MINI-PROJECT REPORT

ON

'OVERALL WATER QUALITY SYSTEM'

SUBMITTED BY

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UNDER THE GUIDANCE OF

PROF. SAGAR VANARASE

DEPARTMENT OF

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

MKSSS's

Cummins College of Engineering for Women, Pune

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

(2020-2021)

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CERTIFICATE

This is to certify that the Mini Project work entitled

'Overall Water Quality System'

is a bonafide record of project work carried out in this institute

by

Singh Jahanvi Ashok (C. No.- 22018111042)

Jare Shreya Sachin (C. No.- 22018111043)

Katre Anushka Anil (C. No.-22018111050)

In partial completion of team work for the Third Year B. Tech.

In

Electronics and Telecommunication Engineering

In the academic year 2020-2021.

This Mini-Project Report is a record of their own work carried out under our supervision and guidance.

Prof. Sagar Vanarase	Dr. Prachi Mukherji	Dr. M. B. Khambete
Internal Guide	Head of Department(E&Tc)	Principal,CCOEW,Pune52

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We take this opportunity to express our sincere thanks to all the staff members of E&Tc. Department for their constant help whenever required. Finally; we express our sincere thanks to all those who helped us directly or indirectly in many ways in completion of this mini-project work.

Student Names:

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OVERALL WATER QUALITY SYSTEM

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1. ABSTRACT

- The surface of the earth mostly consists of water, only a small part of it is usable, which makes this resource limited. This precious and limited resource, therefore, must be used with care.

- As water is required for different purposes, the suitability of it must be checked before use. Also, sources of water must be monitored regularly to determine whether they are in sound health or not. Poor condition of water bodies are not only the indicator of environmental degradation, it is also a threat to the ecosystem.

- Thus, water quality analysis is essential for using it in any purpose.

- Keywords: Water quality, drinking water, water quality analysis, pH, turbidity, TDS.

1. 1 INTRODUCTION

WATER QUALITY:

- Water Quality can be defined as the chemical, physical and biological characteristics of water, usually in respect to its suitability for a designated use.
- Water can be used for recreation, drinking, fisheries, agriculture or industry.
- Each of these designated uses has different defined chemical, physical and biological standards necessary to support that use.
- For example, there are stringent standards for water to be used for drinking or swimming compared to that used in agriculture or industry.

WATER QUALITY ANALYSIS:

Water quality analysis is required mainly for monitoring purpose. Some importance of such assessment includes:

- To check whether the water quality is in compliance with the standards, and hence, suitable or not for the designated use.
- To monitor the efficiency of a system, working for water quality maintenance.
- To check whether upgradation / change of an existing system is required and to decide what changes should take place.
- To monitor whether water quality is in compliance with rules and regulations.

2. LITERATURE REVIEW

2.1 TURBIDITY

The haziness or cloudiness of a fluid due to various individual particles (TSS or TDS) that can be seen with naked eyes (like smoke in air) is known as turbidity. The determination of value of turbidity might be termed as one of the most important tests of water quality.

Fluids may have suspended solid matter comprising of particles of various different sizes. While some will be big enough settle down quickly at the bottom of the container if a liquid sample is left to stand, the smaller ones might settle very slowly or might not settle at all if the sample is agitated consistently or if the colloidal particles are present. These solid particles, which are smaller in size are the reason for any liquid to look like turbid.Turbidity (or haze) is considered in the case of transparent solids such as glass as well. In plastic production, the percentage of light that is deflected more than 2.5° from the incoming light direction is known as haze.

Turbidity can also be termed as the measure of a liquid’s relative clarity. Turbidity is an optical characteristic of water and is also an expression of the amount of light scattered by material in the water when a light shine through the water sample. The higher the intensity of scattered 14 light the higher the turbidity. Material causing water to be turbid include silt, clay, finely divided inorganic and organic matter, soluble colored organic compounds, algae, plankton and various other microscopic organisms.Turbidity makes water cloudy or opaque. The water collected in the bottle is used to find out the turbidity, which is measured by shining a light through the water and is measured in nephelometric turbidity units (NTU). During periods of low flow (base flow), many rivers are a clear green color, and turbidities are low, usually less than 10 NTU.

Turbidity and water quality

High concentrations of particulate matter affect light penetration and productivity, recreational values, and habitat quality, and cause lakes to fill in faster. In streams, increased sedimentation and siltation can take place, which might result in harming the habitat areas for fish and other aquatic life. Particles also provide attachment places for some other pollutants, especially bacteria and metals. That’s why, turbidity readings are used as an indicator of potential pollution in a water body.

Turbidity and human health

Excessive turbidity, or cloudiness, in drinking water is aesthetically unappealing, and may also represent a health concern. Turbidity can provide shelter and food for pathogens. Regrowth of pathogens in the distribution system is promoted if the turbidity is not removed, leading to waterborne disease outbreaks, which have caused significant cases of gastroenteritis throughout the world. Although turbidity is not a direct indicator of health risk, numerous studies show a strong relationship between removal of turbidity and removal of protozoa. The particles of turbidity provide "shelter" for microbes by reducing their exposure to attack by disinfectants. Microbial attachment to particulate material has been considered to aid in microbe survival. Fortunately, traditional water treatment processes have the ability to effectively remove turbidity when operated properly.

2.2 pH Value

pH is basically a measure of the acidity or basicity of an aqueous solution. Solutions having pH less equal to 7.

Primary pH standard values are found out by using a concentration cell with transference, simply by measuring the potential difference between a standard electrode such as the silver chloride electrode & hydrogen electrode. Measurement of pH for aqueous solutions can be done with a pH meter or a glass electrode. We can also find the value of pH by using indicators.

pH measurements have significant importance in the field of biology, environmental science, chemistry, medicine, oceanography, food science, agriculture, nutrition, civil engineering, chemical engineering, forestry, water treatment & water purification and many other applications.

Mathematically, it can be said that pH is the negative logarithm of the activity of the hydrogen ion.

Importance of pH

The solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.) can be determined by pH of water. For example, in addition to affecting how much and what form of phosphorus is most abundant in the water, pH also determines whether aquatic life can use it. Metals are generally more toxic at lower pH as they are more soluble.

Extremely low and high pH can be significant for the use of water. High pH causes a bitter taste, water pipes and water-using appliances become encrusted with deposits, and it also depresses the effectiveness of the disinfection of chlorine, thereby generating the need for additional chlorine when pH is a bit high. Low-pH water might corrode or dissolve metals and other substances.Pollution has the potential to change a the pH of water, which might harm animals and plants living in the water.

Effects on Laboratory

Animals If pH is more than 10, skin irritation might be observed in some of the animals. For rabbit, this can be observed at a pH of about 9 as well. And if the pH is more than 10, it might behave as an irritant for the eyes of rabbit, but for a pH less than 5, no significant effects on eyes were observed.

Effects on Humans

If human beings are exposed to extreme pH values, it might cause irritation to the eyes, skin, and mucous membranes. Eye irritation and exacerbation of skin disorders have been associated with pH values greater than 11. In addition, solutions of pH 10–12.5 are said to cause hair fibers to swell. In sensitive individuals, gastrointestinal irritation may also occur. Exposure to low pH values can also result in similar effects.

2.3 Total Dissolved Solids

A measure of the combined content of all inorganic and organic substances contained in a liquid in molecular, ionized or micro-granular suspended form is called Total Dissolved Solids (TDS). The solids should be small enough to survive filtration through a filter which has two micrometer (nominal size or smaller) pores. We generally discuss TDS for freshwater systems only, as salinity consists of some of the ions contributing in the definition of TDS. The Study of water quality for streams, rivers and lakes is the most important application of TDS, although TDS is not a primary pollutant, but TDS is used as an indication of aesthetic characteristics of drinking water and as an indicator of the presence of a broad array of chemical contaminants.

