PROJECT REPORT

ON

"AquaAlert: Overflow Prevention System with Arduino"

THIS PROJECT & RESEARCH REPORT HAS BEEN INDEPENDENTLY DEVELOPED BY ME AND IS NOT SUBMITTED TO ANY COLLEGE OR UNIVERSITY FOR ACADEMIC EVALUATION

Developed by

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DEPARTMENT OF IOT

POLISHLINE.BALASORE, ODISHA, INDIA

MAY -2026

“Dedicated to my beloved parents ,and teachers who have worked hard throughout my education”

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CERTIFICATE

This is to certify that the project entitled

"AquaAlert: Overflow Prevention System with Arduino"

Has been independently developed and completed by Suzen Kumar Mohanty for the purpose of enhancing technical knowledge, skills, and practical understanding.

This project is a self-initiated work carried out with person al interestand research. It has not been submitted to any college, university, or institution for the award of any degree or diploma.

The work presented in this project is genuine and has been completed by the developer himself.



Suzen Kumar Mohanty

(Project Developer)

Date: 23/05/2026

SELF ATTESTATION

I here by declare that I have personally worked on the project entitled "**AquaAlert: Overflow Prevention System with Arduino**"All the data, analysis, and implementation presented in this project are the result of my own efforts and genuine work .Any external sources of information, if used, have been properly acknowledged.

This project is created solely for learning , skill development ,and professional improvement, and has not been submitted to any institution for academic purposes.



Suzen Kumar Mohanty

(Project Developer)

Date: **23/05/2026**

Place:Balasore,Odisha,India

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DECLARATION

I hereby declare that the project titled "**AquaAlert: Overflow Prevention System with Arduino**"is an original work carried out by me based on my own idea, research, and implementation.

This project that has not been submitted previously ,in part or in full, to any college, university, or institution for the award of any degree, diploma, or certification.

I confirm that all the information presented in this project is true to the best of my knowledge. Any references or sources used have been properly acknowledged.

I take full responsibility for the authenticity and originality of this work.

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Date:[**29/05/2026**]

ACKNOWLEDGMENTS

I would like to express my sincere gratitude to everyone who contributed, directly or indirectly, to the development of this project, "**AquaAlert: Overflow Prevention System with Arduino**."

This project is the result of my personal interest, dedication, continuous learning, and exploration of electronics, automation, sensor technology, and control systems.

I am thankful to the developers of Arduino, the creators of open-source hardware and software resources, and the technical communities whose documentation, tutorials, and knowledge-sharing platforms helped me understand and implement the concepts used in this project.

I would also like to acknowledge the importance of self-learning, practical experimentation, and problem-solving throughout the development process. These experiences helped me strengthen my technical knowledge and improve my understanding of real-world automation systems.

Finally, I am grateful to everyone who supports innovation, DIY engineering, and independent technical projects. This work reflects my enthusiasm for learning, creating, and exploring new possibilities in technology.

Developed By:

Suzen Kumar Mohanty

ABOUT MYSELF



I am Mr. Suzen Kumar Mohanty , a passionate and dedicated Web Developer and SOC Analyst (Level 1) from the field of Computer Science and Engineering, with strong expertise in HTML, CSS, JavaScript, and I specialize in building scalable, responsive, and high-performance web applications that deliver seamless user experiences across all devices and screen sizes.

With a keen eye for detail, I focus on writing clean, maintainable, and well-structured code. My development approach is centered around Creating intuitive user interfaces, ensuring both functionality and aesthetic quality. I follow modern front-end development practices such as component-based architecture, responsive design principles, and performance optimization techniques to build efficient and user-friendly applications.

Beyond web development, I actively work on IoT-based solutions, where I integrate hardware and software to create smart, real-world systems. I have hands-on experience with Arduino Uno and various sensors, enabling me to develop projects such as environmental monitoring systems, smart automation solutions, and real-time data tracking applications.

One of my key strengths lies in connecting IoT devices with web technologies. I build interactive dashboards that allow real-time data visualization, giving users the ability to monitor, analyze, and control devices remotely. My work focuses on bridging the gap between the physical and digital world by transforming raw sensor data into meaningful insights.

I am deeply interested in developing innovative, data-driven solutions that combine web technologies with embedded systems. My goal is to create impactful applications that solve real-world problems while improving efficiency, automation, and user experience.

With a strong passion for continuous learning and innovation, I consistently explore new tools, frameworks, and technologies to enhance my skills and deliver high-quality, future-ready solutions.

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ABSTRACT

Water is one of the most essential natural resources required for human survival and daily activities. However, the wastage of water due to overflowing storage tanks is a common problem in residential buildings, educational institutions, commercial establishments and industrial facilities. Traditional water-filling systems generally depend on manual monitoring, which can lead to unnecessary water overflow when users forget to switch off the water pump. To overcome this problem, **AquaAlert: Overflow Prevention System with Arduino** is designed as an automated and cost-effective water-level monitoring and overflow prevention solution.

The proposed system uses an **Arduino UNO microcontroller and an HC-SR04 ultrasonic sensor** to continuously monitor the water level inside a storage tank. The ultrasonic sensor measures the distance between its mounting position and the water surface without requiring direct contact with water. Based on the measured distance, the Arduino calculates the approximate water level and identifies the current tank condition.

The system incorporates LED indicators and a buzzer to provide visual and audible notifications when the water reaches predefined warning levels. Furthermore, a relay module is used to control the water pump automatically. When the water reaches the configured maximum level, the Arduino sends a control signal to the relay, switching off the pump and helping

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prevent water overflow. The system also supports continuous monitoring to detect changes in the water level.

AquaAlert aims to minimize water wastage, reduce human intervention, improve water management and provide a convenient automatic water-control mechanism. Its low-cost hardware architecture makes it suitable for educational projects, residential applications and small-scale water storage systems. Additionally, the proposed design can be enhanced through IoT integration, wireless communication, mobile application notifications and cloud-based monitoring.

In conclusion, AquaAlert demonstrates the practical application of embedded systems, ultrasonic sensing and automation technology in addressing everyday water-management challenges. It offers an effective foundation for developing smarter, more efficient and environmentally responsible water storage solutions.

Keywords: AquaAlert, Arduino UNO, Water Level Monitoring, Overflow Prevention, HC-SR04 Ultrasonic Sensor, Automatic Water Pump Controller, Relay Module, Embedded Systems, Water Conservation, Smart Automation.

