pH and Temperature Monitoring with a GSM-based Auto Feeding System of a Biofloc Technology

Md. Bulbul Ahammed, Abdul Momin, Sadia Sultana, Anirban Sarkar

Abstract— Biofloc technology (BFT), the new "blue revolution" in aquaculture, has the potential to increase aquaculture production's sustainability without sacrificing quality. The main challenge of biofloc technology is the recycling of waste nutrients, particularly nitrogen, into microbial biomass by controlling the water property. Much work has been published since the introduction of BioFloc Technology to evaluate this system in various contexts and under various nutritional situations. This paperwork is being done on the design and development of a water quality monitoring system of a Biofloc, with the objective of notifying the user through some LED's and display. The pH value and temperature of water in Biofloc are sensed with a pH sensor and temperature sensor respectively and will notify through LED's. Also, an automatic feeding system is added which is controlled by sending SMS through a GSM module that controls a servo motor to open and close the food gate accordingly.

Index Terms— Biofloc, pH Meter, Temperature Sensor, GSM, Servo Motor, Monitoring System, SMS Controlled.

1 Introduction

BIOFLOC technology was introduced in the 1990s to help fish and shrimp farmers save money on feed by reusing wastewater during production. It was created in order to increase environmental control over the production of aquatic animals. In aquaculture, the strong influential factors are feed cost (60% of total cost) and the most limiting factor is the water and land availability. High stocking density and rearing of aquatic animals require wastewater aquaculture. The objective behind this strategy is to create a nitrogen cycle by maintaining a greater C/N ratio by encouraging heterotrophic microbial growth, which assimilates nitrogenous waste that can be used as feed by cultivated species. The addition of a carbohydrate source (molasses) maintains a higher C/N ratio, and the water quality is increased by the creation of high-quality single-cell protein [1].

In Biofloc systems, pH and temperature are to be maintained as the pH is recommended in the range of 7.0-8.5, to ensure the proper behavior of the system. In regards to temperature, the ideal temperature of the system should be 26°C-30°C to avoid the affecting growth of species of the system [2]. pH control and maintenance are one of the most important operations in the water treatment industry because even a minor change in the pH value will have an impact on the nature of water [3].

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Most aquatic species cannot survive in pH values that are either too high (higher than 9.5) or too low (less than 4.5). Young fish and immature aquatic insect stages are very sensitive to pH levels below 5 and may perish if they are exposed to them. By denaturing cellular membranes, high pH levels (9-14) can kill fish. Changes in pH can have an indirect impact on aquatic life by affecting other aspects of water chemistry [4]. Metals are released more quickly from rocks or sediments in the stream when the pH is low. These metals can interfere with a fish's metabolism and capacity to absorb water. Most ammonium in water is converted to hazardous ammonia (NH_3) at high pH (>9), which can kill fish where pH was one of the key facts in all the studies. In Biofloc systems, pH and temperature are to be maintained as the pH is recommended in the range of 6.5-8, to ensure the proper behavior of the system [13].

In this study, we have built a system that measures the pH value and temperature of the water of BT so that the pH and temperature can be controlled to maintain a healthy environment in BT. In the event of executing the act of opening and closing the feeding system's gate, a GSM-based feeding system was also introduced.

2 Literature Review

According to the National Agricultural Library (NAL) Glossary (the United States Department of Agriculture), Biofloc technology (BT) is defined as "the use of

aggregates of bacteria, algae, or protozoa, held together in a matrix along with particulate organic matter for the purpose of improving water quality, waste treatment and disease prevention in intensive aquaculture systems". In other words, "biofloc is a water-based symbiotic process involving cramped aquatic animals, heterotrophic bacteria, and other microbial species". Consumption of biofloc also provides nutritional value to cultured aquatic species. This simply means that BT can be an ideal option for sustainable and environmentally friendly aquaculture [15].

According to a new study of Ray and Mohanty which was published in "Biotica Research Today", the technology requires ongoing monitoring in order to be successful [1]. Despite the fact that pH has no direct effect on water users, it is a critical operational water-quality criterion. At all phases of water treatment, the pH should be regulated to achieve optimum water clarity and disinfection [3].

Yinchi Ma and Wen Ding worked on an intelligent monitoring system for dissolved oxygen of the aquaculture water are designed which provides a powerful technology method for maintaining the dissolved oxygen level of the aquaculture water in a good range. Their technology can also transmit an alarm message to the aquaculture management and technician, as well as provide feedback on the operating status of the oxygen-increasing equipment [7].

