Automated Shrimp Farming & Monitoring System

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***Abstract*— This paper proposes an approach to improve the accuracy of environmental monitoring and to reduce the workforce for shrimp production in industrial homes. An arduino uno-based prototype has been utilized for monitoring and controlling water temperature, the pH level of water, the salinity of water, water level, illumination of the environment, and dissolved oxygen. This system can gather, analyze and show data on LCD displays. The entire system is programmed in the C language. This system also enables the user to obtain information about the reading of the sensor. This lessens the impacts of environmental variations resulting from rapid changes and decreases farmers' expenditure on labor. This reduces the cost of employing workers and power utilization by the suggested system. The design supports an adaptable, cheap, and commercially usable form that best works for small- to medium-sized farms. Automation of agricultural procedures replaces modern technology with intact conventional processes, and the user interface has been developed conveniently and compactly for farming.**

Keywords*— Shrimp Farm, Aquaculture, Arduino Uno, Water Quality, Automated & Monitoring System.

I. Introduction

In the current century, the Shrimp Market is growing rapidly for huge consumption. The average person eats about 4 pounds of shrimp every year.[1] That is more than any other seafood. The Bangladesh Frozen Food Exporter Association reports that Bangladesh's exports of shrimp amounted to $507.3 million for the fiscal year ended June, down 1.5% from the previous fiscal year. 95 percent of frozen food exports, which amounted to $534 million, represented shrimp output.[2] Shrimp Farming is not easy to handle, it requires so much care. The disease is the most prevalent difficulty in Bangladeshi shrimp aquaculture. Unintended mortalities of shrimp are caused by diseases and the efficacy of defences is also reduced. Currently, farmers are manually and sporadically monitoring environmental conditions in the pond, mostly based on farmers' time-demanding and expensive labour expertise. A lot of shrimp farms in the sector are currently shuttered and automated. However, the initial investment costs (minimum USD 300 000 to 1 hectare) of these models are enormous and are only suited to large farmers [3]. We have seen that the actual demands of small and medium-sized firms are not only being examined to solve the problem of inefficient personnel, but also to reduce the power consumption, automating some operations scientifically. Research shows that water is very significant for the variables such as water temperature monitoring, pH level, illumination control, and dissolved oxygen (DO) levels. Based on the information collected, we provide a highly interactive and user-friendly solution that monitors possibly poor operating environments and some automated procedures.

II. Related Works

Nowadays, shrimp farming has become very popular in our country as farmers are earning a large amount of foreign currency by exporting shrimp. If better support of technology can be implemented in shrimp farming farmers will be benefited on a large scale. Researchers are now trying to improve the quality of shrimp cultivation by implementing newer technical support.

Shilpa et al, implemented a microcontroller which is attached with multiple sensors to monitor the environment where shrimp is cultivated and real time data is logged in a Raspberry PI based single board computer. If any abnormality is occurring in the environment parameter then their system notify farmers by using an Android app named telegram.[6]

Tang et al, implemented a ZigBee-based wireless sensor network for monitoring environmental conditions where a series of low-power embedded MSP430 microcontrollers from Texas Instruments is also used. They also used a Graphical User Interface for analyzing and presenting from collected data with the help of LabView, a platform for generating programs. Their system helps farmers with updated information by sending sms through their system.[7]

A study found that poor water quality causes serious diseases of shrimp. They implemented a microcontroller-based automated system named Auto Switch Aqua Feeder1 which allows feeding the shrimps on a specific time. They also implemented user interface design, and timer controls on dsPIC30F5011 for automation of feeding methods and substantially reducing the labor cost by improving farming quality.[8]

Another study implemented a wireless sensor network-based system for monitoring the quality of pond water where shrimps are cultivated. Their system can identify the temperature, pH level of water, oxygen level of water and water salinity. By collecting those data farmers can do necessary measures to improve water quality if needed.[9]

III. System Requirements

We propose a method that does not require too much investment for small to medium-sized firms. In indoor shrimp farming, water must be changed from time to time as shrimp waste makes the water dirty. The dirty water needs to be changed which requires human resources. Besides, shrimps are extremely fragile they require a lot of care. Our proposed method can monitor water temperature, the pH level of water, the salinity of water, water level, illumination of the environment, and dissolved oxygen.

The proposed prototype needs the following hardware.

- Arduino Uno
- Turbidity Sensor
- pH sensor
- Salinity Sensor
- Ultrasonic sensor
- 3 DC Motors
- LCD Display 16/2
- Speaker
- DC Power Supply
- Light Dependent Resistor (LDR)
- Buzzer
- 2 Variable Resistor
- 2 Resistor
- LED Light
- Breadboard

IV. Proposed Work

The main goal of this project is to build an efficient and smart shrimp farming system that would be beneficial to all other traditional farming systems.

