COURSE NAME:

Industrial Applications of Micro-Controllers – A Practice Based Approach

TOPIC NAME:

Automated Slug detection Systems for Water-Tanks

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INTRODUCTION

Water is essential for life, but it can also be a breeding ground for harmful bacteria and other contaminants. If water is not properly cleaned and maintained, it can pose a serious health risk to humans. One way to keep water clean is to use a microcontroller-based prototype to alert users when the sludge level in a water tank is too high. This prototype can be used in a variety of settings, such as homes, businesses, and schools. The prototype uses an ultrasonic sensor to measure the distance to the sludge level. This sensor works by emitting a pulse of sound and then measuring the time it takes for the pulse to return. The distance to the sludge level is calculated by multiplying the time by the speed of sound.

If the distance to the sludge level is less than a certain threshold, the prototype will turn on an LED and a buzzer to alert the user. The prototype will also start a water pump to remove the sludge. This prototype is a simple and effective way to keep water clean and safe. It is relatively inexpensive to build and maintain, easy to use, and customizable to meet the specific needs of the user. For example, the threshold distance can be adjusted to account for the size of the water tank and the desired level of cleanliness. The prototype can also be equipped with a relay to control larger water pumps.

Overall, the microcontroller-based prototype is a valuable tool for keeping water clean and safe. It can be used to protect the health and well-being of people and animals in a variety of settings.

I. PROBLEM STATEMENT

Water is a resource, for sustaining life. It can also become a breeding ground for harmful bacteria and contaminants. If water is not properly treated and maintained it can pose health risks to humans.

One common issue associated with water tanks is the accumulation of sludge. Sludge consists of matter and debris that gradually builds up over time. The presence of sludge levels can result in problems, including;

- Diminished water quality
- Heightened risk of waterborne diseases
- Corrosion of components within the water tank
- Blockages in pipes and filters
- Increased expenses for maintenance

To prevent these issues from occurring, regular monitoring and cleaning of water tanks are crucial. However, this process can be time consuming and labour intensive. Additionally, manually monitoring sludge levels proves challenging in remote tanks.

To address these challenges effectively there is a need for an user friendly system that monitors and regulates sludge levels, in water tanks. This system should possess the capability to accurately measure sludge levels alert users when they become excessively high and automatically initiate a pump to remove the accumulated sludge.

II. SCOPE OF THE SOLUTION

The scope of the solution is to develop a low-cost and easy-to-use microcontroller-based prototype, so that whenever Sludge level in the Water tank is High, it will alert the user. This prototype contains 3 LED Bulbs which will measure the Water level, a buzzer which will alert the user and a pump which will automatically flush out the Water and Lastly, Ultra-Sonic Sensor for measuring the Water distance in the Water tank.

The prototype is easy to build and is customisable by the interest of user. For Example, the Prototype contains Ultra-Sonic Sensor which will measure the distance and User can Control the threshold distance according to his choice and for large amount of water flow, the user can use relay module.

The Prototype is planned to be used in a variety of operations such as homes, businesses and schools. It can be more useful in monitoring Sludge levels in Water tanks which is used for drinking water.

The prototype is not indulged in complete water filteration system. It is simply a device which will alert the user that sludge level is too high and it will automatically flush out the sludge water from the Water tank.

Here are some specific examples of how the prototype can be used:

A Home-Owner can use this prototype for monitoring sludge level in their water tanks. If the Sludge level comes out to be High, it will going to alert the homeowner and automatically flush out the dirty water which is not fit for drinking purpose at all.

A Business man can use this product for monitoring the sludge level in the water tank which is used for industrial purpose. If the sludge level comes out to be high, then the prototype will alert the user, and the business man will stop the process and wait for pump to flush out the sludge water.

A school can use this prototype for monitoring the sludge level in Swimming pool. If the sludge level comes out to be high, the prototype will alert the school so that they will close the pool and Water pump will automatically flush out the dirty water.

Overall, the proposed prototype is a versatile and affordable tool that can be used to help people keep their water clean and safe.