Agricultural and residential runoff are primary sources for TDS in receiving waters, and so are leaching of soil contamination and point source water pollution discharge from industrial plants. Calcium, phosphates, nitrates, sodium, potassium, sulphates and chloride comprise few of the important chemical constituents. The chemicals might be cations, anions, molecules or agglomerations on the order of one thousand or fewer molecules, so long as a soluble microgranule is formed. Pesticides arising from surface runoff are more exotic and harmful elements of TDS. Certain naturally occurring total dissolved solids arise from the weathering and dissolution of rocks and soils.

Concentration of dissolved ionized solids in the water is directly related to the electrical conductivity of water. Ions in the dissolved solids in water generate the ability for that water to conduct electrical current, which is measured by a TDS meter or conventional conductivity meter. Conductivity generally provides an approximate value for the TDS concentration, usually to within ten-percent accuracy.

Hard water has high TDS levels, which might be the reason for scale buildup in filters, pipes, and valves, reducing performance and adding to the cost of system maintenance. 11 In aquariums, spas, swimming pools, and reverse osmosis water treatment systems, we can see these effects. Total dissolved solids are tested frequently in all these applications, and filtration membranes are also checked just to prevent adverse effects.

TDS is generally monitored in order to create a water quality environment which is favorable for organism productivity in the case of hydroponics and aquaculture. For freshwater oysters, trout, and other high value seafood, highest productivity and economic returns are achieved by mimicking the pH and TDS levels of native environment of each & every species. Total dissolved solids is considered one of the best indices of nutrient availability for the aquatic plants being grown for hydroponic uses.

Significance of Total Dissolved Solids in Water

The total dissolved solids concentration of good & palatable drinking water should not be more than 500 mg/L according to general belief. However, higher concentrations might be consumed without harmful physiological effects and might be even more beneficial indeed. This limit was set on the basis of taste thresholds. Wildlife and livestock might get injured by drinking water that contains total dissolved solids exceeding this limit. Continuous use of such water might cause weakness, scouring, reduced production, bone degeneration and death. However, temporarily, animals can drink high saline waters, but that will be harmful if used continuously.

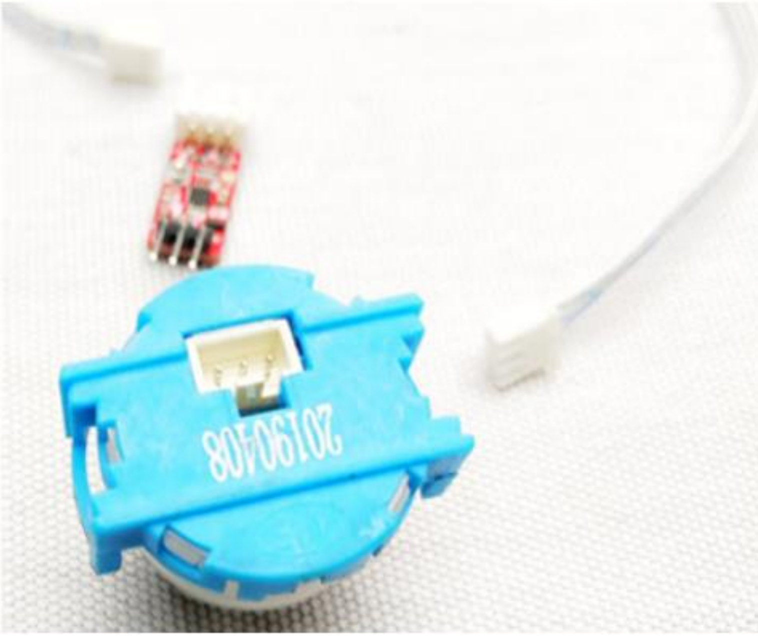
3. Experimental Procedures

This control system is powered by ATmega328p microcontroller present inside Arduino Uno R3. It consists of Turbidity sensor, pH sensor and TDS sensor. 16*2 LCD display module and LEDs are also connected to the Arduino Uno**.**

The sensors are as follows:

- **Turbidity Sensor**
- **pH Sensor**
- **TDS Sensor**

3.1 Turbidity



Apparatus Required

1. Turbidity meter
2. Distilled Water
3. Beaker

- **<u>FEATURES OF TURBIDITY MODULE</u>:-**

➢ Operating Voltage: 5V DC.
➢ Current: 30mA (MAX).
➢ Operating temperature: -30 ° C to 80 ° C.
➢ Compatible with Arduino, Raspberry Pi, AVR, PIC, etc.

Components used are:
1.Arduino Uno Board(1)
2.Potentiometre(2) - 1Kohm
3.LCD 16X2 (1)
4.9V battery(1)
5.5V voltage regulator(1) (LM 7805)
6.Capacitors (2)- 0.1microfarad
7.resistor (1)-220 ohm

<u>**Turbidity sensor: SKU SEN0189**</u>

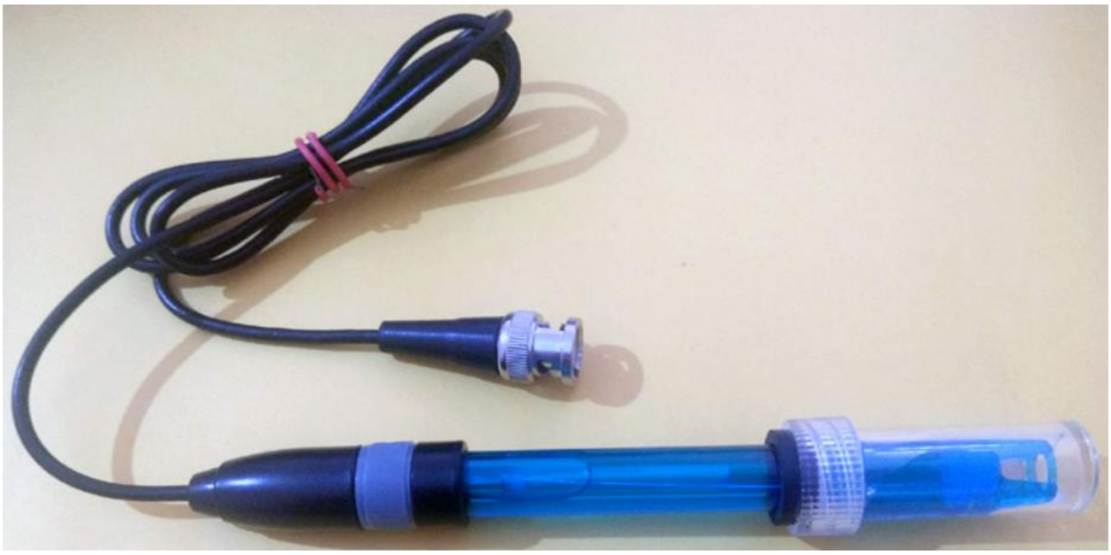
<u>**Specifications:**</u>

- **Operating Voltage: 5V DC**
- **Operating Current: 40mA (MAX)**
- **Response Time : <500ms**
- **Insulation Resistance: 100M (Min)**
- **Output Method:**
  - **Analog output: 0-4.5V**
  - **Digital Output: High/Low level signal (you can adjust the threshold value by adjusting the potentiometer)**
- **Operating Temperature: 5℃~90℃**
- **Storage Temperature: -10℃~90℃**
- **Weight: 30g**
- **Adapter Dimensions: 38mm*28mm*10mm/1.5inches *1.1inches*0.4inches**

Procedure:

- First, the beaker is taken & is washed properly.
- Then, distilled water is poured into the beaker.
- Turbidity of distilled water is measured by the turbidity meter.
- If the turbidity is not zero, then the settings are adjusted as to make it zero.
- Then, the beaker is again washed properly.
- Then, the sample is poured into the beaker.
- The turbidity of the beaker is measured using the turbidity meter.
- The same procedure is repeated for all the samples.

