Penerbit UTHM

© Universiti Tun Hussein Onn Malaysia Publisher's Office

JAITA

http://publisher.uthm.edu.my/ojs/index.php/jaita

e-ISSN : 2716-7097

Journal of Advanced Industrial Technology and Application

Development of Monitoring System Based on Internet of Things (IoT) for Freshwater Prawn Farming

Muhammad Irham Rami[1], Huda A Majid[1]*, Najib Al-Fadhali[1]

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

*Corresponding Author

DOI: https://doi.org/10.30880/jaita.2022.03.02.002
Received 4 August 2022; Accepted 01 October 2022; Available online 8 December 2022

Abstract: Aqua-farming or water farming is an aquatic counterpart to agriculture or ground farming. It is one of methods to make out foods or commercial product. With the current incompetent aqua-farming activities such as labour energy consumption to monitor the water quality and to change the water in the tank in schedule so that this project is important to tackle down the problems stated. This project aimed to reduce the incompetency of water quality monitoring process and the water changing process by developing a vertical freshwater prawn tank to reduce space with an automated water changing and IoT based monitoring system. The autonomous system implemented with solenoid valve and water pump will recycle the water from the prawn tanks with the clean water from the reservoir tank. The monitoring system employs ultrasonic sensor and waterproof temperature sensor that will monitor the water level in the prawn tanks and the temperature of the water respectively that will be visualized in the Thing speak Channel regularly. This project will be implemented as a prototype with an IoT technology for the freshwater prawn farming activity using low-cost embedded devices like Arduino Mega2560, ESP8266 Wi-Fi module and the RTC module. The value from the sensors' reading will be visualized in the Thing speak Channel display.

Keywords: Aqua-farming, IoT, autonomous, monitoring system

1. Introduction

Aquafarming or also known as aquaculture farming is familiar method nowadays which involved controlled cultivation farming method of aquatic organisms or plants. This method engaged with freshwater and saltwater populations cultivated under supervised or semi-natural circumstances. Aquafarming can be carried out in totally man-made facilities on land (onshore aquaculture) such as in the fish tank, raceways, or pond in such literally rely on human energy and control. Data from Food and Agriculture Organization of United Nations has been published by World Development Indicators – World Bank in ourworldindata.org website. The data shows an output from aquaculture activities that designated for final harvest for consumption. From Fig. 1 below shows that East Asia & Pacific region increasingly and highest aquaculture output production from 1960 to 2018 which can be concluded that aquaculture farming is one of the big and important contributors to the economy and humankind food chain supplies.

Corresponding author: mhuda@uthm.edu.my

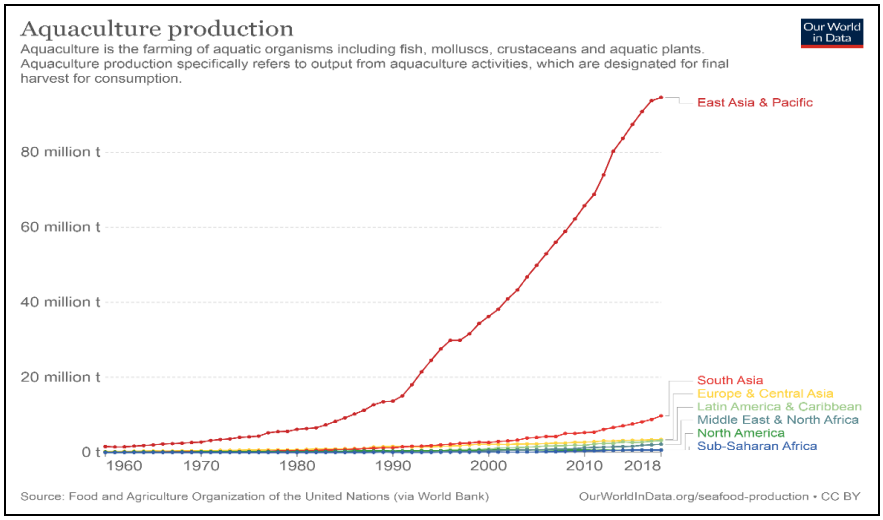

Fig. 1 - Aquaculture production (by: FAO)