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1. Introduction

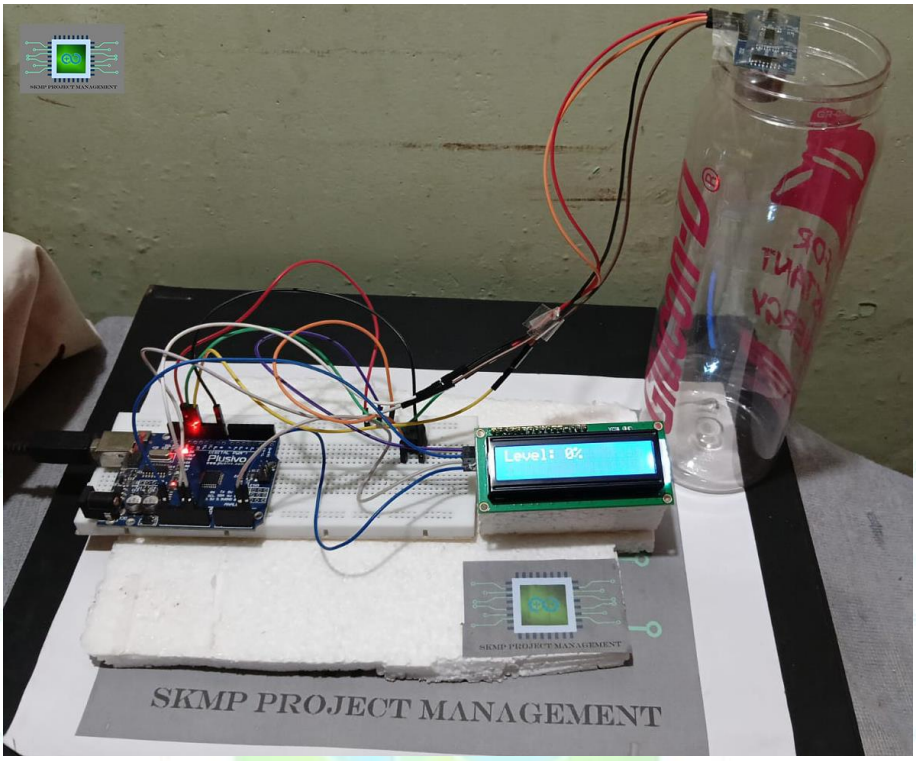

FIG-01

Water management is an important aspect of modern infrastructure. Residential buildings, apartments, schools, hospitals, offices, factories and agricultural facilities require reliable water storage systems to maintain their daily operations.

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In many buildings, water is supplied to an underground reservoir or directly to an overhead tank using an electric water pump. Although the process is straightforward, monitoring the water level manually creates several practical challenges.

A user may forget that the pump is running, become occupied with other activities or fail to notice that the tank has reached its maximum capacity. Consequently, water continues to flow into the tank, resulting in overflow.

This problem may appear minor in an individual household, but repeated water overflow across thousands of buildings can result in considerable water wastage.

AquaAlert is designed to address this issue through an automated water-level detection and pump-control mechanism.

The project uses an Arduino UNO as its central processing unit. An ultrasonic sensor is installed at the top of the water tank. It continuously measures the distance between the sensor and the water surface.

As the water level rises, the measured distance decreases. The Arduino interprets this measurement and determines whether the tank is empty, partially filled, nearly full or completely filled.

Based on the programmed threshold values, the system performs appropriate actions:

- Displays the current water-level status through indicators.
- Activates an audible warning when the water reaches a critical level.
- Sends a control signal to a relay module when the tank reaches its maximum configured level.
- Switches off the connected water pump through the properly rated relay interface.
- Continues monitoring the tank to identify changes in water level.

The system provides a practical and economical approach to reducing unnecessary water overflow.

2. Problem Statement

Conventional water storage systems often require users to monitor tank filling manually. This creates a dependency on human attention and increases the possibility of water wastage.

The major problems associated with conventional systems include:

1. **Manual Monitoring:** Users must physically check the tank or estimate its water level.
2. **Water Overflow:** Pumps may continue operating even after the tank reaches maximum capacity.
3. **Electricity Wastage:** Unnecessary pump operation consumes additional electrical energy.
4. **Human Dependency:** The system cannot independently respond to changing water levels.
5. **Lack of Warning Mechanism:** Many traditional arrangements do not provide an audible or visual indication when the tank is full.
6. **Inconvenience:** Users must repeatedly inspect the tank during the filling process.
7. **Resource Management Challenges:** Uncontrolled filling makes efficient household water management difficult.

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Proposed solution: Develop an Arduino-based water-level monitoring and automatic overflow prevention system that continuously measures the water level, generates warnings and switches off the water pump at a predefined maximum level.

3. Aim of the Project

The primary aim of AquaAlert is to design and develop a low-cost automatic water overflow prevention system using Arduino UNO and an ultrasonic sensor.

The project aims to:

- Monitor water levels continuously.
- Detect the water surface without direct sensor contact.
- Provide real-time water-level status.
- Generate an audible alert when the tank approaches its maximum capacity.
- Automatically stop the water pump when the tank becomes full.
- Reduce unnecessary water wastage.
- Minimize manual monitoring.
- Demonstrate the practical application of embedded systems in water conservation.

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4. Objectives

The specific objectives are:

1. To understand the working principles of ultrasonic distance measurement.
2. To interface the HC-SR04 ultrasonic sensor with Arduino UNO.
3. To develop an embedded program for water-level calculation.
4. To establish predefined water-level thresholds.
5. To implement visual and audible warning mechanisms.
6. To control a water pump using a relay module.
7. To evaluate the system under different water-level conditions.
8. To develop an affordable prototype suitable for educational and household applications.
9. To explore the possibility of integrating IoT-based remote monitoring in future versions.

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5. Scope of the Project

The scope of AquaAlert includes the development of a working prototype capable of monitoring water levels and controlling a water pump automatically.

5.1 Functional Scope

The proposed prototype covers:

- Non-contact water-level measurement.
- Continuous monitoring through a microcontroller.
- Four-level water-status identification.
- Visual indication using LEDs.
- Audible alerts using a buzzer.
- Automatic pump switching through a relay module.
- Configurable water-level thresholds.
- Testing and performance evaluation.

