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IoT Monitoring System for Aquaculture Farming

Lim Jia Hui[1], Huda Bin A Majid[1]*

[1]Department of Electrical Engineering Technology, Faculty of Engineering Technology,
Universiti Tun Hussein Onn Malaysia, 84600 Pagoh, Johor, MALAYSIA

*Corresponding Author Designation

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Abstract: In aquaculture farming, the water quality is important to maintain the health of the aquatic along the farming period. Aquaculture monitoring procedures in Malaysia are currently inefficient as the farmers waste many time and costs to reduce the mortality of the aquatic in terms of human resources. The main objective of this project is to develop a wireless system which is Internet of Things (IoT) for remote monitoring aquaculture farming. Besides, the objective is to develop a water monitoring system android application for aquaculture farming and to study the proper habitat for freshwater prawn. The cloud the database system for the water condition and the surrounding condition is proposed. Arduino Uno, humidity sensors, waterproof temperature sensor and ultrasonic sensor are used to collect and send data. The data will be sent to cloud platform via wireless internet connection and can be viewed on android-based smartphone. The system can be improved by integrating an autonomous farming system.

Keywords: IoT, Monitoring System, Aquaculture, Wireless

1. Introduction

Malaysia were developed well before independence as Malaysia is well known for its aquaculture activities and is still one of the main holders of aquaculture products in South East Asia where the production of freshwater prawns is one of the industries. Nowadays with the advancement in integrated on chip computers which is reaching ground level with its application in aquaculture.[1] In freshwater prawn aquaculture, water quality is important and need to maintain in good condition to make sure a healthy prawn life along the farming period of the aquaculture.[2] There are water quality parameters and environment condition parameters involved such as water temperature, water level, air temperature and air humidity. Online water quality monitoring systems allow monitor data collection and take action only when the data fall below a particular threshold. This has the advantage of not only enhancing the current aquaculture management but also providing valuable data for the potential growth of aquaculture sector.[3]

Corresponding author: mhuda@uthm.edu.my

Aquaculture monitoring procedures in Malaysia are currently inefficient as the farmers waste many time and costs to monitor and enhance the survival rate of the freshwater prawn in terms of human resources. Traditional water monitoring method need the farmers manually collecting the water sample and then testing it in the laboratory.[4] The testing should be carried out frequently to maintain the water quality for high yield, health and safety of aquatic.[6] It needs to spend a lot of money and time to be done. A more sophisticated technique is often used to calculate the water quality parameters regularly by using handheld instruments.[5]

1.1 Problem Statement

Aquaculture is a rapidly developing form of food production that has effectively produced significant amounts of fish and prawn to help support the rising population of the world and increase food appetite. However, this food processing system faces many obstacles, some of which included rising prices, tighter regulatory controls and insufficient water sources. Hence, it is important to solve the problems with the support of technology.[7] Besides, aquaculture monitoring procedures in Malaysia are currently inefficient as the farmers waste many time and costs to monitor and enhance the survival rate of the freshwater prawn in terms of human resources.

1.2 Objective

This project is carried out to study the proper habitat for freshwater prawn and develop a wireless system for remote monitoring aquaculture farming. A wireless system will be built for remote monitoring aquaculture farming. Besides, a water monitoring system android application for aquaculture farming will be developed to that the user could receive notification if the value dropped to a particular threshold. All the database of the water condition and surrounding condition will be cloud on a platform. The wireless system with wireless connection inserted to the monitoring system for aquaculture so that is can automatically update the data of the water condition anytime.

2. Literature Review

The related projected is investigated to identify the important part of this type of monitoring system. The project entitled Design and Implementation of a Distributed IoT System for The Monitoring of Water used Arduino Uno as the Microcontroller Units. This project will be lower cost and power consumption compare to others related project. The project entitled Water Monitoring IoT System for Fish Farming Ponds used DS18b20 as the water temperature sensor. This water temperature sensor is the cheapest, most easy to be setup among all the related projects. The characteristics of water suitable for the freshwater prawn farming is recorded. The table 1 shows the recommended range of the parameter for freshwater prawns, Macrobrachium Rosenbergii. [8]

Table 1: Characteristics of water suitable for the freshwater prawn [8]

Parameter	Recommended Range for Freshwater Prawns
Water Temperature	28℃ - 33℃
pH (units)	7.0 – 8.5
Dissolved oxygen (ppm DO_2)	3 – 7
Salinity (ppt)	<10
Transparency (cm)	25 - 40

3. Materials and Methods

The material and the methods are included in this subchapter. The microcontroller as the MCU used in this project is Arduino Uno. The cloud platform used to store and analyse data is ThingSpeak. MIT App Inventor is used to develop an application that is only for Android based smartphone.

