ISSN No:-2456-2165

Solar-Powered Fishpond Feeder with Real-Time Water Quality Monitoring System

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Abstract:- Automated fish feeding has been developed to automate food carrying and handling of fish products and to automate the feeding of the fish to overcome feed waste, malnourished or over fat fish and water pollution problems. The system includes a feeding mechanism, commercial water quality sensors (DO and pH sensors), a wireless communication system (GSM Module), and the positioning system (GPS). All data like feeding status, water quality parameters, location, and other important parameters were collected, processed, saved, and stored in SD Card in the form of CSV (Comma-separated values). The experimental results for the feeding mechanism prove that the system is reliable in terms of dispensing feeds based on the desired time and location. The system can monitor real-time the water quality and send directly the sample data thru GSM-SMS technology.

Keywords:- *component; formatting; style; styling; insert.*

I. INTRODUCTION

For the past three decades, fish farming became one of the most growing food producers, which produces a majority of humankind's direct consumption.[1]

In fish farming, a water quality monitoring system plays an essential part as the farmers must balance and maintain the condition of the fishponds for the growth/health of the fish[2].

The European Water Framework Directive has highlighted the necessity for water quality monitoring in the sea, lake, and freshwater areas. The tasks are performed using traditional laboratory analysis, fixed monitoring stations (buoys), and portable meters. Deploying water quality monitoring instruments using buoy can allow a collection of the water's properties physically, chemically, and biologically. It will enable the temporal deviations in water quality to be characterized. The buoy system is designed and integrates sensors for monitoring various water quality parameters, such as temperature, water level, and dissolved oxygen. The data gathered using a buoy system are transferred and sent to the data center where people can observe and monitor real-time the status of the water. As a means of measuring the water quality, a manual analysis in which the distributed water is sampled and manually analyzed with an off-line measurement. However, these traditional approaches are not applicable to sustain.

The monitoring needed by environmental experts because of its cost, the need for technical personnel, lesser frequency, high power consumption, and coverage. For the last two decades, the new system has ended a development advancement in sensing technology like marine robotics for continuously sampling oceans, rivers, and other bodies of water with increased frequency of sampling at a lower cost compared to traditional methods. Although fixed and portable sensor/meters increased the rate of data gathering; it also has some limitations like small coverage area. Nowadays floating mobile vehicles can improve the sequential scale of monitoring the water quality. It can provide real-time monitoring of freshwater, rivers, and other water bodies to generate sustained observations[3-8].

Intelligent systems are being applied in freshwater aquaculture to contribute to an increased and better production which reduced the expenses by monitoring the water quality such as dissolved oxygen (DO), water temperature (Ambient and humidity temperature), pH, etc. Scientists from Jiangsu University China developed a system that has the capacity for determining the various water parameters in real-time by wireless data transmission[9].Fish farming entails a big chunk of its budget in the manual feeding of fish. Also, the number of feeds usually differs as a result of human error (lesser of more than) the required amount thus causing malnourished or over fat fish. The automatic fish feeder is designed to distribute the exact number of pellets at a specified time and location. This device fed the fish with the exact time and amount inputted by the user, therefore preventing the overfeeding of the fish [10].

Moreover, any delay in the feeding process can affect the quality of the fish such as the size of the fish, less maturity, and the condition of the fish. An automatic feeding system is a perfect solution to provide accurate, and cost-effective food in every fishpond. By implementing an automatic feeding system proper, effective, and efficient feeding could be reached[11].Hence, this study proposes an automatic feeding with a water quality monitoring system. It will automate the concept of automation and GSM technology and reduced supporting structure, capital, and maintenance costs.

The unmanned self-controlled vessel is equipped with a storage area and sensors. A storage area contains fish food to dispense, and a sensor to monitor the water quality. A vessel/boat navigates autonomously through the guidance of GPS. It will travel through a target area, dispense the fish food, conduct water quality testing, preprocess data, and transmit the data into the pre-programmed cellphone number. It will also identify the precise locations of the boat, where the system receives information about each vehicle's location[12].