In freshwater prawn aqua-farming activities, it is important to monitor the parameters of water quality for the prawn. The basic physical parameters to determine the water quality in this project need to be maintained and managed in an aqua-farming system. Dissolved oxygen (DO), temperature, potential of hydrogen (pH) level and salinity is among the parameters for the survival of the freshwater prawn. Sudden alteration in these parameters can make a massive difference on the aquatic life welfare and survival such as the health, feeding utilization, growth rate and carrying capacities [3].

It is already proven that Internet of Things (IoT) can develop tremendous ton of smart application domain worldwide years to years [2,3]. It can help agriculture practitioner or farmer to improve and modernize their method to cultivate their crops [4-6]. In some other cases, IoT in aquaculture can make aquaculture operations more efficient and eco-friendlier. For example, IoT technology can help to reduce human power to collect data on site, monitor water quality, analyze feeding patterns and monitor weather conditions with the help of developed platform using mobile devices, sensors, and automated feeding system.

In the IR4.0, one of the aims is to modernize crops and to make the enterprises smart. With the help of smart technologies, farmers and agriculture methods will have greater control over their operations [7-10]. Some of the available technologies are already in the marketplace and some of them in the trial phase. These technologies said to be the solution and more efficient and accurate than traditional methods. Briefly, there are many applications of IoT system in aquaculture nowadays such as Artificial Intelligence shrimp counter (solution to hand-counting), On-Site camera fish behavior monitor used for automated and precision fish-feed to avoid overfeeding and one of the simple technologies is using satellite imaginary to include data such as water temperature that mainly effects the feeding behavior [1].

1.1 Problem Statements

With the current incompetent aqua-farming activities especially regarding with water quality monitoring process lead for this project development. There is still problem with the labor energy consumption to monitor the water quality and to change the water in the tank in schedule. This monitoring process should be repeated on a regular basis to assure that the water quality level complies with the parameter of good water quality for the freshwater prawn habitat.

1.2 Objectives

Several numbers of objectives that must be achieved in this project development are:

- To develop a vertical farming for freshwater prawn to save crop spaces
- To develop an autonomous water exchanging system with smart monitoring system for the freshwater prawn farming
- To secure a connection system between the monitoring system with the Thingspeak Channel database

1.3 Project's Scopes

To meet with the project's goals, the project development will be guided with several scopes of project set and planned to ensure the project implementation run smoothly.

- A vertical farming style prawn tank will be developed and placed on a boltless steel rack with dimension of 180cm (Height) x 180cm (Length) x 60cm (Width)
- The monitoring system will include an automatic sensor which are the waterproof temperature to measure the water temperature and ultrasonic sensor to evaluate water level respectively.
- The project is using Arduino for autonomous and monitoring system and the wireless connection should inserted to the Arduino.
- The monitoring system will gather data information from the sensors and will stored the data into the clouds which are the Thingspeak database.
- The autonomous system will play a role for the automatic water changing process via the Solenoid valve to control the water flow connected to relay module.

1.4 Research Methodology's Summary

An autonomous system with an IoT (Internet of Things) based for the vertical farming of the freshwater prawn will be developed that mainly to monitor the temperature of the water and water level that will be sent to Thingspeak database. The autonomous system includes on the process of water exchanging from the tank with the reservoir tank. This system includes Arduino Mega 2560 as the main MCU, and other components such as temperature sensor, ultrasonic sensor and water flow sensor for the monitoring process will be listed in the next section.

2. Materials and Methods

The materials and methods section, otherwise known as methodology, describes all the necessary information that is required to obtain the results of the study.

