Chapter 1

Development of Real-Time Wireless Monitoring System for Aquaculture Industries

Airul Sharizli Abdullah, Ahmad Syahiman Bin Mohd Shah, Mohd Shawal Bin Jadin, Ruhaizad Bin Ishak, Mohamad Shaiful Bin Abdul Karim

Universiti Malaysia Pahang

Abstract

Aquatic farming activity is most interesting part because shrimp can generate income and economy for our country progressively. Water quality for shrimp pool is most critical part in shrimp farming and monitoring issues need to develop in order to maintain shrimp production. Water quality monitoring system using wireless sensor network for shrimp pool give the information about water quality condition based on its parameters in real time. We are developing a prototype of system consist of two mini pools. Each pool consists of two sensors which are ph and temperature sensor. These two sensors and Zigbee Xbee S1 module (wireless module) will connect to Arduino NANO (microcontroller). Data will transmit to another wireless module and PC display. Microsoft Visual Studio (graphical user interface) is equipped in PC to display water quality condition based on sensor detection in set time stamp. Alarm system will be equipped as parameters are higher than their threshold and message will be delivered to person in charge. This system will be useful for sampling and collecting data faster and give user time to troubleshoot and maintain water quality.

Introduction

The aquaculture sector has recorded an annual growth rate of about 20 percent in the last 5 years. It has now grown into a lucrative and sustainable industry, associated with the culture of high value species, mainly shrimp, marine fish and high value freshwater fish. Malaysia, a country with around 29 million people in 2015, fish food is always the necessary source of animal protein to their community. Fisheries sector is responsible in providing food security to the growing population. Malaysia, surrounded by South China Sea and the Strait of Malacca, coupled with development of aquaculture industry, this country is rich in fish resource.

Commercial aquaculture in many countries, including Malaysia has been prompted due to increasing demand of international market (Ismail and Abdullah, 2013). Therefore, aquaculture industry is playing increasingly important role in Malaysian economy. In the Third National Agricultural Policy (NAP3), Malaysian government has promoted brackish water shrimp culture under taking a number of initiatives (Ministry of Agriculture Malaysia, 2003). Targeted shrimp production in 2010 was set at 180,000 metric tons or RM 4.3 billion (Islam et al., 2011). However, the targeted volume of supply was not materialized.

Water quality is a critical factor when culturing any aquatic organism. Optimal water quality varies by species and must be monitored to ensure growth and survival. The quality of the water in the production systems can significantly affect the organism's health and the costs associated with getting a product to the market. Water quality parameters that are commonly monitored in the aquaculture industry include temperature, dissolved oxygen, pH, alkalinity, ammonia, and nitrites. Some

parameters such as alkalinity and hardness are fairly stable, but others like dissolved oxygen and pH are fluctuate daily, therefore required monitoring daily.

Traditionally, the quality of water in aquaculture farm is monitoring using hand-held devices that are available in the market. However, the existing product does not have big storage capability and cannot transfer the data automated and wirelessly, which requires a considerable time commitment from the person-in-charge to come on to the site every day. Due to these limitations, the sample size often cannot be large enough to cover the entire month or year. Therefore the difficulty of overall and successive water quality sampling becomes a barrier to water quality forecasting.

Therefore, one significant objective of this research is to design and develop a multi-parameter real time water quality measurement system, which would be easy to maintain, wirelessly transfer the data and store a large data that can readily interpretable by the end user. Real-time monitoring will allow aquaculture operators to be aware of preventable diseases in order to save costs in diseases treatment and keep aquatic organism in good health before harvesting job as well as mange aquatic organism loss to the minimum rate.

The proposed system would measure the three main parameters from multiple pools. Three of these parameters is temperature, pH and Dissolve Oxygen (DO). This proposed system will integrate the water qualities sensors, data acquisition, microcontroller, wireless devices and data logging system. Data can be observed in real time as well as offline by downloading it to the personal computer (PC).

Methodology

Figure 1 shows the overall concept of the project development. Design system and prototype that will be implemented using these hardware components. It consists of temperature sensor, ph sensor, Arduino NANO board and Zigbee Xbee S1 (transmitter and receiver). The ph and temperature data that acquired from these components would be displayed and analyzed. The system will cooperated with other Arduino Nano and Zigbee which act as receiver to receive data and interpret it to GUI that display at the computer. GUI will be invented using Microsoft Visual Studio 2015 software. GSM also connected to computer that will sync up with GUI to send alert message if the parameter values exceed its limit.