We build our system by integrating some effective features which are Water temperature monitoring, Illumination Control, Water level control, Oxygen supply, Water extraction based on water clarity, pH level monitoring and pH level alert, Dissolved oxygen monitoring, Water salinity monitoring, Water Turbidity Monitoring. The details of these features have been explained below.

A. The Brain of this System

The brain of this system is an Arduino UNO. Arduino UNO provides necessary pins, hardware, and software support for this work, also it is a cheaper option as compared to a Raspberry Pi. An Arduino UNO is connected to a pH sensor, turbidity sensor, salinity sensor, ultrasonic sensor. These sensors send values to the Arduino UNO. The Arduino UNO responds accordingly.

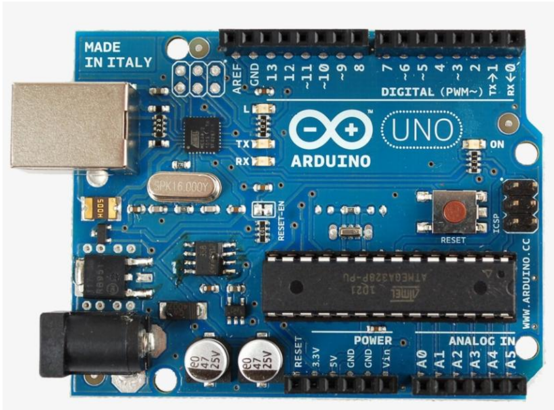

Fig. 1 Arduino Uno front view.

B. Illumination Control

Light intensity is a very effective factor for shrimp growth and maintaining water quality. It is also the most essential factor in the growth of natural fish food such as phytoplankton, zooplankton, etc. to ensure constant light we use a water turbidity sensor. The most suitable level of water turbidity is 35. Water turbidity sensor always takes reading and it shows turbidity value by 16*2 LCD displays.

C. pH control

pH is the measurement of acidity or alkalinity of a solution and the pH scale ranges from 0 to 14.[10] pH is used to indicate how acidic or alkaline a solution is. The pH of the water is indicative of its fertility or potential productivity. The growth of shrimps is retarded if pH falls below 5.0. Water with low pH can be corrected by adding lime to neutralize the acidity. If the pH value falls below or goes above. The pH reading from the sensor is displayed on the 16*2 LCD display.
.

D. Water Temperature Monitoring

Maintaining water temperature is a crucial factor for any kind of fish farming system. In our developed system, we use DS18B20 Waterproof Temperature Sensor to monitor the water temperature. By monitoring water temperature, the farmer can take the necessary steps. The LCD display shows the temperature of the water.

E. Turbidity Control, Clarity of Water

In indoor shrimp farming, water becomes dirty frequently by shrimp waste and wasted foods so checking how clean the water is really important. We used a turbidity sensor to measure the turbidity of water. The turbidity value measured by the sensor is then shown in the display.

Fig. 2 Turbidity Sensor Suspended Turbidity Value Detection Module Kit

F. Water Level Control

Our system will change the water of the tank in certain scenarios(when the turbidity value is not between 6.28-16.51 NTU). So making sure the correct water level is necessary. We used an ultrasonic sensor to measure the water level which would be pointed towards the water. If the water level falls below, a DC motor will start pumping water. It remains on until the tank is filled with water. No person is required for turning the switch of the motor.

G. Dissolved Oxygen Monitoring

Maintenance of an adequate level of dissolved oxygen in indoor water is very important to shrimp growth and survival. Prolong exposure to the stress of low concentrations of oxygen lowers their resistance to disease and inhibits their growth. In most cases, oxygen depletion often resulted in mass mortality (anoxia) of shrimp stock.

During the daytime, more oxygen is produced through photosynthesis than is removed from the water by the respiration of shrimps. In night time oxygen can not be produced. Also, some other events like not changing the water for a long time can also decrease the dissolved oxygen in the water. We measure the Dissolved Oxygen using a dissolved oxygen sensor. If the reading from the sensor is lower than 4mg/l a fan that rotates on the water starts off. It is a replication of the water slapping technique farmers use.

The suitable value of the parameters we have used is given in Table I.

TABLE I
NECESSARY PARAMETERS FOR WATER REQUIREMENTS

Parameter	**Suitable value**
Water temperature	25-31° C
Dissolved oxygen	4-7 mg/l
pH	5-8
Turbidity	6.28-16.51 NTU
Salinity(ppt)	10-13

Source: Bangladesh Fisheries Research Institute[5], [4].