3.1 Materials

Materials used in this project are Arduino Uno, ESP8266 Wi-Fi module, DHT-11 temperature and humidity sensor, ultrasonic ranging module SN-HC-SR04 and Waterproof Temperature Sensor DS18B20. The software and website used in this project are Arduino IDE, ThingSpeak and MIT App Inventor.

- Arduino Uno is chosen because the pins needed by this project not more than 13 digital PWM pins.
- ESP8266 is a Wi-Fi module to allow the Arduino connected to the Wi-Fi and send the data to ThingSpeak. The TX pin and the RX pin of the module is connected to the Pin 11 and Pin 10 of the Arduino respectively.
- DHT-11 is a temperature and humidity sensor. It can detect the air temperature and humidity and send it to Arduino through the data pin. In this project Pin 7.
- Ultrasonic Ranging Module SN-HC-SR04 is used as a water level sensor in this project. It used to detect the water level of the container. The trigger pin and the echo pin on the sensor are connected to the pin 2 and the pin 3 of Arduino respectively.
- DS18B20 is the waterproof temperature sensor. It used to detect the water temperature in this project. The data pin of this sensor is connected to the pin 7 of Arduino.
- ThingSpeak is signed up and free to use up to 8 fields. This project only used 4 fields. ThingSpeak will auto analysed the data and show as chart form.
- MIT App Inventor is a website to create android application. It is free to use and very user-friendly so it is suitable for the beginner in application development.

3.2 Method

Figure 1 is the flow of the project. The project began with the problem statement. The objective and solution are defined according to the problem based on the study of the related IoT aquaculture monitoring system. After deciding the scope of the project, the next step is to design the system. The designing of the system included schematic design of the system, component selection, hardware development of the prototype and software development. The software development is the coding and simulation. Next, the hardware developed, and software developed is tested before the finalize the product. The report writing is keep going along with different phase of the project so that no information is left behind.