5.2 Application Scope

The system can be adapted for:

- Residential overhead water tanks.
- Apartment buildings.
- Schools and colleges.
- Hospitals and healthcare facilities.
- Hotels and restaurants.
- Small commercial buildings.
- Agricultural water storage tanks.
- Industrial water reservoirs.

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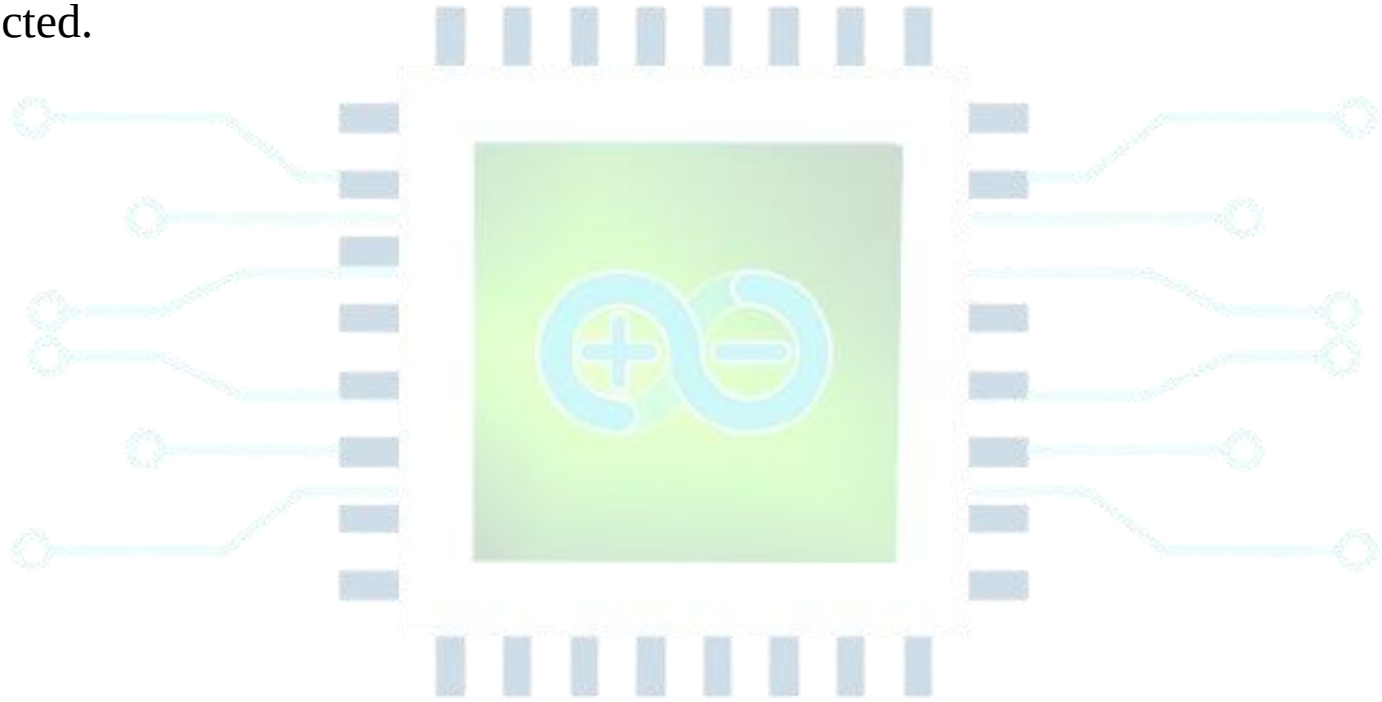
5.3 Project Limitations

The basic version is designed for local monitoring and control. It does not inherently provide mobile notifications, cloud-based monitoring or internet connectivity. These capabilities require additional hardware and software.

The HC-SR04 is intended for indoor prototype use and should not be exposed directly to water, rain or excessive condensation. For permanent outdoor or industrial installation, a suitably protected waterproof sensor should be selected.



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6. Existing System and Proposed System

6.1 Existing System

In a conventional water-filling arrangement, an electric pump transfers water from a ground-level reservoir or supply line to an overhead storage tank.

The user manually operates the pump and checks the water level periodically.

