Journal of Engineering and Applied Sciences 14 (9): 2840-2847, 2019
ISSN: 1816-949X

Development of Water Quality Monitoring for Smart Aquaculture System

[1, 2]Mohd Saad Hamid, [1]Muhammad Amirul Abd Wahab, [1]Rasyidah Abdullah,
[1, 2]Shamsul Fakhar Bin Abd Gani and [1, 2]Rostam Affendi Hamzah
[1]Fakulti Teknologi Kejuruteraan,
[2]Center for Advanced Computing Technology, Universiti Teknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

Abstract: Water quality monitoring for smart aquaculture system is a device that helps to describe the water quality parameter such as pH, turbidity and temperature of the water. It will monitor the process of sampling and analysing the water condition. This project is focused on local aquaculture species. Water quality monitoring for smart aquaculture system is designed to allow fish farmers to monitor and control their fish in the pond much more easily than before. It will help fish farmers to understand more about the water quality parameter that needed for their fish. It is equipped with an early warning detection that can help fish farmers monitoring their pond. The data collected will be transmitted to the cloud server and user will get notifications regarding the condition of their pond by using push notification services to their smartphone. This can enhance the productivity of the fish pond because user can always monitor the level of water quality that suitable with the fish. This study proposed a monitoring system with the ability to measure temperature, pH, turbidity and water level. The ability of the system to provide information and notification proven when the system sent a notification from Raspberry Pi board to smartphone where the pH level of the water beyond the allowable range. User also, able to control water pump to control the water over wireless connection using Blynk platform. Finally, the system successfully embedded new technology to help to revolutionize the aquaculture industry with the help of internet of things technology.

Key words: Monitoring system, water quality, sensor, aquaculture, temperature, pH, Raspberry Pi

INTRODUCTION

Water covers two-third of the Earth's surface with over 97% presents in the oceans and <1% in freshwater streams and lake. Water is an essential habitation for fish and other marine lives. The source and quantity of water available are the most important factors to consider when choosing a site for an aquaculture facility. Many undesirable chemicals and environmental factors associated with certain fish farms can be traced to lack of background information on the source of water used before the final site for a new farm is selected a thorough investigation of the quality and quantity of water must be considered by the producer (Zakaria, 2006).

Wolpe (1980) defined aquaculture in many ways. It has been called as the rearing of aquatic under controlled or semi controlled condition underwater agriculture. The other definition of aquaculture is the art of cultivating the natural produce of water, the raising or fattening of fish in enclosed ponds. Aquaculture can be potential means of reducing organism for commercial products it can mean an increased number of jobs, enhanced sport and commercial fishing and a reliable of protein for the future.

As described by Bartram and Ballance (1996) water quality depends on the various chemical where it dissolved in the water. Good water quality level is determined by all attributes present in the water at an appropriate level and not outside tolerable range. Often aquaculture water quality does not equal to environmental water quality. Therefore, different parameters are used in monitoring aquaculture farm as compared to environmental water quality. Good water quality condition differs from species to species.

Bhatnagar and Devi (2013) mentioned that the physical, chemical and biological properties are interrelated and it affects survival, growth and reproduction of aquaculture. Aquaculture can also have reverse effect to the environment as aquatic organisms

Corresponding Author: Mohd Saad Hamid, Fakulti Teknologi Kejuruteraan, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

Table 1: Tolerable range of parameter

Parameters	Catfish	Tilapia	Carp
Temperature	18-27°C	23-34°C	18-27°C
Dissolve oxygen	>1.5 mg/L	>5.0 (Peferred) 3.0-4.0 (Tolerable)	>1.5mg/L
pH level	6-8	6-8	6-8

consume oxygen and produce by products, carbon dioxide and ammonia. Important water quality parameters to be considered are temperature, salinity, pH, DO, ammonia, nitrite/nitrate, hardness, alkalinity and turbidity.

In most of the aquaculture industries, manual water quality monitoring has been employed in order to assess the water quality of the pond. Due to the importance of maintaining the water quality for better production, the aquaculture farms normally perform daily physical monitoring on the ponds. The workers need to manually observed the water condition at the pond. This activity is very time consuming and it lacks of automated alert system for the owners. As mentioned by Kayalvizhi *et al.* (2015) the problem also related to the requirement of manpower to perform manual activities and need to be minimized the researchers also proposed a monitoring system in their research.

Thus, this study aims to present the details of the design and implementation of a remote water quality monitoring for smart aquaculture system. This system has been designed to allow fish farmers to monitor and control their fish in the pond much more easily than before. The system is also equipped with an alert feature to inform the farmers on the degradation of water quality via. smartphone notifications. This include the introduction of cloud monitoring and the internet of things element in the system. The four criteria that has been identified to monitor and to detect water quality changes are water temperature, pH level, water level and turbidity. Table 1 shows summarizes tolerable range of chosen water quality parameter for several species of fish.

Litreature review: As part of the literature review process, several works by other researchers on water quality by Simbeye and Yang (2014), Haron *et al.* (2009), Kayalvizhi *et al.* (2015) and Rao *et al.* (2013) have been analysed and compared to identify the suitable component and methodology to be used in the project. Simbeye and Yang (2014) in their study described the communication method used was through wireless sensor networks through Zigbee from ATmega16L microcontroller to the base station host and use Global System for Mobile (GSM) module for user notification. The parameter transmitted were temperature, dissolved oxygen, pH and water level.

