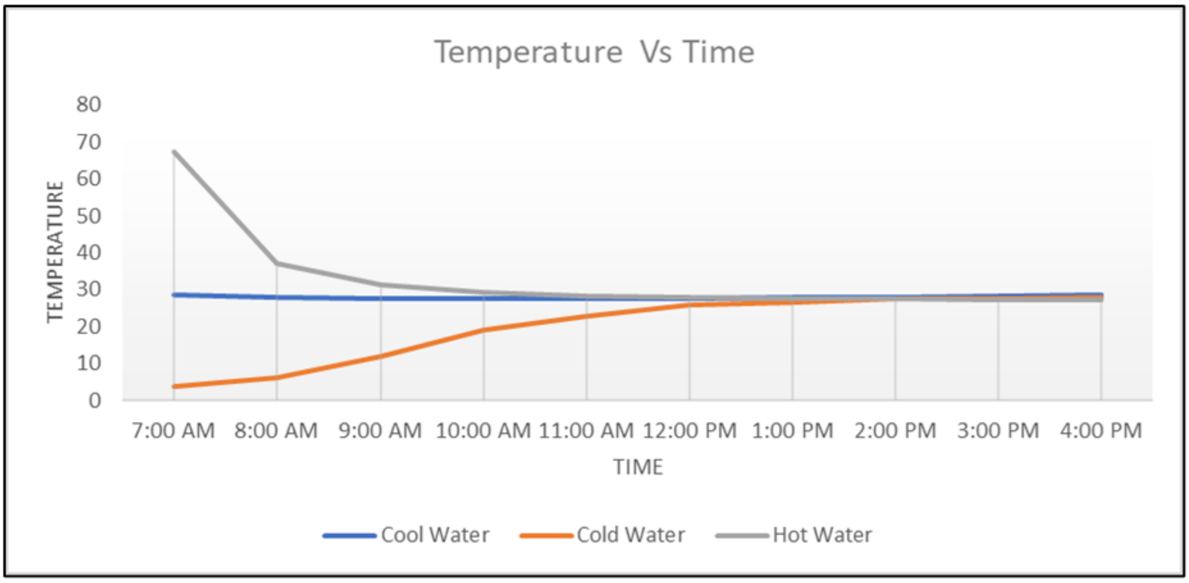


Figure 9: Graph of Temperature vs Time

The graph in Figure 8 above shows the data that has been taken for both water samples for pH level. The data readings for each water sample were taken simultaneously but on different days. The highest pH reading recorded for tap water was at pH 7.5, while the lowest was recorded at pH 6.4. For the contaminated water sample, the highest reading was at pH 5.7, while the lowest reading was recorded at pH 5.0.

According to the author of the first article [9], a pH level between 5 and 9 should be maintained to retain the lobster in its natural habitat. According to the author of the second article, crayfish can be found in waters with a pH of 6.4 to 8.0 [10]. Still, the most significant colonies are frequently found in waters with a pH greater than 7, and a pH of 7 to 8.5 is recommended for freshwater crayfish aquaculture. The author of the previous article [11] stated that the pH level should be set between 7.0 and 8.5 since crayfish are inclined to slower development, disease, and migration if the water quality deteriorates. Based on those studies and experiments carried out, it can be proven that tap water with a pH value of 6.5 to 7 is suitable for lobster breeding; however, pesticide-contaminated water with a pH value of less than 6 is not.

While taking the measurement reading, the reading value from the pH sensor is not stable. So, the data is taken by taking the average reading value at each hour. As a result, the data gathered readings might be less precise than the actual pH value measurement because only a pH analog-type sensor is used in this test. The results obtained from this experiment by using the pH analog-type sensor should be compared to the readings from the digital pH sensors to determine the difference in measurement % error between the two types of sensors.

The graph in Figure 9 above depicts the data collected for each of the three water samples, each of which had a different temperature, and the type of water being used is tap water. Also, each water sample's data was collected simultaneously but on different days. According to the graph, cool water temperature remains steady at roughly 27.5 °C to 28.5 °C. For cold water temperatures, the coldest temperature was recorded at 3.6 °C, and it took around 5 to 6 hours for the temperature to stabilize. For hot water, the measured boiling temperature is at 67.3 °C, and the water temperature stabilizes in around 3 to 4 hours.