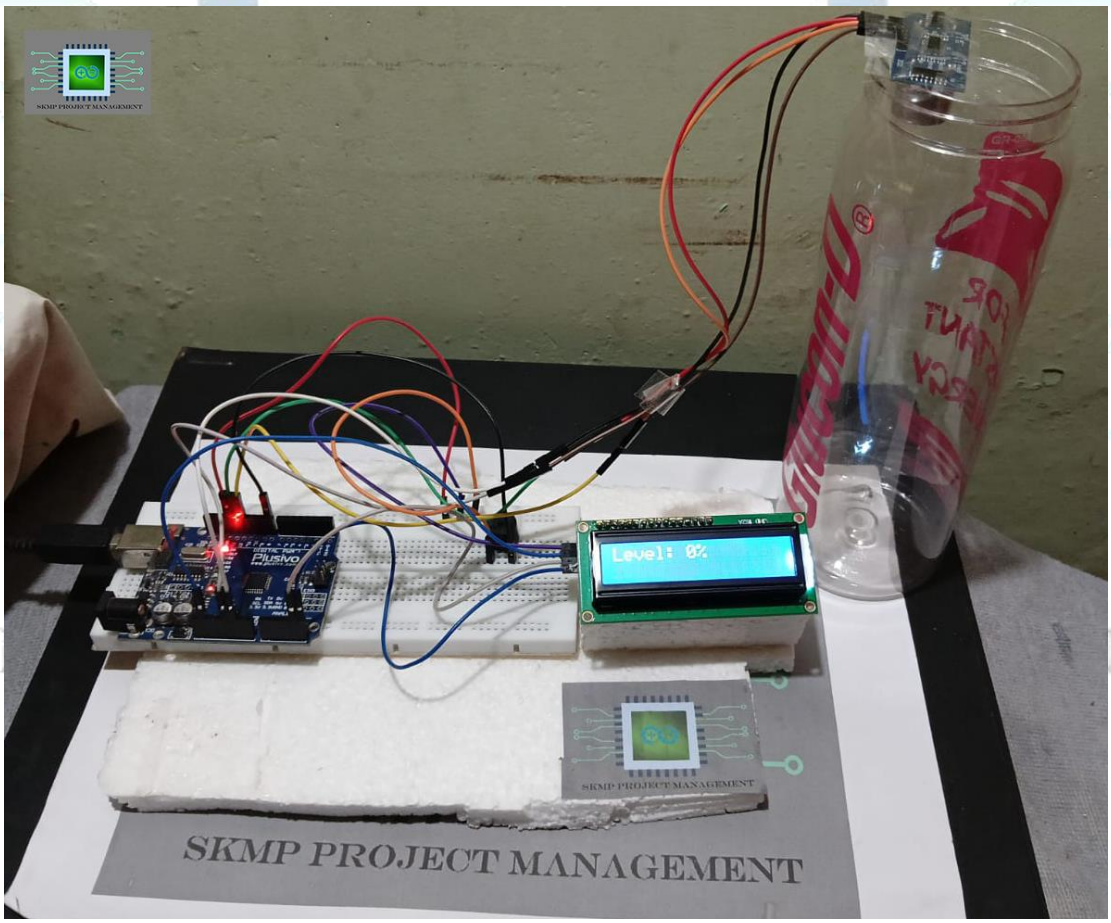

FIG-02

Disadvantages of the existing system:

1. Requires continuous human attention.
2. Does not automatically detect maximum water level.
3. May cause water overflow.
4. Can waste electricity through unnecessary pump operation.
5. Offers limited warning facilities.
6. Is inconvenient when the user is away.

6.2 Proposed System

The proposed AquaAlert system uses an ultrasonic sensor and Arduino UNO to automate water-level monitoring.

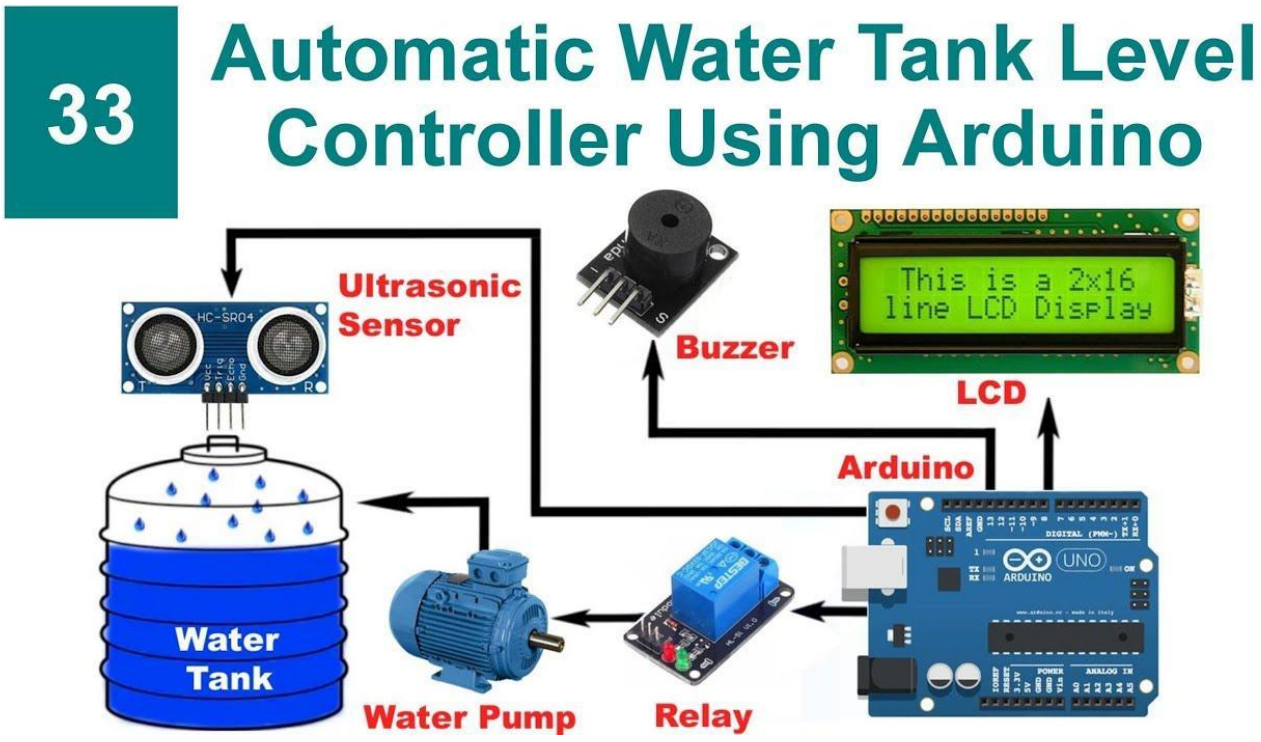

FIG-3

Advantages of the proposed system:

1. Automatic water-level monitoring.
2. Contactless measurement.
3. Audible and visual warnings.
4. Automatic pump cutoff.
5. Reduced human intervention.
6. Low-cost electronic components.
7. Expandable architecture.
8. Improved convenience and water management.

6.3 Comparative Analysis

Feature	Traditional System	AquaAlert
Water-level monitoring	Manual	Automatic
Overflow warning	Usually unavailable	Buzzer and LED
Pump control	Manual	Automatic with relay
Human involvement	High	Low
Contact with water	Not applicable	No sensor contact required
Expandability	Limited	High
Remote monitoring	No	Possible with upgrades
Initial complexity	Low	Moderate

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7. Working Principle of AquaAlert

The fundamental working principle of AquaAlert is based on ultrasonic distance measurement.

An ultrasonic sensor emits high-frequency sound waves that travel through the air and reflect from the water surface. The sensor receives the reflected waves and calculates the distance using the time taken by the sound waves to travel to the surface and return.

The Arduino UNO uses this distance measurement to calculate the approximate water level.