S. Maqbool and N. Chandra's research demonstrates how to remotely monitor the water level of water systems such as water tanks, rivers, groundwater tables, and bore wells. They have also shown that how to control the working of a pump automatically and remotely [5].

The antecedent fact in most studies was the C:N ratio. However, according to the study pH Controller for Water Treatment by R.Suchithra and P. Navaseelan the pH value of BT water is an important factor in aquatic species' healthy growth [3]. M. de la L. Sanchez-Estrada and J.F. Garcia-Trejo have mentioned temperature as another important fact for the BT in their paper [2].

3 METHODOLOGY

The main purpose to design the system was to measure the pH value of a biofloc system. To design the system, we have used a pH sensor with Arduino and some additional equipment. Also we have connected a temperature sensor to measure the temperature of the system and a GSM was used to control a feeding system by sending sms. The temperature sensor was connected to the Arduino. Some LED's were used to indicate the range of pH value and temperature. Also a display was used to watch the actual value of pH and temperature.

Arduino UNO R3 was used as the main controlling section of this project which contains ATmega328P micro-controller and other supporting chips. It's technical specifications are given below. The controlling unit gets a signal from the GSM module as well as from the pH and temperature sensor then performs according to the conditions given in the driving software [6].

The block diagram and a flow chart is shown in figure- and figure- respectively.

A. Block Diagram:

A simple block diagram of the proposed system is shown in fig-1. Figure 1 depicts a simplified block diagram of the proposed system. The pH sensor and temperature sensor are used to sense the pH value and temperature of the water of Biofloc respectively and will show the result on display as well as indicated by LED's. A GSM module is used to control a servo motor that serves as the feeding portion. The subscriber transmits text messages containing commands and instructions to the mobile station using the mobile unit as a transmitting section. The message sent by the user is saved in the GSM module's SIM memory and the controlled part extracts the data and processes it to switch on or off the feeding section as users wish. The SMS that is sent by the users through the GSM module to the controlled section is finally performed by the micro-controller as requested by the user [6].

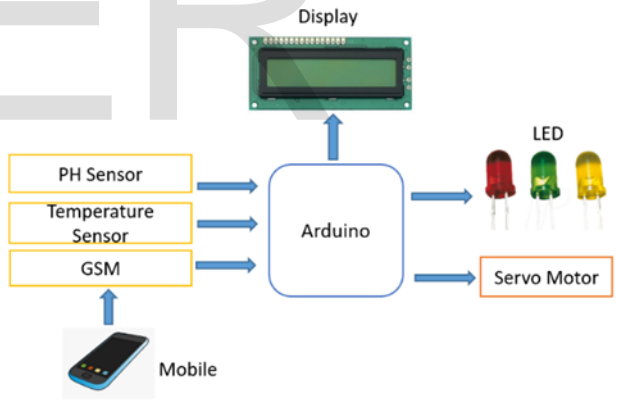

Fig. 1. Block Diagram

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B. Flow Chart

The system has been made with Arduino. The program was developed with Arduino IDE. The flow chart of the system is given in figure-.

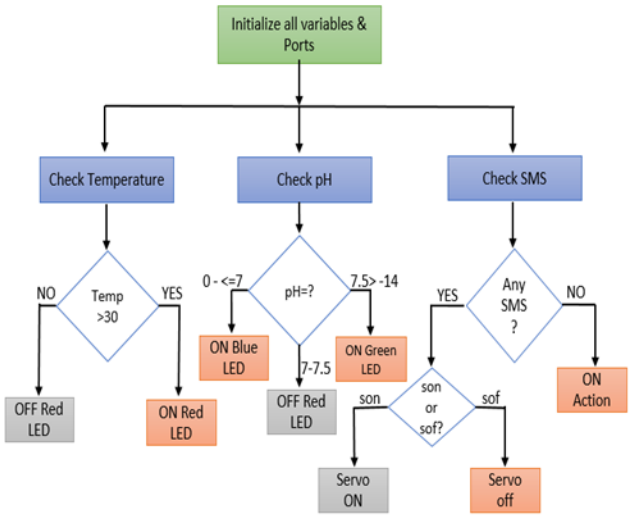

Fig. 2. Flow Chart.