V. ARDUINO UNO PROGRAM:

```
#include<LiquidCrystal.h>
LiquidCrystal lcd(5,6,7,8,9,10);
float tem;
float mv;
int temp;

float turs;
float ts;
int ts1;
int t=11;
float tt;

float ph;
float tp;
int tp1;
int p=0;
float y;


//Do sensor
float do1;
float do2;
float do3;
float doc;

//salinity
float sl1;
float sl2;
float sl3;
float slc;


int ldr;
int led=12;

const int echoPin = 2;
const int pingPin = 3;
int b=1;
void setup()
{

 pinMode(pingPin, OUTPUT);
 pinMode(echoPin, INPUT);
 pinMode(b,OUTPUT);
  lcd.begin(16,2);
 pinMode(led,OUTPUT);

 pinMode(t,OUTPUT);
 pinMode(p,OUTPUT);
 pinMode(13,OUTPUT);
}
```

```
void loop()
{
 do1=analogRead(A2);
do2=(do1*5000)/1024;
 do3=do2/10;
 doc=do3/21.43;

   sl1=analogRead(A1);
sl2=(sl1*5000)/1024;
 sl3=sl2/10;
 slc=sl3/3;

tem=analogRead(A5);
mv=(tem*5000)/1024;
 temp=mv/10;

  turs=analogRead(A4);
ts=(turs*5000)/1024;
 ts1=ts/10;
 tt=ts1/3;


  //turbity sensor condition
if(ts1<20)
 {
  digitalWrite(t,HIGH);
 }
 else
  digitalWrite(t,LOW);


  ph=analogRead(A3);
tp=(ph*5000)/1024;
 tp1=tp/10;
 y=tp1/10.714;
 //Ph sensor condition
if(y<5.5||y>8)
 {
  digitalWrite(p,HIGH);
 }
 else
  digitalWrite(p,LOW);


  lcd.setCursor(0,0);
 lcd.print("Water PH. =");
  lcd.setCursor(0,1);
lcd.print(y);
delay(2000);
lcd.clear();


lcd.setCursor(0,0);
 lcd.print("Water Tempe. =");
 lcd.setCursor(0,1);
lcd.print(temp);
lcd.print(char(223));
 lcd.print("C");
  delay(2000);
lcd.clear();


  lcd.setCursor(0,0);
 lcd.print("Water Turbid. =");
  lcd.setCursor(0,1);
lcd.print(tt);
delay(2000);
lcd.clear();

  lcd.setCursor(0,0);
 lcd.print("Water DO. =");
  lcd.setCursor(0,1);
lcd.print(doc);
delay(2000);
lcd.clear();


   lcd.setCursor(0,0);
 lcd.print("Water Salin. =");
  lcd.setCursor(0,1);
lcd.print(slc);
delay(2000);
lcd.clear();

ldr=analogRead(A0);
Serial.println(ldr);
if(ldr<500)
 {
  digitalWrite(led,HIGH);
 }
 else
  digitalWrite(led,LOW);

  digitalWrite(13,HIGH);


 long duration, inches, cm;

 digitalWrite(pingPin, LOW);
 delayMicroseconds(2);

 digitalWrite(pingPin, HIGH);
 delayMicroseconds(10);

 digitalWrite(pingPin, LOW);


 duration = pulseIn(echoPin, HIGH);
 cm = microsecondsToCentimeters(duration);
if(cm<100)
{
        digitalWrite(b,HIGH);
}
```

```
else {
        digitalWrite(b,LOW);
}

  Serial.print(cm);
  Serial.print("cm");
  Serial.println();

  delay(100);
}

long microsecondsToCentimeters(long microseconds)
{
  return microseconds / 29 / 2;
}
```