3. 2.1 Full System Block Diagram (Autonomous & Monitoring System) Design

A block diagram connection of the components used for the monitoring and autonomous system that will be connected to the Arduino Mega 2560 as the main MCU was shown in the fig. 2 below. The system will be parted with two section which are monitoring process and the water changing process (autonomous system). The Arduino Mega will be powered by 9V power supply while the Solenoid valve will be powered by 5V external power supply to ensure the relays will be isolated circuit.

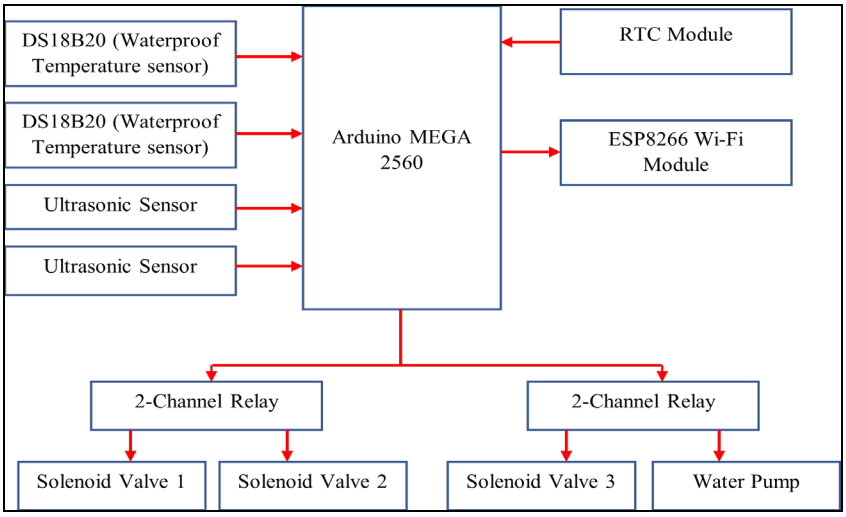

Fig. 2 - Block diagram design of the autonomous and monitoring system

2.2 Monitoring Methods

The monitoring procedures through the sensors data in the case of ultrasonic sensor for water level measuring and the DS18B20 waterproof temperature sensor to monitor the water temperature reading shown in the fig. 3 below.

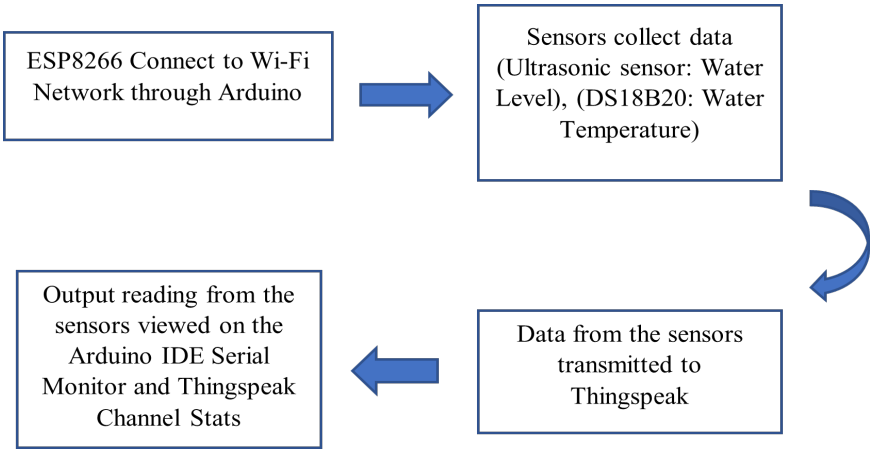

Fig. 3 - Monitoring Process communication to Thingspeak via ESP8266

2.3 Autonomous System

Autonomous system procedure involving the water exchanging from the tank 1 or tank 2 with the reservoir tank. This process involves with the help of solenoid valve that enable water flowing in and out from the tank, water pump to pump water from the reservoir tank into tank 1 or tank 2 and ultrasonic sensors to monitor the water level from each tank so that it will not spill out. Fig. 4 shows the flowchart process of the autonomous system.

