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CC5068NI– Cloud Computing & IoT

Water Level Monitoring System

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Group members

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I confirm that I understand my coursework needs to be submitted online via Google Classroom under the relevant module page before the deadline in order for my assignment to be accepted and marked. I am fully aware that late submissions will be treated as non-submission and a mark of zero will be awarded.

Acknowledgement

I would like to express my profound gratitude to our module leader Mr. Sugat Man Shakya, and module instructors, Mr. Umesh Nepal and Mr. Sujil Maharjan sir for assisting us to accomplish the group project titled "Water Level Monitoring System" and for thoroughly guiding me to understand the group project.

I would also like to thank my group members in particular for their contributions, time, and efforts in completing the project. Their helpful recommendations and advice were really beneficial to me during the project's completion. I will be eternally thankful to them in this regard.

Abstract

This report covers the development and theory for the project, “Water Level Monitoring System”. This report includes the current scenario and problems which depicts the facts about global warming and its effects on rising of water level in various water sources such as rivers, dams, seas, etc. Then, this report states the problems related to rapid grow of water level in various water sources and a solution to be alerted of water level of various water sources in real time. This report includes short description about hardware and software resources that are used by the system.

The report also consists of system overview along with hardware architecture, flowchart and circuit diagram of the water level monitoring system. The report also depicts the development process of the system and its results and findings. The system was tested and is included in this report. Along with testing, the report also contains probable future use/works of the system developed and how it can be implemented in real life scenario.

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1. Introduction

The water level is among the most widely measured parameters, which refers to the amount of water in a body of sea, river, groundwater, a tank, and so on. Detection of water levels in such water bodies possesses numerous applications that contribute to secure navigation, tsunami warnings, incident response, storm modelling, search and rescue operations, tidal datum, sea-level trends, etc. However, the level of water in rivers, lakes, streams and the ocean keep rising and falling according to the change in environmental factors, so it is difficult to measure the level of water resources manually. Hence, there is a need for a system that detects the water level in water bodies automatically and with more accuracy.

The rise of water levels in river, sea, lake, and ocean introduces flooding causing loss of life and destruction. The majority of property and human loss occurs in rural areas where there are no indications of rising water levels and no proper alert systems. Thus, using an autonomous water level monitoring system, water level data can be obtained which can be used to provide scientific early warning of flood disasters, improve flood control command capabilities, and reduce rain and flood disaster losses.

Figure 1 Monitoring river water level

1.1 Current Scenario

In recent years, due to climate change and rise in temperature mountain glaciers and polar ice sheets are melting at an increasing rate, adding water to the ocean. In addition, volume of water in river, the sea is expanding as they absorb the large amount of heat caused due to the increase in earth's temperature. Similarly, natural factors like heavy rainfall are impacting the total water level.

According to report the sea level has risen 8-9 inches since 1880. In 2020, the global mean sea level was risen by 3.6 inches. Similarly, between the year 2006 and 2015, the global mean water level of the ocean was increased by 0.14 inch per year. The annual growth rate is currently around 3.2 mm. Based on the data collected, it is expected that the water level will rise by a foot by 2050.

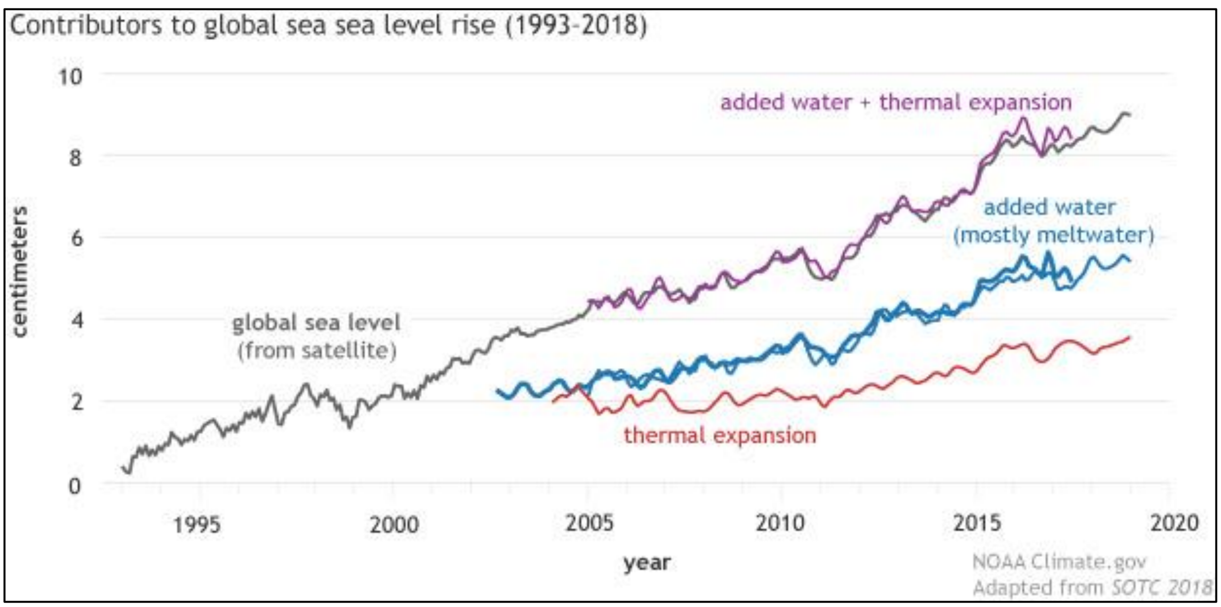

Figure 2 Current scenario of sea water level (LINDSEY, 2022)

1.2 Problem Statement and Project as a Solution

Due to global warming, sudden climate change and rainfall are becoming more common, increasing the water level of water resources like rivers, seas, dams, and oceans. Hence, natural disasters like floods are occurring frequently. It is causing loss of thousands of human lives along with properties like crops, residents, buildings, marines, etc., and eventually affecting the national economy.

The problem stated above can be solved by utilizing the project's product, i.e. water level monitoring system. It provides real-time data on the changes in the level of such water resources. With such data, flood forecasting can be done, and people can be made aware of the flood-critical situation. In addition, the system generates an alarm in the event of a sudden rise in water level. It encourages people to take precautions, which ultimately saves human lives, property and reduces loss of flood.

1.3 Aims and Objectives

The aim of this project is to create an autonomous system that detects the water level in a river/dam and generates an alarm for water rise, thus reducing the damage due to flood risk.

The objectives done to meet the above aim are as follow.

- To conduct thorough research on components used for water level detection system and their functioning along with usage.
- To develop an automatic water level indicator system using Arduino, ultrasonic sensor, and microcontroller, and assemble them via jumper wires.
- To perform computing technique i.e. coding for detecting variation in water level.
- To generate alerting sound using a buzzer and indicate the rise in water level.
- To display rise or fall in water level in the form of water depth using LCD.
- To test out the functioning of the developed water level monitoring system.
- To provide real-time water level data that can be used for flood risk analysis.

2. Background

2.1 System Overview

The system is about monitoring the level of water in dams, river, lake, ponds etc. It measures the depth of the water in water bodies and provides real time data about rising or falling water level. In addition, it generates an alert sound via a buzzer indicating a sheer rise in water level. Thus, the system is useful for predicting flood possibility by visualizing water level data.

