AQUATECH: A SMART FISH FARMING AUTOMATION AND MONITORING APP

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ABSTRACT

This study is sought to address the problem of the 'manual' monitoring system which renders "low" accuracy on monitoring the water value. The existing practice of manual testing uses a refractometer to check the salinity level device and pond thermometers for testing the water temperature of fish farm water environment. It needs extra effort and more workers to regularly monitor such as: opening and closing the gate valve to control the level of fresh and saltwater needed to become accurate 'brackish' water. On the contrary, this research wants to establish an IOT-Based project to attempt solving this existing problem. Hence, this may create a unique system to help monitor and maintain the salinity, temperature and water level using the sensors that triggers the relay switches to automatically open or close the gate valves and operate the motors depending on the parameter's desirable range values that the sensors passed. The sensors and motors also monitor the pond environment between air and water for sufficient increase of oxygen concentration in farm water environment. Likewise, this new IOT-based monitoring system specifically uses Raspberry PI 3B+, Wemos Wireless Microcontroller, Sensors (for water level, conductivity, temperature, toxic gases) and Relay Switches, Equipment (i.e. paddle wheel aerator, water pump and pipe valve), Computer and Mobile Phone, Long Range access point/Point to Point network to cover the entire fish farming areas for wide ranges wireless connectivity, and USB modem which sends SMS messages to keep the management updated with the current water behavior in the farm.

Keywords: Aquatic technology, Automated fish farming, Wireless technology, Raspberry pi server, Micro-computer, Motors, Sensors, Web application, Philippines

INTRODUCTION

In 2012, the Philippines ranked among the major fish producing countries in the world with a total production of 3.1 million tonnes of fish, crustaceans, mollusks and other aquatic animals. Aquaculture contributed 790,900 tonnes, or 25.4 percent to the total fish production. (Fishery and Aquaculture Country Profiles. Philippines, 2014). In addition, the Philippines is the world's third largest producer of farmed seaweeds with a production of 1.8 million tonnes in 2012. The Fish Farming sector had significantly contributed to the total fishery performance in Central Visayas for the year 2000. Unwavering commitment of the majority of the Local Government Units (LGU) and the fisherfolks groups, supported by the Bureau of Fisheries and Aquatic Resources, Region 7 and the other institutions are the salient attributes of such performance.

More so, the current IOT-based monitoring studies made to improve fish farming production is incompetent. These studies do not seem to accurately meet the objective of the actual fish farming events. So to speak, researchers in this field have initiated studies merely for the sake of research but devoid of any actual productive outputs. Consequently, a research project AquaTech was conducted to fill-in the loopholes on their gaps and to improve fish farming productivity. AquaTech is a network of sensor, motors, micro-computers, and web application that is designed to help manage the fish farms with less human intervention.

OBJECTIVES OF THE STUDY

The study developed a wireless automation and monitoring system for aquaculture farming. Specifically, it aimed:

1. To track, record, and act to the changes of environmental factors.
2. To create a decision support system that is capable of forecasting events ahead of time.
3. To improve farm management with the use of technologies.
4. To increase the fish production of the fisherfolks.

MATERIALS AND METHODS

The study is a capstone project that aimed to develop a wireless automation and monitoring system for milk fish aquaculture farming.

Table 1
Ranges of the Parameter

#	Parameter	Acceptable Range	Desirable Range
1	**Temperature (˚C)**	15-35	20-30
2	**Salinity (PPT)**	0-35	.5-30
3	**Conductivity (µS/cm)**	30-5,000	60-2,000
4	**NH3-N (Ammonia-Nitrogen)**	NH3-N: Less than 4 mg/l	NH3-N: 0-2 mg/l
5	**Tide Height (m) (Main Supply)**	0-2.2	.5-2

A wemos wireless modules are used to transmit data captured by the sensors to the server. Meanwhile, the Raspberry PI 3B+ functions as server toward the wireless access point connected to the terminals and at the same time it is the system which collects or stores data. The system receives and evaluates the data from the sensors. It maintains a specific standard set. If the received data is lower or higher than the allowable value, the system sends back a signal passing through the wireless modules and automatically commands the equipment to operate.