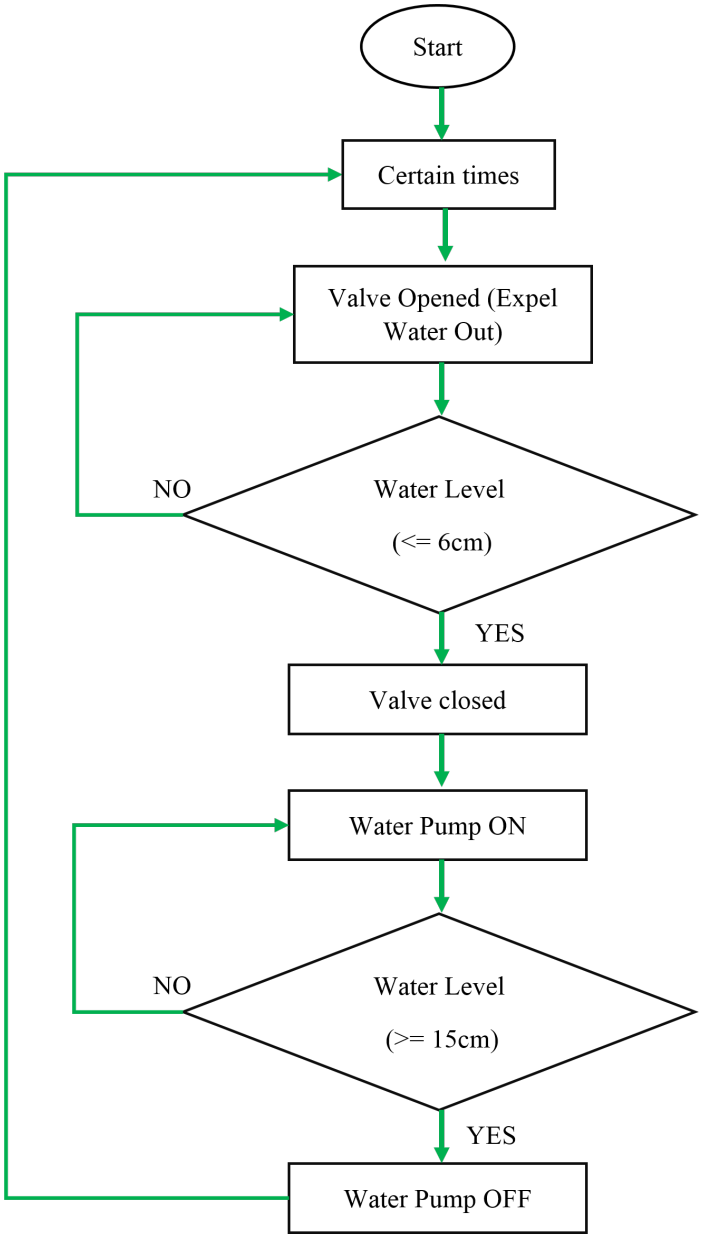

Fig. 4 - Process flowchart of the autonomous system

2.4 Components and Materials

Table below show components to develop autonomous and monitoring system hardware.

Table 1 - Components and material

Item	Description
• Arduino Mega 2560	• Main MCU
• RTC Module (DS1307)	• Provide precise time and date
• DS18B20	• Waterproof Temperature Sensor ~ 5V
• Ultrasonic Sensor	• Measures water level
• ESP8266	• Wi-Fi Module
• 2-Channel Relay	• Switch for Solenoid valve and water pump

• 12V Solenoid Valve	• Control water flow
• AC to DC Power Supply (12V)	• Power for Solenoid Valve
• Water Flow Sensor	• Monitor water flow

2.5 Project Design Development

Fig. 5 below shows full connection from the components to the Arduino Mega 2560 Pinout. The circuit above can be divided into two parts which are the autonomous system which work as water filtering system where the water from the tank will be filtered and recycled from the reservoir tank (clean water). The autonomous system is using "gravity feed" system where the water pressure and gravity that help to expel the water out from the tank. Solenoid valve choosing is important so that the water can flow out easily with no high pressure needed.