III. COMPONENTS USED IN THE PROTOTYPE

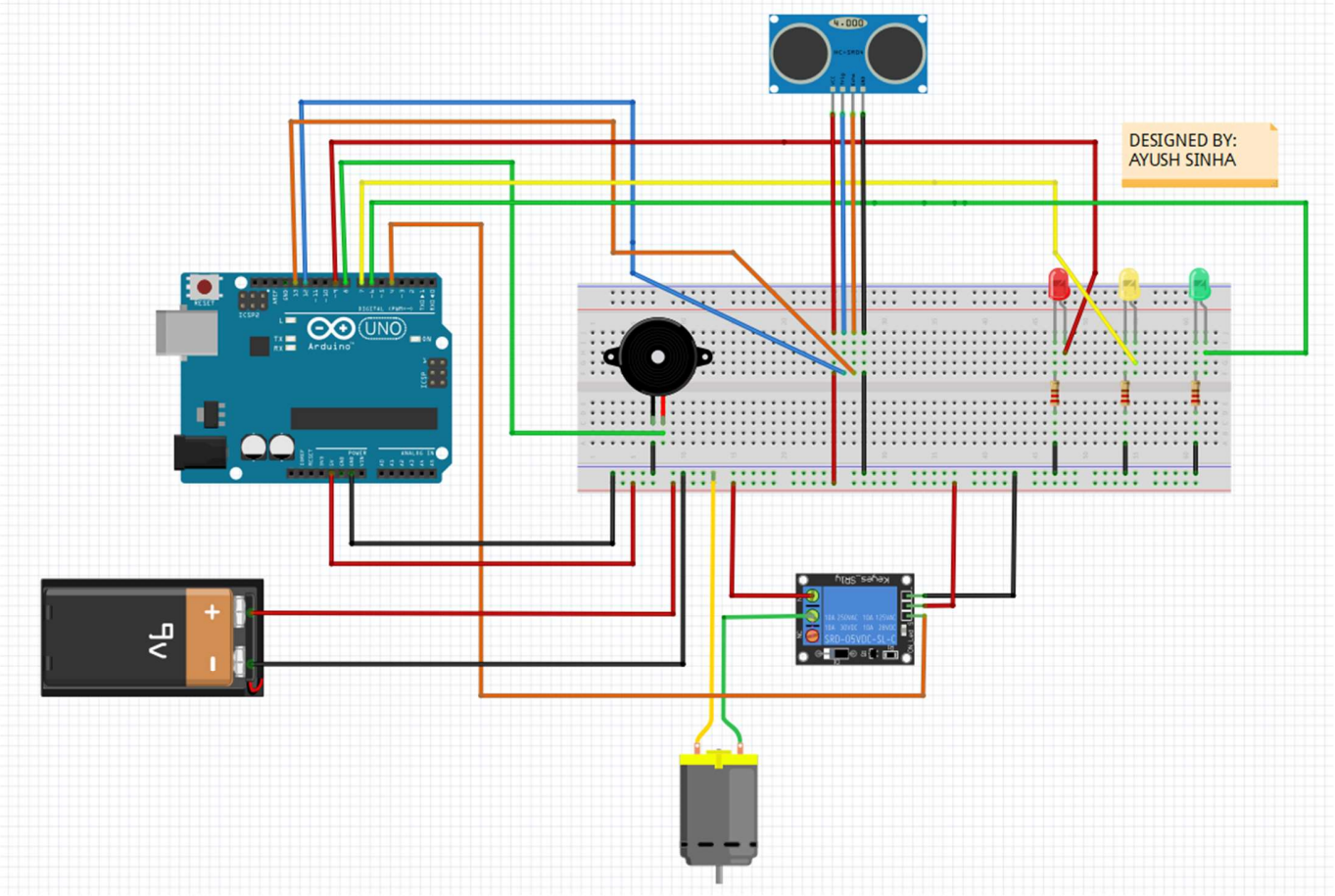
The Components which are used to build the prototype are:

- 3 LED Bulbs
- 3 Resistors (220 ohm each)
- Active Buzzer
- Arduino Board (ATMEGA328P)
- Ultra-Sonic Sensor (HC-SR04)
- Submersible Water Pump
- Relay Module(5V)
- Power Supply (9V- Battery)
- Few jumper wires
- Bread Board

The Description for following components is as follows:

1. LED Bulbs: Led Bulbs or, we can say light-emitting-diode are a type of lighting that uses less energy and last for very long period of time as compared to traditional bulbs. Led Bulbs work by passing electricity through a semi-conductor material, which results in emitting light.
2. Resistors: A resistor is a passive two-terminal electrical components that results in providing impedance to electrical flow of current. In this prototype we use 220ohm resistor in LED bulb so that it doesn't get override.
3. Active Buzzer: It is an type of buzzer which has a built-in-oscillator and it produce a single tone sound which basically alert someone.
4. Arduino Board: Arduino is an open-source electronics platform which tell what exactly we can do by programming the board using IDE.
5. Ultra-Sonic Sensor: It is a device which uses sound wave to measure the distance of the object.
6. Submersible Water Pump: It is a type of water pump which gets submersed inside the water which takes the water from the inlet and extracts water from outlet which also can be used in cleaning water.
7. Relay Module: A relay module is an electronic device which uses a small amount of current to control the large amount of current, Relay modules are used in variety of things such as controlling motors, lights and other electrical devices.

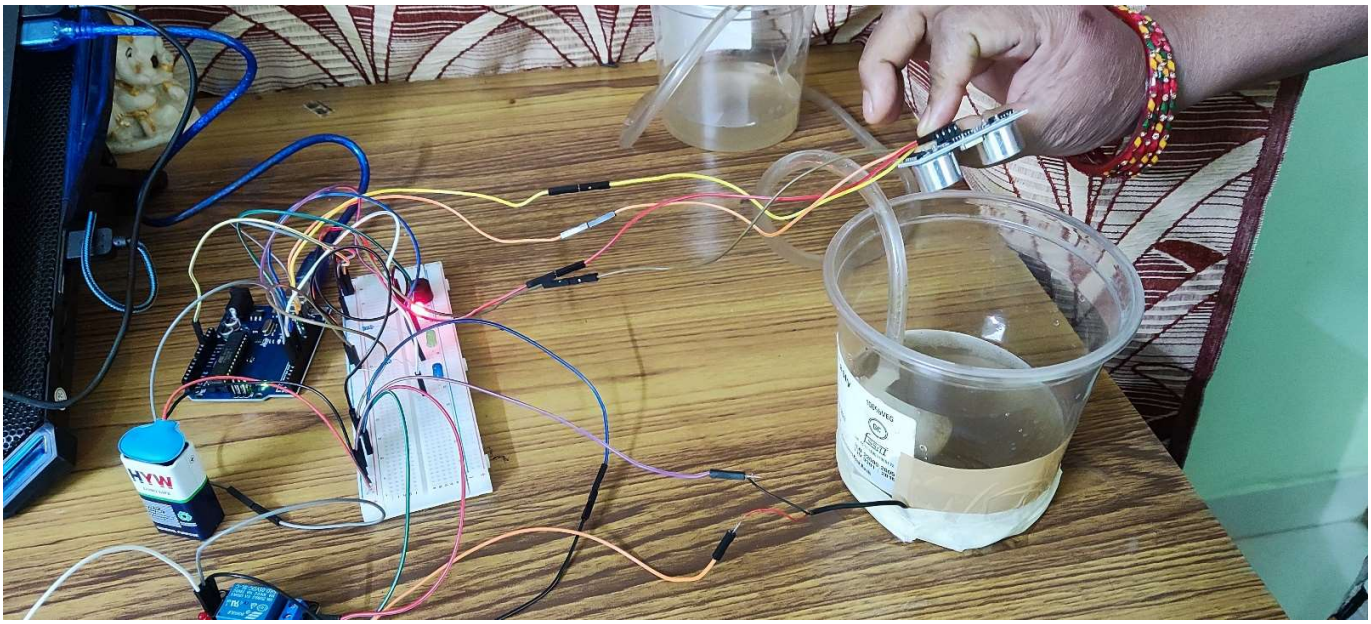
IV. SIMULATED CIRCUIT



This circuit is designed in Fritzing Software which describes about the connections are made:

- We use 3 led bulbs which tells what is the distance of water is their and 3 resistors of 220ohm are used which basically helps in not exploding the bulbs.
- The buzzer is used to alert the user that Sludge level is more.
- We use power supply which basically helps the Submersible Water pump to power on with the help of the relay module.
- The Arduino board is their for the connection which we will program the code according to our preferences.
- Ultra-Sonic Sensor are their for measuring the distance of the water.