The entire system is controlled by a single power button, which is turned on to supply power of 5V to the Arduino board. Then, Arduino begins to perform logical operations based on the interval codes, which detects even the smallest change in water level. The measured value of the current water level is displayed via LCD indicating rise or fall in water. If the system detects high water rise, it generates alarm. The device is installed above the surface of the water; thus, it has no contact with water.

The system detects the change in water level by measuring the distance between the sensor and the surface of water via the use of the ultrasonic sensor. At first, the transceiver transmits the ultrasonic pulses which gets bounce back when it hits the water's surface. Then, the time taken by the receiver to receive the pulses back after transmitting the wave is calculated. On the basis of the calculated value, change in water is detected. If the time taken to receive the wave is less, the water level is high and if the time taken to receive the wave is high, the water level is less. Likewise, the alert sound is generated if the distance between sensor and water surface gets less than 10 cm.

2.2 Design Diagrams

2.2.1 Hardware Architecture

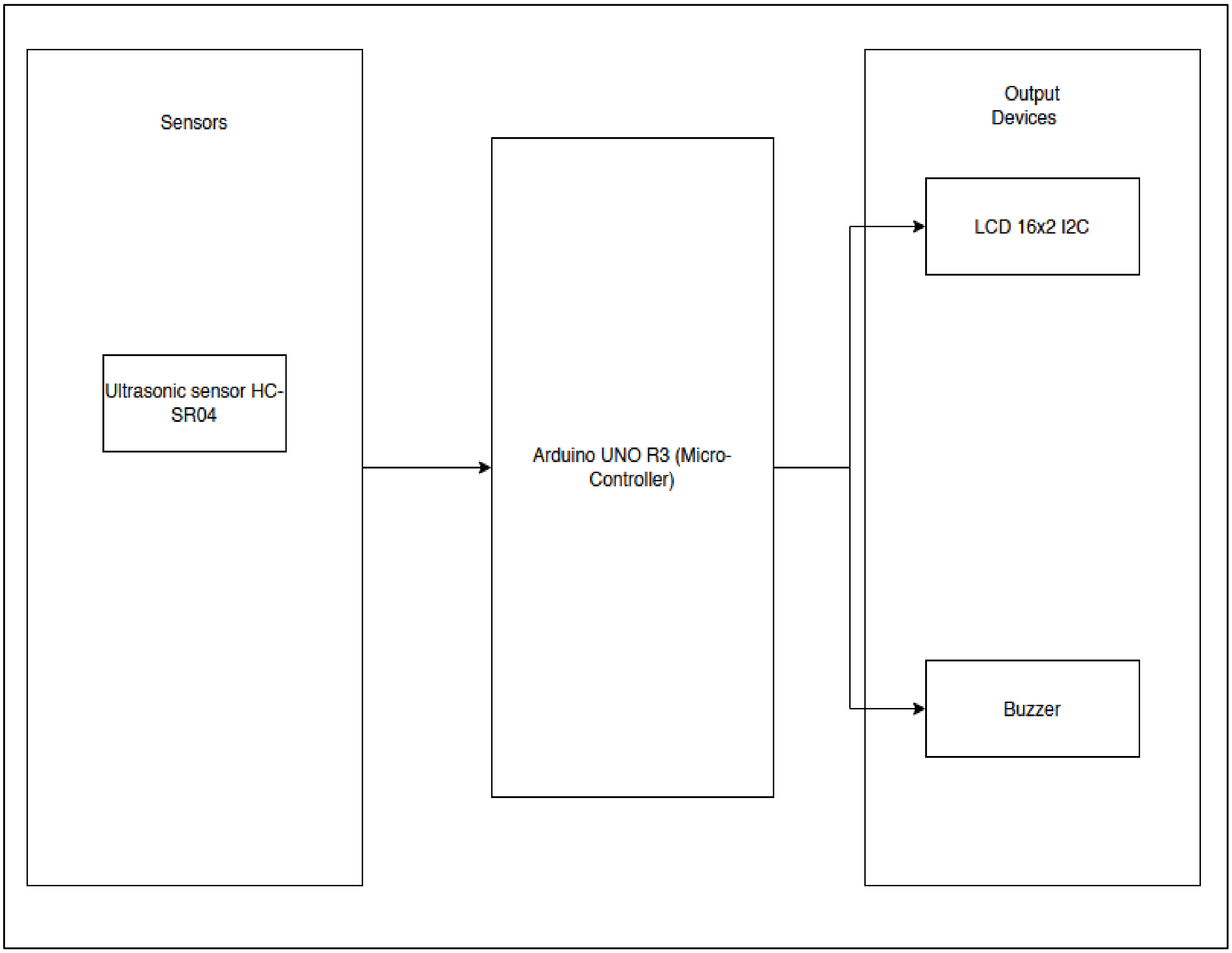