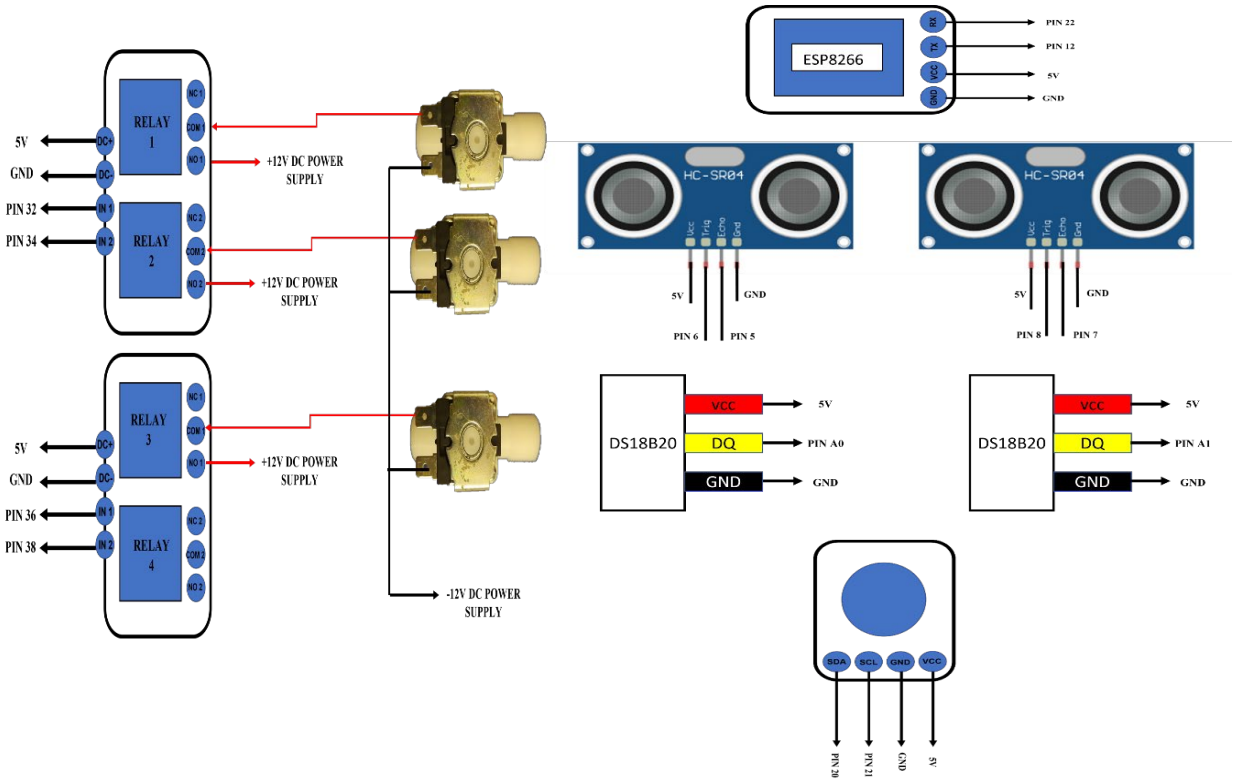

Fig. 5 - Components connection to Arduino Mega 2560 Pinout

The monitoring part is where the sensor from DS18B20 waterproof temperature sensor and ultrasonic sensor monitor the temperature and water level reading respectively and the data will be transmitted to the Thingspeak through the ESP8266 Wi-Fi module.