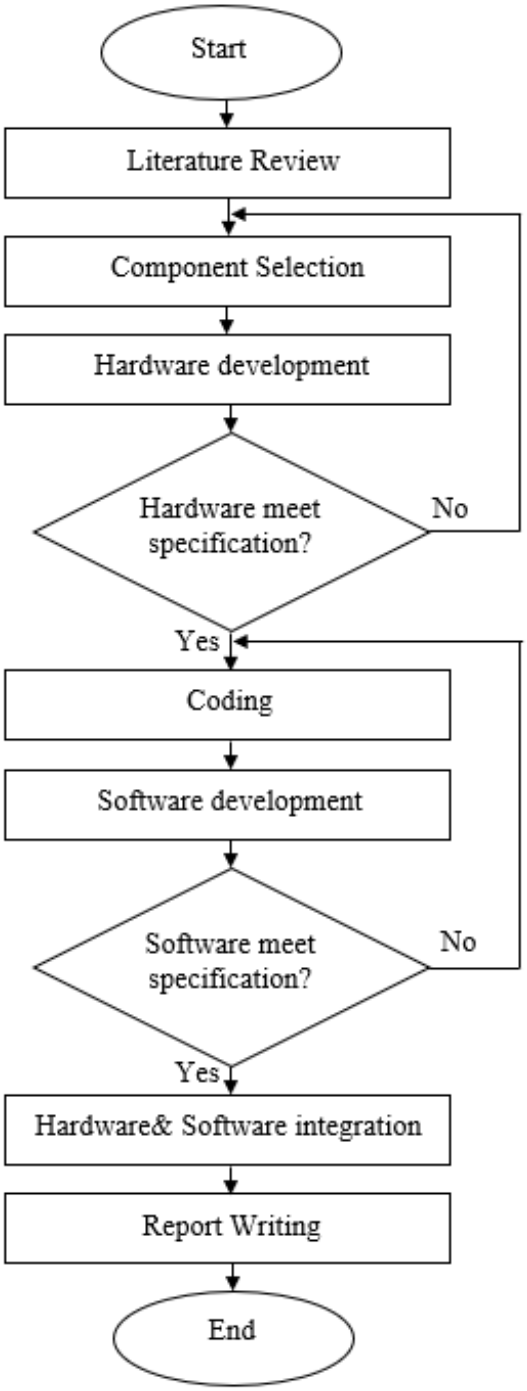

Figure 1: Flowchart of the project

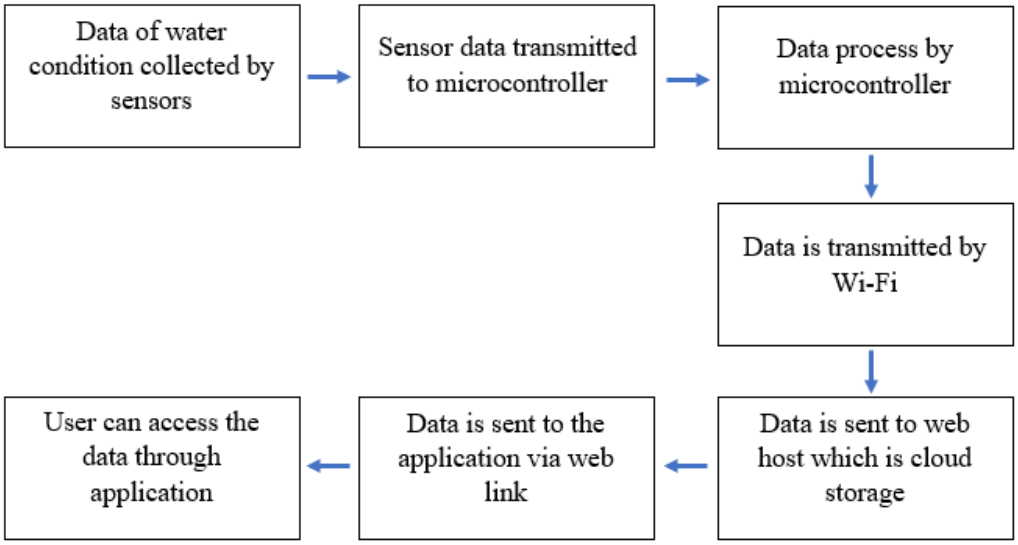

Figure 2: Data transmission block diagram

Figure 2 roughly described the data transmission of the project. Sensor was put in the tank which is the source of data collection. The data collected will be sent to the microcontroller unit (MCU) and transmitted to the web host service by web host. The data will be store and analyzed by web host. After that, the data can be access by the user through the application that developed on the android-based smartphone by using MIT App Inventor. The application will indicate whether the data achieve the requirement. An alarm will be issued if one of the parameter data failed to achieve the requirement.