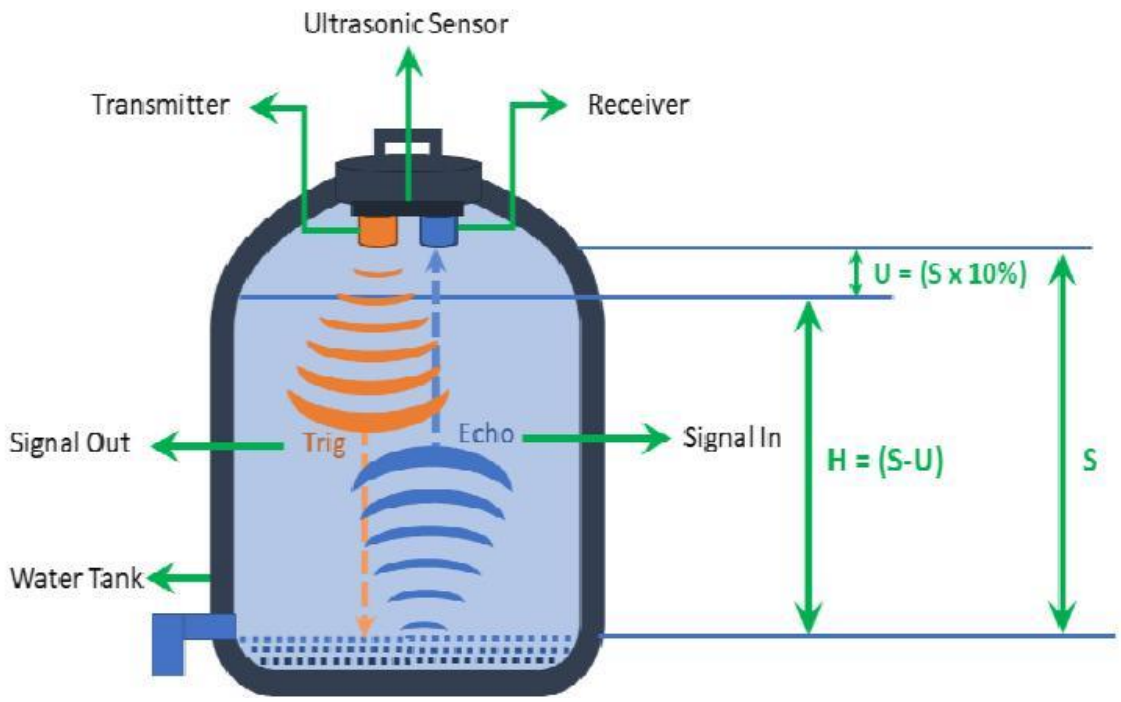

FIG-04

7.1 Ultrasonic Measurement Principle

The HC-SR04 generates an ultrasonic burst at approximately 40 kHz.

The process consists of four stages:

Stage 1: Trigger Signal

The Arduino sends a HIGH pulse of at least 10 microseconds to the TRIG pin.

Stage 2: Ultrasonic Transmission

The sensor transmits eight ultrasonic pulses.

Stage 3: Echo Reception

The sound waves strike the water surface and return to the receiver.

Stage 4: Distance Calculation

The sensor generates an ECHO pulse whose duration represents the travel time of the ultrasonic signal.

The distance is calculated using:

$$D=\frac{T\times V}{2}$$

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Where:

- D = Distance between sensor and water surface.
- T = Total ultrasonic travel time.
- V = Speed of sound in air.
- 2 = Division for the outward and return journey.

For practical calculations using microseconds:

$$D(cm)=\frac{T(\mu s)}{58}$$

The approximate speed of sound used is 340 metres per second.

7.2 Water-Level Calculation

The ultrasonic sensor is installed at a fixed position above the maximum water surface.

Let:

- H = Internal tank height.
- D = Measured distance from sensor to water surface.
- L = Water height inside the tank.

Then:

$$L=H-D$$

The water-level percentage is:

$$Water\ Level(\%)=\frac{H-D}{H}\times100$$

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Example calculation:

Assume the tank has an internal height of 100 cm.

The sensor measures a distance of 25 cm from its mounting reference to the water surface.

Therefore:

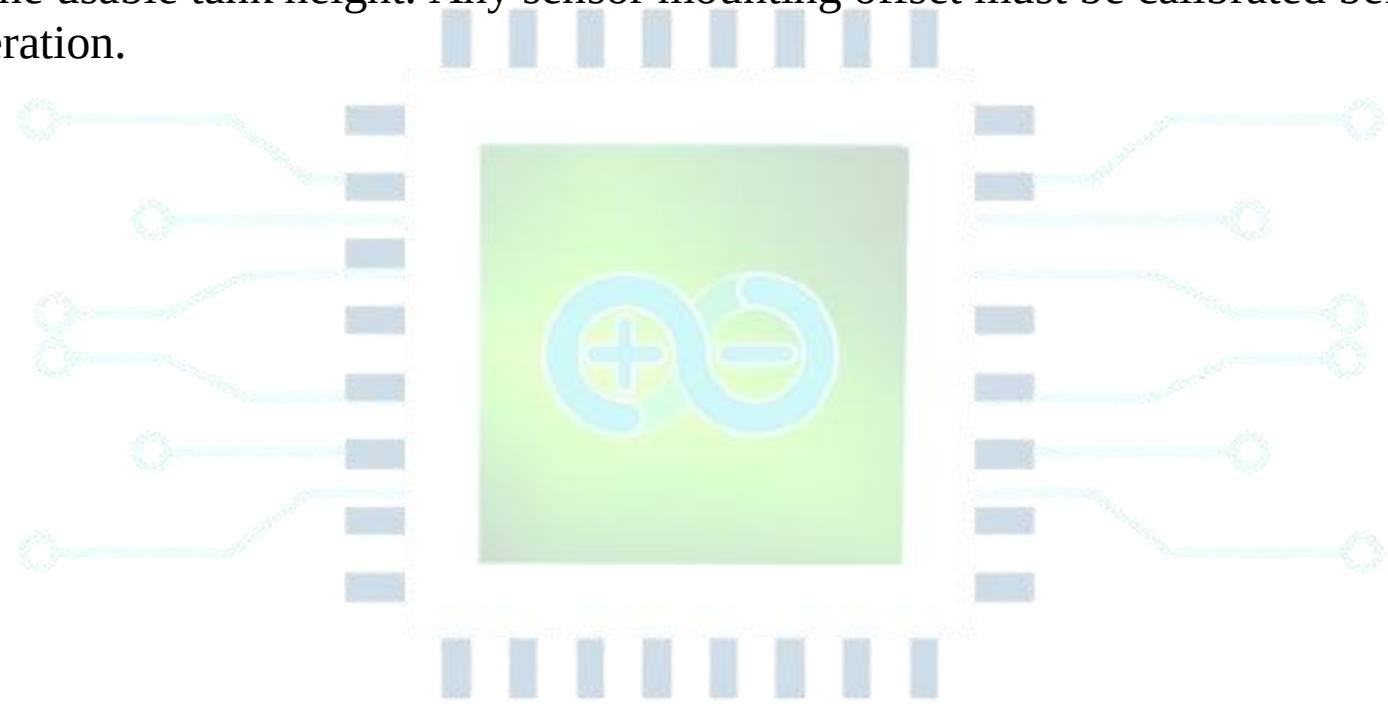
$$ L=100-25=75cm $$

$$ Water\ Level=\frac{75}{100}\times100=75\% $$

Calculated example

The water tank is approximately 75% full.