V. HARDWARE DEMO

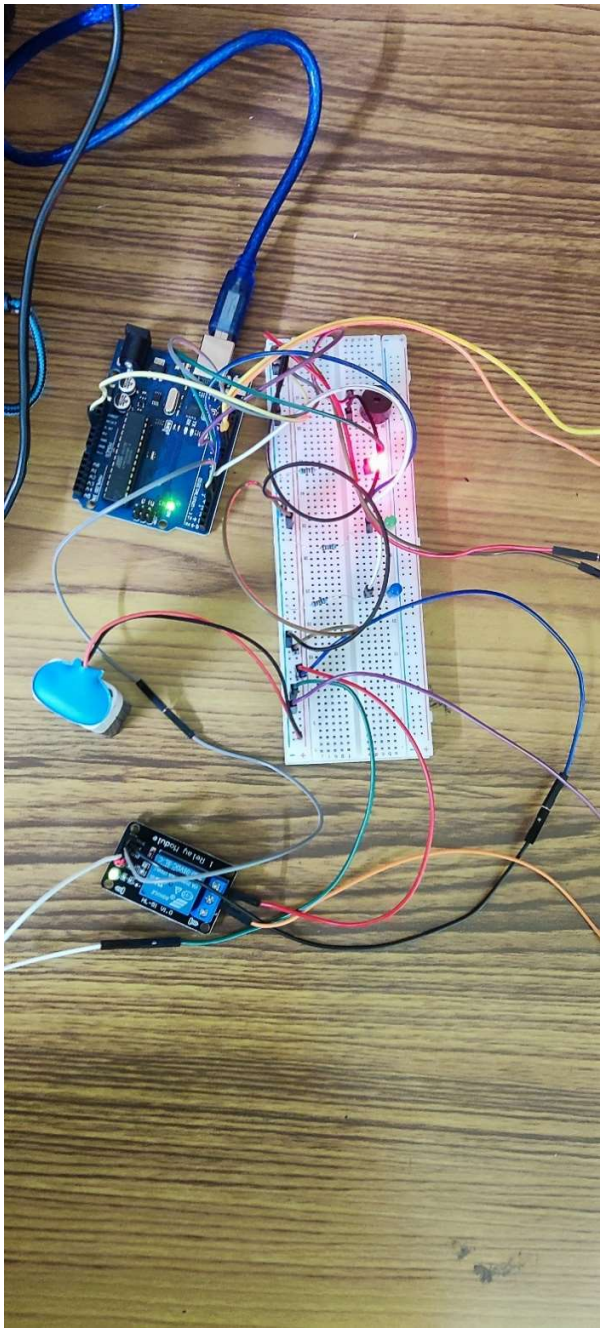


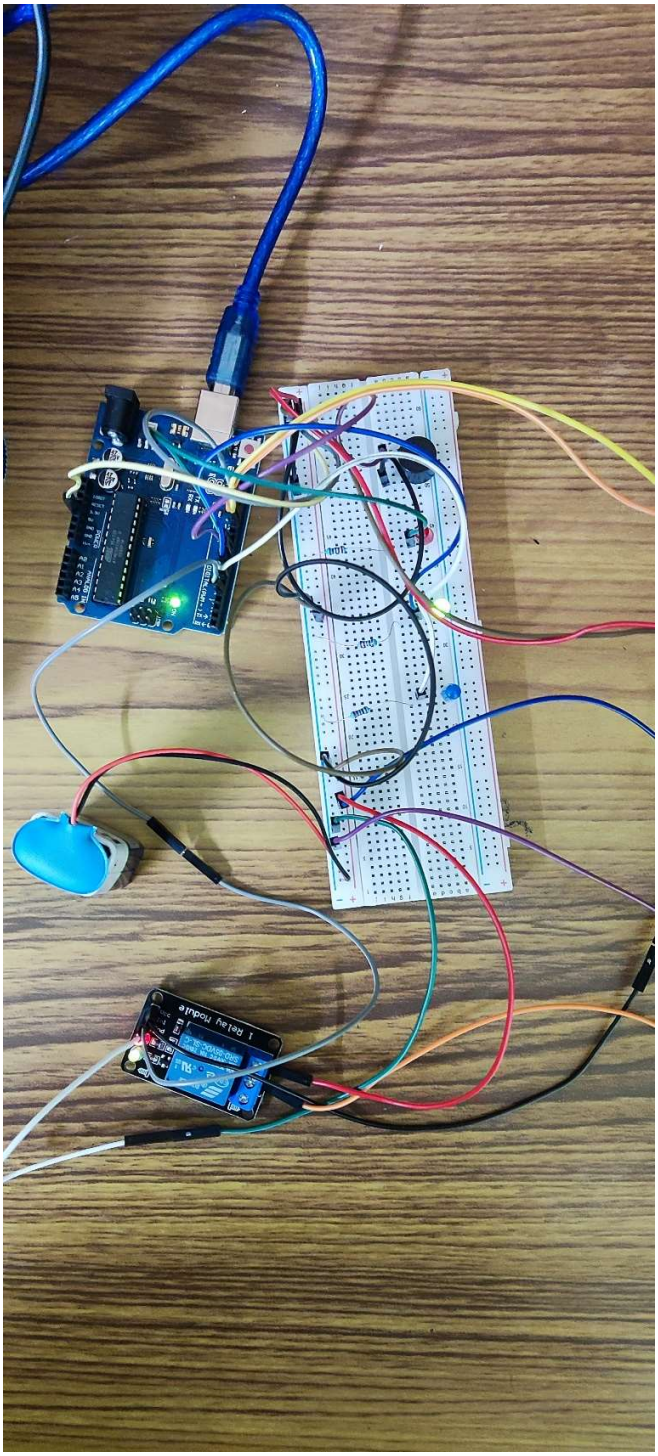
The Arduino Board is programmed in such a way that getting buzzer on will result in the submersible motor will flushing out the sludge water.