Figure 3 Hardware architecture of the water level monitoring system

2.2.2 Flowchart

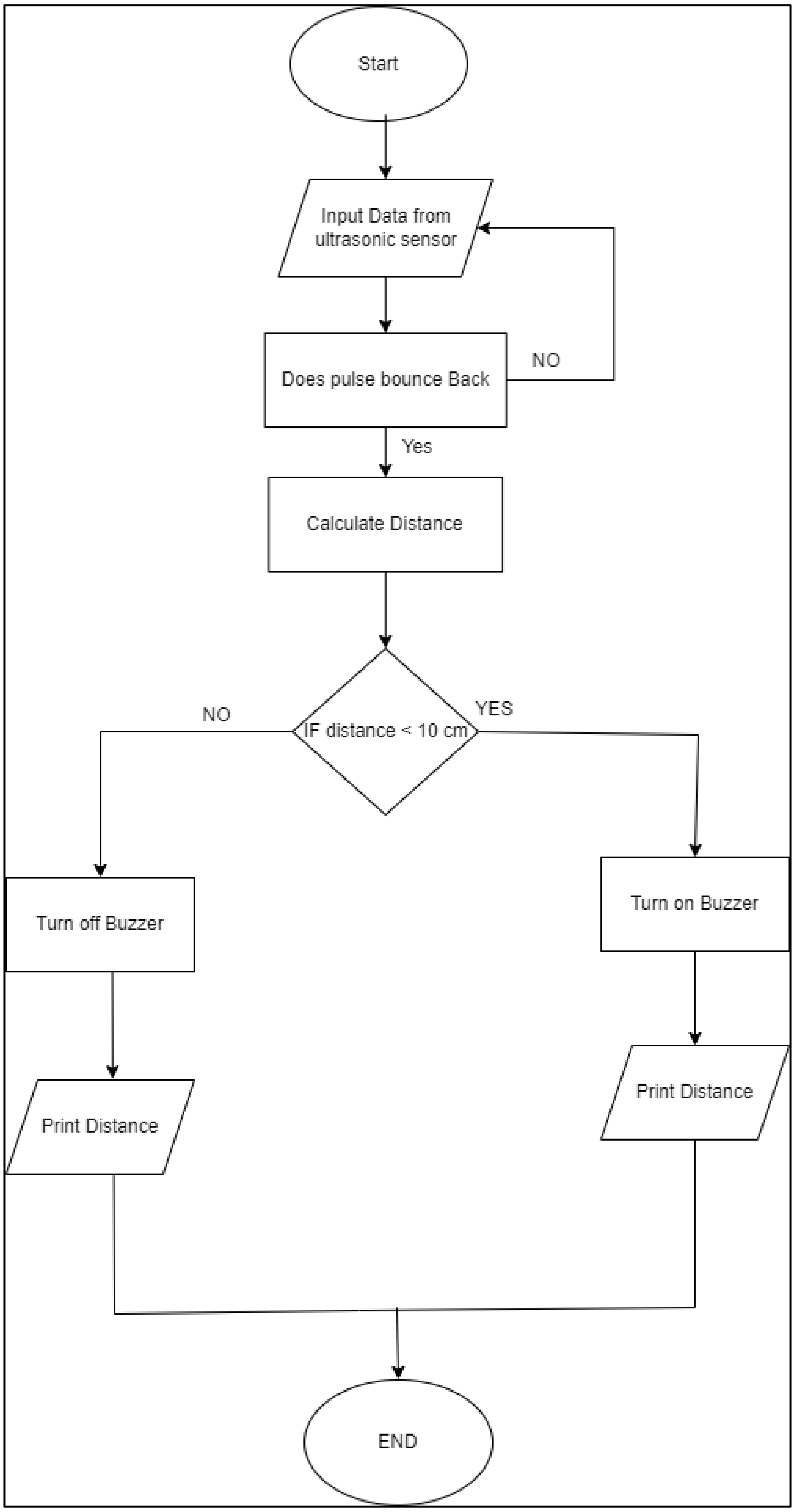

Figure 4 Flowchart of the water level monitoring system

2.2.3 Circuit Diagram

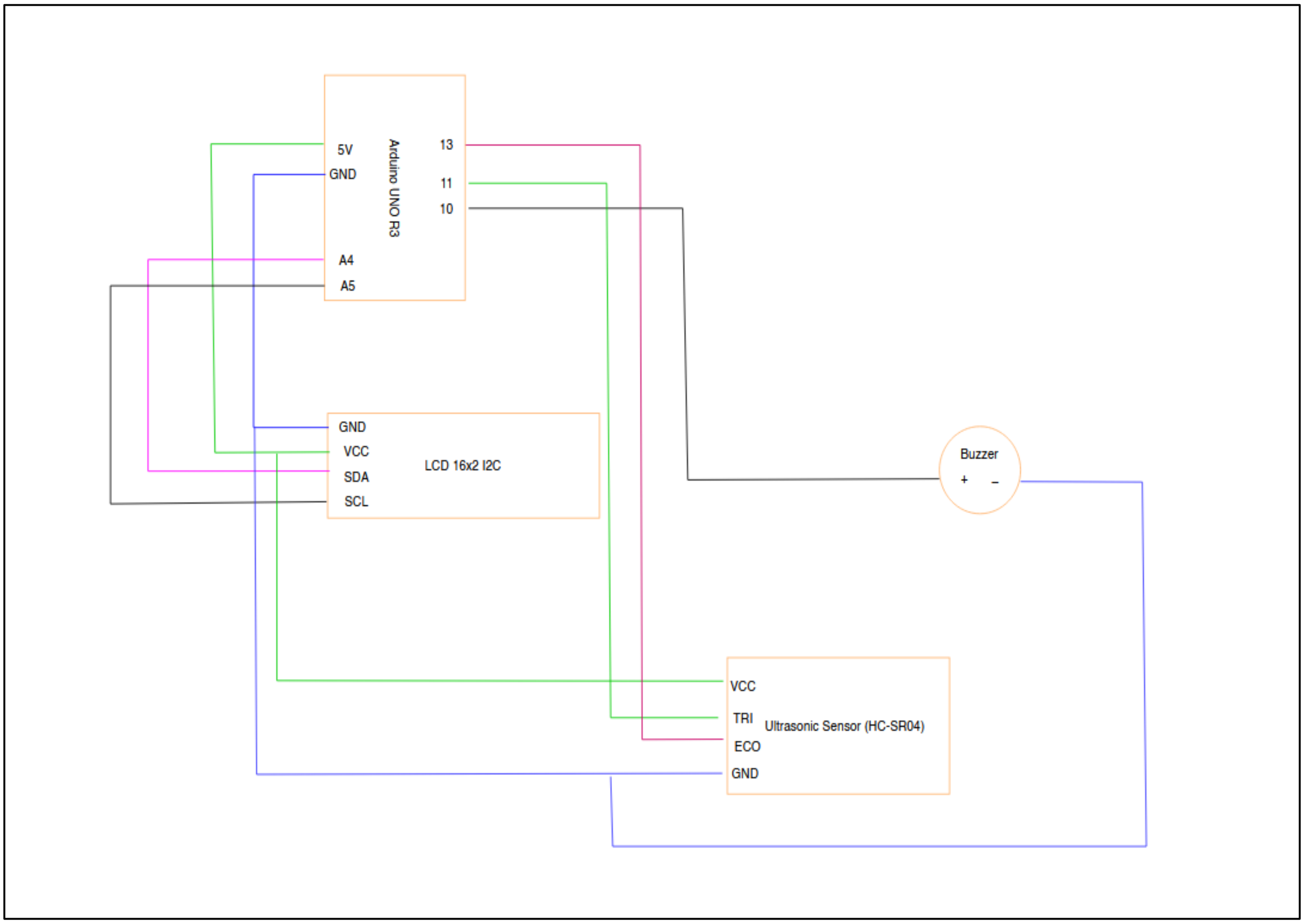

Figure 5 Circuit diagram of the water level monitoring system

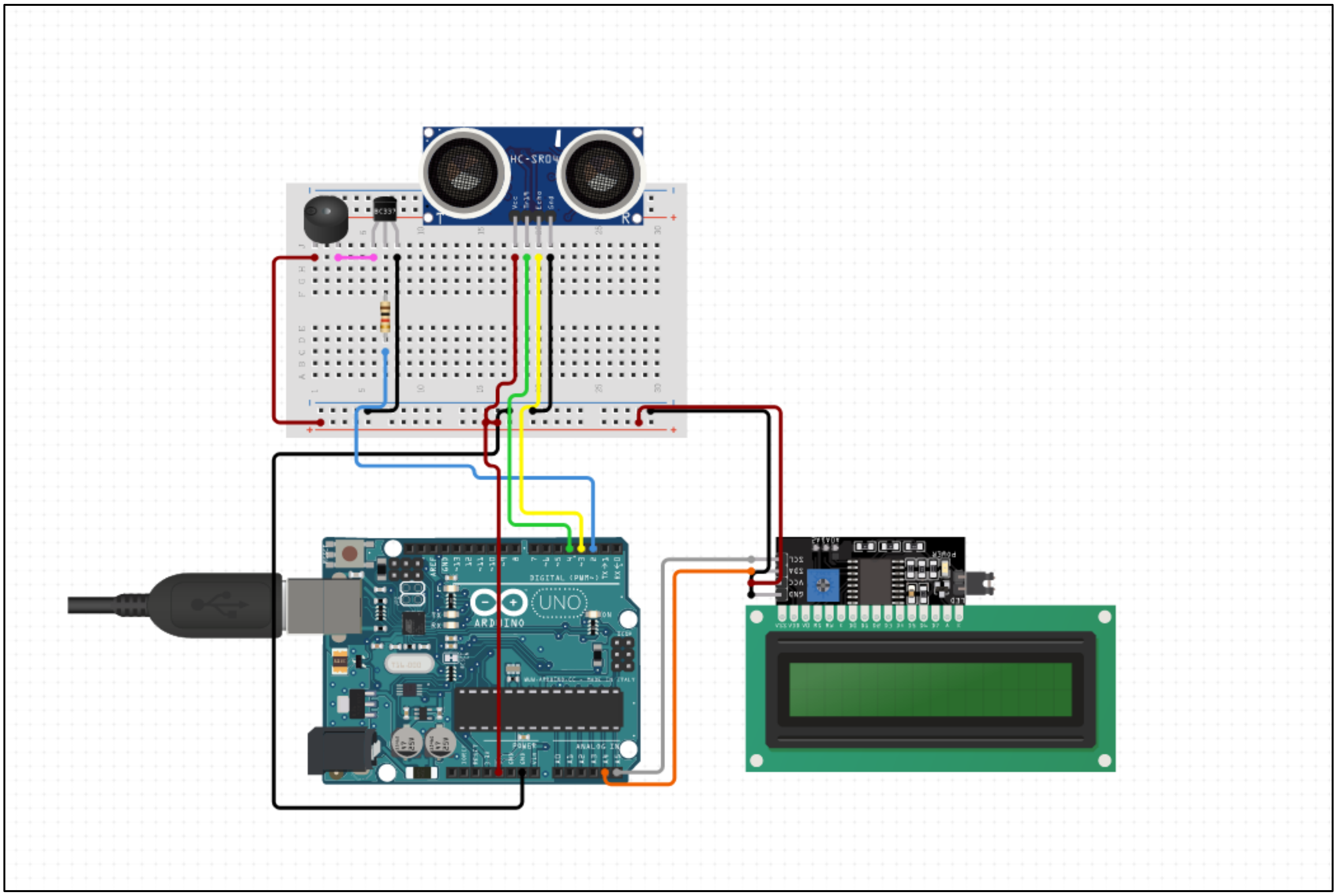

Figure 6 Graphical representation of the circuit diagram

2.3 Requirement Analysis

2.3.1 Hardware

i. Arduino UNO Board

It is a microcontroller or programmable circuit board that is used for detecting surrounding via input. It is featured with GPIO pins, main IC, LED indicator, crystal oscillator, USB connection, etc., (Elprocus, 2022). The system read the signal from sensor via analog pins whereas the output was shown via digital pins of Arduino board.

Arduino UNO R3 was used to execute all tasks such as logical, arithmetic, control tasks and process the input from the ultrasonic sensor to provide output to LCD screen and buzzer.

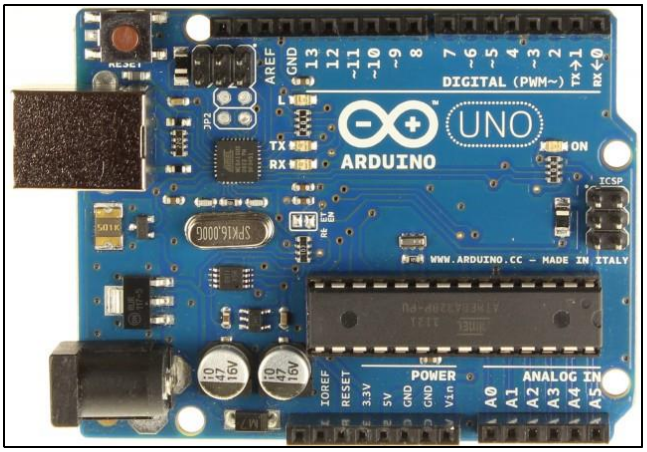

Figure 7 Arduino board (Brodkin, 2022)

ii. Ultrasonic sensor

An ultrasonic sensor (HC-SR04) is an electronic device that are designed to measure the distance between sensor and target. The system detects the water level by emitting ultrasonic waves and calculating the time by sensor took to receive the reflected wave.

