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Quality Maintenance of Fish Farm: Development of Real-time Water Quality Monitoring System

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***Abstract*— Fish farming is a challenging job for producing fish without any hazard. By maintaining the water quality of the pond can safe fish production. This paper will discuss the development of a real-time water quality system to monitor fish farm. The water quality monitoring system consist of a dissolved oxygen sensor, pH sensor and water temperature sensor using CC3200 Launchpad as the microcontroller, integrated with Internet of Things (IOT) platform is set up to enable the real-time remote water monitoring system. The system is designed to efficiently monitor the water quality in fresh-water fish farm, specifically the water parameters suitable for the catfish habitat. Instead of testing the system in the real catfish farm, it is tested using a water that is simulated to the water quality for the catfish habitat.**

***Keywords*— Fish; real-time; IoT; water quality.**

I. INTRODUCTION

Maintaining the water quality is the major problem that is faced by most of the fish farmers nowadays as it causes a huge fish kills that leads to significant loss of income to fish farmers in. It is impossible to completely avoid fish kill, but in most cases, there are warning signs that the farmers can identify and act on it before it's too late. This is because most of them must check the water quality in their farm manually and it is not very efficient as it needs repeated human intervention to collect and test the sample of the water from the fish farm which cost a lot of time and money. This is where the real-time monitoring is crucial in monitoring the water quality as it will provide the data continuously on the water quality that can be accessed easily by the farmers by using their smartphone or even tablets for efficient water quality management.

Xiuna Zhu, Daoliang Li, Jianqin Wang, Daokun Ma, Feifei Li and Dongxian He (2010) states modern intensive fish farming management requires water quality monitoring and forecasting as it fundamental system. Using artificial neural networks (ANNs) along with the mobile telecommunication technology, a real-time monitoring system has been designed to forecast the water quality besides controlling the water quality in actual time to prevent huge losses in the fish farming industry. The designed system has proven to provide an early warning with accuracy of 81.4% without any false alarm which is useful for high-density fish farm [1-3].

Huang V., Carlsson R., Qiang Li, Liu E. (2011) has adapt the Machine-to-machine (M2M) technology to observe and improve the aquaculture surrounding in maintaining the ideal surrounding. M2M solution developers is supported by the Sensor Data Service Platform to enable them to merge with the broad range of sensor and actuators to automatically monitor and respond immediately on any changes in the surroundings of the aquaculture. This feature of the technology amplifies the capacity and quality of the yield while reducing the human's intervention and also lessen the possibility of a diseases which can be prevent from infecting the fish [4-6].

Chandanapalli S. B., Sreenivasa R. E., and Rajya L. D., (2014) states that by maximizing fish yields, the water quality parameters such as dissolved oxygen, temperature, and pH level needs to be kept at certain optimal levels. This is because these parameters diverse during the period of a day and can abruptly change depending on the environmental circumstances thus, a system with a ZigBee standard and virtual instrument technology as it fundamental is developed for monitoring and controlling purpose of the aquaculture system. The system is divided into two modules that is the transmitter station which mainly consist of the hardware such as the sensor nodes, microcontrollers, GSM and ADC while the receiver station is for receiving the information from the transmitter via GSM network to the GSM module. The designed user interface enables the farmers to keep up with the water quality in their fish farm as the information is sent to their mobile phone and warns them when the water quality drops [4].

Octavian Postolache, José Dias Pereira, Pedro Silva Girão (2014) introduced a wireless sensor network composition that integrate low cost sensing nodes and multiparameter sensing probe for reliable monitoring of water quality parameters of the surface waters in metropolitan areas. The temperature, conductivity and turbidity measuring channel is used to monitor the water quality parameters. The signals obtained is then processed and transmitted by the ZigBee sensor node to a

computer internet connection through the LabVIEW web server capabilities. This system is durable enough to be use in harsh condition or environment besides the electrode cell used is easy to be clean because of its simplicity. The accuracy of the information on the water quality produced by the system is proved by the laboratory tests that have been carried out on the system [2, 7-8].