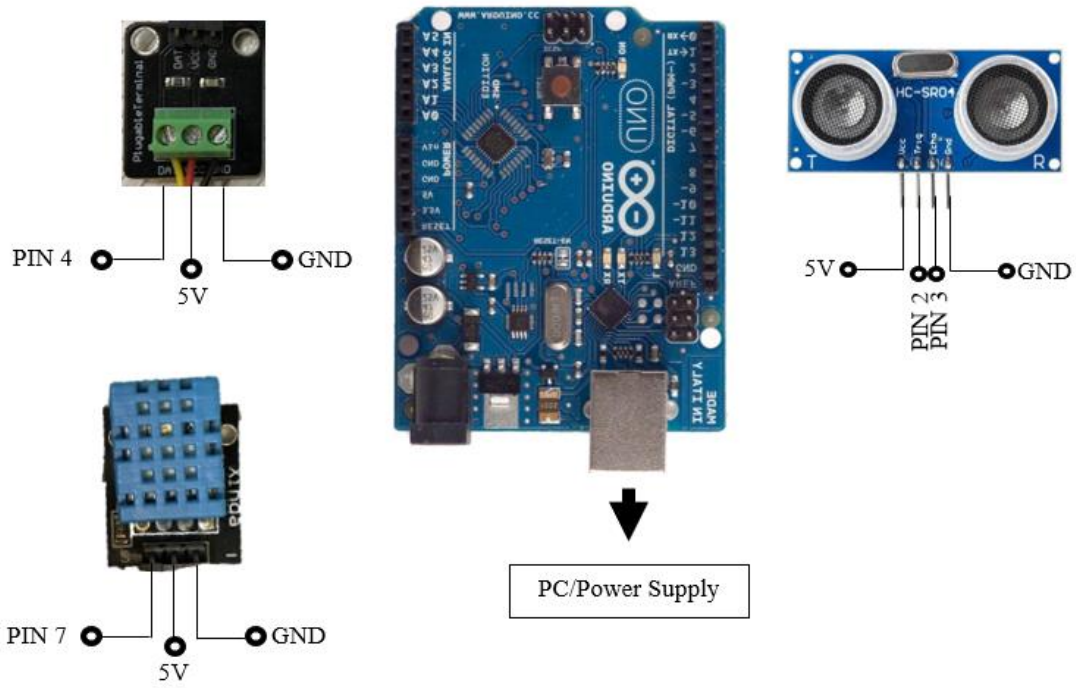

Figure 3: Components connection diagram

Figure 3 is the components connection diagram. All the sensors data pin are connected to the digital (pwm) pin on the Arduino Uno. All the sensors used 5 V and connected to ground. Arduino Uno is connected to the computer to upload the code and run by using a portable charger.

4. Results and Discussion

In this subchapter, the results and the discussion of the project are included.

4.1 Results

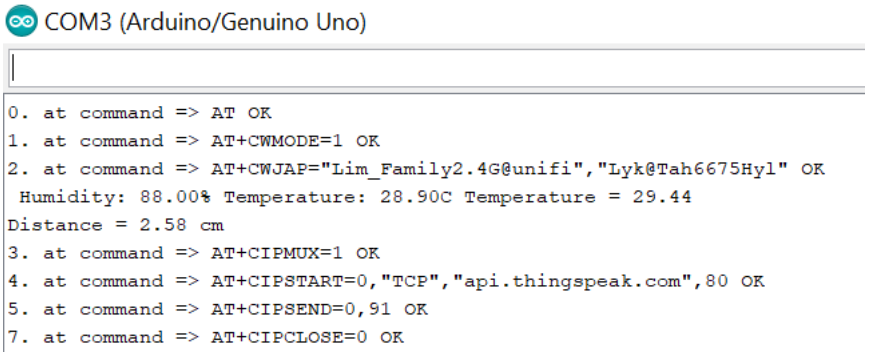

Figure 4: Output on serial monitor

Figure 4 is the output of the serial monitor on Arduino IDE application. The results AT+CWJAP is "OK" means the ESP8266 is successfully connected to the Wi-Fi. All the at command represent the data transmission between the component. The value detected by the sensors also displayed on the serial monitor output as it will be easier to check the coding before connected to ThingSpeak. When Arduino is successfully connected with the ThingSpeak, data will auto be analyzed, and a graph will show on each field.

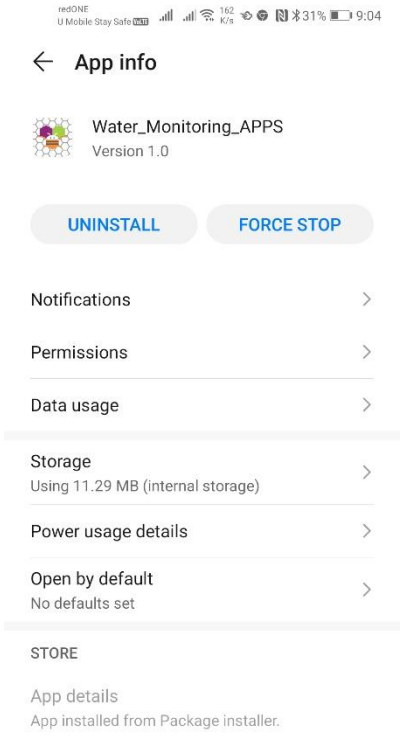

Figure 5: Application information in Huawei smartphone

Figure 5 is the application developed by using MIT App Inventor and installed in the Huawei 5T smartphone with android based. The application named Water_Monitoring_APPS. This application is taking up 11.27 MB from the internal storage of the smartphone.