This image interprets that sludge level is detected through an ultra-sonic sensor and it's within the 10cm so the buzzer will alert the user and motor gets turn on automatically to flush out the water.

The Submersible Water Pump is connected with the relay Module which basically help the motor to run.

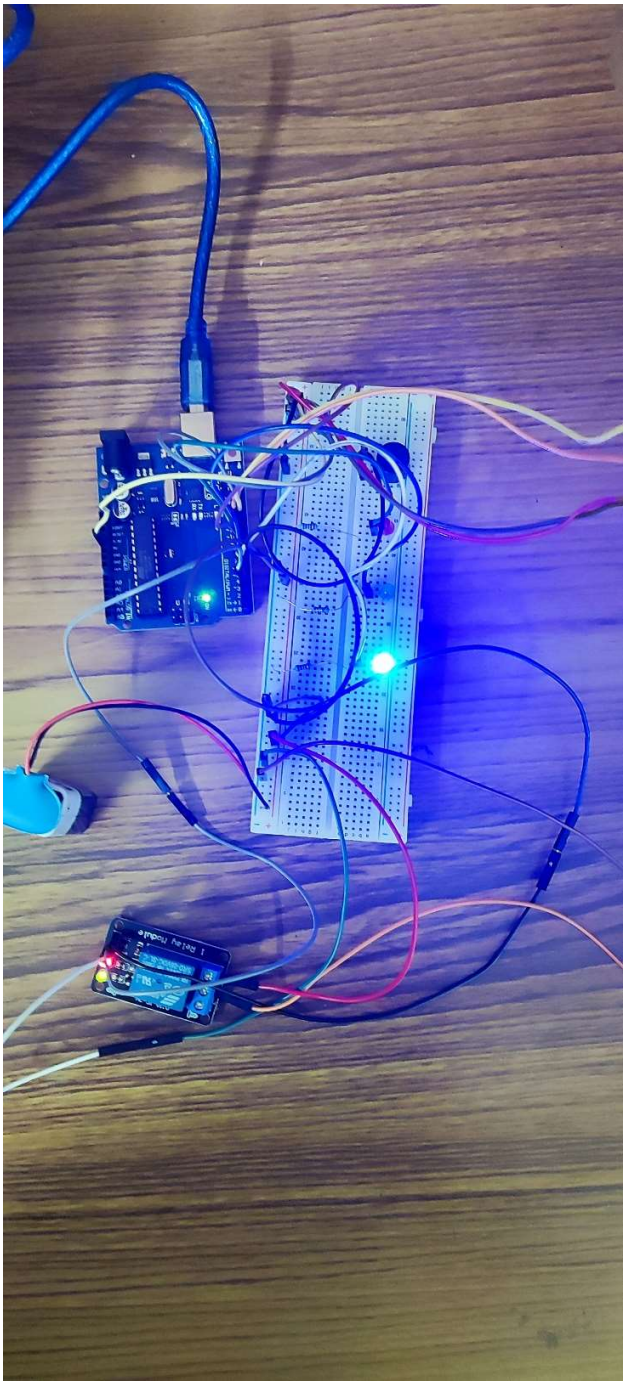
- Red Light indicates that the distance of sludge water is less than the 10cm.
- So, the water pump gets turned on to flush out the dirty water.



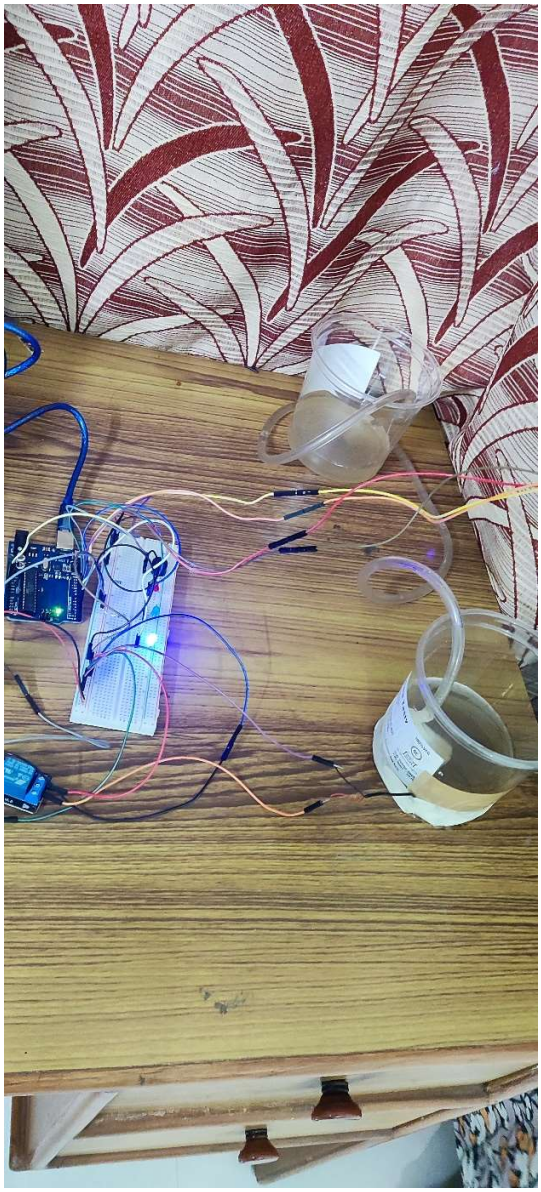


- The green light indicates that the sludge water is between 20cm and 10cm will basically tells that the sludge water is almost full.
- Here, the motor will not get turned ON as sludge water is not that much.