II. METHODOLOGY

A. Schematic Diagram of the System

The central part of the mobile surface vehicle is the microcontroller unit which consists of a hardware microcontroller and software program that enable and guide the operation of the overall system. The system uses an Arduino Mega 2560, an expandable Arduino microcontroller that has the capability of present and future expansion of the system. It is an open-source, easy-to-use, and user-friendly prototyping platform, and programming environment[13-15]. The data of the preprogrammed commands downloaded to the microcontroller are being preprocessed by the vehicle (MSV). The software program uploaded into the memory of the microcontroller which set the sensor node will measure the quality of water at a specified time interval. Before the transmission, the data being gathered are copied to the SD card as backup data storage. Figure 1 shows the overall schematic diagram of the system.

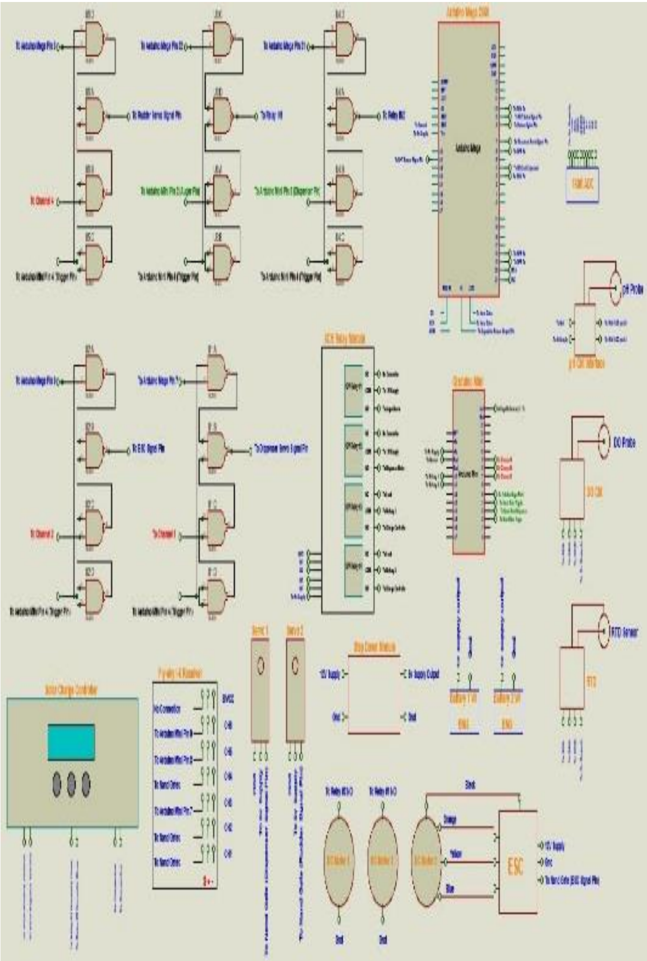

Fig. 1: Overall schematic diagram of the system

The surface vehicle is embedded with a solar panel. The charge controller of a solar panel controls the charging and managing the batteries to generate the needed voltages. Renewable energy systems – specifically solar power - are applied in various applications such artificial intelligence, in rural electrification, or in residential applications among others [16-24].

B. Prototype of the MSV

The mobile surface (MSV) can be remotely controlled or automated depending on the location and area covered by the vehicle. The area is suitable only for remote-controlled operation if it is small and if there is an obstacle like floating materials that might damage the vehicle propeller, a casing, onboard sensors, and a feeding mechanism. While automatic operation fits only to a considerable wide area with no obstruction like floating objects. The user/operator can design a plan for defining the coordinates for feeding and for checking the water quality in a given location. With these, deployment of the vehicle would be easier, especially in gathering and determining the data in areas difficult and dangerous to reach. Figure 2 shows the prototype of MSV wherein it is protected with an intellectual property according to the policy of the university [25].