This calculation assumes that the sensor reference point is aligned with the top of the usable tank height. Any sensor mounting offset must be calibrated before operation.



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8. System Architecture

The AquaAlert system is divided into five major functional units.

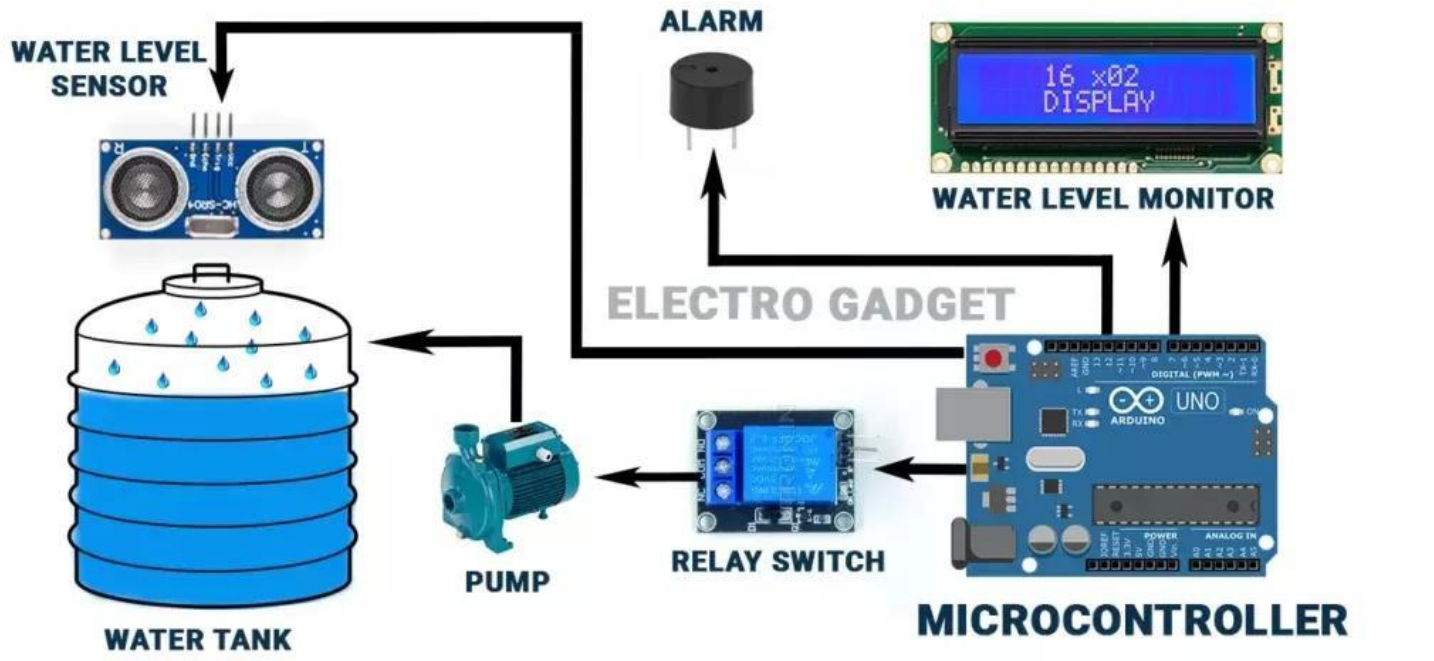

FIG-05

8.1 Input Unit

The HC-SR04 ultrasonic sensor measures the distance between the sensor and the water surface.

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8.2 Processing Unit

The Arduino UNO receives the ECHO signal, calculates the distance and determines the water-level percentage.

8.3 Alert Unit

The alert unit consists of a buzzer and LEDs.

It provides immediate feedback about the current tank condition.

8.4 Control Unit

A relay module acts as an electrically controlled switch. The Arduino sends a control signal to the relay, which switches the pump circuit.

8.5 Power Supply Unit

The power supply provides the appropriate voltage to the Arduino, sensor and other electronic components.

The pump must have a properly rated independent power circuit.

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9. Hardware Components Required

The following components are recommended for constructing the AquaAlert prototype.

No.	Component	Quantity	Purpose
1	Arduino UNO	1	Main controller
2	HC-SR04 ultrasonic sensor	1	Water-level detection
3	5V relay module	1	Pump switching
4	Active buzzer	1	Audible warning
5	Red LED	1	Full-tank indication
6	Yellow LED	1	Warning indication
7	Green LED	1	Normal indication
8	220Ω resistors	3	LED current limiting
9	Breadboard or PCB	1	Circuit assembly
10	Jumper wires	As required	Electrical connections
11	USB cable	1	Programming and power
12	DC power adapter	1	External power supply
13	Water tank or container	1	Demonstration
14	Water pump	1	Water transfer
15	Connecting pipes	As required	Water circulation

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●Arduino UNO Board

- The Arduino UNO is an open-source microcontroller development board based on the ATmega328P microcontroller. It is widely used in electronics, robotics, automation, and embedded system projects. It allows users to connect various electronic components, such as sensors, LEDs, motors, displays, and other devices, to develop interactive electronic applications.
- The Arduino UNO board has 14 digital input/output pins, of which 6 can be used as PWM outputs, 6 analog input pins, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.
- It can be programmed using the Arduino IDE with a simple programming language based on C and C++. The board receives instructions from the program and controls connected devices according to the given commands.