Figure 6: User interface of the Water_Monitoring_APPS

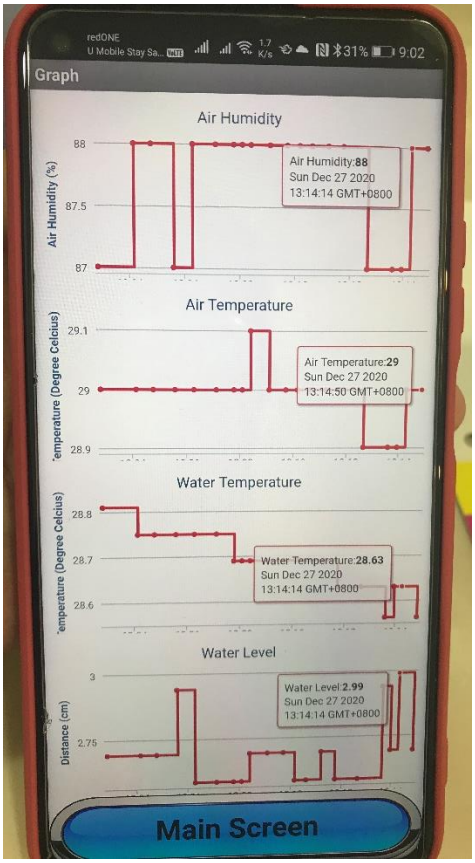

Figure 7: User interface of the Water_Monitoring_APPS

Figures above are the interface of the application Water_Monitoring_APPS. Figure 6 is the screen 1 in the MIT App Inventor. The alarm statements will switch between black and green colour. When the blue button 'Graph' is pressed, the screen will switch to screen 2 which is Figure 7. Screen 2 is the graph with 20 latest results on the graph. The graph style is step graph. There is also a blue button 'Main Screen' function to switch the screen to screen 1 which is the screen with data values, ThingSpeak status and alarm.

Figure 6 displayed the real-time air humidity, air temperature, water level and water temperature. It will automatically update from time to time. The status is the time of the result received by the ThingSpeak and shown on the application. The function of the alarm is to notify the user when the water condition is abnormal. The font colour of the statement will turned from green to red when there is any abnormal water condition.

Figure 7 display the analysed graph of the data received by the sensors. The graph shown the latest 20 results received on the ThingSpeak. The first graph, second graph, third graph and fourth graph displayed the air humidity, air temperature, water temperature and water level respectively. The graph can be zoom in and zoom to easier the user check the value.

All the results are taken indoor. Hence, the air temperature is the room temperature, and the water temperature took the water placed in the room. The ESP8266 is connected to home's Wi-Fi. The results will be updated from time to time since the Wi-Fi is connected.

4.2 System Testing

Since the results in the previous subchapter were taken in the room temperature, all the condition is good. This subchapter is about the testing of the system in specific condition.

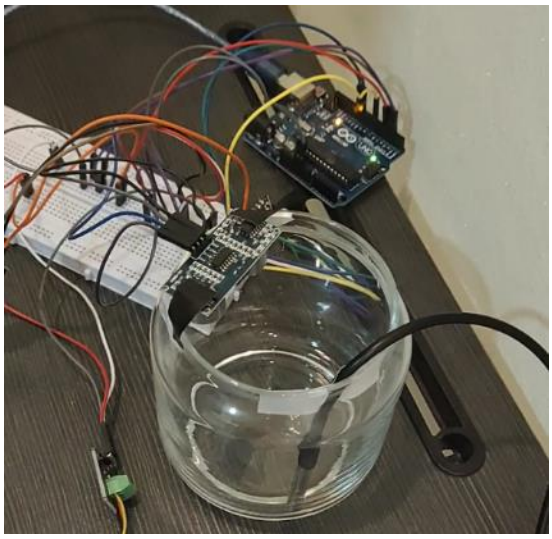

Figure 8: A container is prepared without any water

Figure 8 is an empty glass container. This is the first setup condition for the testing. An ultrasonic sensor and a temperature sensor were installed. The Arduino is powered on by using a portable charger. The data is collected by the sensors and shows in the Water_Monitoring_APPS. In this case, the water level alarm will be generated and shown that "The water level is too low."

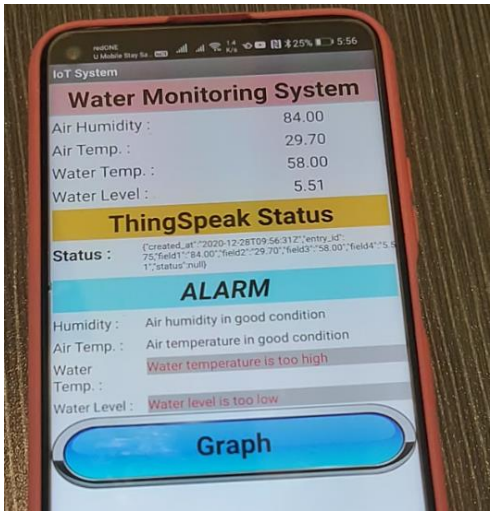

Figure 9: Water_Monitoring_APPS result

After the hot water added to the container, the statement become red, and it stated the water temperature is too high. Figure 9 display an alarm generated by the application when the water temperature is over the range. Since the water added is too little, the water level have not reached the assign range. Hence, the alarm of the water level still too low. After that, the humidity sensor is tested by using a lighter and the result was recorded.