II. Methodology

In this section, the materials and methods used in the project is described including the block diagram, flowchart, hardware and software used to develop the system. First of all, the crucial parts of this development are considered before development starts.

A. System Block Diagram

The block diagram shown in Fig.1 is the whole circuit explanation in the form of a diagram. For this development, CC3200 launchpad is the main part of this project which is the controller for the input and output of the project. For the input, there are three types of sensors that is used to measure the water quality parameters that is temperature, dissolved oxygen sensor and pH sensor. The temperature sensor measures the temperature of the water while the pH of the water is indicated by the pH sensor. The sensors transmit the signal to the CC3200 launchpad to process the information. Then, the information is sent to the cloud via the Wi-Fi to be access by the user. The data from the microcontroller is stored in the cloud and then send to user interface as in the devices such as the mobile phone, laptop and tablet for monitoring purpose.

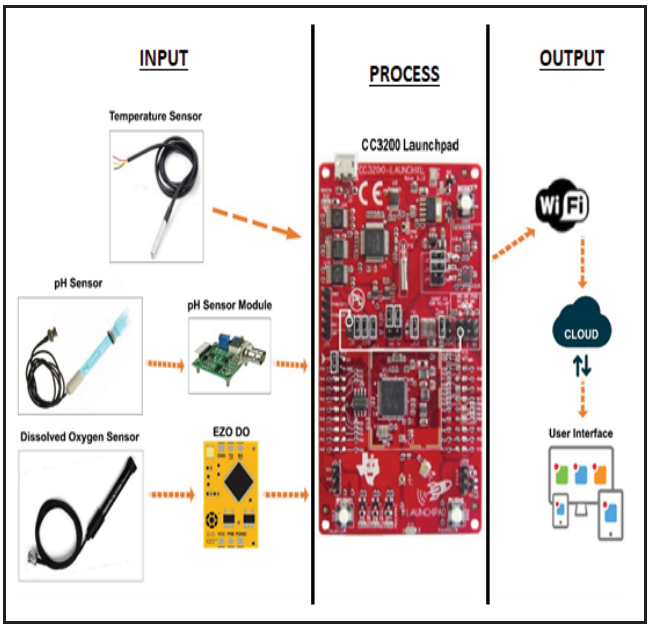

Fig. 1. Block Diagram of the project

B. Working Flow

The flowchart in Fig.2 shows the flow of the project. When the project starts, it will monitor all the water quality parameters which is associated to the sensors used that is the water temperature, dissolved oxygen sensor and pH sensor. User can access the information by login to the website on any devices such as mobile phone, laptop or tablet by accessing the specific IP address.