The ultrasonic sensor was used to measure the distance between the device and the surface (water) in order to monitor water level.

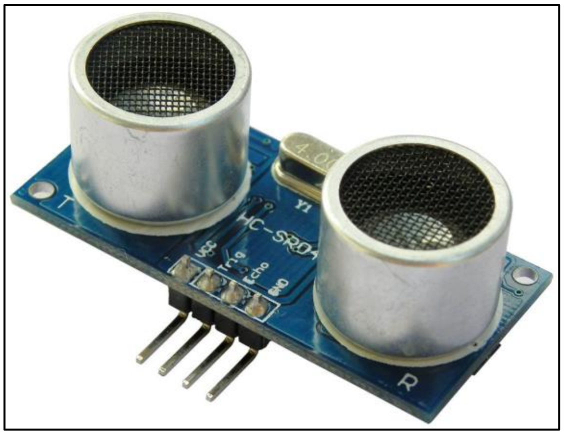

Figure 8 Ultrasonic sensor (Kartha, 2022)

iii. Breadboard

It has sets of small sockets laid out on a 0.1-inch grid that accept the manual insertion of component leads and tinned copper wire (TCW) linkages on a breadboard. It has rows of contacts connected in groups on either side of the board's center line, where the integrated circuits (ICs) are installed, allowing numerous contacts on each IC pin (Bates, 2011).

It was used to connect multiple pins from various devices such as LCD screen, buzzer, and ultrasonic sensor to the Arduino R3.

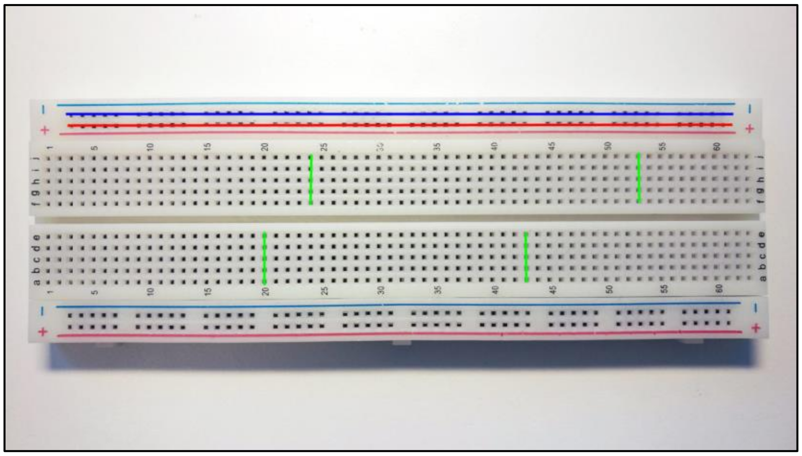

Figure 9 Breadboard (Aasvik, 2022)

iv. LCD(16x2) Display

LCD (Liquid Crystal Display) is a type of flat panel display that operates primarily with liquid crystals. It is used to display the distance between sensor and water surface and indicate variation of water level.

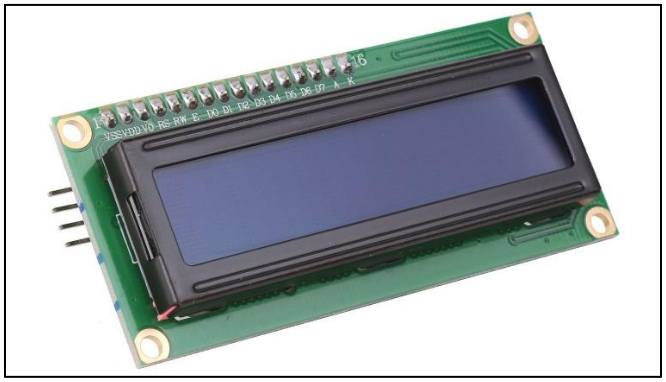

Figure 10 LCD (Electronics, 2022)

v. Jumper Wire

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. These wires are used to connect system’s component with each other.