- The Blue light indicates that the Water is not full in the water tank as it detects through the Ultra-Sonic Sensor.
- Here, also Water Pump will not get turned ON.



VI. WORKING VIDEO



Briefly Description:-

The Trigger Pin is connected to PIN 12, The Echo Pin is connected to PIN 13, LED_red is connected to PIN 9, LED_green is connected to PIN 7, LED_blue is connected to PIN 6, the buzzer is connected to PIN 8 and lastly the Pump is connected to PIN 4. The Circuit connection is done according to circuit diagram which is already attached.

The Relay is connected with the water pump to supply enough power to get turned when needed.

Whenever the Sludge level in the Water tank is more, the Ultra-Sonic will detect the Sludge and alert the user that the sludge level is more and automatically flush out the water.

The Video Link is provided here for better understanding kindly refer:-

- https://drive.google.com/file/d/1wQ5n9mSUvHbvAfCEO4nobgOZmX7T1y4S/view?usp=share_link
- https://drive.google.com/file/d/1wTPGKPw9fIda95Cx-fD8Zd8Fpv815rtD/view?usp=share_link

Detailed Explanation:

Step 1: Hardware

The first step is to gather the necessary hardware components, which include:

Microcontroller (Arduino Uno, ESP32, etc.)

Ultrasonic sensor

Water pump

Buzzer

3 LEDS

Step 2: Connections

Next, we need to connect the hardware components to the microcontroller.

Connect the ultrasonic sensor to the microcontroller's digital pins.

Connect the water pump to the microcontroller's digital pins.

Connect the buzzer and LED to the microcontroller's digital pins.

Step 3: Software

Once the hardware is connected, we need to write the software code to control the system. The software code will need to:

Read the Ultra-Sonic Sensor reading.

If the distance is less than the threshold distance red led will get turned ON and Buzzer Gets ON and Water Pump gets ON for cleaning the dirty water.

If the distance is between the 10cm and 20cm, the green light gets turned ON indicating that the Water is about to get filled.

If the distance is more than 20cm, the blue led gets turned ON indicating that Water is not filled yet.

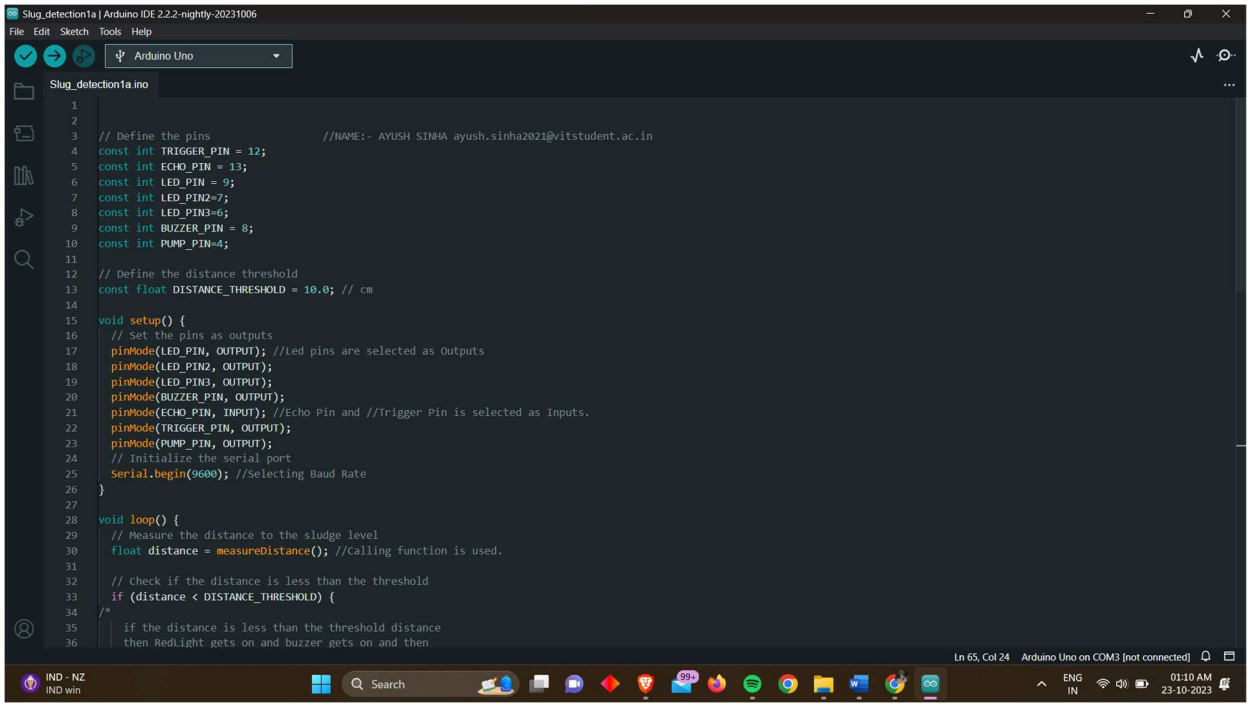
Step 4: Testing

Once the software code is written, we need to test the system to make sure it is working properly. We can do this by placing the ultrasonic sensor in the water tank and adjusting the distance threshold. The buzzer and LED should turn on when the ultrasonic distance is less than the threshold. The water pump should start when the buzzer and LED turn on.