At first, it initializes all the variables and ports. Then it initializes GSM, temperature sensor and the pH sensor. After checking GSM, temperature sensor value, and pH sensor value some decisions are made. If there is no sms found, it takes no action. If there is any message available, it checks the msg code and performs accordingly. If it finds 'son', it turns the servo and the gate of the feeding system becomes open. If it finds 'sof', the servo backs into its initial position and the gate of the feeding system becomes closed. After performing that it checks the GSM again. It checks whether the temperature is below 30 °C or above 30 °C. If it is below 30 °C, Red LED stays off. And if it is above 30 °C, Red LED turns ON. Also, it checks the pH value of the water of Biofloc. If it is in the range of 7.0 to 7.5, no LED turns ON. If the range is 0 to = to 14, Blue LED turns ON. After performing these it starts to check again.

pH measurement: The most important parameter of water is pH. It actually indicates whether a sample is alkaline or acidic. A numeric scale spanning from 0 to 14 is used to express pH. A solution to be neutral should have a pH value of 7. Increasing the value of pH indicates the alkalinity increment of the solution and decreasing the value indicates the acidity increment of the solution [4][14]. The pH sensor was used to sense the pH value of the water of the Biofloc system. It senses the value and transfers it to Arduino. After receiving the analog value Arduino decodes it to a digital value and shows it on display as well as indicating the range with LED's. If the value is less than 7.0, the yellow LED turns ON, and if the value is greater than 7.5, the blue LED turns ON. When it finds the value between 7.0 and 7.5 both the LED's turn OFF. At the same time, the value is displayed on 16x2 display. The pH sensor circuit board has six pins that are connected to any multipoint control unit, in this project we have connected with Arduino Uno. To, Do, Po, G, G and V+ are used for temperature, limiting pH signal, analog pH value, analog GND, supply GND and 5 volt supply respectively [8].

Temperature: To measure the temperature of the water in the Biofloc system, we have used a thermistor which is commonly used worldwide nowadays. A thermistor's operational temperature range is determined by the probe type and is normally between -100°C (173 K) to 300°C (573 K). Increasing the temperature will decrease the resistivity of a Thermistor (negative temperature coefficient or NTC type typically) and using this method we have measured the temperature of the water of biofloc [10]. It was connected to the analog pin of the Arduino while the other side of the sensor was connected to 5V supply. The thermistor checks the temperature of the system which is processed by Arduino. If the temperature is below 300 the LED stays OFF and it turns ON if the temperature is greater than 300. The exact temperature is also displayed on 16x2 display [9].

Food controlling Unit: We have also added a food controlling system as an additional option for the Biofloc system. It can save the time of a fish farmer. A servo motor was used to open and close the feeding gate. The servo motor operates according to a SMS that is sent by the user through a GSM. The user's message is saved in the GSM module's SIM memory, then extracted by the controlled section and processed to switch on or off the feeding section as the user requests. The SMS that is sent by the users through the GSM module to the controlled section is finally performed by the micro-controller as requested by the user [6]. Once the user sends 'son' the servo motor turns to a specific angle to open the food gate. When 'sof' is sent, the motor turns back to close the food gate. Tx and Rx of the GSM were connected to digital pin 2 and 3 respectively to perform this process. The Tx and Rx pins can also be connected to the Rx and Tx pins of the Arduino Uno as these pins are also used for uploading programs into Arduino. A Board LED display is used to figure out the network coverage state (no network coverage - fast blinking, logged in - slow blinking) [11].

In this project, we have used an SG90 servo motor which has three wires. Out of which two are used for supply and the other is used to receive the signal from the controlling unit.

Display: A 16x2 display was used in this project to show the value of pH and temperature of the water in the Biofloc system. Thermistor and pH sensor senses the

values and the values are decoded by Arduino. Then the values are transfered by the Arduino to the display to show the exact value.

4 Results and Discussion

The produced program was uploaded into the Arduino micro-controller, and all of the designed modules were connected. A model of the Biofloc has also been created as a prototype where the pH and temperature are measured. Also, a prototype of a feeding system is added to this model. The hardware connection and output results are shown in the diagrams below.

Once powering the system, it initializes all the variables and probs. Then the pH and temperature are measured by the sensors and show the values on a display as well as indicated by LED's.