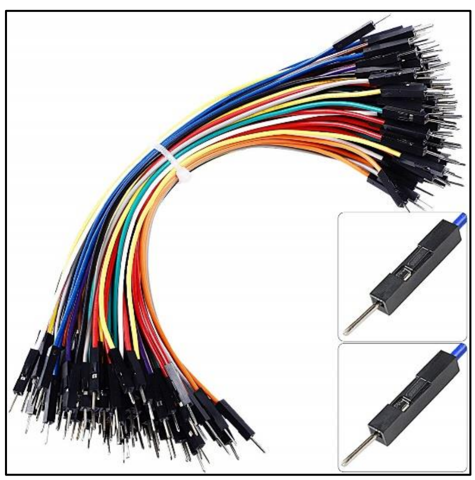

Figure 11 Jumper Wire (Markerpartswarehouse, 2022)

vi. Buzzer

A buzzer is a basic device that turns electrical signals into sound. It has a 2-pin configuration with positive and negative terminals to connect to circuits, making it incredibly small and compact. The buzzer will be utilized in the project to inform the user with a buzzing sound anytime the water level has exceeded the safety level.

The buzzer was used to notify about the increasing water level from the water source.

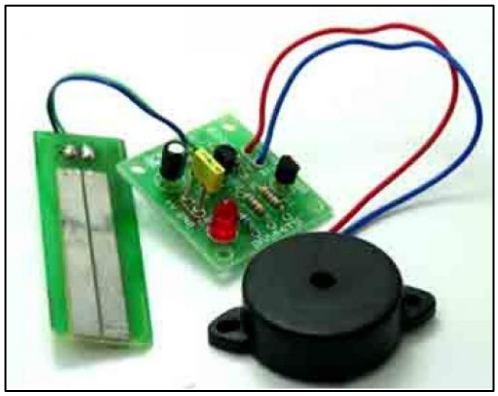

Figure 12 Buzzer (Sharma, 2022)

2.4.2 Software

Arduino IDE: The software for Arduino is known as the Arduino IDE (Integrated Development Environment). It is a text editor with various features, similar to a notepad. It is used to write code, compile the code to check for errors, and upload the code to the Arduino.

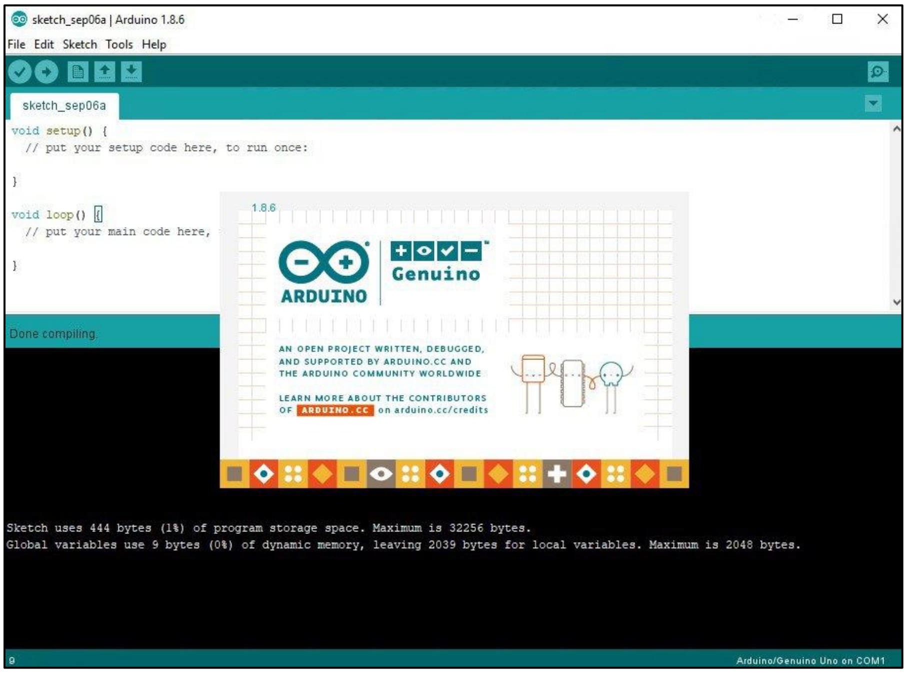

Figure 13 Arduino IDE (Do Connect, 2019)

Draw.io: Draw.io is a free internet - based diagramming software program for creating diagrams. It also develops web-based diagramming software and integrates with Google Drive and Dropbox (Crunchbase, 2022).

Draw.io was used to create flowcharts and circuit diagram needed for the project.

Circuito.io: Circuito.io is a web-based tool for creating complete circuit boards. The Circuito app generates accurate schematics and code for your electronic circuit in real time. You choose the major building blocks, and it calculates all of the electrical requirements for your choice (Ayibiowu, 2018).

Circuito.io was used to create a graphical representation of the circuit diagram.

3. Development

3.1 Planning and design

In the development process we planned to build a water level monitoring system. For the system, it was found that Arduino unoR3, ultrasonic sensor, buzzer and LCD display were required. First of all, Arduino UNOR3 is used as a microcontroller. Ultrasonic sensor is used to measure the distance between the water surface and the sensor. If the distance between the water surface and sensor is less than 10cm it alerts by buzzing the buzzer. LCD display is also used to display the distance between the water surface and the sensor.

3.2 Resource collection

For the resources required, the resources were collected through online website, Himalayan Solutions which provided all the equipment needed for the project. The orders were done online and collected from Himalayan Solutions which is located at New Baneshwor.

3.3 System Development

After all the parts needed for the system was collected, all that was left was to assemble the parts and upload a program/function into the system. First of all Arduino Uno R3 board was connected with the HC-SR04 ultrasonic sensor with the help of breadboard. The supposed connections of these devices are VCC from the sensor to 5V of Arduino board, TRI to the digital pin D11 of the Arduino Uno R3 board. The ECO of the ultrasonic sensor was connected to digital pin D13 of the Arduino Uno R3 board and the GND of sensor was connected to GND pin of the microcontroller.

Similarly, for the buzzer, the positive pin of the buzzer was connected to D10 of the Arduino UNO R3 board and the negative pin of the buzzer was connected to the GND pin of Arduino UNO R3.

Whereas, for the LCD 16x2 I2C display, the VCC and GND connections were same as of the ultrasonic sensor, i.e., GND of the display was connected to GND pin of the microcontroller and VCC of the display was connected to 5V pin of the Arduino Uno R3 board. The SDA and SCL of the LCD display was connected to the A4 and A5 pin of the Arduino Uno R3 board respectively. After all the connection was established, the last step was to upload the program to the Arduino board. The program was then uploaded through Arduino IDE.

After the program was uploaded to the Arduino UNO R3 board, the system was found to work as intended. The ultrasonic sensor was able to send inputs of the distance and the microcontroller was able to process it through logical and arithmetic operations and the output was then displayed to the LCD screen and notified by the buzzer in case the water level was deemed to be at unsafe level.

4. Results and Findings

4.1 Project Outcome

The project we wanted to build to solve a problem was a success. The system functioned very well and was effective. The sheer purpose of the system was to monitor the water level and the system served its purpose. The HC-SR04 Ultrasonic sensor functioned well and provided the data needed to calculate the distance between the sensor and the water level. As the data was gathered the microcontroller, Arduino R3, processed the data with the help of source code that was uploaded to it and determined whether the level of water was safe or unsafe. Depending upon the result processed by the Arduino R3, the LCD screen displayed the details of water level and buzzer alerted only when the water level had breached the safety threshold.