3.2 pH value



Apparatus Required

1.Arduino Uno Board(1)
2.Potentiometre(2) - 1Kohm
3.LCD 16X2 (1)
4.9V battery(1)
5.5V voltage regulator(1) (LM 7805)
6.Capacitors (2)- 0.1microfarad
7.resistor (1)-220 ohm

Technical Features: SKU SEN0161

Signal Conversion Module:

- **Supply Voltage: 3.3~5.5V**
- **BNC Probe Connector**
- **High Accuracy: ±0.1@25°C**
- **Detection Range: 0~14**

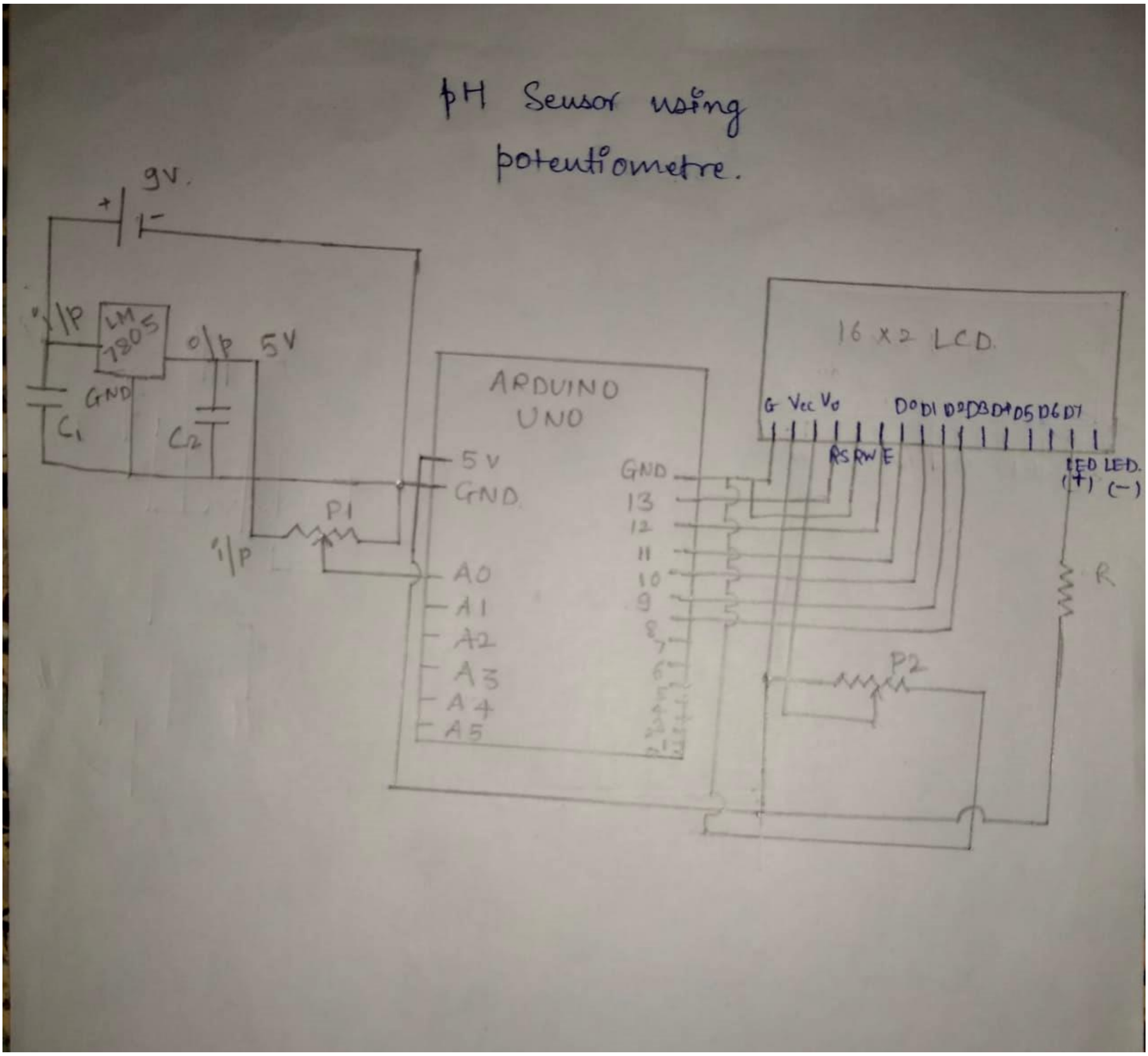
PH electrode:

- **Operating Temperature Range: 5~60°C**
- **Zero (Neutral) Point: 7±0.5**

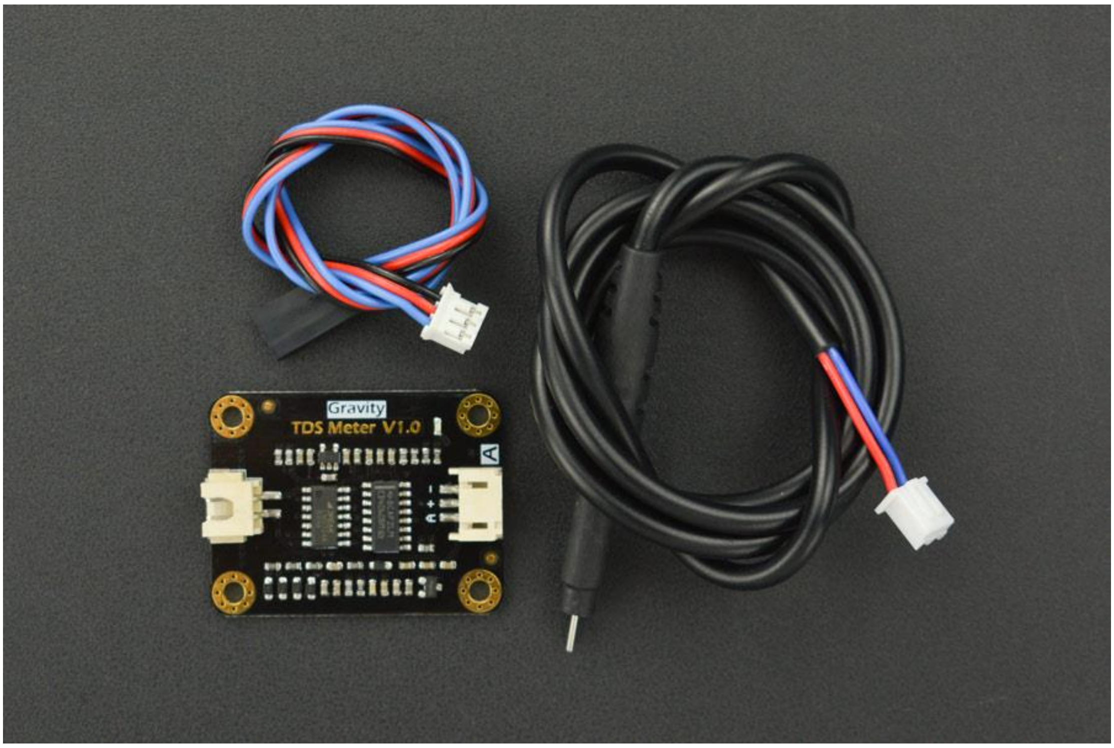
- **Easy calibration**
- **Internal Resistance: <250MΩ**

Procedure

- All the samples are taken in the beaker one by one.
- The pH value is recorded for all the sample using the pH meter.