This is a web-based application system that uses wireless connectivity. It allows the authorized person through a certain device to monitor the real time results of water temperature, water salinity, and water level based from the sensors installed in farm environment. To expand wireless connectivity to distant terminals which range more than 50 meters, a Long Range access point/Point to Point network is added.

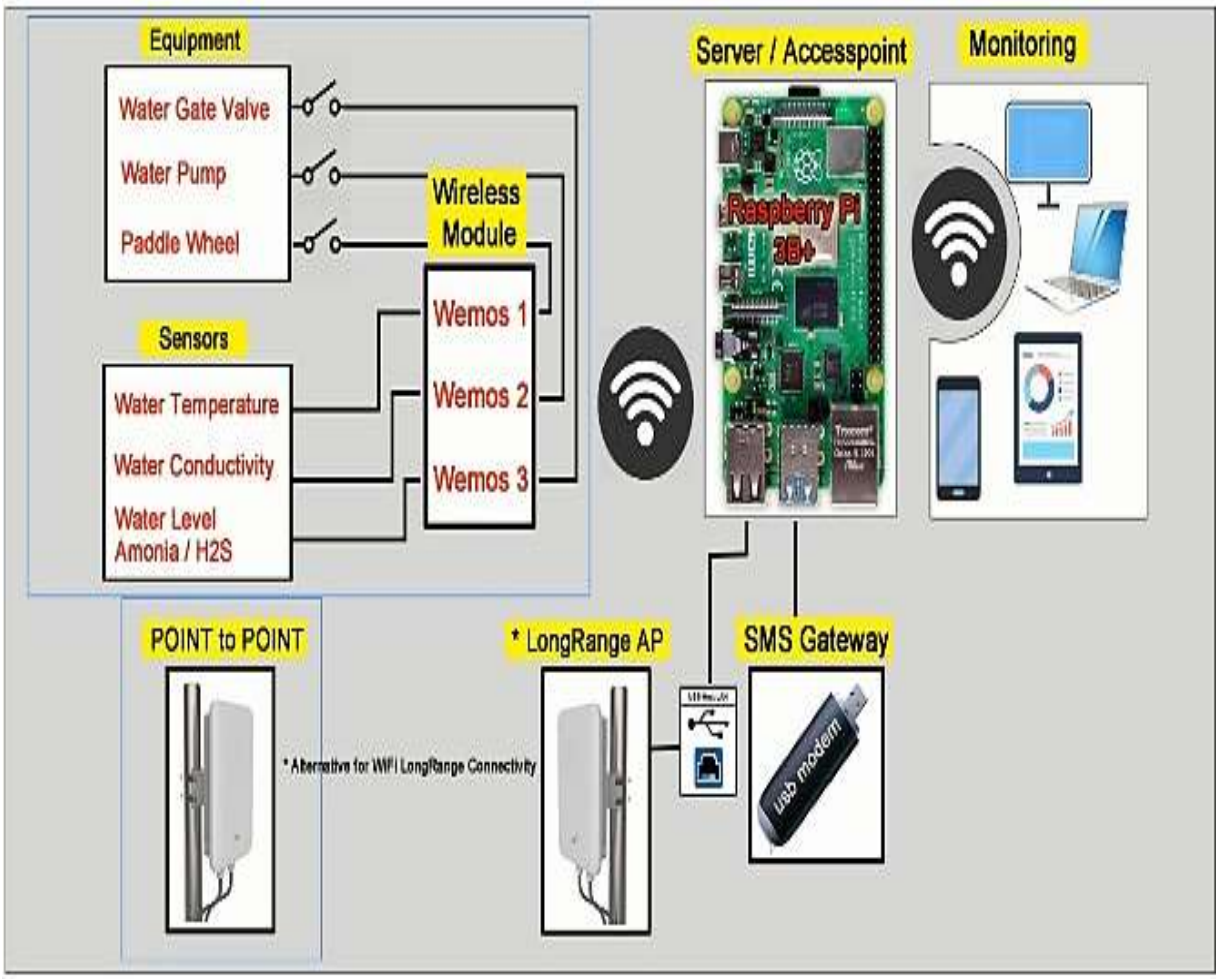

Figure 1. System/ Hardware Architecture

Figure 1 illustrates the general scheme of the system. The temperature, conductivity and water level sensors and relay switches are connected to wemos wireless micro-controller and connected to Raspberry pi thru wireless communication. Sensor values are performed by Arduino program. The Arduino program sends and receives the data from the sensors to trigger the relay switches based on the given parameter values from the system thru wireless connectivity. Also, Python program in the Raspberry pi is included which sends SMS messages to keep the management updated with the current water behavior in the farm and to stores the real time sensor data in the MySQL database installed in Raspberry pi. To expand wireless connectivity to distant terminals which range more than 50 meters, a Long Range access point/Point to Point network is added.