As the system was found to work effectively in a small scale, it can now be implemented in large scale such as flowing rivers, dams with further upgrades needed accordingly. With the implementation of IoT, the system can work 24/7 with alerting users/people without delay. It can be used as an alerting system to personnel monitoring dams, water flow of rivers, etc. It can help save time is accurate while measuring data. With proper utilisation, the system can be the future of monitoring water level of various water source.

4.2 Testing

4.2.1 Test 1: The water cup was slightly filled.

Objective	To monitor the water level when the water cup was slightly filled.
Action	The water cup was filled very low and the sensor was kept above the bottle to measure the distance.
Expected result	The buzzer would not buzz as the distance between the sensor and water was higher than threshold and the data would be shown on the LCD screen.
Actual result	The buzzer did not buzz and the data was shown in the LCD screen.
Conclusion	The buzzer doesn’t buzz when the water is in the safe level.

Table 1 Test 1

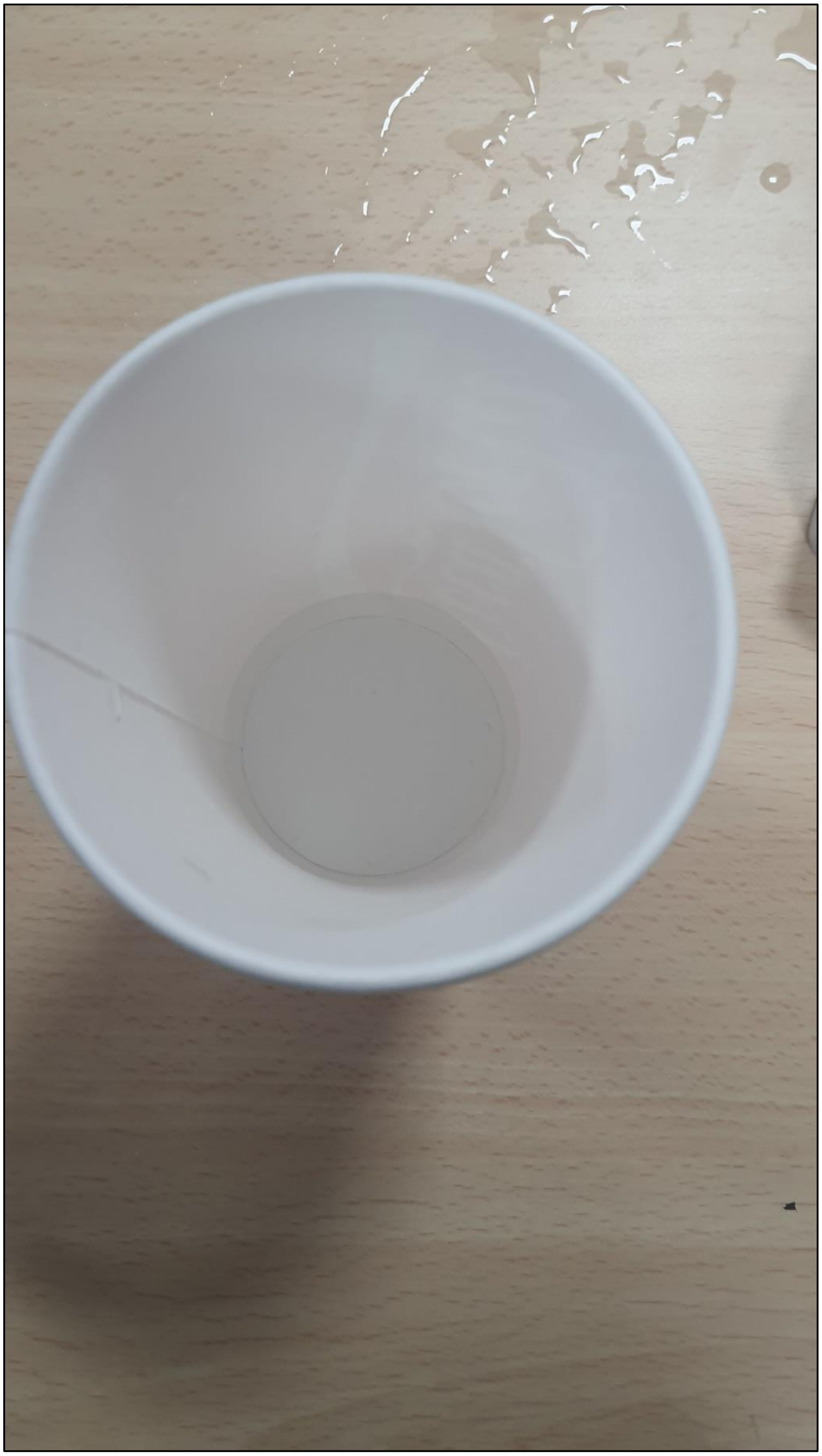

Figure 14 Water cup was slightly filled

Figure 15 Reading of water level by ultrasonic sensor I

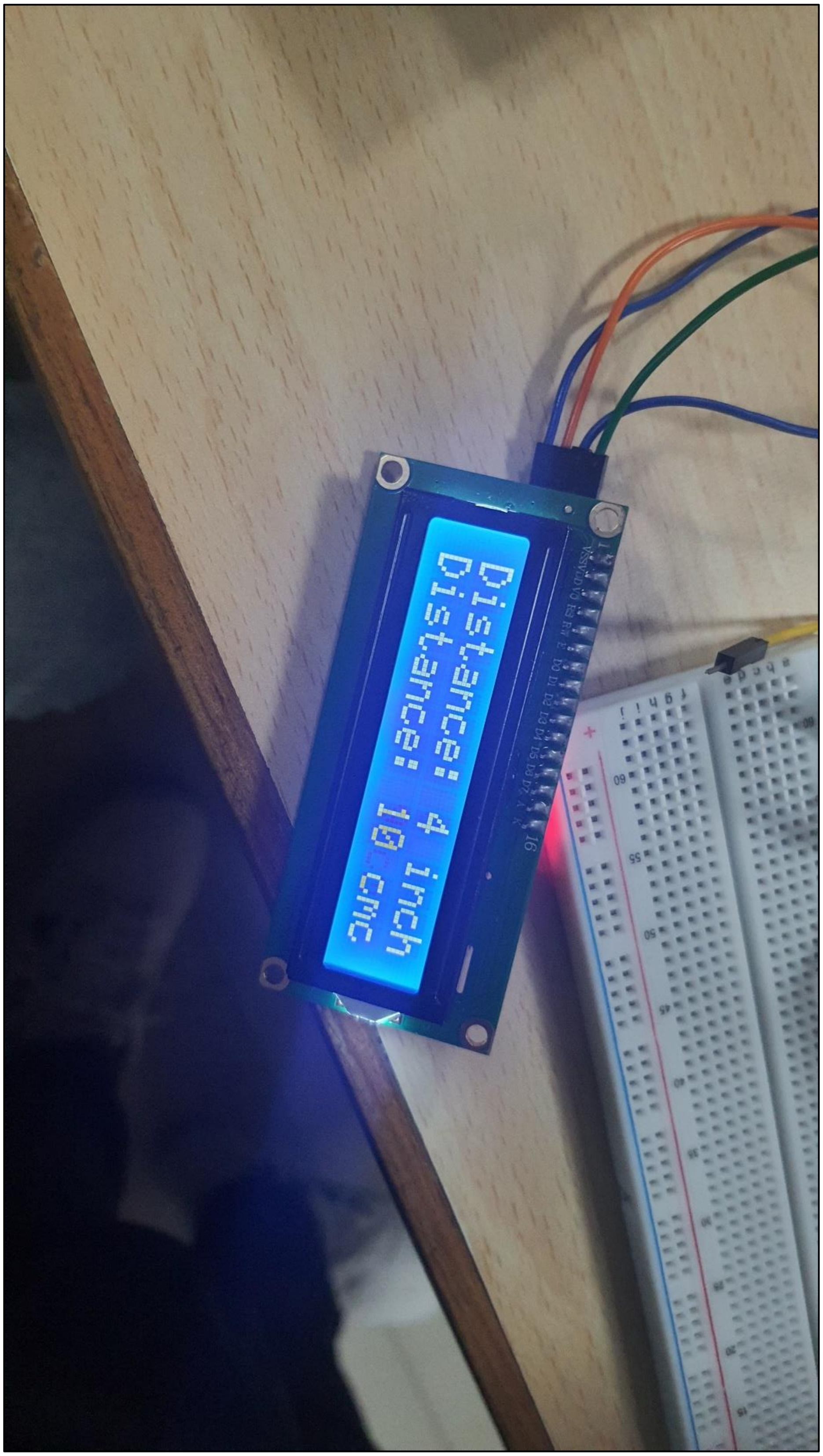

Figure 16 Display of water level by LCD screen I

4.2.2 Test 2: The water cup was half filled.

Objective	To monitor the water level when the water cup was half filled.
Action	The water cup was half filled and the sensor was kept above the bottle to measure the distance.
Expected result	The buzzer would not buzz as the distance between the sensor and water was slightly high than the threshold and the data would be shown on the LCD screen.
Actual result	The buzzer did not buzz and the data was shown in the LCD screen.
Conclusion	The buzzer doesn’t buzz when the water doesn’t cross the safe level.

Table 2 Test 2

Figure 17 Water cup was half filled

Figure 18 Reading of water level by ultrasonic sensor II

Figure 19 Display of water level by LCD screen II

4.2.3 Test 3: The water cup was almost fully filled.

Objective	To monitor the water level when the water cup was almost fully filled.