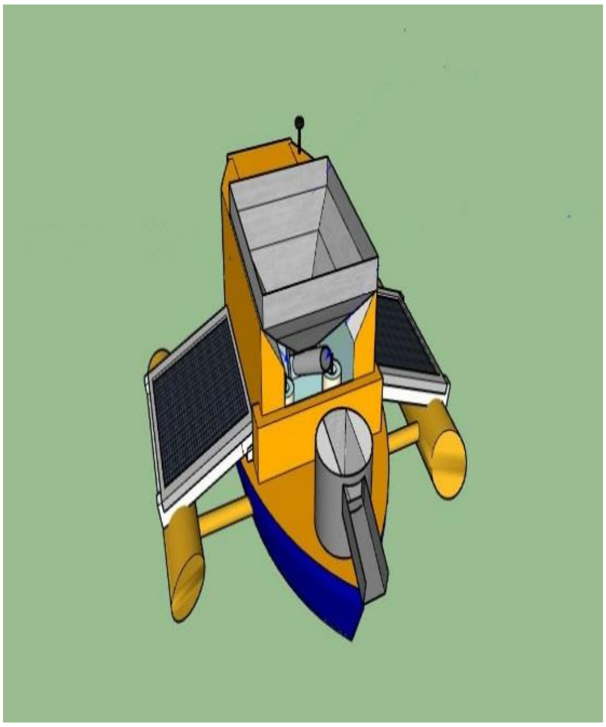

Fig. 2: Prototype of MSV

III. TEST RESULTS AND DISCUSSIONS

During the navigation test, the mobile surface vehicle moves from point to point assigned by the location specified by the GPS. The vehicle with the sensors onboard acquire the possible values of the water quality. The surface vehicle will only test the water quality during the point where the feeds is pumped out thru the dispenser.

A. Water Quality Monitoring

Table 1 shows the water quality throughout the overall navigation testing of the boat. The average pH value is 7.28 means that the fishpond's pH level is neutral. According to the study [26] the aquatic animals can live under the pH levels of 6.5 to 9.0. The study suggests that the minimum amount of DO is 4-5ppm that support the diverse fish population and generally averages at about 9.0 ppm in good fishing [24]. The level of DO during testing is 6.87ppm, the result suggest that the output value is in line with the required level of DO in fishpond. The water temperature is 30.19, humidity value is 80 and the ambient temperature value is 31.

pH	DO	Water temperature	Humidity	Ambient temperature
7.29	7.09	30.19	80	31
7.28	7.16	30.19	80	31
7.28	7.06	30.19	80	31
7.29	6.85	30.19	80	31
7.29	7.04	30.19	80	31
7.29	6.61	30.19	80	31
7.28	7.02	30.19	80	31
7.28	6.44	30.19	80	31
7.28	6.68	30.19	80	31
7.28	6.77	30.2	80	31

Table 1. Water quality monitoring

B. Feeding timing

To prove that the system was reliable, two experimental tests were conducted which were the functionality, and validation of the timing, precise feeding, and the accuracy of the positioning. The main concern and essential factors were the timing and positioning accuracy during the feeding time.