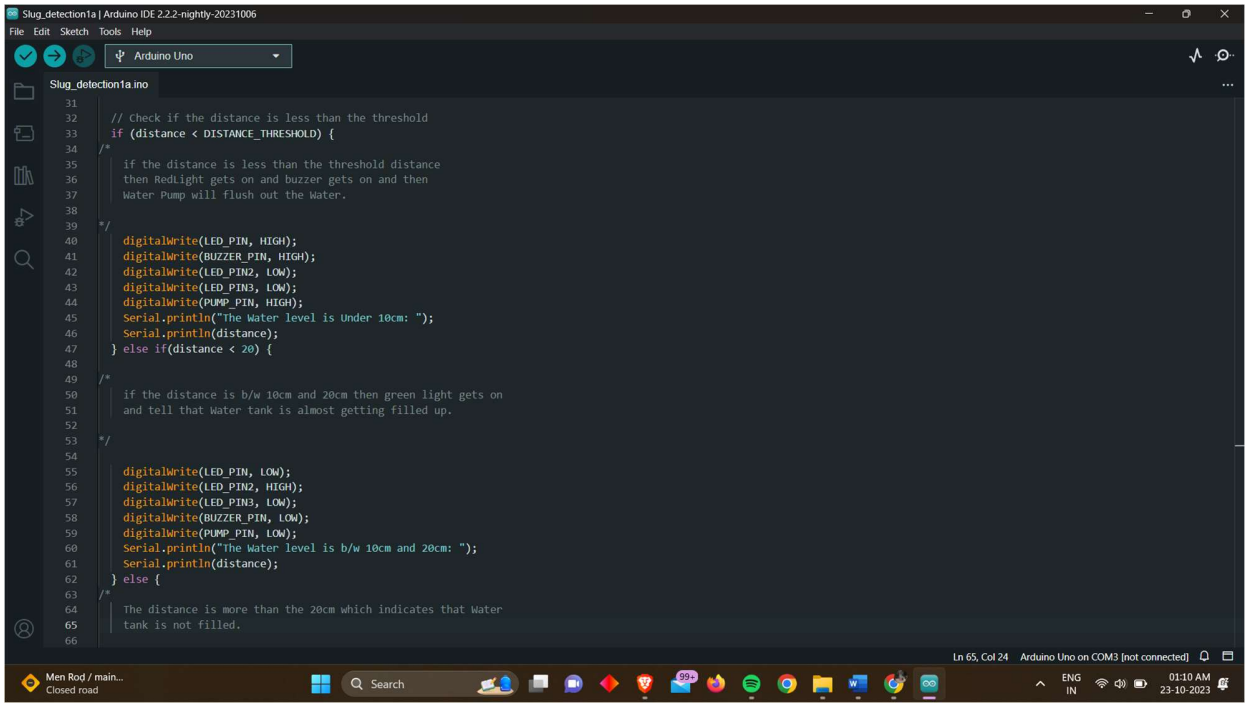
Step 5: Deployment

Once the system is working properly, We can deploy it in the water tank. We can place the ultrasonic sensor in the water tank and mount the buzzer, LED, and water pump on the outside of the tank.