Action	The water cup was almost fully filled and the sensor was kept above the bottle to measure the distance.
Expected result	The buzzer would buzz as the distance between the sensor and water would cross threshold and the data would be shown on the LCD screen.
Actual result	The buzzer did buzz and the data was shown in the LCD screen.
Conclusion	The buzzer buzzes when the water crosses the safe threshold.

Table 3 Test 3

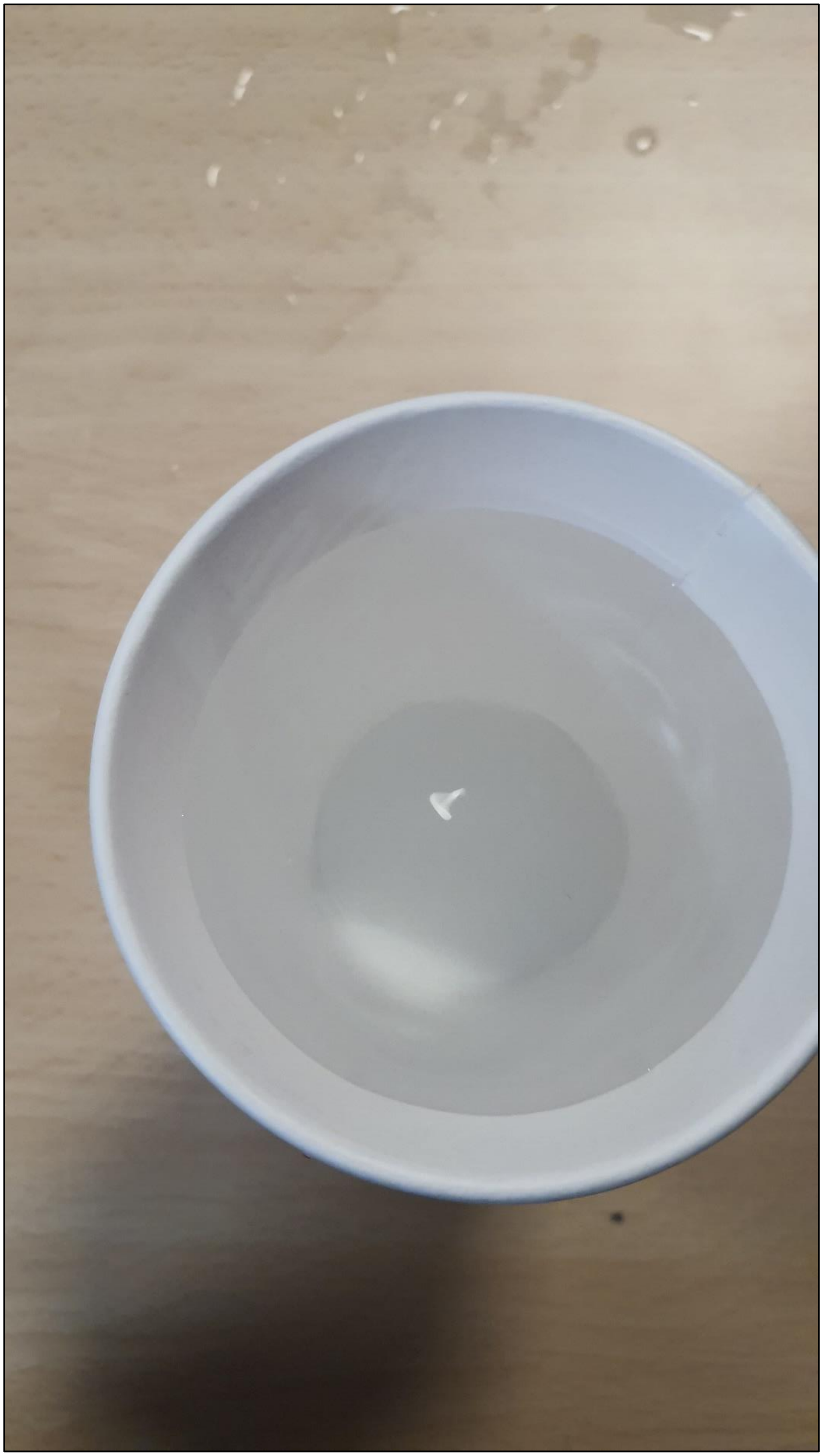

Figure 20 Water cup was almost fully filled

Figure 21 Reading of water level by ultrasonic sensor III

Figure 22 Display of water level by LCD screen III

5. Future Works

The use of water level monitoring system IoT in water reservoir sector is reviewed as a topic with great scope, the water reservoir sector is also leaning towards it. In the context of Nepal this IOT project can be very resourceful, as many developed and under construction hydropower project requires constant water level monitoring system. This system can also be used for flood monitoring as the flow of rivers are found to be high during the monsoon season. This system simply includes a display and a buzzer system, but there might be numerous upgrades in the future, such as an alert notification system. These days, in our hectic lives, we require notification messages on our phones or laptops that are linked to the internet, and this system may provide the user with water level notifications at any time. It will also aid in the creation of a smart city focusing on water conservation. The following are some of the elements that might be included in the future to help the system development:

- The system can be controlled remotely in future after some upgrade.
- System can control motors when danger level raises.
- The flow of water is detected by a water flow sensor.
- To deal with sensor failure, redundant sensors are being added.
- Using high-quality equipment that is also waterproof.
- Combining encryption with a hashing method to safeguard the connection.
- Solar panels provide electricity, making the system environmentally friendly and productive even when there is no electricity.