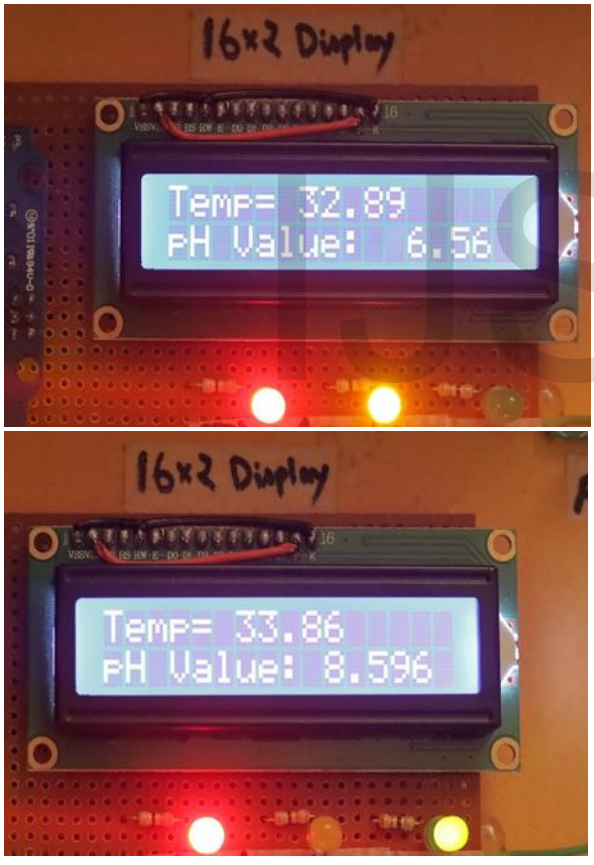

Fig. 3. Display & LED's.

While a message is sent to the system through GSM the servo acts accordingly. If the system finds 'son' the servo turns on to open the gate of the feeding system while the servo turns off to close the gate of the feeding system if the system finds 'sof'.

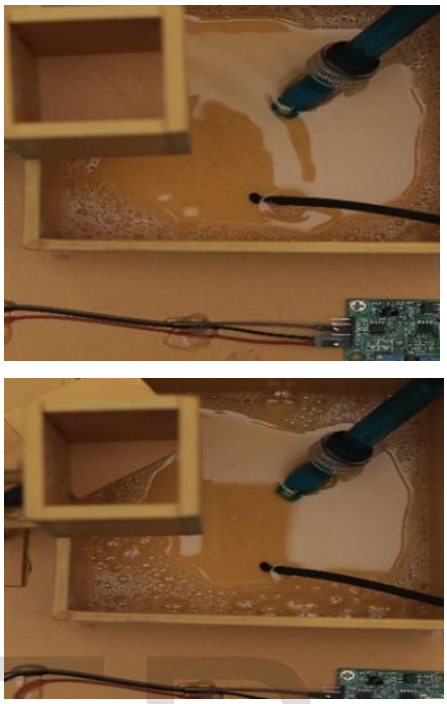

Fig. 4. Feeding System (Prototype pond and feeding pod)

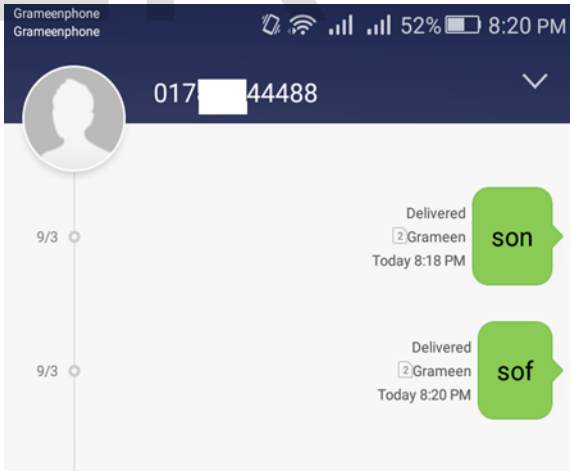

Fig. 5. SMS Command for the feeding system.

5 Conclusions

pH and Temperature of the water of Biofloc can easily be measured in this system. Thus the fish farming owner can take necessary steps to keep the water safe for the healthy growth of the aquatic species. The system will save time as the feeding system is GSM-based. Though it was a "prototype project" but it ran perfectly and gave us real values. Also, the GSM performed according to the

message is received. The servo motor was perfectly turned on and off to open and close the feeding gate respectively by sending the message through GSM.

ACKNOWLEDGMENT

We would like to express my deep gratitude to Anirban Sarkar and Sadia Sultana for their guidance, enthusiastic encouragement, and useful critiques of this research work. We would also like to thank Md. Abdul Hasib Siddique for his advice and assistance in keeping my progress on schedule. We would also like to extend my thanks to the technicians of the departmental laboratory for their help in offering me the resources in running the program.

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