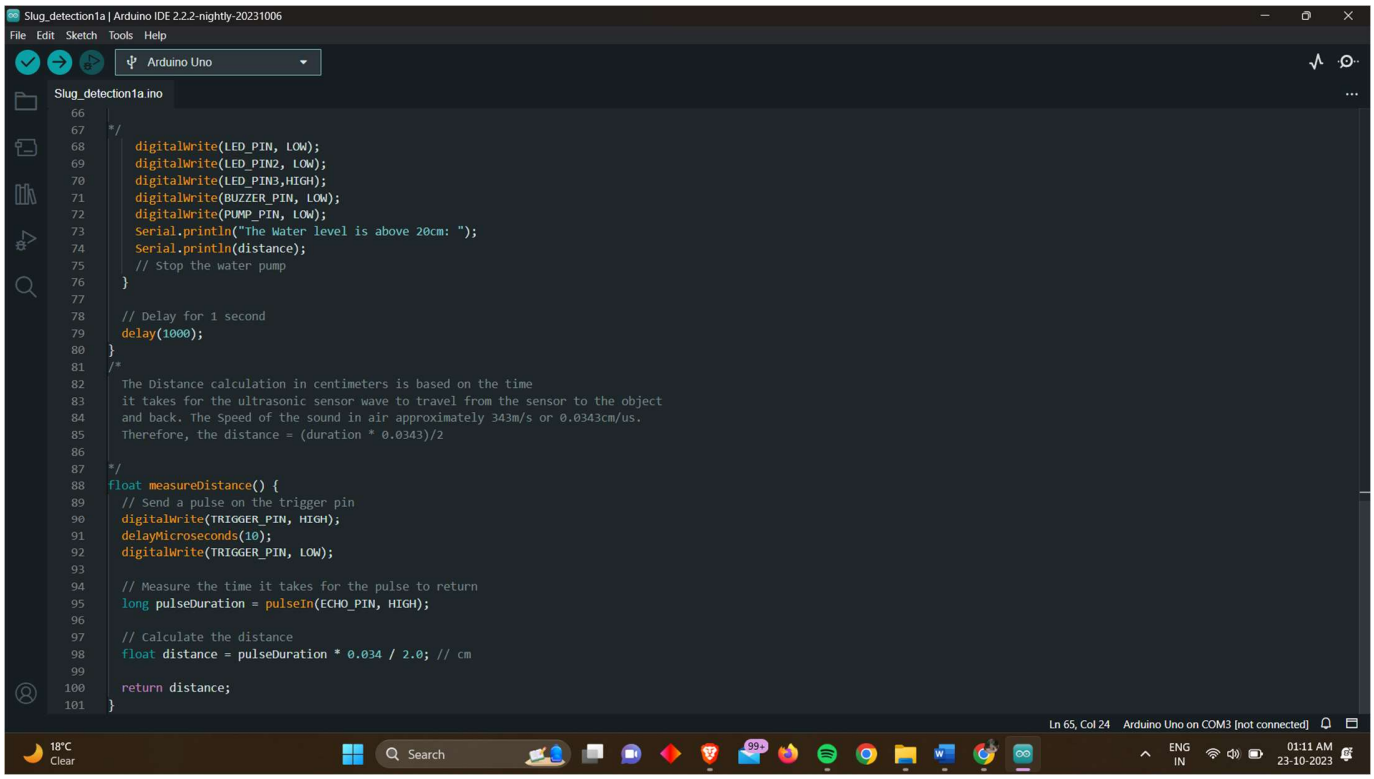
VII. CODE IMPLEMENTED IN THE ARDUINO



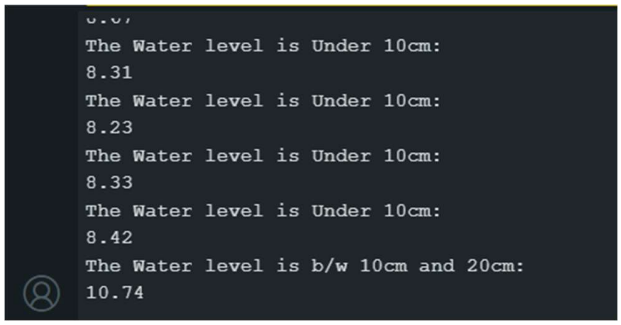
```
// Define the pins                  //NAME:- AYUSH SINHA ayush.sinha2021@vitstudent.ac.in
const int TRIGGER_PIN = 12;
const int ECHO_PIN = 13;
const int LED_PIN = 9;
const int LED_PIN2=7;
const int LED_PIN3=6;
const int BUZZER_PIN = 8;
const int PUMP_PIN=4;

// Define the distance threshold
const float DISTANCE_THRESHOLD = 10.0; // cm

void setup() {
  // Set the pins as outputs
  pinMode(LED_PIN, OUTPUT); //Led pins are selected as Outputs
  pinMode(LED_PIN2, OUTPUT);
  pinMode(LED_PIN3, OUTPUT);
  pinMode(BUZZER_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT); //Echo Pin and //Trigger Pin is selected as Inputs.
  pinMode(TRIGGER_PIN, OUTPUT);
  pinMode(PUMP_PIN, OUTPUT);
  // Initialize the serial port
  Serial.begin(9600); //Selecting Baud Rate
}

void loop() {
  // Measure the distance to the sludge level
  float distance = measureDistance(); //Calling function is used.

  // Check if the distance is less than the threshold
  if (distance < DISTANCE_THRESHOLD) {
/*
    if the distance is less than the threshold distance
    then RedLight gets on and buzzer gets on and then
```

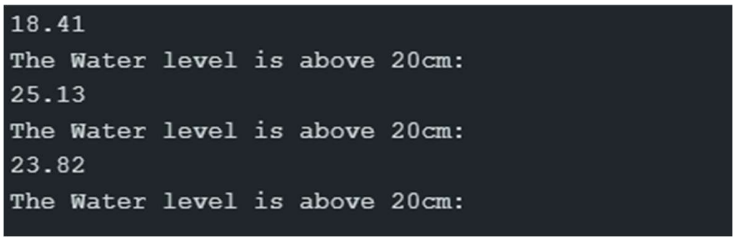


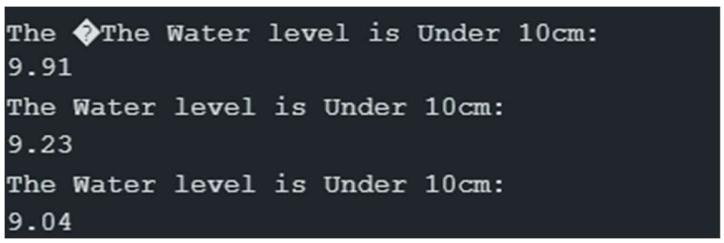
```
  // Check if the distance is less than the threshold
  if (distance < DISTANCE_THRESHOLD) {
/*
    if the distance is less than the threshold distance
    then RedLight gets on and buzzer gets on and then
    Water Pump will flush out the Water.

*/
    digitalWrite(LED_PIN, HIGH);
    digitalWrite(BUZZER_PIN, HIGH);
    digitalWrite(LED_PIN2, LOW);
    digitalWrite(LED_PIN3, LOW);
    digitalWrite(PUMP_PIN, HIGH);
    Serial.println("The Water level is Under 10cm: ");
    Serial.println(distance);
  } else if(distance < 20) {

/*
    if the distance is b/w 10cm and 20cm then green light gets on
    and tell that Water tank is almost getting filled up.

*/

    digitalWrite(LED_PIN, LOW);
    digitalWrite(LED_PIN2, HIGH);
    digitalWrite(LED_PIN3, LOW);
    digitalWrite(BUZZER_PIN, LOW);
    digitalWrite(PUMP_PIN, LOW);
    Serial.println("The Water level is b/w 10cm and 20cm: ");
    Serial.println(distance);
  } else {
/*
    The distance is more than the 20cm which indicates that Water
    tank is not filled.
```


Slug_detection1a | Arduino IDE 2.2.2-nightly-20231006
File Edit Sketch Tools Help
Arduino Uno
Slug_detection1a.ino
*/
digitalWrite(LED_PIN, LOW);
digitalWrite(LED_PIN2, LOW);
digitalWrite(LED_PIN3,HIGH);
digitalWrite(BUZZER_PIN, LOW);
digitalWrite(PUMP_PIN, LOW);
Serial.println("The Water level is above 20cm: ");
Serial.println(distance);
// Stop the water pump
}
// Delay for 1 second
delay(1000);
}
/*
The Distance calculation in centimeters is based on the time
it takes for the ultrasonic sensor wave to travel from the sensor to the object
and back. The Speed of the sound in air approximately 343m/s or 0.0343cm/us.
Therefore, the distance = (duration * 0.0343)/2
*/
float measureDistance() {
// Send a pulse on the trigger pin
digitalWrite(TRIGGER_PIN, HIGH);
delayMicroseconds(10);
digitalWrite(TRIGGER_PIN, LOW);
// Measure the time it takes for the pulse to return
long pulseDuration = pulseIn(ECHO_PIN, HIGH);
// Calculate the distance
float distance = pulseDuration * 0.034 / 2.0; // cm
return distance;
}
Ln 65, Col 24 Arduino Uno on COM3 [not connected]
18°C Clear
Search
ENG IN
01:11 AM 23-10-2023