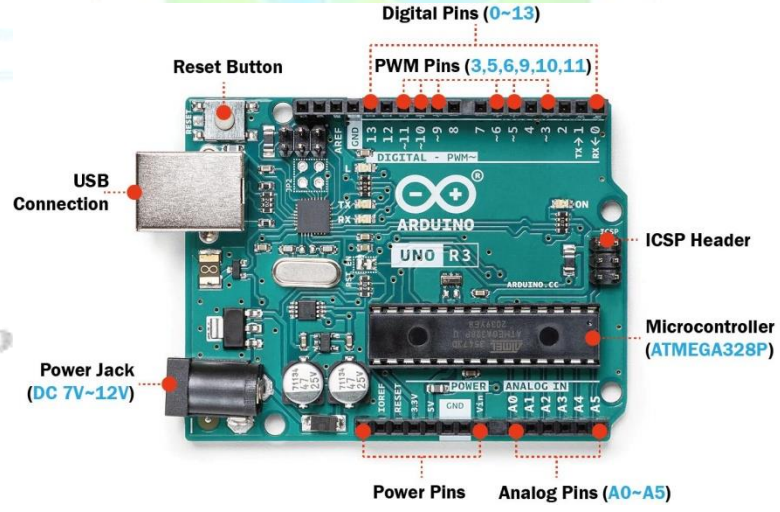

Fig -06

• *HC-SR04 Ultrasonic Sensor*

- The HC-SR04 Ultrasonic Sensor is an electronic distance-measuring sensor that uses ultrasonic sound waves to detect objects and measure the distance between the sensor and an object. It operates by transmitting high-frequency ultrasonic waves (approximately 40 kHz) and receiving the reflected waves (echo) from an object.
- The sensor consists of two main ultrasonic transducers: one acts as a transmitter (Trig), which sends ultrasonic waves, and the other acts as a receiver (Echo), which detects the reflected waves. The distance is calculated by measuring the time taken for the ultrasonic waves to travel to the object and return to the sensor.
- The HC-SR04 sensor is commonly used with microcontrollers such as Arduino UNO for distance measurement, obstacle detection, robotics, and automatic control systems.



Fig -07

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• . Resistor 220ohm

- A 220-ohm (220Ω) Resistor is a passive electronic component used to limit or control the flow of electric current in an electronic circuit. It provides a specific resistance of 220 ohms and helps protect sensitive electronic components from excessive current that may cause damage.

- In Arduino-based projects, a 220Ω resistor is commonly used to limit current flowing through LEDs and other electronic components. It helps maintain safe operating conditions and improves the reliability of the electronic circuit.
- The resistor works according to Ohm's Law, which describes the relationship between voltage, current, and resistance.

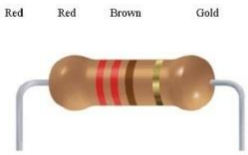

FIG-8

• Breadboard

- A Breadboard is a reusable electronic prototyping board used to build, test, and develop electronic circuits without soldering. It provides a convenient platform for connecting different electronic components using jumper wires.
- A breadboard contains several small holes arranged in rows and columns, which are internally connected through conductive metal clips. These connections allow electronic components such as resistors, LEDs, sensors, and microcontrollers to be connected easily.
- In Arduino-based projects, a breadboard is commonly used to connect components such as the Arduino UNO, HC-SR04 ultrasonic sensor, SG90

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servo motor, and resistors. It helps users assemble and modify circuits quickly during the testing and development process.

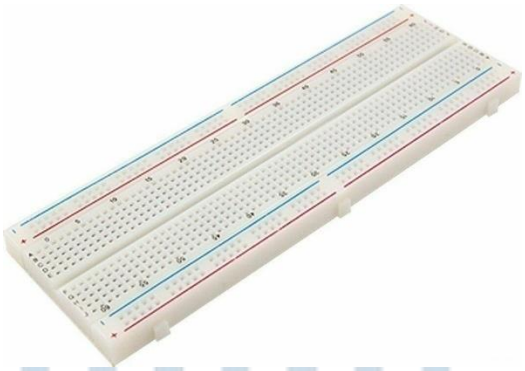

Fig-09

• Servo Motor (SG90)

- The SG90 Servo Motor is a small, lightweight, and compact rotary actuator used to control angular position with high precision. It is commonly used in robotics, automation, and Arduino-based electronic projects. The SG90 is a micro servo motor that can rotate approximately 180 degrees, allowing accurate control of its shaft position.
- The SG90 servo motor consists of a DC motor, a gear mechanism, a position feedback system, and an electronic control circuit. It operates based on Pulse Width Modulation (PWM) signals received from a microcontroller such as the Arduino UNO. By varying the width of the control pulse, the motor shaft can be positioned at a desired angle.
- The SG90 servo motor is widely used in projects requiring controlled movement, such as robotic arms, automatic doors, obstacle-avoiding robots, and digital measurement systems.

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Fig -10

• *Jumper Wires*

- Jumper Wires are electrical connecting wires used to establish temporary connections between different electronic components, sensors, and microcontroller boards. They are commonly used in electronics prototyping, Arduino projects, and embedded system development.
- Jumper wires are used to connect components such as Arduino UNO, ultrasonic sensors, servo motors, breadboards, LEDs, and other electronic modules without requiring soldering. They provide an easy and flexible method of transferring electrical power and signals between different components.
- Jumper wires are generally available in three types: Male-to-Male, Male-to-Female, and Female-to-Female. They are commonly insulated with different colours to help identify power supply, ground, and signal connections.

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Fig -11

• *LED*

- An LED (Light Emitting Diode) is a semiconductor electronic component that produces light when an electric current flows through it in the forward direction. It is a type of diode that converts electrical energy into light energy through a process known as electroluminescence.
- LEDs are widely used in electronic circuits as visual indicators to display the operating status of a system. They are available in different colours, such as red, green, blue, yellow, and white.
- In Arduino-based projects, LEDs are commonly connected to digital output pins to indicate different operating conditions. The Arduino UNO controls the LED by switching it ON or OFF according to the programmed instructions.