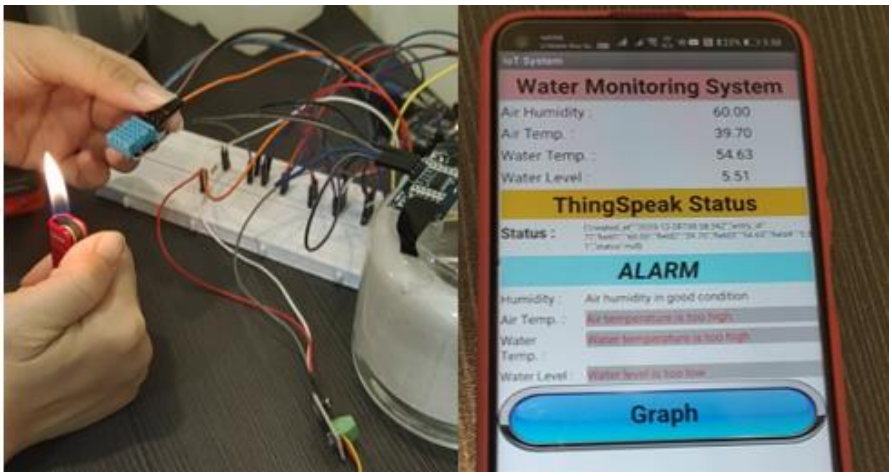

Figure 10: The humidity sensor tested by using lighter and the results on the application

Figure 10 shown the testing of the humidity sensor. A lighter is used to heat up the surrounding air temperature of the sensor. By heating up the air temperature, the humidity will decrease as well. The application shown the results of the testing. The font colour of the air temperature is turned to red as the air temperature is over the assigned range.

Figure 11: The result recorded after adding cold water

After adding the cold water, the water level reached the assign range, and the temperature is cooled down. Since the surrounding temperature is cooled down, so the air temperature is turn into good condition. The results shown that all the sensors worked properly and precisely. The ThingSpeak Status shown the data received time.

The water level range is assigned between 25.00 % to 75.00 % of the container. The air temperature is set between 25 ℃ to 35 ℃ because when the air temperature will cool down or heat up faster than the water temperature. Hence, the farmer can take action before the water temperature change. The air humidity is set between not less than 50.00 % because the water will evaporate faster when the humidity is low. The farmer can take action before the water level drop to danger level.

4.3 Notable features of the system

Notable features of this system is monitoring from anywhere and anytime. This is an IoT monitoring that used the wireless connection function allowing the user to observe the water condition, or the surrounding situation of the farm. On the other hand, this system can save the expenses of the user. Aquaculture farmer will be the target user and they can save the expenses of farm by using this system. The hardware cost is cheaper than using the traditional water testing method and also the time can be saved. This system can last at least 10 years with maintenance. Besides, this system also will generate the alarm if the farm has any condition. Farmer can take action as soon as possible to reduce the amount of loss. It can increase the gross profit of the farmer and maintain the health of the aquatic life.

5. Conclusion

In conclusion, the Internet of Things (IoT) monitoring system is an improvement for the aquaculture farming. The project was developed successfully by spending less than RM 100. Hence, it is affordable for all farmers. The system can monitor the condition of water and environment from time to time so that the income and the food production can be increased. The farmer can reduce the expenses in water monitoring by integrating this system to the farm. By implementing this system, the rate of mortality of the aquatic can be reduce and the profit can be increased as the farmer can monitor the water from smartphone and take action immediately when the alarm shown any abnormal. There are some limitations of the system. The system only can monitor the water without any control or autonomous function. Besides, the data transmission is relied on the Wi-Fi connection, so the application will not be able to update when connection lost. Furthermore, the application developed is only applicable on

android based smartphone. However, there are some improvements can be done to enhance the utility of the system by adding the control function to the system such as adding water manually or automatically when the water level is too low. Besides, the backup for the internet connection can be added by installing the 4G/LTE module on the microcontroller.

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