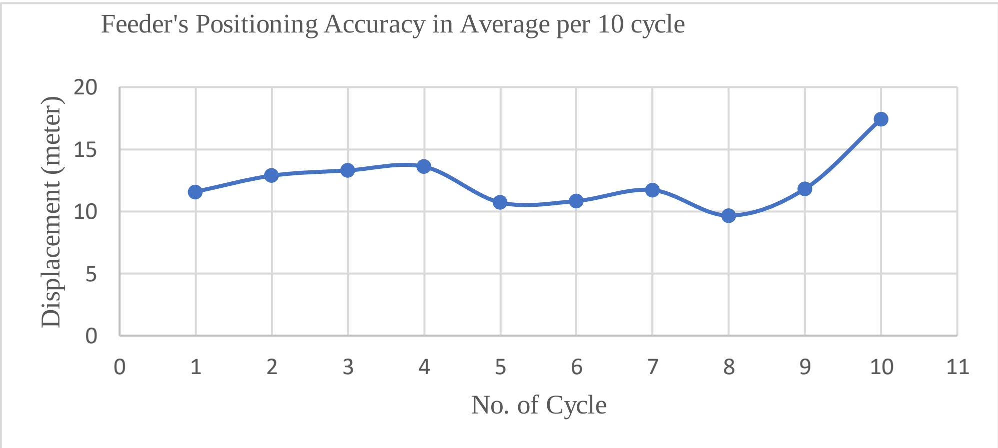

Fig. 3: Feeder's Positioning Accuracy

ISSN No:-2456-2165

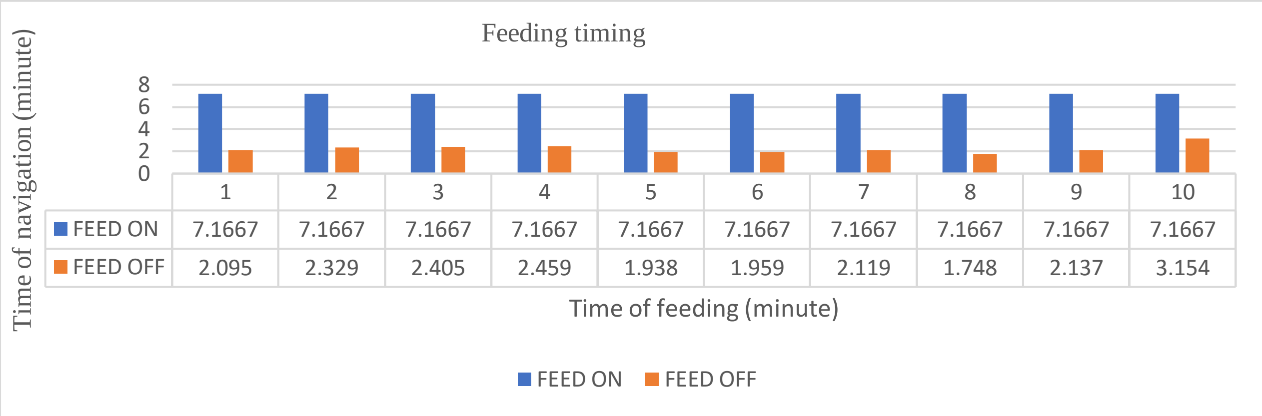

Fig. 4: Time of feeding with respect to time of navigation

C. Testing of DO,pH and temperature sensor

The aptitude of the sensors for dissolved oxygen, pH, and temperature was evaluated by comparing its actual data values to that of a Horiba® probe, a commercial multi-parameter water checker. Synchronized measurements at a particular sampling point were done during testing. The study showed that the water sampling results were good as it yielded better values of R^2 of the linear plots between the two readings, the developed prototype, and the Horiba® Water Checker. Figure 5,6, and 7 shows the comparison of the three sensors.