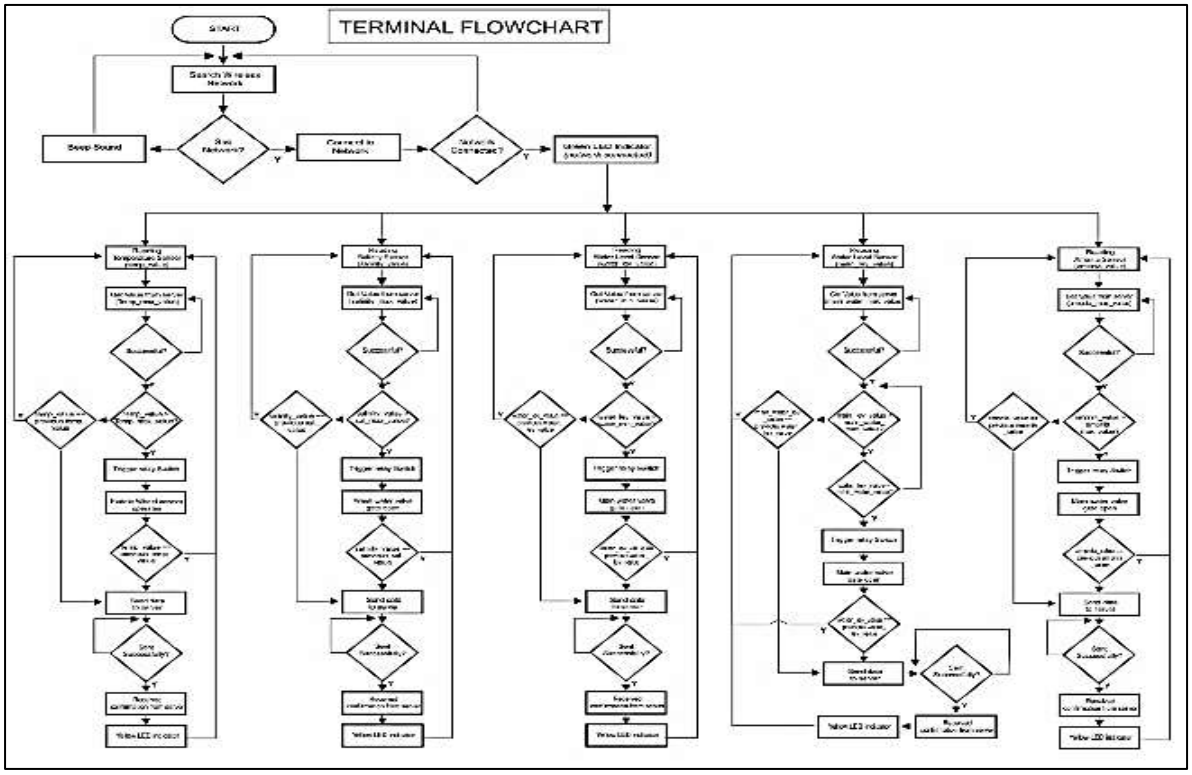

Figure 2. Terminal Flowchart

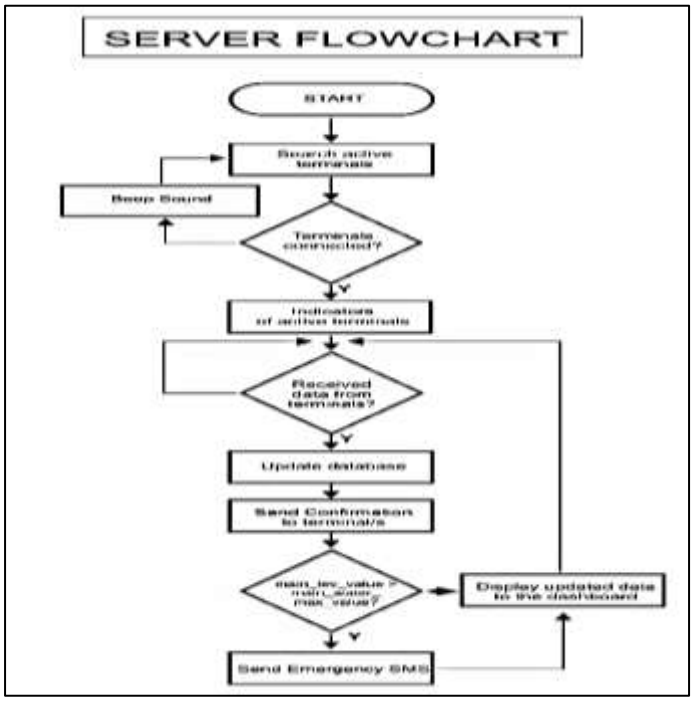

Figure 3. Server Flowchart

RESULTS AND DISCUSSION

Existing studies/application

Basically, this project used pH and dissolved oxygen (DO) sensors to ensure the health and growth of fish, sooner or later as their farms grow. In this project, water, temperature, pH and DO levels are measured and integrated with aerating and water supply pumps using Arduino. User could receive information at predetermined intervals on preferred communication or display gadgets if they have internet. Since integrating devices are comparatively not expensive; it usually consists of Arduino board, internet and relay frames and display system, farmer could source these components easily. A sample of two days measurements of temperature, pH and DO levels show that the farm has a high-quality water. Oxygen levels increases in the day as sunshine supports photosynthesis in the pond. With this integration system, farmer need not hire worker at their site, consequently, drive down operating costs and improve efficiency. (Harun et al., 2018)

On the other hand, the infrastructure requirement for setting up catfish farms includes a source of clean water, an avenue for discharging the wastewater and reliable water containment systems. The challenges faced by the operators of these fishponds include the need for regular feeding of the fish, monitoring of the water quality and the changing of the water when the quality becomes unhealthy for the fish. This work presents an Internet of Things (IOt) based approach for automating the management of the farms and enabling remote monitoring and management of the ponds. The system comprises of a pond controller which uses appropriate sensors to monitor the water quality of the pond. A CCTV records the activities around the pond and stores them in a cloud location. The Pond controller manages the automatic feeding system of the fish and the water control system for the pond. The system is also designed with capacity for remote operation through a specially designed mobile application which accesses the CCTV files and controls the operation of the pond controller. This system enables the management of one or more fishponds from one mobile device; it will reduce the costs associated with managing the fish farms and improve quality of their yield. (Idachaba et al., 2017)