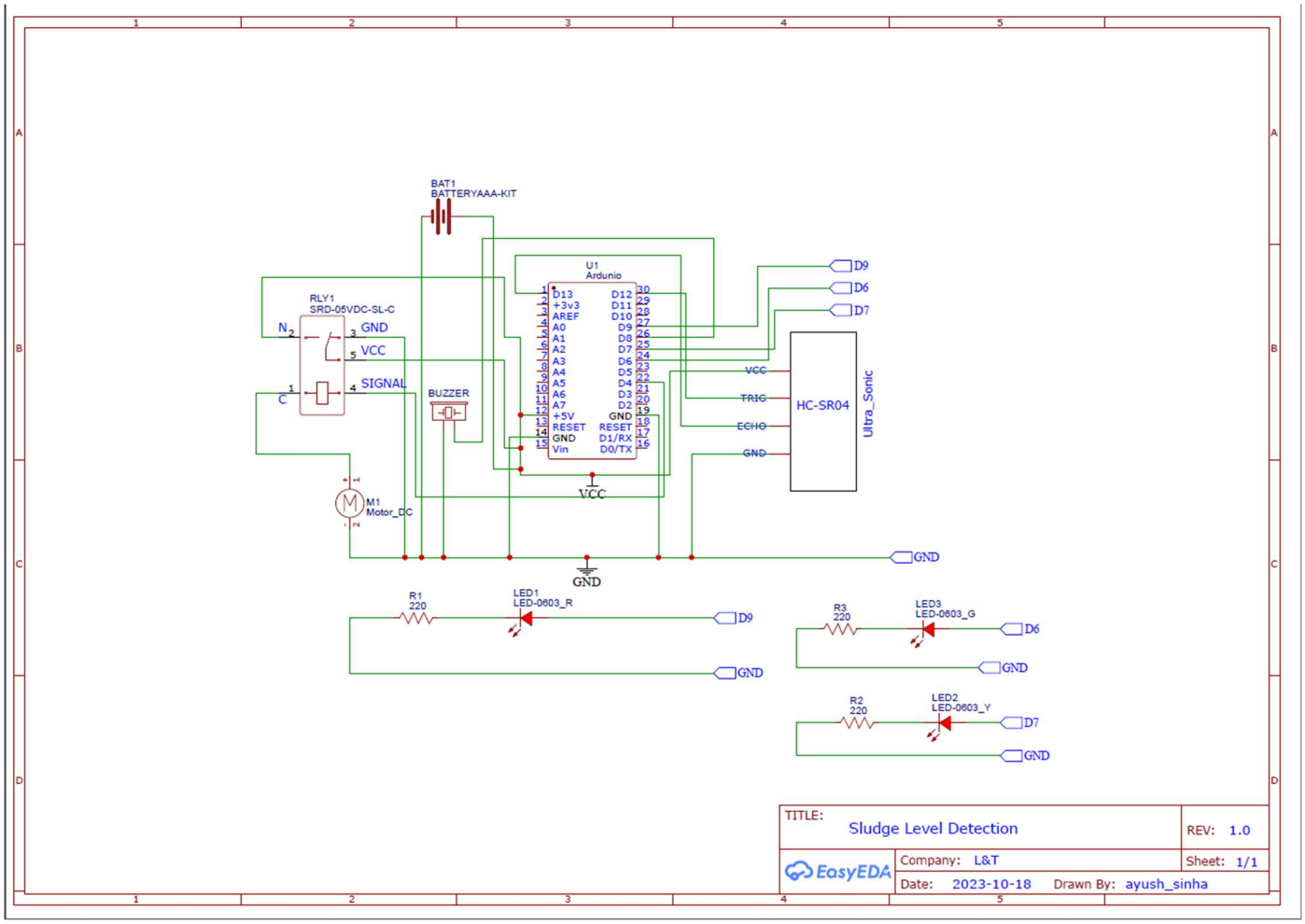
OUTPUT:


The Water level is Under 10cm:
8.31
The Water level is Under 10cm:
8.23
The Water level is Under 10cm:
8.33
The Water level is Under 10cm:
8.42
The Water level is b/w 10cm and 20cm:
10.74


18.41
The Water level is above 20cm:
25.13
The Water level is above 20cm:
23.82
The Water level is above 20cm:


The The Water level is Under 10cm:
9.91
The Water level is Under 10cm:
9.23
The Water level is Under 10cm:
9.04

VIII. GERBER FILE



This Circuit diagram how exactly the connections are made.

IX. CONCLUSION

Water tanks are getting used in daily purpose of many households and businesses, providing clean water for drinking, cooking, and cleaning. However, over time, Sludge gets accumulated in the bottom of the tank, reducing the water quality and increasing the risk of waterborne diseases.

To mitigate the risk, it is important to clean water tanks regularly. However, it can be difficult to know when tanks needs to get cleaned, especially if the tank is large or not early accessible.

A microcontroller-based prototype which alerts the user to clean the water as the sludge level is more. This can be valuable tool for ensuring that the water tanks are cleaned on time. This prototype is relatively simple to build and easily customized according to user specific.

The prototype can be used in variety of settings, including households, businesses, and schools. It can also be used in remote locations where it is difficult to access the water tanks regularly.

Overall, a micro-controller based prototype is a way to ensure that water tanks are cleaned on time and that water quality is maintained.

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