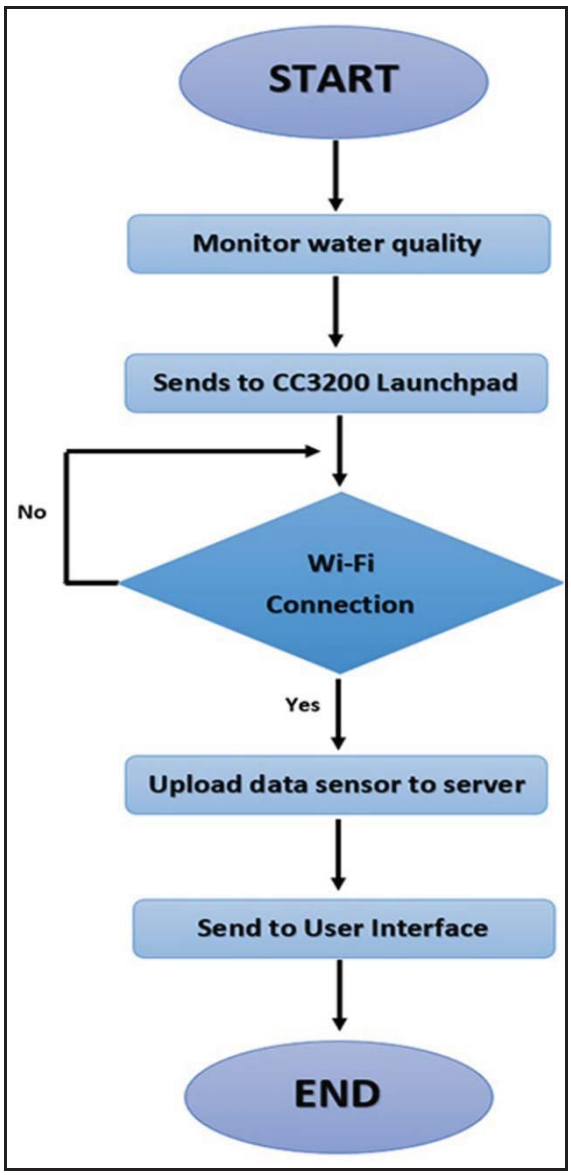

Fig. 2. Flowchart of the project

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C. System Circuit Diagram

The proposed system circuit diagram of the project is as shown in the Fig. 3. All of the sensors are connected to its

complementary pin based on the pin configuration of the CC3200 Launchpad. Only the dissolved oxygen sensor is connected to the I2C pin of the CC3200 Launchpad while the others are connected to the analog pin. The output from the DS18B20 temperature sensor is connected to the analog Pin 23 and the pH sensor is also connected to the analog pin that is Pin 2. The dissolved oxygen sensor is connected to Pin 9 and 10 that is the specific pin for I2C mode where Pin 9 is the SCL pin and Pin 10 is the SDA pin.

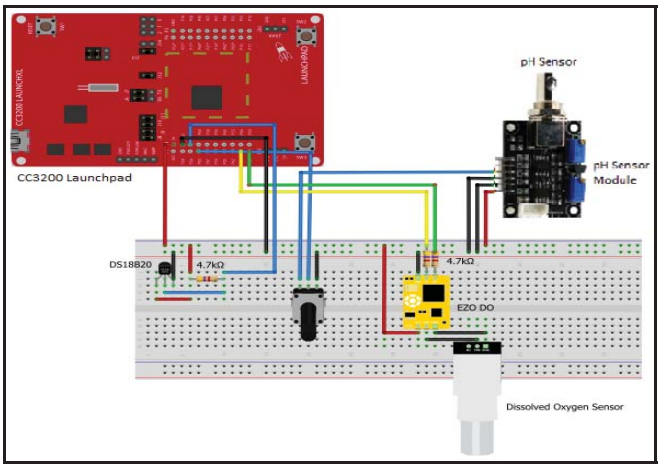

Fig. 3. Circuit Diagram of the Project

D. Product Sketch Diagram

The sketch of the final product for the water monitoring system is as shown in the Fig. 4. The system includes the CC3200 Launchpad as the microcontroller, DS18B20 Waterproof Temperature sensor to measure the water temperature, SKU SEN0161 pH sensor with its sensor module to measure the pH of the water and lastly, the dissolved oxygen content in the water is measured using the Atlas Scientific Dissolved Oxygen Sensor with the EZO DO sensor module. Each of the components mentioned has its own important part to ensure the water quality monitoring system is working and making sure this project is successful.