3.3 Total Dissolved Solids



Apparatus Required

1. Conical flask
2. Petri dish
3. Oven
4. Weighing machine

TDS sensor for Arduino:- SKU SEN0244

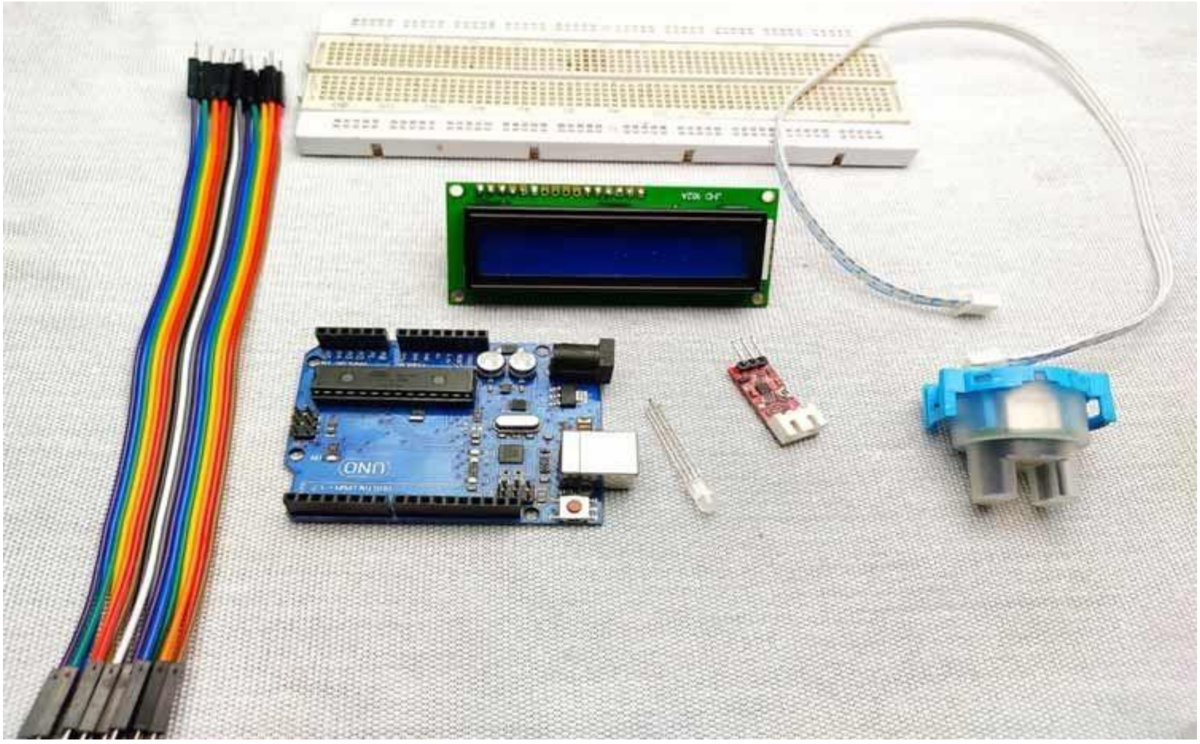
Signal Transmitter Board:

- **Input Voltage: 3.3 ~ 5.5V**
- **Output Voltage: 0 ~ 2.3V**
- **Working Current: 3 ~ 6mA**
- **TDS Measurement Range: 0 ~ 1000ppm**
- **TDS Measurement Accuracy: ± 10% F.S. (25 ℃)**
- **Module Size: 42 * 32mm**

Procedure:

- TDS is measured in continuation to the procedure of finding TSS.
- A petri dish is taken.
- Weight of the petri dish is recorded.
- Filtered water from the TSS process is transferred into the petri dish.
- Petri dish is then kept in the oven.
- The temperature of the oven is set at over 100° C.
- After sometime, water is evaporated.
- The petri dish is then taken out.
- The weight of petri dish is then recorded.
- The initial weight of the petri dish is then subtracted from the final weight.
- The result which we get is the amount of dissolved solids in 10 ml of water.
- It is divided by 10 in order to get the amount of TDS per ml of water.

4. Components Required



- **<u>HARDWARE COMPONENTS-</u>**
  - Turbidity module (Rs. 900 approx.)
  - Digital pH sensor and TDS sensor module (Rs. 600 approx.)
  - Arduino (already have one)
  - 16*2 I2C LCD (Rs. 300)
  - Common cathode RGB LED (Rs. 50)
  - Breadboard (Rs. 200)
  - Jumper wires (Rs. 150)

- **<u>SOFTWARE COMPONENTS-</u>**
  An Arduino IDE or an Online Arduino Editor can be used to write Arduino code for the given idea.

5. Software Modules and Libraries Required

1. **Arduino IDE:-**The **Arduino Integrated Development Environment (IDE)** is a cross-platform application that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards. It provides many libraries and modules which contain many in-built functions that can be directly used by the programmer.

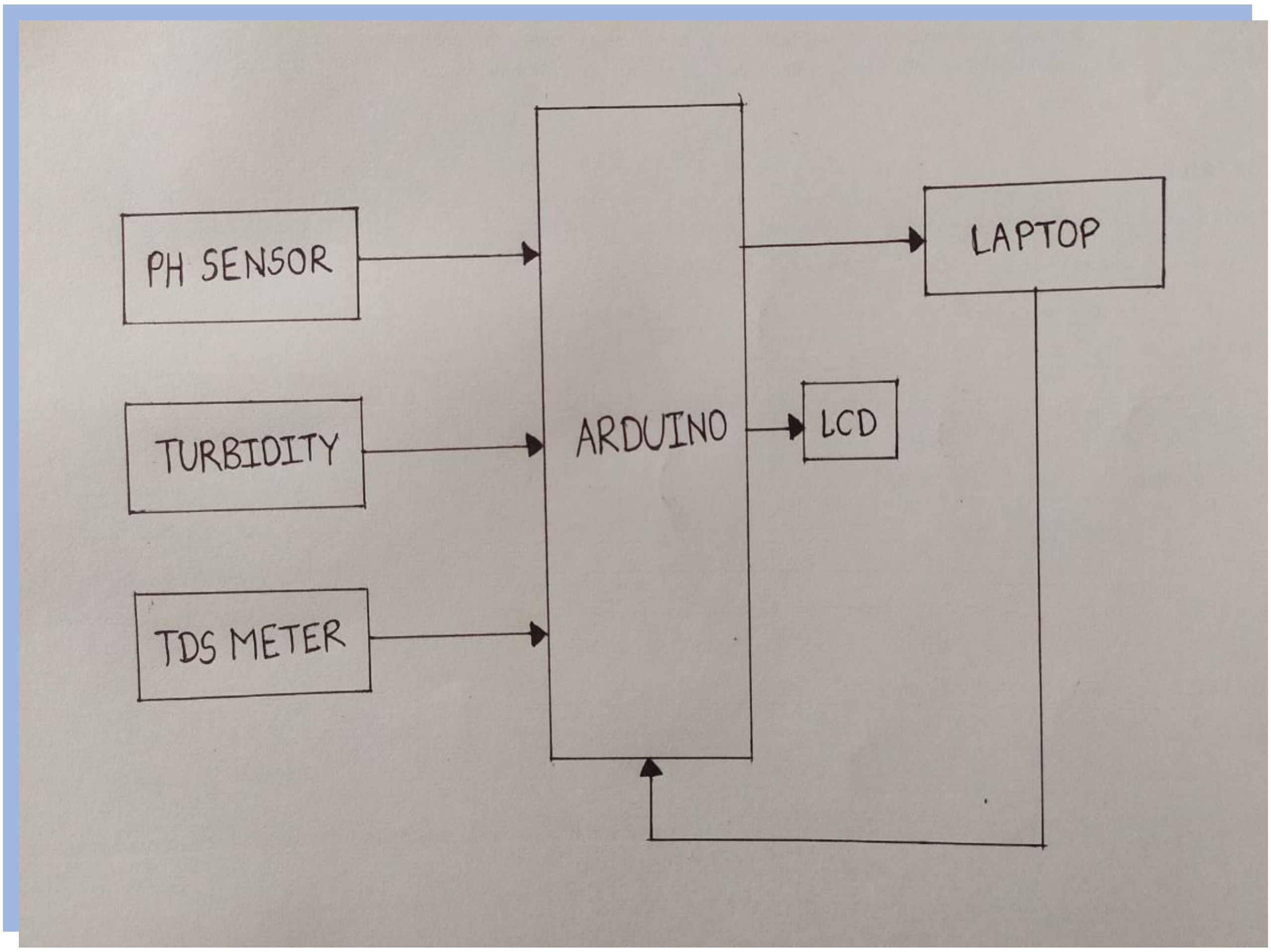
2. **Gravity TDS Sensor Library (GravityTDS.h):-** It is a library used for TDS sensors by DFrobot.This library provides many in-built functions like gravityTds.begin(), gravityTds.setpin() etc.