The design of this system took the simplicity of required input data and data output into consideration. The second part is a microcontroller based open loop control system for mechanical aeration process based on the calculations of the DSS. The aeration management part input and output data fed to the control system with a specially developed program using µC-language. This program performs the calculations of aeration requirements and energy demands based on the DSS calculations. Furthermore, the controller had the feature of working from isolated power supply or in collaboration with renewable energy system. These utilities were created to be suitable for three fish types, which are Mullet, Tilapia, and Carp fish. These types have a wide acceptance in the aquaculture activities under warm water conditions. The data obtained from the calculations of the spreadsheet under simulated and real field conditions were compared to a reference data. The spreadsheet showed an agreement with the reference values. The control systems succeeded to operate 1hp-3phase induction motor for a time that was identical to the required aeration time calculated through the DSS. It was recommended to rely on the created DSS and the control system for farm area planning, water environment evaluation, and mechanical aeration management and operation. In addition, improvements for the control system should be carried out to be a real-time system especially with water quality parameters considering system power requirements and operating costs. (El-Nemr1* et al., (2013)

Also, outlined and actualized monitoring of water quality of aquaculture utilizing Raspberry Pi, Arduino, various Sensors, Smartphone Camera and Android application. Water quality parameters used in this work are Temperature,

pH, Electrical Conductivity and Colour. Sensor acquisition is conducted by Arduino and Raspberry Pi is used as data processing device as well as server. Photo acquisition is also performed by Raspberry Pi with the help of the smartphone camera to detect the colour of the water. Android phone is used as the terminal device. (Saha et al., 2018)

This study helps to address a problem of the 'manual' monitoring system which renders "low" accuracy on monitoring the water value. This existing practice of manual testing uses a refractometer to check the salinity level device and pond thermometers for testing the water temperature of fish farm water environment. This manual monitoring needs extra effort and workers since it is done on a regular basis. For instance, opening and closing the gate valve to control the level of fresh and saltwater needed to become accurate 'brackish' water is crucial. In relation to this, the inaccurate monitoring of water value consequently reduces the target production and market of the fish farming. In contrast, this study wants to establish an IOT-Based project to attempt solving this existing problem.

This study will create a unique system to help monitor and maintain the salinity, temperature, and water level of the water with the use of sensors and triggers the relay switches to automatically open and close of the gate valves and operate the motors that depends the parameter desirable range values from the sensors. These sensors and automatic motors also monitor the water environment contact between air and water for sufficient increase of oxygen concentration in farm water environment.

This new IOT-based monitoring system specifically uses Raspberry PI 3B+, Wemos Wireless Microcontroller, Sensors (for water level, conductivity, temperature, toxic gases) and Relay Switches, Equipment (i.e. paddle wheel, water pump and pipe valve), Computer and Mobile Phone, Long Range access point/Point to Point network to cover the entire fish farming areas for wide ranges wireless connectivity, and USB modem which sends SMS messages to keep the management updated with the current water behavior in the farm.

Most of the existing studies are using sensors and wireless modules but what is lacking in their studies is the automation of the equipment. The automation relies on the sensors that predict the allowable water value. The equipment automatically operates if it is triggered by the system that sends back a signal passing through the wireless modules. It is needed to avoid lapses of the target date which hugely affects the target production and market. Another related study uses Raspberry PI 3B+ (as main server) like this study. But the difference of this study is that the Raspberry PI uniquely serves as access point to the terminal and user device(s).

To expand wireless connectivity to distant terminals, a Long-Range access point/Point to Point network is added. And the most special feature of this study is not found in any existing related studies. It has SMS messaging which reports daily operations and emergency situations like unexpected increase of water from its main water supply source. Moreover, it sends SMS that keeps the management updated the current water behavior in the farm.

CONCLUSIONS

The growth of fish, the length of time spent, effort and amount of harvest a fish farmer have every season is based on the water environment parameters that a pond has. Controlling these parameters to make the pond environment a desirable one for fish to grow normally is a great help for the fish farmers. With the use of technology, better fish farming results will be achieved. Monitoring and controlling the water environment parameters are great factors to maximize fish production in the fish farm. AquaTech filled in the gaps of the existing studies and it can give benefits to the fish farmers.

RECOMMENDATIONS

Fish farmers should maximize the use of technology for them to increase their production. Then, for the fish to grow normally, the pond environment parameter must be desirable for them to live. With fish farming technologies such as AquaTech, managing their fishponds and controlling environment parameters are easier and safe. The smarter way of fish farmin 136 more productive it gets.

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