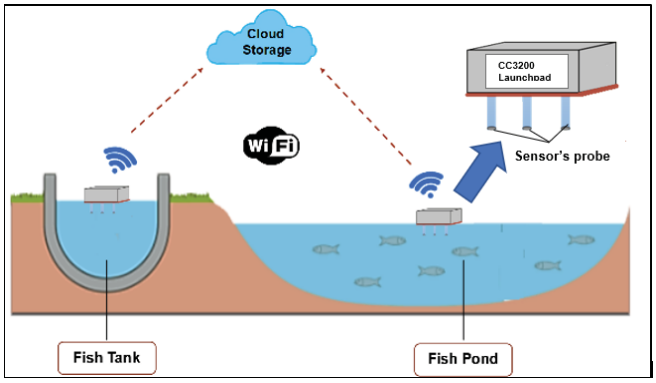

Fig. 4. Product Sketch Diagram

III. RESULTS AND DISCUSSIONS

This chapter explains the results obtained by testing the functionality of the monitoring system. The system has been tested and the results obtained are according to the objective requirement as the project's final result. The results produced are based on the parameters in measuring the water quality that is the water temperature, pH, and the dissolved oxygen content in the water. The results are arranged and categorized in terms of a graphical method as system is tested where the test for the parameters mentioned are conducted simultaneously. This water quality monitoring system produce a real-time data to keep on updating the current water quality for the user to monitor on the user interface.

A. Experimental Setup

The experiment to test the functionality of the monitoring system is set up by placing the sensors in the water. The sensors are tested using a water that is simulated to the one used in the catfish tank except for the chlorine content in the water is not filtered but it will not affect the reading produced by the sensors. The temperature sensor is tested by adding a slightly hot and cold water into the container used to hold the water which also will affect the amount of dissolved oxygen and the pH value of the water. This is because more dissolved oxygen present in the cold water than warm and the pH measurement varies in different temperature. The normal condition for the pH measurement is at 25 □C at where the pH value varies at ±0.001 pH in a temperature other than 25 □C.

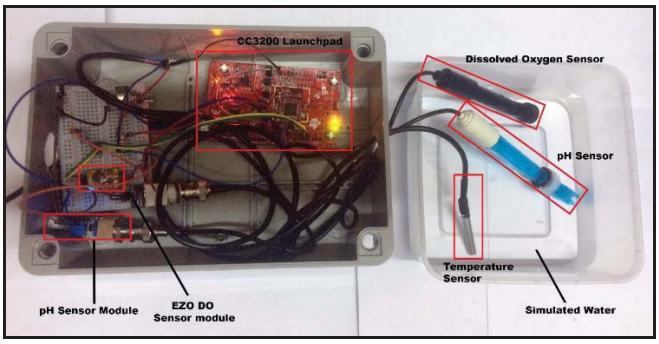

Fig. 5. Hardware Setup

B. Results

The results are described based on the data displayed on the Node-Red dashboard which can be obtain by accessing the specific IP address, http://18.218.173.185:1880/ui to open the user interface. The x-axis of the graph is set to show the data for the last 10 minutes to clearly see the changes of the parameters value and it will keep on going as it displays a real-time data.

C. DS18B20 Waterproof Temperature Sensor

The temperature sensor measures the water temperature where it is tested by adding a warm and cold water. It is observed that the water temperature varies for a while before a constant reading is produced. The diagram shows the data produced from the DS18B20 temperature sensor. The constant

reading shows that the reading is stabilized after a little at the start which indicates the temperature of the water is equal to the current room temperature. The temperature varies starts from 1.15 am before the readings produced becomes constant at 1.45 am. The graph rises a bit when a little hot water is added before it goes back to a constant reading (see Figure 6(a)). When a slightly cold water is added, the water temperature drops from 30.31°C to 28.43°C (see Figure 6). The changes in the water temperature is not obvious as shows in the graph for the insignificant drops of 1.88°C

(a) **b)**

Fig. 6. The Changes in Water Temperature

IV. Conclusion

This development has its own advantages and also disadvantages by going through this paper especially based on the results obtained as described here. Overall, the parameters needed in monitoring and maintaining the water quality is investigated which eased the selection of the suitable sensors to be use for the measurement. This development consists of the water quality monitoring sensors connected to the CC3200 Launchpad which then integrated with the IOT platform for data collection. In short, this project is successfully designed to monitor the water quality in the fish farm by collecting the data from the sensors and send it to the cloud server via the Wi-Fi to be accessed by the user using specific IP address for the monitoring purpose through the data displayed on the user interface.

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