6. Conclusion

Water monitoring is demonstrated in our proposed methodology. This project has been built effectively based on the results for flood management system. The system's parts and modules are all functional. All modules are integrated with the Arduino UNO module to execute display with buzzer system. The designed system consists of several sensors and is controlled by an Arduino. A circuit was built to use IoT to manage and monitor the water level of an upstream dam and flowing rivers. It also helps to reduce flood hazards by monitoring the amount of rising water in rivers, dams, as well as other water reserves systems where this application is installed.

Ultrasonic sensor module is supposed to work effectively to measure the height of water. Furthermore, by after giving the appropriate coding to the system, the system should be able to avoid any unintentional input. As a result, the system is found to be dependable, and the user can rely on the results. The second goal is to successfully build an experimental setup that will allow the system to be tested and provide results that are similar to the predicted results.

The water level of the river/dam is regularly monitored and shown on a monitor. When the level rises over a predetermined threshold, the buzzer will begin to beep and serve as an alarm notification.

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8. Appendix

8.1 Appendix A: Source Code

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h> //including library LiquidCrystal_I2C


// Set the LCD address to 0x27 for a 16 chars and 2 line display

LiquidCrystal_I2C lcd(0x27, 16, 2);


int trigPin=11;

int echoPin=13;

int buzzerPin =10;


long duration;

int distance;

int distanceCm;

int distanceInch;


void setup() {

  // put your setup code here, to run once:

  pinMode(trigPin, OUTPUT);

  pinMode(buzzerPin, OUTPUT);

  pinMode(echoPin, INPUT);

  Serial.begin(9600);

  lcd.begin(16,2);

  lcd.init();

  lcd.backlight();



}
```

```
void loop() {
  // main code
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);

  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  duration=pulseIn(echoPin, HIGH);
  distance=duration*0.034/2;
  distanceInch=duration*0.0133/2;

  if(distance<=10)
  {
    Serial.println(distance);
    digitalWrite(buzzerPin, HIGH);
    lcd.setCursor(0, 1);//Sets the location at which subsequent text written to the LCD will be displayed
    lcd.print("Distance: "); // Prints string "Distance" on the LCD
    // Prints the distance value from the sensor
    lcd.print(distance);
    lcd.print(" cm");
```

```
    lcd.setCursor(0, 0);
    lcd.print("Distance: ");
    lcd.print(distanceInch);
    lcd.print("inch");
    delay(100);




    }
    else{
      digitalWrite(buzzerPin, LOW);
      lcd.setCursor(0, 1);// Sets the location at which subsequent text written to the LCD
will be displayed
      lcd.print("Distance: "); // Prints string "Distance" on the LCD
      lcd.print(distance);
      lcd.print("cm");
      lcd.setCursor(0, 0);
      lcd.print("Distance: ");
      lcd.print(distanceInch);
      lcd.print("inch");
      delay(100);



      }
}
```

8.2 Appendix B: Screenshot of the system

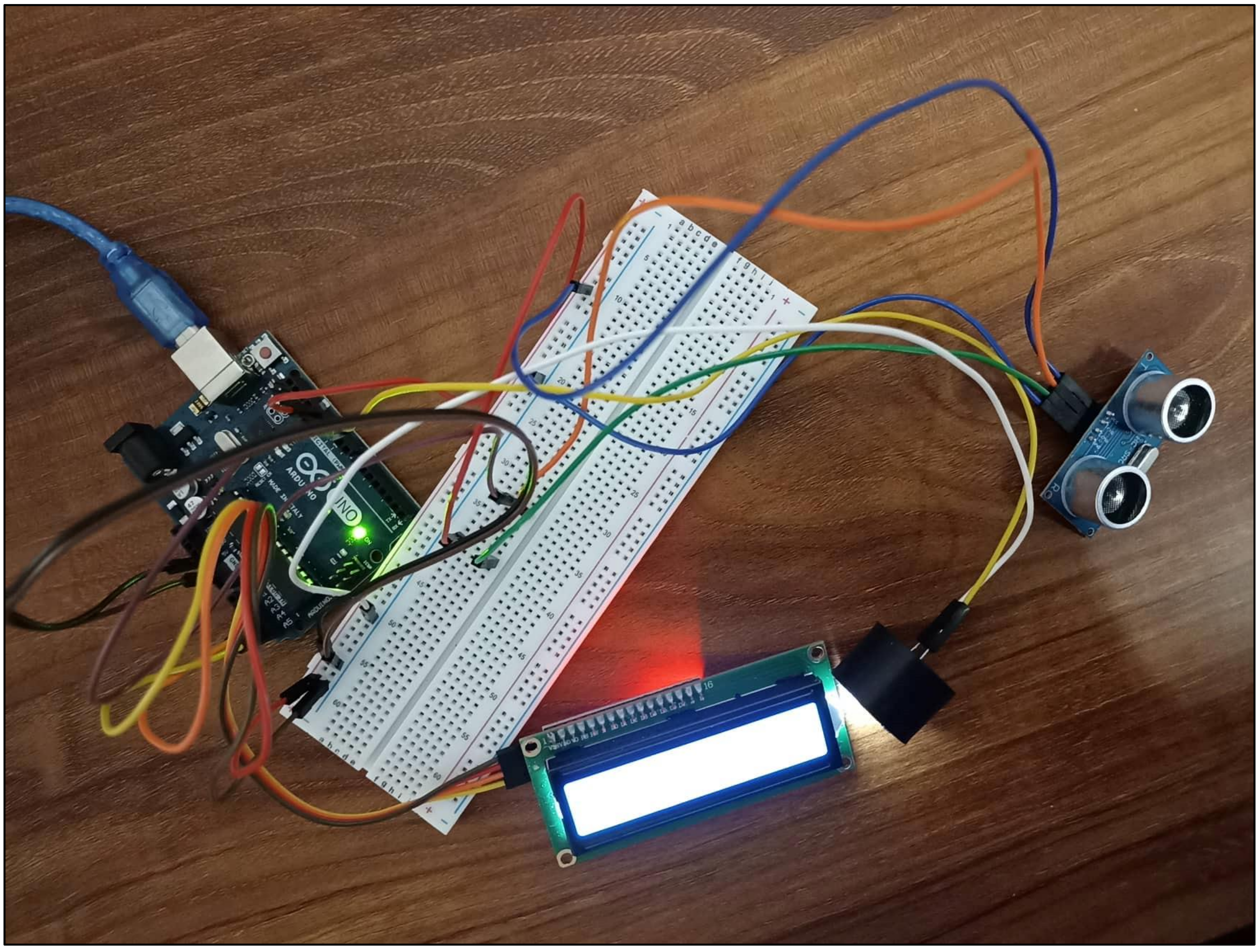

Figure 23 Screenshot of the water level monitoring system

8.3 Appendix C: Work Division

Anuj Shilpakar	Ujjwal Shrestha	Pasang Dolmo Tamang	Gaurab Khadka
System architecture design	Coding	Documentation	Documentation
Coding	System architecture design	Sketches for Arduino	Assembly and testing
Documentation	Documentation	Assembly and Testing	Sketches for Arduino
Presentation	Presentation	Presentation	Presentation