3. **Liquid Crystal Library (LiquidCrystal.h):-** This library allows an Arduino board to control LiquidCrystal displays (LCDs) based on the Hitachi HD44780 (or a compatible) chipset. The library works in either 4 or 8-bit mode. It provides functions like clear(), setcursor() etc.

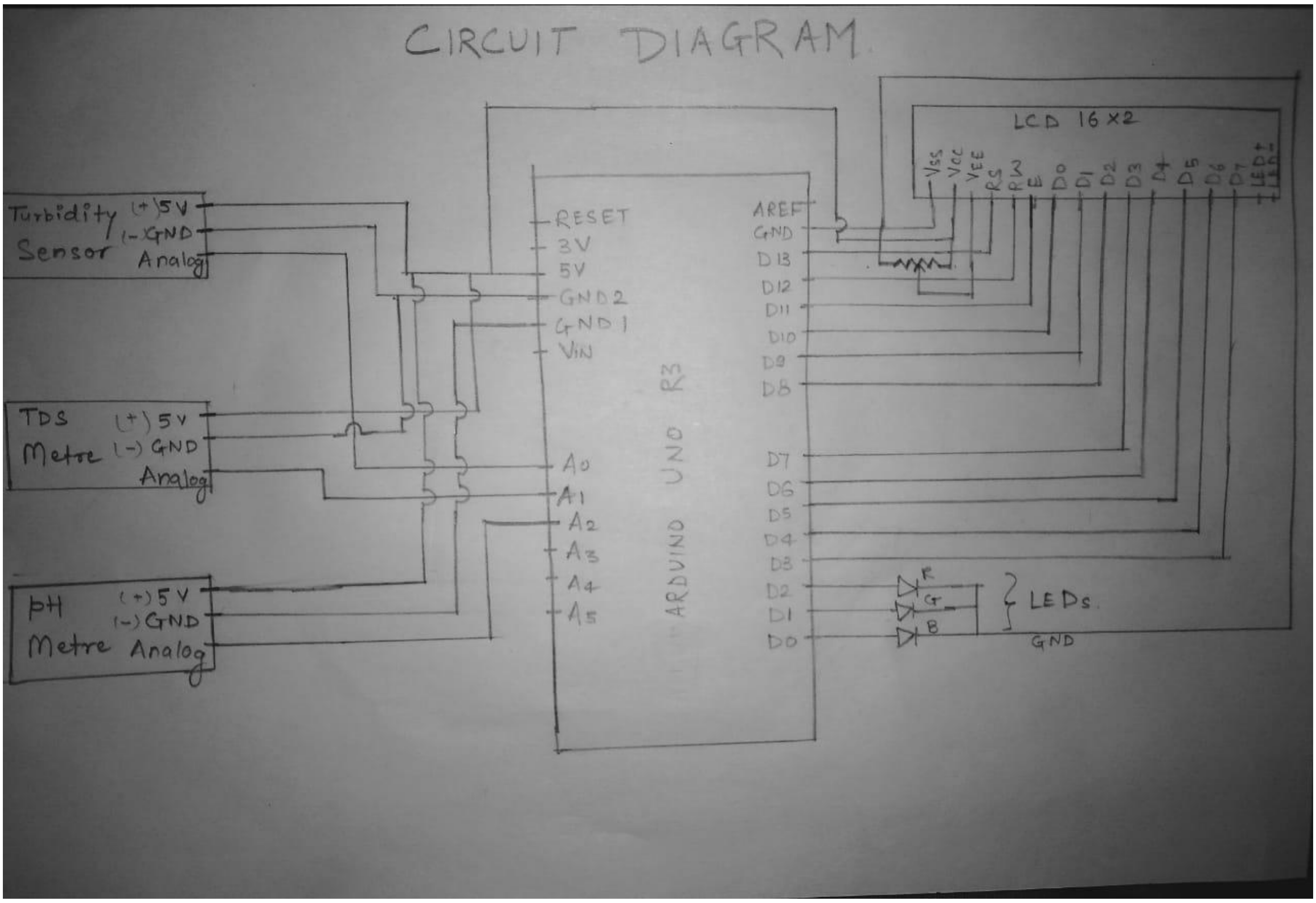
OR

I2C LCD library(LiquidCrystal_I2C.h):- The library allows to control I2C displays with functions extremely similar to LiquidCrystal library. If we use an I2C LCD this library can be useful. In this case we will have to use SDA and SCL pins of Arduino. To use I2C functionality of arduino we also need to include **<Wire.h>**.

6. BLOCK DIAGRAM



7. CIRCUIT DIAGRAM



8. ALGORITHM

- Connect the Turbidity sensor, PH meter and TDS meter to analog pins A0, A1, A2 of the Arduino Uno board and also connect their GND.

- Connect the LCD display to digital pins of Arduino. In case I2C LCD is used, connect the SDA and SCL pins of LCD and Arduino. Connect RGB LEDs to digital pins of Arduino.

- Upload the source code using above libraries and their functions.

- In the source code, for a turbidity sensor we need to map the minimum and maximum in the range of 0-100 using map (). Also, we will need to calibrate the pH meter using distilled water.

- For accurate pH value, we will take 5 analog inputs and the final value will be the average of these 5 analog values.

- If turbidity<20, it will show “clear” and green led will glow, 20<turbidity<50, it will show “cloudy” and blue led will glow, and if turbidity>50, it will show “dirty” and red led will glow.

- Also pH value and TDS value will be displayed on the LCD.