Haron *et al.* (2009) mentioned in their method focused on leveraging on wireless sensors in detecting the water quality. Short Message Service (SMS) has been employed as a method to deliver alert to the farmers upon detection of degradation of the water quality. The parameter measured same as Simbeye and Yang (2014) but without the water level information. The research by Haron *et al.* (2009) only focused on water quality for single species, prawn.

Another related work by Kayalvizhi *et al.* (2015) measured dissolved oxygen, pH and temperature parameter. Kayalvizhi *et al.* (2015) used ATmega8 processor to sense the parameter value and sent the data to Raspberry Pi. Raspberry Pi connected to the router using LAN cable. The ATmega processor has been used to perform Analog to Digital Conversion (ADC) before transmit to Raspberry Pi.

Rao *et al.* (2013) described in their research that Arduino Mega 2560 has been used to perform the ADC conversion on temperature, pH and light parameter. The parameter data sent to a base station (computer) using Universal Serial Bus (USB) port. The data then saved on MySQL database server for further data analysis.

Based on the works done by researcher by Simbeye and Yang (2014), Haron *et al.* (2009), Kayalvizhi *et al.* (2015) and Rao *et al.* (2013) the literature review from data sheet of the related electronic components and other sources there were many methods available to transmit the water quality parameter. The research also, discussed on ADC process. Different methods on providing user notification can be used such as SMS. The parameter data also can be stored as online or offline source for further water quality analysis. Thus, gives the motivation and the direction towards the proposed system as described in the next section.

MATERIALS AND METHODS

Figure 1 illustrate the basic design of the system. The hardware module received the input from the sensors and analysed the data and exchange it with the cloud server. The basic hardware controller platform for this project based on Raspberry Pi 3 board. This board powered by Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit System on Chip (SoC). It is also equipped with 1GB RAM. This board also, WiFi and Bluetooth enabled board. That will provide flexibility on data transmission. This hardware also, provides several feature such as I2C controller to communicate with I2C based sensors and displays.

Fig. 12: Displaying graph for temperature sensor from the SQLite database

Fig. 13: Displaying graph for ultrasonic sensor from the SQLite database

is installed on the user's smartphone, the Raspberry Pi 3 also need to be connected to the internet via. Wi-Fi. Uploading the code to the Raspberry Pi 3 completes the vital steps in applying the Blynk application which is connecting hardware with the Blynk cloud server. The interface created using Blynk also provide the ability to control pump at the site manually as illustrated in Fig. 9. Current reading of the water quality parameter can be observed through physical view on 3.5-inch LCD as illustrated in Fig. 10. Figure 11-13 illustrate the another capability of the system where the user able to view the water quality parameter through web browser in where the user in the same wireless network.

CONCLUSION

At the end of this project after all the things considered the objectives mentioned earlier in a previous chapter has been achieved successfully where this project was able to help entrepreneurs of fish pond in urban areas and especially in rural areas to keep abreast of the latest technology in the hope that it can cause the labour cost to be minimized. Moreover, this system also may enhance the water quality monitoring process which can reduce the use of time and energy. Besides that, this project will give the big contribution to the fishing industry in order to improvise the rearing and breeding process for the aquaculture species. This project also was equipped with the notification warning systems from the smartphone applications via. the cloud, so that, if anything occur or any changes of the condition of water quality that will harm the fish detected, fish farmer will be informed as soon as possible and they are able to effectively control the problem. Specifically, this system also allows the user to control the water level and monitor the current condition of water quality in the pond even with they are

far away from the pond. All relevant information in this project can be utilized in the process of project improvement in the future in the hope that the next generation will generate more useful projects for the community.

ACKNOWLEDGEMENTS

The researchers would like to thank for the support given to this research by Ministry of Higher Education Malaysia and Universiti Teknikal Malaysia Melaka under Research Acculturation Grant Scheme (RAGS) (Reference Number: RAGS/1/2015/ICT01/FTK/03/B00115).

REFERENCES

Bartram, J. and R. Ballance, 1996. Water Quality Monitoring: A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring Programs. Chapman and Hall, London.

Bhatnagar, A. and P. Devi, 2013. Water quality guidelines for the management of pond fish culture. Int. J. Environ. Sci., 3: 1980-2009.

Haron, N.S., M.K. Mahamad, I.A. Aziz and M. Mehat, 2009. Remote water quality monitoring system using wireless sensors. Proceedings of the 8th WSEAS International Conference on Electronics, Hardware, Wireless and Optical Communication (EHAC'09), February 21-23, 2009, WSEAS, Cambridge, UK., ISBN:978-960-474-053-6, pp: 148-154.

Kayalvizhi, S., G.K. Reddy, P.V. Kumar and N.V. Prasanth, 2015. Cyber aqua culture monitoring system using Arduino and Raspberry PI. Intl. J. Adv. Res. Electr. Electron. Instrum. Eng., 4: 4554-4558.

Rao, A.S., S. Marshall, J. Gubbi, M. Palaniswami and R. Sinnott *et al*., 2013. Design of low-cost autonomous water quality monitoring system. Proceedings of the 2013 International Conference on Advances in Computing, Communications and Informatics (ICACCI), August 22-25, 2013, IEEE, Mysore, India, ISBN: 978-1-4799-2432-5, pp: 14-19.

Simbeye, D.S. and S.F. Yang, 2014. Water quality monitoring and control for aquaculture based on wireless sensor networks. J. Networks, 9: 840-849.

Wolpe, A., 1980. Introduction to fresh horizons. Feminist Rev., 6: 89-92.

Zakaria, S.M.H., 2006. Predicting water quality for aquaculture using fuzzy logic prototype. BS Hons Thesis, Universiti Teknologi MARA, Malaysia.