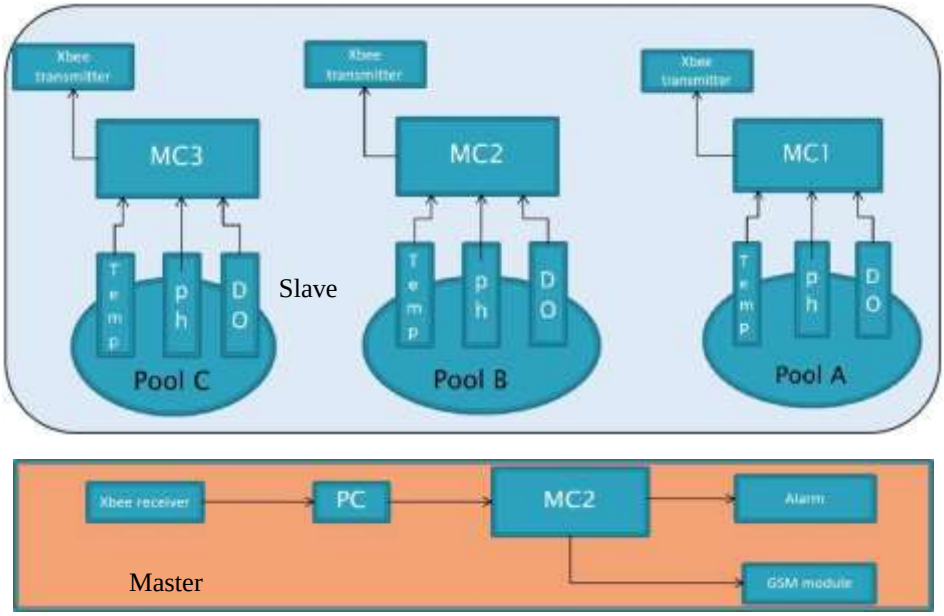

Fig. 1 Project Development Flow

Result & Discussion

Figure 2 shows complete prototype design for this system. Our proposed systems will monitor and record quality of aquaculture water around the clock providing continuous data that can be used to identify trends and improve production. This proposed system combines of two main part: system at site (pool) and system at office (control room). There are three pools, where each pool will be monitor by three sensors (temp, pH and Dissolved Oxygen), one microcontroller and one wireless device to transmit data to main office.At main office, data transfer from site will be receive and display in GUI as shown in Figure 3. GUI will save and process the data in, and will trigger an alarm and send SMS notification to person-in-charge if the data above the setting threshold.

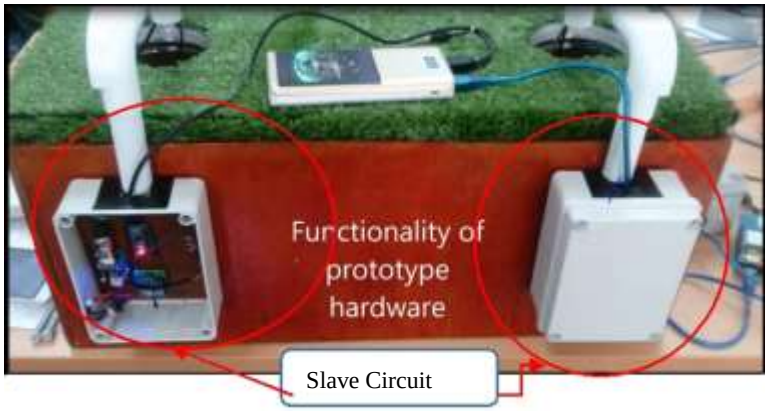

Fig. 2 Complete Prototype Hardware

Data sent from slaves will be transmit wirelessly to main controller which is Arduino Nano that connected with Xbee Zigbee S1 then connected to computer. From computer, it will display through GUI that made up using Visual Studio 2015 as shows in Figure 3

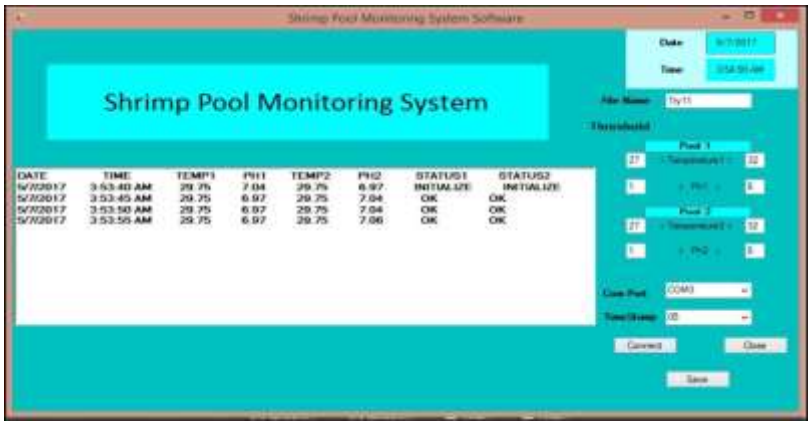

Fig. 3 GUI display when monitoring occur

Conclusion

In conclusion, this project was successful as it achieve all of the objectives that listed at the beginning of the project. The water quality monitoring system using wireless sensor network at shrimp pool was designed and fabricated with temperature and ph sensors. The system was capable to monitor the parameters that important for shrimp to grow and survive which are temperature and ph and display the data on GUI developed. Wireless concept is implemented on this system to transmit data from the

pools to the GUI. The system displaying the value is equipped with precaution systems which are it display the status of water quality whenever the parameter value exceeds it limit. The system also triggered alert message to the user as the status display over limit.

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