9. WORK PLAN

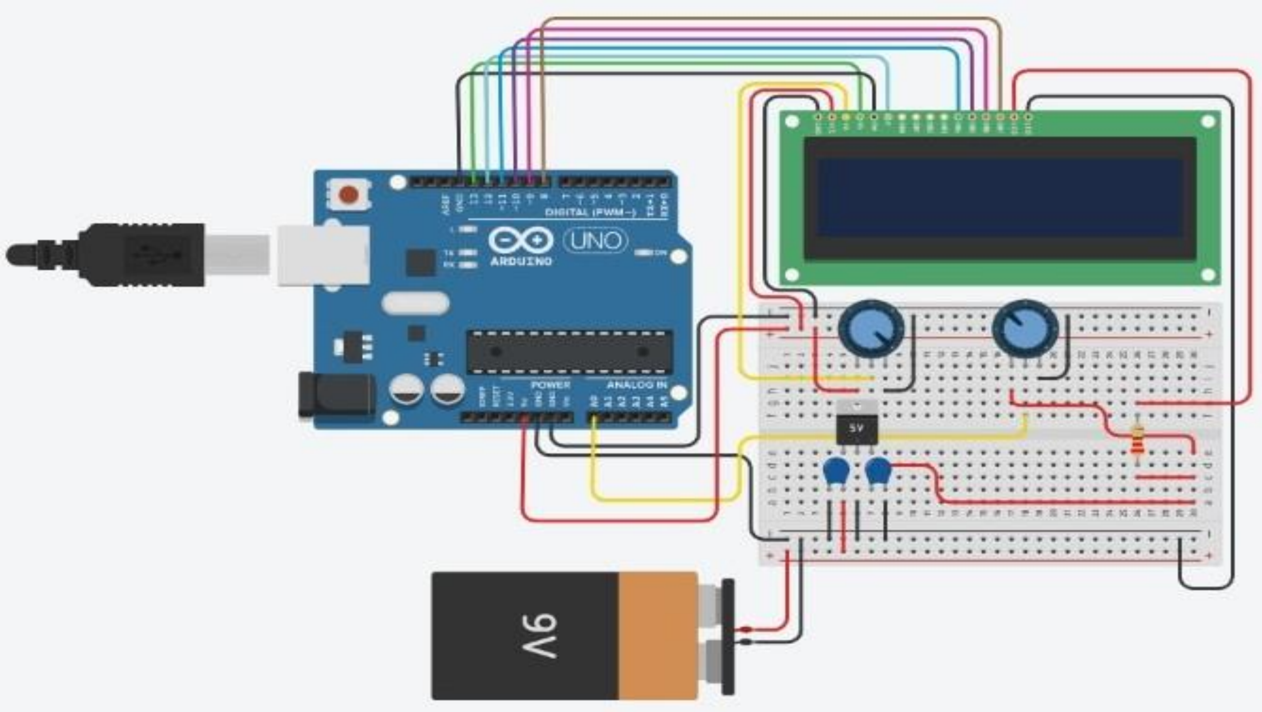
WORK PLAN

Sr. Number	Timeline	Task Given	Task Completed
1.	10/03/2021	Formation of Groups	Group formation done.
2.	18/03/2021	Research on Various Project Topics	Referred various newsletters, articles, topics and research papers.
3.	25/03/2021	Finalization of Project Topic	Water Quality Analysis along with block diagram and circuit diagram(modifications done)in the project.
4.	15/04/2021	Components selection, Datasheets of sensors and modules and the libraries being used	Components selection, Datasheets of sensors and modules and the libraries being used (final circuit & block diagrams).
5.	22/04/2021	Prepare document with abstract, software modules and algorithm	Proper document prepared with abstract, intro, specifications, software modules and algorithm.
6.	29/04/2021	Document shown and Completed	Codes and Output Shown
7.	05/06/2021	Show Simulation	Simulation Shown

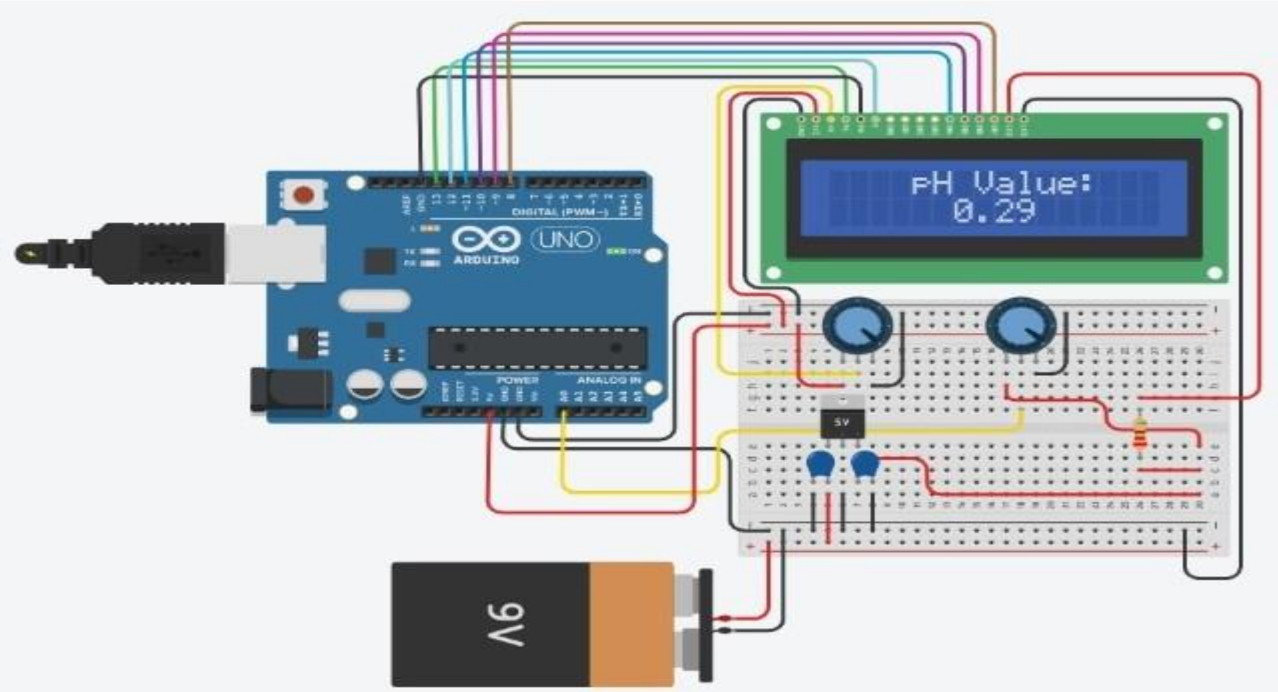
DATASHEETS LINK :- https://drive.google.com/folderview?id=1hTf9NdjxMfaRXEXrP0c5OVcWk--PGi0R