Fig. 6 - Full prototype development

4. Results and Discussion

This project purposes are to build a smart autonomous system with IoT based monitoring system. Basically, the system can monitor the temperature of the water from both tank and the water level taken from the ultrasonic sensor. The reading from the sensors then will be sent to the Thingspeak via ESP8266 Wi-Fi module. The system also can recycle and filter the water with the help of the autonomous system built.

4.1 Results

Results from the Arduino IDE serial monitor shown in Fig. 7 below. The serial monitor display from Arduino IDE for monitoring system which monitor the water temperature and the water level from tank 1 and tank 2. The water level distance is being calculated from the tip of the sensor and the top level of the water level.

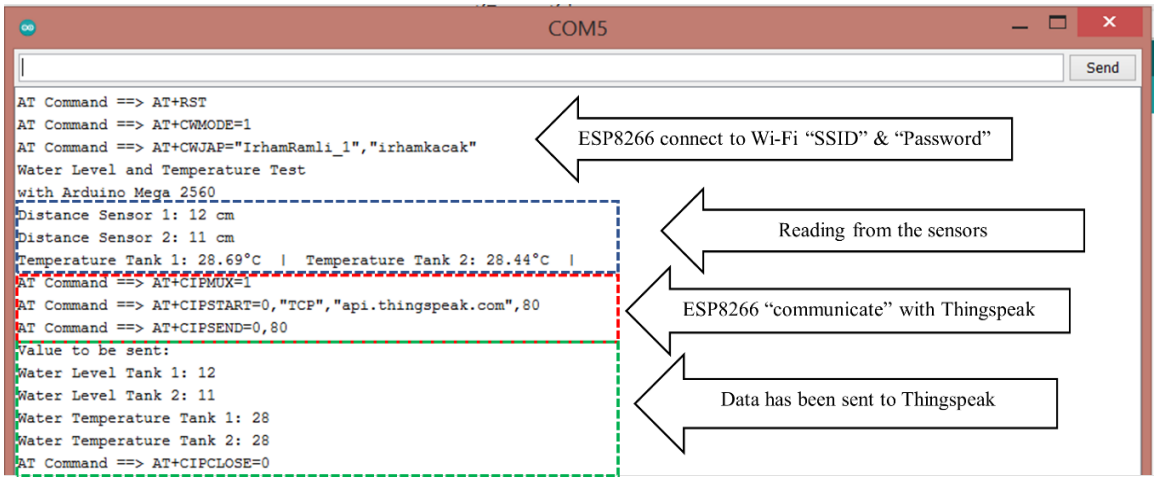

Fig. 7 - Serial monitor display for monitoring system

Fig. 8 below shows the data displayed on the Thingspeak website where the reading is being sent by the ESP8266 Wi-Fi module via API Key method. The channel can be written by the Wi-Fi module with the help of API Key.