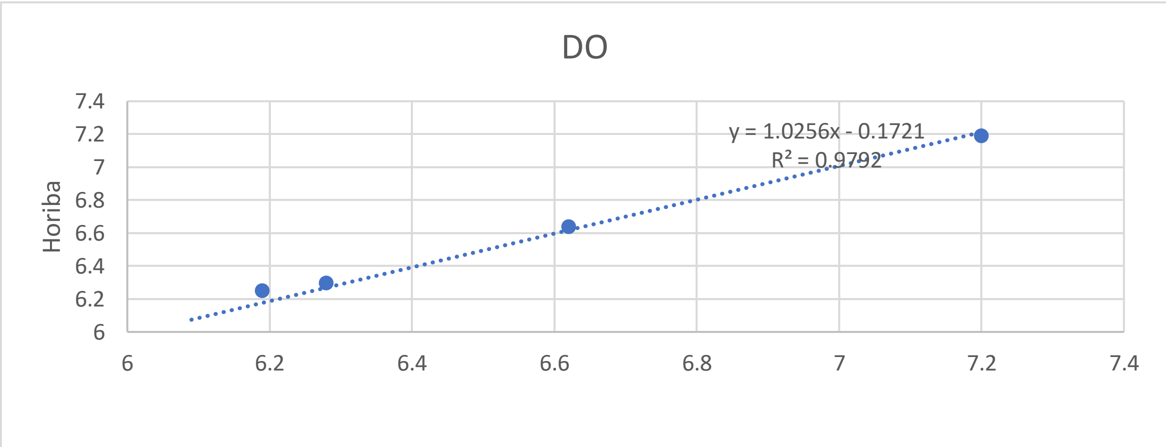

Fig. 5: DO sensor

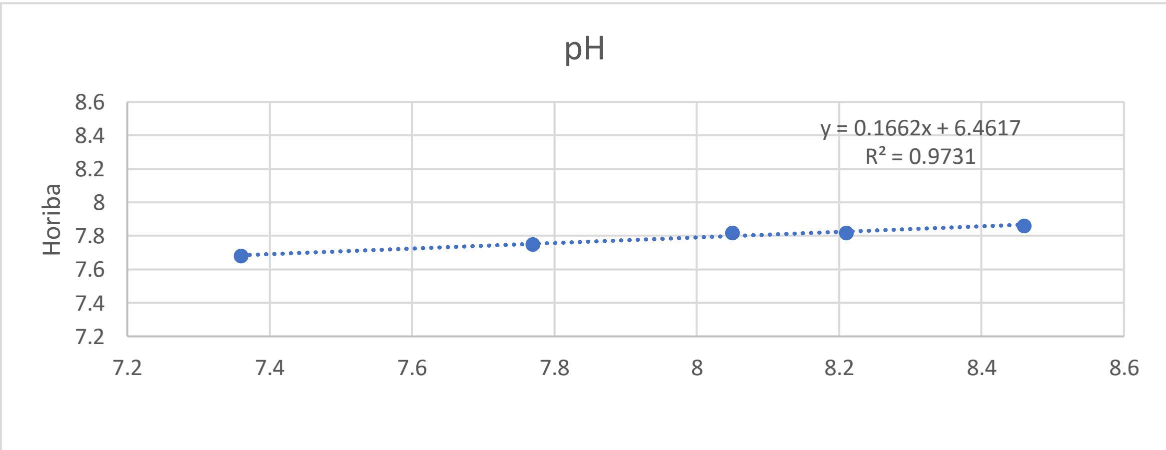

Fig. 6: pH sensor

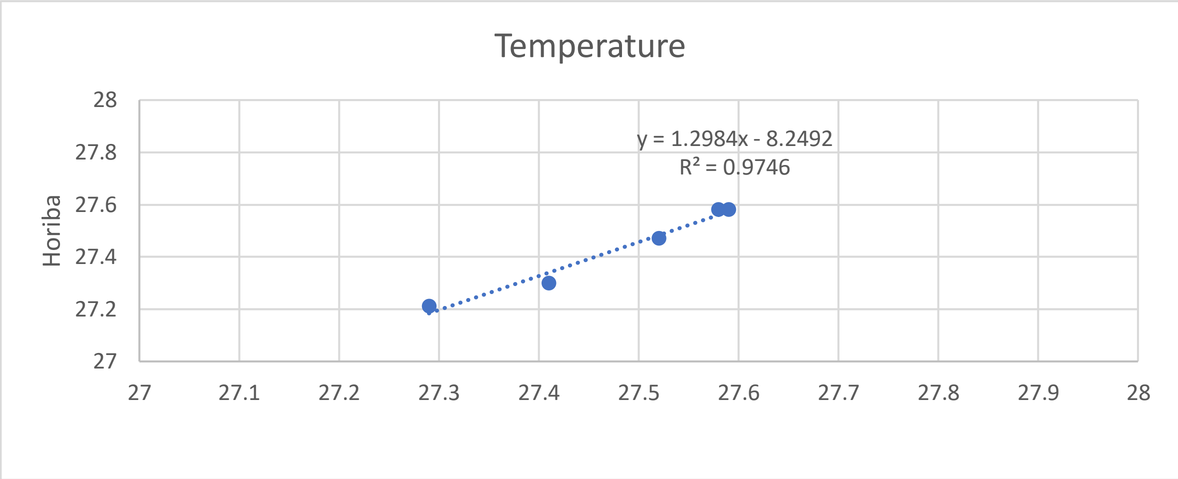

Fig. 7: Temperature sensor

IV. CONCLUSION

This study is one of the alternatives to feed the fish easily at a specified time. Nowadays, fish farmers have to hire more workers to feed the fish and to handle any related work in a fishpond which is time-consuming and costly. This study can reduce the time and the owner would not hire more laborers to handle the feeding system.

An automatic fish feeding system was designed. It integrates a capacitive sensor to detect if there are feeds in a conical shape container and send the data to a Mobile phone thru GSM.

This project gave an effective solution for innovating the feeding system as well as monitoring the water quality which led the farmers to control the feed without much effort. This will make the work/task easier for the aqua farmers.

ACKNOWLEDGMENT

We would like to express our deepest thanks and sincere appreciation to the following people who lead the study successfully. Firstly, to our Almighty God for the guide, blessings, strength, and countless gifts he endowed to us to pursue and finish this study despite all the hardship, trials, challenges, and odds we faced during the development of our project. Second to our parents, for their active support, encouragement to finish our project, cheering us when we've almost given up in times of complications, trust on the journey that we have chosen, and for the unwavering support especially in the financial aspect. Third, to Engr. Alexander T. Demetillo for the guide, knowledge, and time in doing this paper works. And to our adviser Engr. Ronieto N. Mendoza for sharing his experience he imparted to us, especially in electronics part in our study. Fourth to Fablab Laboratory and Center for Robotics, Automation, and Fabrication Technologies (CRAFT) where we make a design, develop and build our project.

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