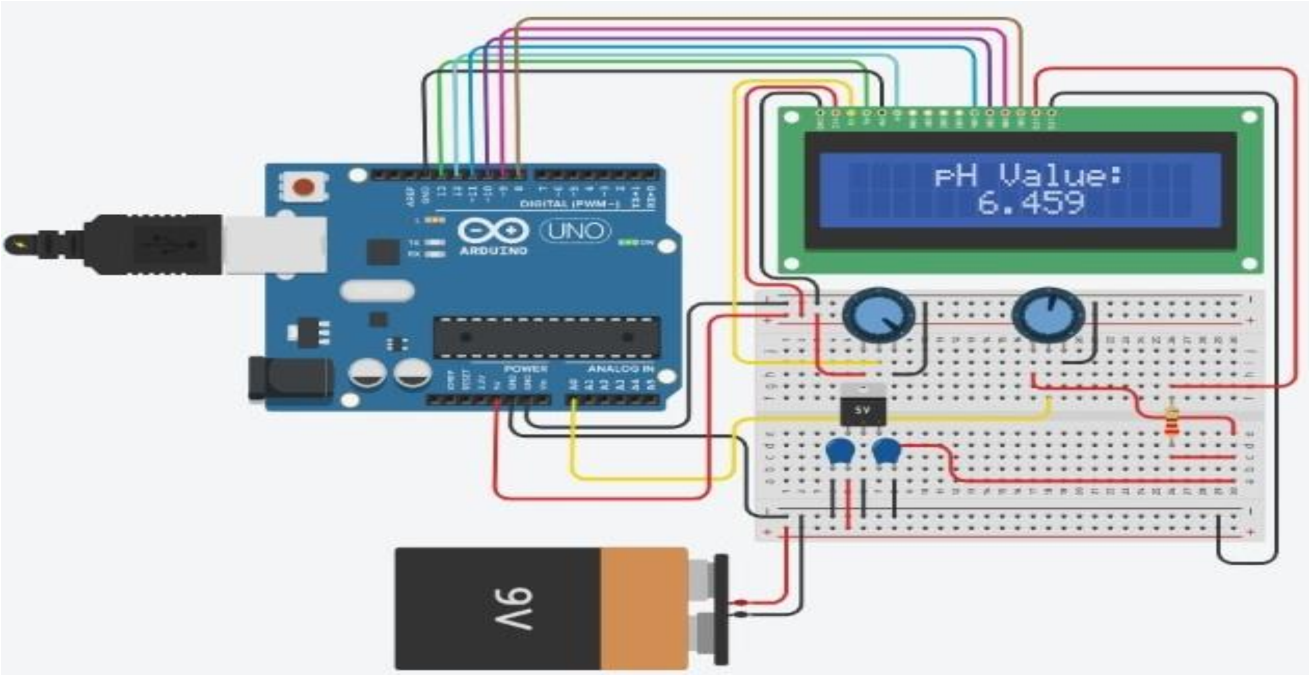
10. SCHEMATIC DIAGRAM & WORKING

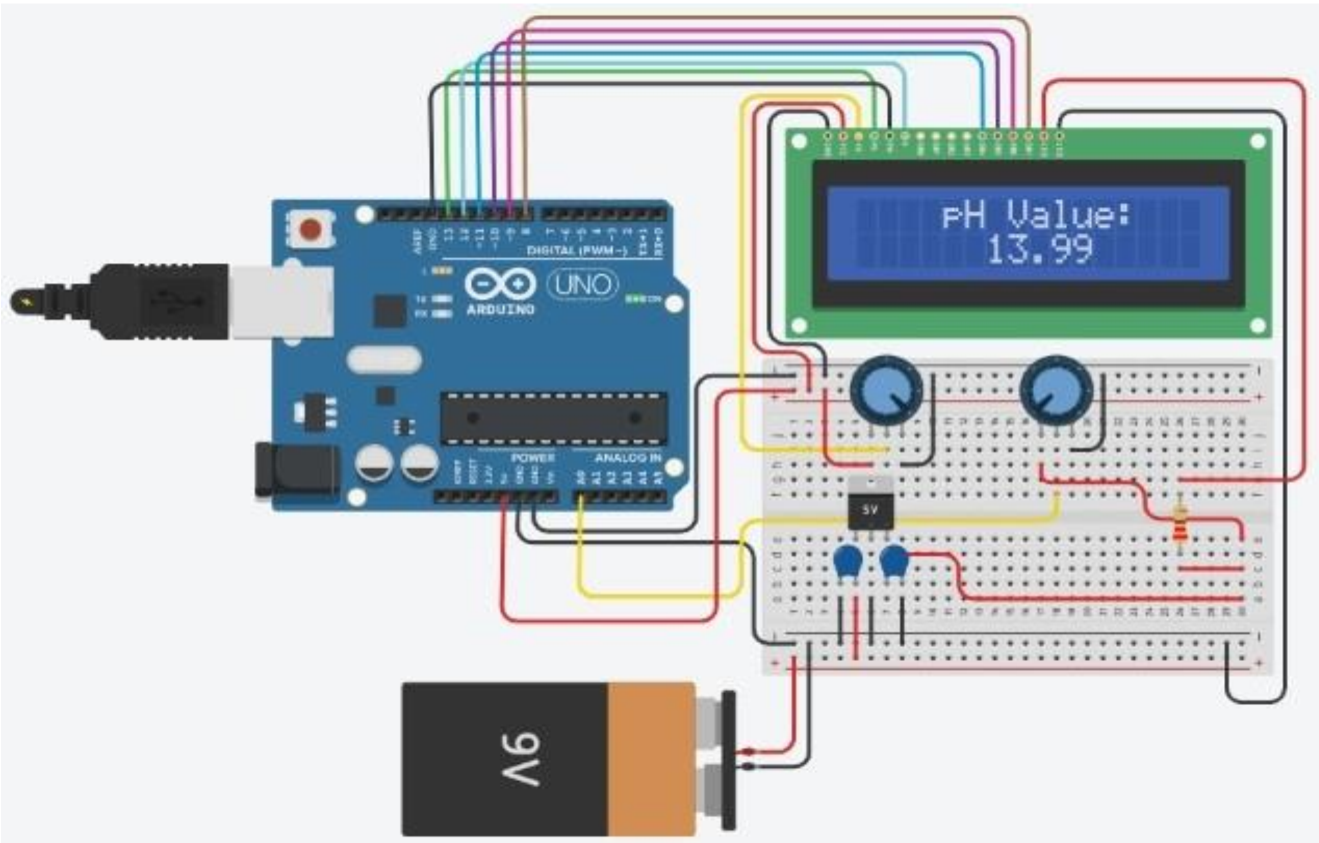
10.1 SCHEMATIC INTERFACING DIAGRAM:-



10.2 SIMULATION RESULTS:




pH Value:
6.459
DIGITAL (PWM~)
ARDUINO
UNO
POWER
ANALOG IN
5V
9V


pH Value:
13.99
DIGITAL (PWM~)
ARDUINO
UNO
POWER
ANALOG IN
5V
9V

10.3 WORKING

Instead of using the pH sensor directly, we implemented it using the above components using **Autodesk Tinkercad**. The pH meter operates like a voltmeter. The pair of electrodes in the combinatorial set-up can measure small changes in voltage (also called potential difference) in the order of millivolts. Changes in potentials are caused by the loss of electrons that correspond with the loss of H+. The voltage produced by the test solution is measured and compared with the voltage produced by the reference solution which is exposed to the test solution via the porous diaphragm. The difference in the voltage between the two is used to calculate the pH. Here calculation of voltage is done by potentiometer and voltage is varied to get different values of pH. Input voltage of 5V is given to potentiometer through a 9V battery via a 5V voltage regulator. Two capacitors are connected to input and output of the voltage regulator to improve the output voltage quality by preventing it from oscillations and give a constant 5V value. Output of first potentiometer is connected to pin A0 of Arduino board. Different pH values are displayed on the lcd screen corresponding to different voltage values. Output of the second potentiometer is connected to V0 pin of lcd which is responsible for varying the brightness of the lcd screen by changing the voltage values. A 220 ohm resistor is connected to LED+ pin of lcd for backlight.4 data pins of lcd are used for display purpose.