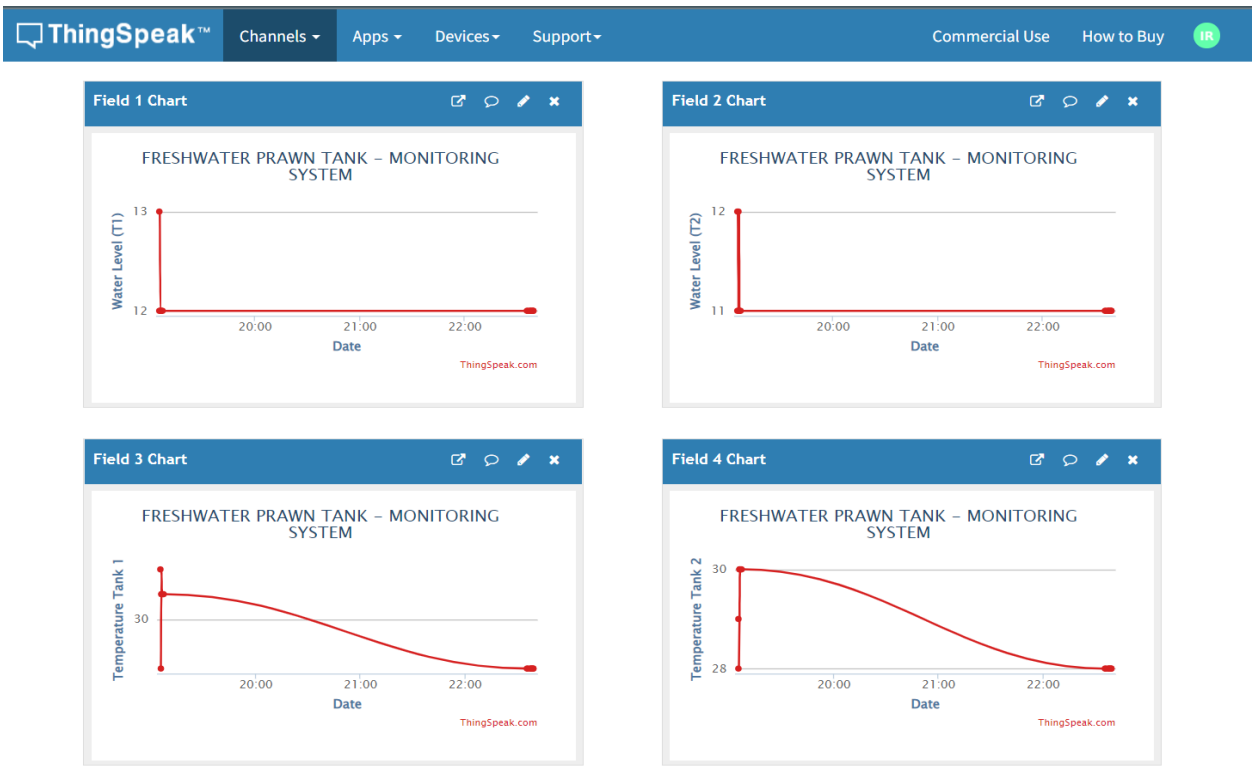

Fig. 8 - Thingspeak channel stats reading from the sensors

4.2 Discussions

The monitoring system successfully monitor the water temperature and water level from tank 1 and tank 2 respectively with the help of the DS18B20 waterproof temperature sensor and the ultrasonic sensor. The data then being processed and transmitted to the Thingspeak through ESP8266 Wi-Fi module. But first, the API Key from the Thingspeak channel must be inserted in the code in the Arduino IDE coding so that the API Key will act as the 'key' to enable data to be written into the channel status. From Fig. 7 and Fig. 8 prove that the monitoring system successfully sent the sensors' reading to the Thingspeak channel.

For the autonomous system which involving water recycle and filter process, the system has successfully change and filter the water from the tank and the reservoir tank. The concept of the system is using "gravity feed" system where the pressure and the gravity act helps to ensure the water flowing out from the tank with the help of solenoid

valve to control the water flow. The water changing process from each tank 1 and tank 2 will take place accordingly in different days of time.

Fig. 9 - Tank 2 operation in progress from Arduino IDE serial monitor (In process)