VI. Proteus Simulation:

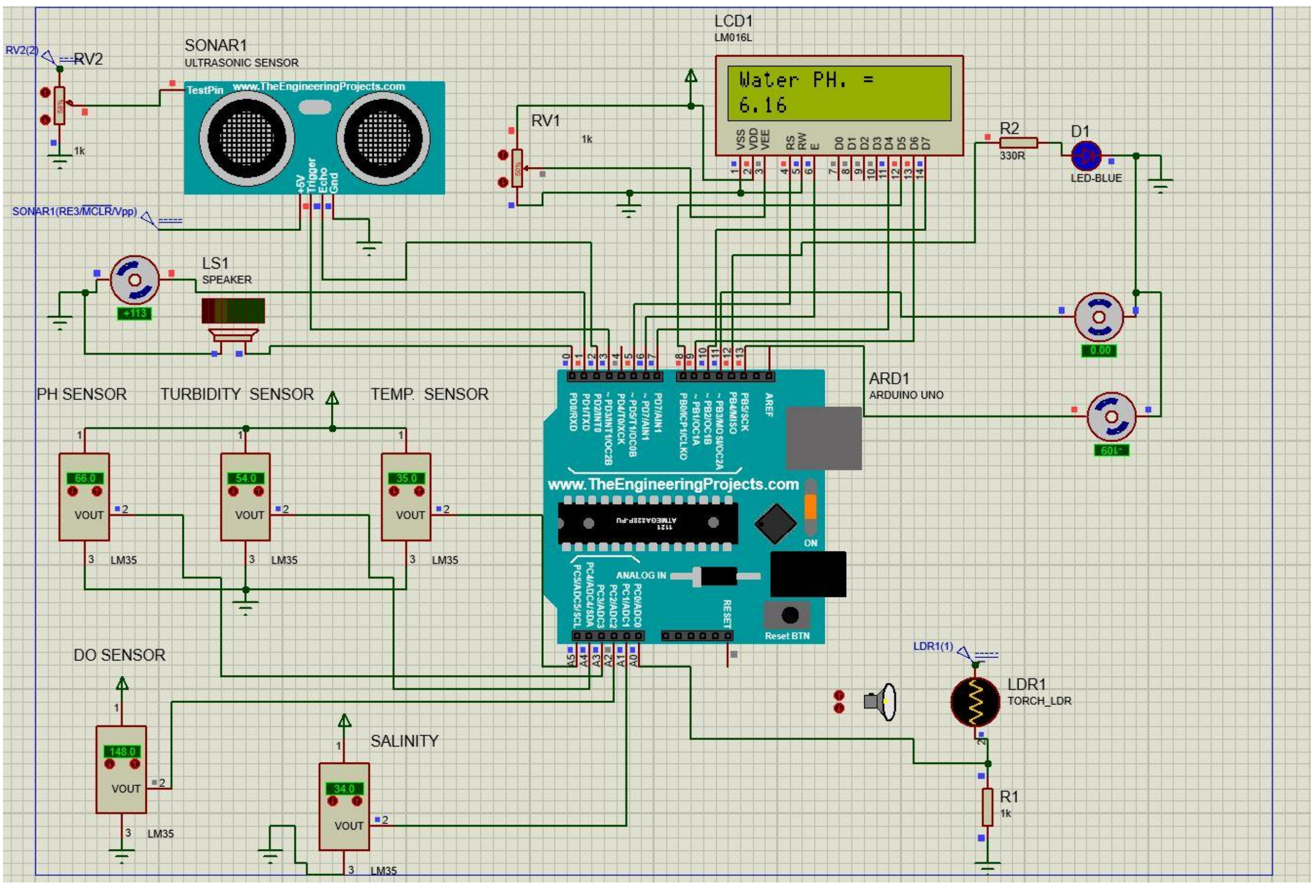

Fig. 3: Simulation of Automated Shrimp Farming and Monitoring System On Proteus

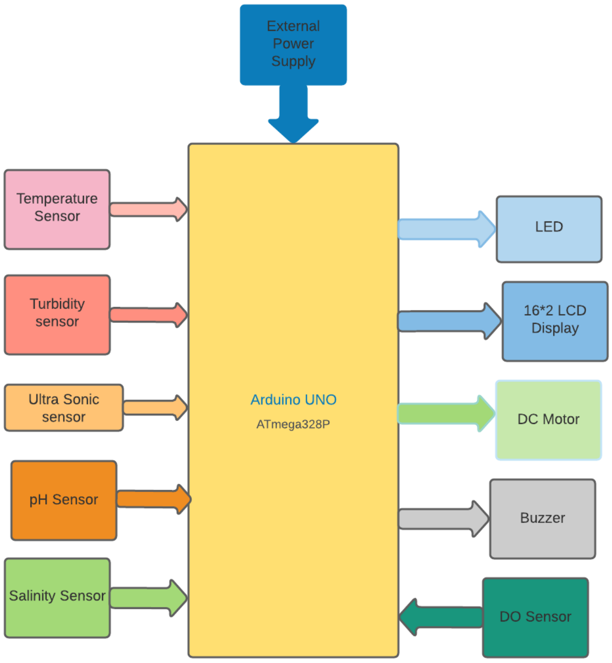

Fig. 4 Flow Diagram of Automated Shrimp Farming and monitoring System

VI. Conclusions

Shrimp farming plays an essential role in Bangladeshi livelihoods, food security, and international trade. As the demand for shrimp has grown gradually, It is most important to give emphasis to it. It is impossible to properly maintain the supply of shrimp according to its demand unless we follow the modern farming system. The proposed farming system boosts up the production of shrimp and efficiently it reduces excess farming cost. This is a low-cost, easy to use and versatile technology to adopt, since it can be integrated with few changes into small and medium size shrimp farms. The method is also very scalable for families or big farms. The team is currently continuing to verify the system's dependability in real-life situations. Thus, The proposed monitoring system is a feasible solution for shrimp farmers.

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