11. INTERFACING CODES

11.1 FOR PH SENSOR :-

```
#define SensorPin A0
  unsigned long int avgValue;  //Store the average value of the sensor
feedback
float b;
int buf[10],temp;

void setup()
{
  pinMode(13,OUTPUT);
  Serial.begin(9600);
  Serial.println("Ready");    //Test the serial monitor
}
void loop()
{
  for(int i=0;i<10;i++)       //Get 10 sample value from the sensor for
smooth the value
  {
    buf[i]=analogRead(SensorPin);
    delay(10);
  }
  for(int i=0;i<9;i++)        //sort the analog from small to large
  {
    for(int j=i+1;j<10;j++)
    {
      if(buf[i]>buf[j])
      {
        temp=buf[i];
        buf[i]=buf[j];
        buf[j]=temp;
      }
    }
  }
  avgValue=0;
  for(int i=2;i<8;i++)   //take the average value of 6 center sample
```

```
   avgValue+=buf[i];
  float phValue=(float)avgValue*5.0/1024/6; //convert the analog into
millivolt

  phValue=3.5*phValue;    //convert the millivolt into pH value
  Serial.print("    pH:");
  Serial.print(phValue,2);
  Serial.println(" ");
  digitalWrite(13, HIGH);
  delay(800);
  digitalWrite(13, LOW);
 }
```

```
//MODIFIED CODE:
#include<LiquidCrystal.h>
const int rs =13,en = 12,d4 =11,d5 =10,d6 =9,d7 =8;
LiquidCrystal lcd(rs,en, d4,d5,d6,d7);
void setup()
{
  Serial.begin(9600);
  lcd.begin(16,2);
  lcd.setCursor(4,0);
  lcd.print("pH Value:");
}

void loop()
{
 int sensorValue = analogRead(A0);
 float ph = sensorValue * (14.0/1023.0);
 Serial.println(ph);
 lcd.setCursor(6,1);
 lcd.print (ph);
}
```

11.2 FOR TURBIDITY SENSOR :-

```
// LiquidCrystal I2C - Version: 1.1.2
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 2, 16);
int sensorPin = A0;
void setup()
{
  Serial.begin(9600);
  //lcd.begin(); //
  pinMode(2, OUTPUT);
  pinMode(3, OUTPUT);
  pinMode(4, OUTPUT);
}
void loop() {
  int sensorValue = analogRead(sensorPin);
  Serial.println(sensorValue);
  int turbidity = map(sensorValue, 0, 750, 100, 0);
  delay(100);
  lcd.setCursor(0, 0);
  lcd.print("turbidity:");
  lcd.print("   ");
  lcd.setCursor(10, 0);
  lcd.print(turbidity);
  delay(100);
  if (turbidity < 20) {
    digitalWrite(2, HIGH);
    digitalWrite(3, LOW);
    digitalWrite(4, LOW);
    lcd.setCursor(0, 1);
    lcd.print(" its CLEAR ");
```

```
  }
  if ((turbidity > 20) && (turbidity < 50)) {
    digitalWrite(2, LOW);
    digitalWrite(3, HIGH);
    digitalWrite(4, LOW);
    lcd.setCursor(0, 1);
    lcd.print(" its CLOUDY ");
  }
  if (turbidity > 50) {
    digitalWrite(2, LOW);
    digitalWrite(3, LOW);
    digitalWrite(4, HIGH);
    lcd.setCursor(0, 1);
    lcd.print(" its DIRTY ");
  }
}
```

11.3 FOR TDS SENSOR :-

```
#define TdsSensorPin A1
#define VREF 5.0      // analog reference voltage(Volt) of the ADC
#define SCOUNT  30          // sum of sample point
int analogBuffer[SCOUNT];    // store the analog value in the array,
read from ADC
int analogBufferTemp[SCOUNT];
int analogBufferIndex = 0,copyIndex = 0;
float averageVoltage = 0,tdsValue = 0,temperature = 25;

void setup()
{
   Serial.begin(115200);
   pinMode(TdsSensorPin,INPUT);
}

void loop()
{
  static unsigned long analogSampleTimepoint = millis();
  if(millis()-analogSampleTimepoint > 40U)     //every 40
milliseconds,read the analog value from the ADC
  {
    analogSampleTimepoint = millis();
    analogBuffer[analogBufferIndex] = analogRead(TdsSensorPin);
//read the analog value and store into the buffer
    analogBufferIndex++;
    if(analogBufferIndex == SCOUNT)
       analogBufferIndex = 0;
  }
  static unsigned long printTimepoint = millis();
  if(millis()-printTimepoint > 800U)
  {
     printTimepoint = millis();
     for(copyIndex=0;copyIndex<SCOUNT;copyIndex++)
       analogBufferTemp[copyIndex]= analogBuffer[copyIndex];
     averageVoltage = getMedianNum(analogBufferTemp,SCOUNT) *
(float)VREF / 1024.0; // read the analog value more stable by the
median filtering algorithm, and convert to voltage value
```

```
    float compensationCoefficient=1.0+0.02*(temperature-25.0);
//temperature compensation formula: fFinalResult(25^C) =
fFinalResult(current)/(1.0+0.02*(fTP-25.0));
    float
compensationVolatge=averageVoltage/compensationCoefficient;
//temperature compensation

tdsValue=(133.42*compensationVolatge*compensationVolatge*comp
ensationVolatge - 255.86*compensationVolatge*compensationVolatge
+ 857.39*compensationVolatge)*0.5; //convert voltage value to tds
value
    //Serial.print("voltage:");
    //Serial.print(averageVoltage,2);
    //Serial.print("V   ");
    Serial.print("TDS Value:");
    Serial.print(tdsValue,0);
    Serial.println("ppm");
  }}
int getMedianNum(int bArray[], int iFilterLen)
{
    int bTab[iFilterLen];
    for (byte i = 0; i<iFilterLen; i++)
    bTab[i] = bArray[i];
    int i, j, bTemp;
    for (j = 0; j < iFilterLen - 1; j++)
    {
    for (i = 0; i < iFilterLen - j - 1; i++)
       {
     if (bTab[i] > bTab[i + 1])
        {
     bTemp = bTab[i];
        bTab[i] = bTab[i + 1];
     bTab[i + 1] = bTemp;
      }  }  }
    if ((iFilterLen & 1) > 0)
   bTemp = bTab[(iFilterLen - 1) / 2];
    else
   bTemp = (bTab[iFilterLen / 2] + bTab[iFilterLen / 2 - 1]) / 2;
    return bTemp;
}
```

12. ADVANTAGES, DISADVANTAGES & APPLICATIONS

➢ ADVANTAGES :-

- **To alert us about the current ongoing and emerging problems.**
- **To determine compliance with drinking water standards.**
- **To protect other beneficial uses of water**

➢ DISADVANTAGES :-

- **There is no continuous and remote monitoring**
- **Human resource is required**
- **No monitoring at the source of water (no on-field monitoring)**
- **Frequency of Testing is very low.**

➢ APPLICATIONS :-

1. **Public Health (especially for drinking water)**
2. **Industrial Use**
3. **Commercial Industries**
4. **Beverage Plants**
5. **Agricultural Sector (required for crop production)**
6. **Water quality testing**
7. **Aquaculture**

13. CONCLUSION

Overall water quality system is presented in this report. The system is incredibly versatile and economical. It is a real time system that measures numerous parameters pertaining to the water and send them to the monitoring center. The system can monitor water quality automatically, and it is low in cost and doesn't need individuals on duty. The system has good flexibility. It is a versatile system, because of which simply by replacing the sensors and by making some changes within the computer code, the system can be used to measure some other parameters of water. The system is reliable and easy to maintain and it can be extended to measure water pollution as well. By effectively using the proposed system, one can save time and cost can also be reduced.

14. FUTURE SCOPE

The capability of water quality monitoring system can be enhanced to obtain more efficient results. The number of parameters to be sensed can be increased by the addition of multiple sensors to measure dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), ammonia nitrogen, nitrate, nitrite, phosphate. The system can be further upgraded using wireless sensor networks. The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural production and so on. It has widespread application and extension value. Work can be carried on to include controlling the supply of water.

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