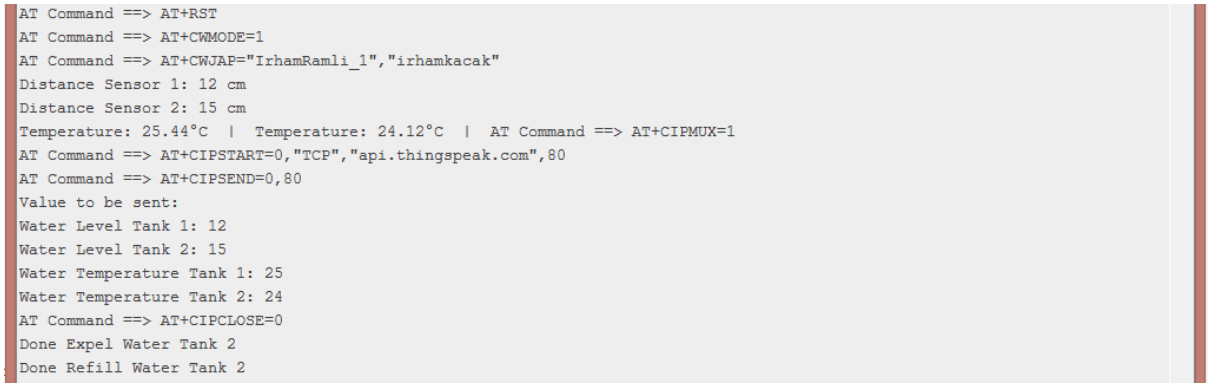

Fig. 10 - Monitoring data sending after the process complete (Process end)

5. Conclusion

As the conclusion, the autonomous system and monitoring system for the aquaculture farming of the freshwater prawn can be built from the included materials described from Methodology section. This project development hopefully will be great innovation with the help of growing Internet of Thing technology in line with IR4.0 which aim to make farms modern and smart enterprises. The project was aimed to improve and solve the stated problem statement early with reasonable price and easy to assemble. The system expected to offer good environment for the freshwater prawn to survive. Improvement and maintenance should be aligned so that the system will be good for the user. For the future, this project's function can be more vary such as auto-feed system and an application-based monitoring system can be built so that it can be monitor just using smart phones.

Acknowledgement

The authors would also like to thank the Faculty of Engineering Technology, Department of Electrical Engineering Technology, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] N. (2021, October 19). "The benefits of aquaculture with IOT Technology". January 8, 2022. [Online] Available: Nanalyze, //www.nanalyze.com/2018/06/benefits-aquaculture-iot-technology

[2] AL-Fadhali, Najib, et al. "Substrate integrated waveguide cavity backed frequency reconfigurable antenna for cognitive radio applies to internet of things applications." International Journal of RF and Microwave Computer-Aided Engineering 30.1 (2020): e22020.

[4] AL-Fadhali, Najib, Huda Majid, and Rosli Omar. "Multiband frequency reconfigurable substrate integrated waveguide antenna using copper strip for cognitive radio applicable to internet of things application." Telecommunication Systems 76.3 (2021): 345-358.

[5] Dupont, C., Cousin, P., & Dupont, S., "IoT for aquaculture 4.0 smart and easy-to-deploy real-time water monitoring with IoT," 2018 Global Internet of Things Summit (GIoTS) (pp. 1-5), doi: 10.1109/GIOTS.2018.8534581

[6] Su, X., Sutarlie, L., & Loh, X. J.,"Sensors, biosensors, and analytical technologies for aquaculture water quality". Research, 2020, IEEE.

[7] Encinas, C., Ruiz, E., Cortez, J., & Espinoza, A., "Design and implementation of a distributed IoT system for the monitoring of water quality in aquaculture," *2017 Wireless Telecommunications Symposium (WTS)*, pp. 1-7, doi: 10.1109/WTS.2017.7943540

[8] Tawfeeq, A., Al Wahaibi, H. A. S., & Vijayalakshmi, K., "IoT based Aquaculture system with Cloud analytics," International Journal of Applied Engineering Research, 14(22), 4136-4142.

[9] Pappu, S., Vudatha, P., Niharika, A. V., Karthick, T., & Sankaranarayanan, S., "Intelligent IoT based water quality monitoring system," International Journal of Applied Engineering Research, 12(16), 5447-5454.

[10] "Emerging industry revolution 4.0 and its relationship with the agriculture sector in Malaysia", December 3, 2020. [Online] Available: FFTC Agriculturural Policy Platform (FFTC-AP) https://ap.fftc.org.tw/article/2618#:~:text=The%20vision%20for%20Agriculture%204.0,greater%20control%20over%20their%20operations.