The optimal temperature for freshwater crayfish is between 23.0 °C and 31.0 °C, and they will perish at temperatures below 10.0 °C and above 36.0 °C, according to the first article [12]. Only if the water temperature remains above 23°C will reproduction occur, and when the water temperature reaches 25.0 °C, the juvenile production will begin to harvest. The author of the second article [13] stated that the ideal water temperature range for crayfish is 23.0 °C to 31.0 °C, and that crayfish growth is significantly impeded at temperatures below 20.0 °C. Based on the findings of those studies and experiments, it appears that cool water, with an average temperature of 27.5 °C to 28.5 °C, is the best temperature for lobster breeding. The lobster will grow in most regions with good water quality, and increasing water temperatures will likely result in higher production rates [10].

However, this test was carried out indoors. So, all of this data is likely affected by room temperature. Each graph depicts in Figure 8 and 9 are generate manually by using Microsoft Excel. In addition to the LCD, the Blynk app on the user's smartphone allows them to keep tabs on the water's condition. With this Blynk app, users can keep track of changes in pH and temperature over time. Figure 10 below shows the interface of the Blynk app.

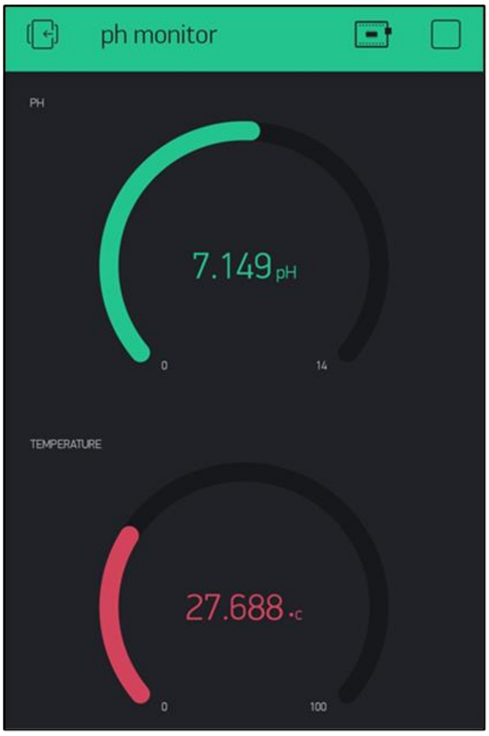


Figure 10: Blynk app's interface

4. Conclusion

Malaysian farmers have responded well to aquaculture, whether for commercial objectives or as a hobby. Some critical water characteristics for lobster farming have been established through research, including pH levels and optimum water temperatures. Tap water with pH ranges of 7 is suitable for lobster reproduction, according to experiments conducted on two water samples, as the pH suited for lobster is approximately 7 to 9. A pH of less than 6 is, on the other hand, extremely dangerous. Regarding water temperatures, lobsters prefer cool water with a temperature range of 27.5 °C to 28.5 °C.

The issues raised in the problem statement section have been addressed in the proposed system. Breeders may benefit from the project because it will allow them to monitor their livestock's living conditions and, at the very least, give them enough time to save their lobsters from fogging activities. However, there are some limitations to this project, such as the manual reset button will cause a delay in reviving the water pump, leading to a lack of oxygen in the pond. Besides, this system only allows users to monitor two types of water parameters: pH and temperature, and users are not able to view previous water parameter reading data.

Various ideas for future work might be made to alleviate the project's limitations and improve the suggested project's lack. For example, users can utilize the Blynk App's virtual button reset instead of the physical reset button to revive the water pump automatically. Then, some sensors, such as turbidity, dissolved oxygen, and conductivity sensors, could be added to understand water quality better. Lastly, users can log historical sensor data by using various Internet of Things (IoT) platforms to store data, such as PLX-DAQ software, ThingSpeak, and Firebase.

To summarize, this project's objectives have all been met. This research has successfully built a system capable of detecting smoke or gas while simultaneously monitoring critical water quality factors such as pH and temperature over time. This study also highlights the importance of water conditions and lobster farming sustainability.

Acknowledgement

The author would like to thank Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia for its support.

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