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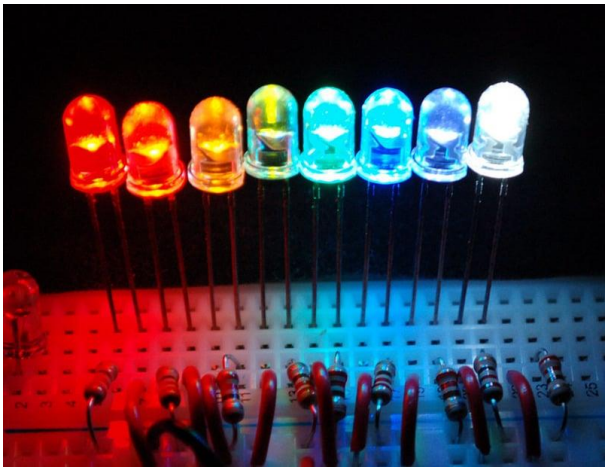

Fig-12

• *USB CABLE*

- A USB (Universal Serial Bus) Cable is an electrical communication cable used to establish a connection between electronic devices for data transmission and power supply. In Arduino-based projects, a USB cable is commonly used to connect the Arduino UNO board to a computer or laptop for programming, uploading code, and supplying electrical power.
- The USB cable allows communication between the computer and the Arduino UNO microcontroller. It transfers program instructions from the Arduino IDE to the board and also supports serial communication for monitoring sensor readings and debugging the project.
- The Arduino UNO R3 commonly uses a USB Type-B cable for connecting to a computer. One end of the cable connects to the Arduino board, while the other end connects to the computer's USB port.



Fig -13

• *Power Supply (9V Battery with connector)*

- A 9V Battery with Connector is a portable DC power source used to provide electrical energy to electronic circuits and microcontroller-based projects. It consists of a 9V battery and a battery connector that allows easy connection to the power input terminals of an electronic circuit or Arduino UNO board.
- In Arduino-based projects, the 9V battery is commonly connected to the Arduino UNO through its DC barrel jack using a 9V battery snap connector with a suitable DC plug. It supplies electrical power to the microcontroller and connected electronic components when a computer or external power adapter is not available.
- The Arduino UNO has an onboard voltage regulator that converts the input voltage into a suitable operating voltage for the board. The 9V battery provides portability and makes the project suitable for standalone operation.

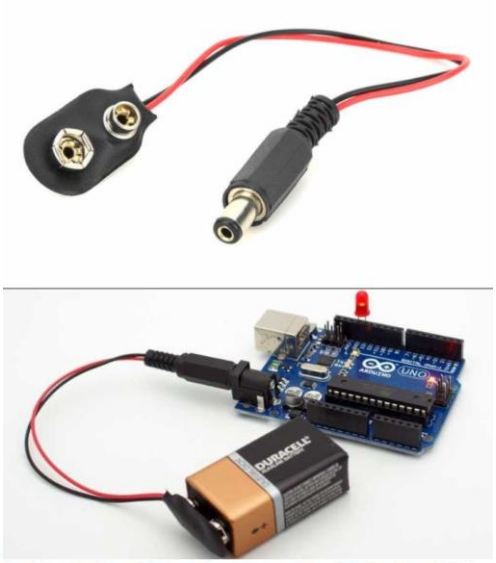

Fig -`11

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10. Circuit Diagram and Hardware Connections

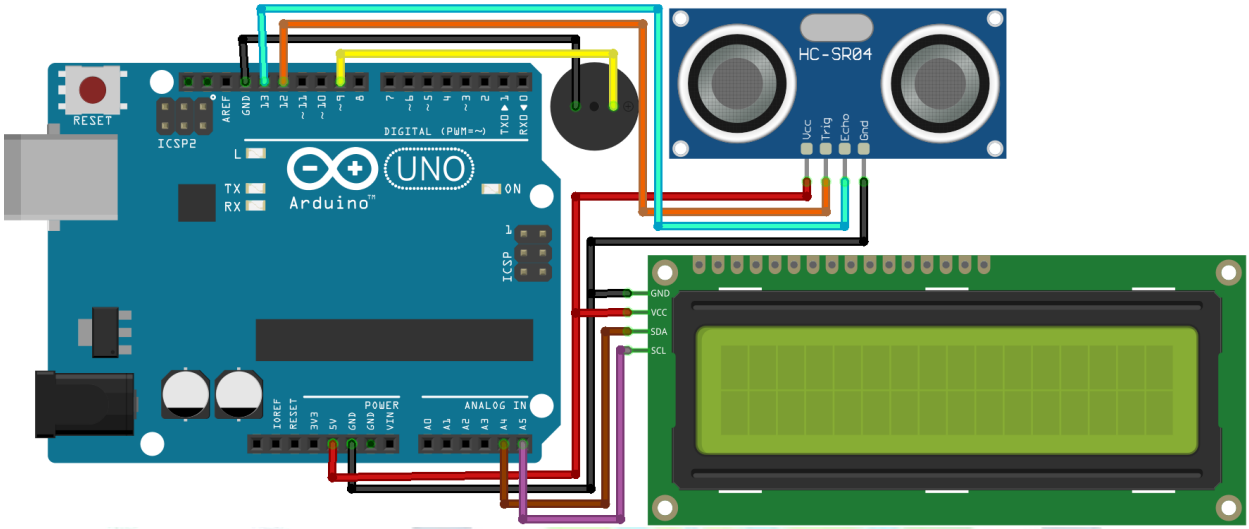

FIG-15

The circuit connects the ultrasonic sensor, Arduino UNO, buzzer, LED indicators and relay module.

10.1 Pin Connection Table

Component	Component Pin	Arduino UNO Pin
HC-SR04	VCC	5V
HC-SR04	GND	GND
HC-SR04	TRIG	D9
HC-SR04	ECHO	D10

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Relay module	VCC	5V
Relay module	GND	GND
Relay module	IN	D8
Buzzer	Positive	D7
Buzzer	Negative	GND
Green LED	Anode through 220Ω	D4
Yellow LED	Anode through 220Ω	D5
Red LED	Anode through 220Ω	D6
LEDs	Cathodes	GND

Important: The connections above assume a 5V-compatible relay module and a low-current active buzzer. Check the actual module pinout and electrical requirements before connecting.

10.2 Relay and Water Pump Connection

The relay contains three main switching terminals:

- COM – Common terminal.
- NO – Normally Open terminal.
- NC – Normally Closed terminal.

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For the normal automatic pump-control arrangement, the COM and NO contacts can be used so that the pump remains off when the relay is not energized.

When the Arduino detects that the tank is not full, it energizes the relay to run the pump. When the maximum water level is reached, the Arduino de-energizes the relay and stops the pump.

The actual contact arrangement must be verified against the selected relay module.

11. Software Requirements

The software component controls the operation of the AquaAlert hardware.

11.1 Arduino IDE

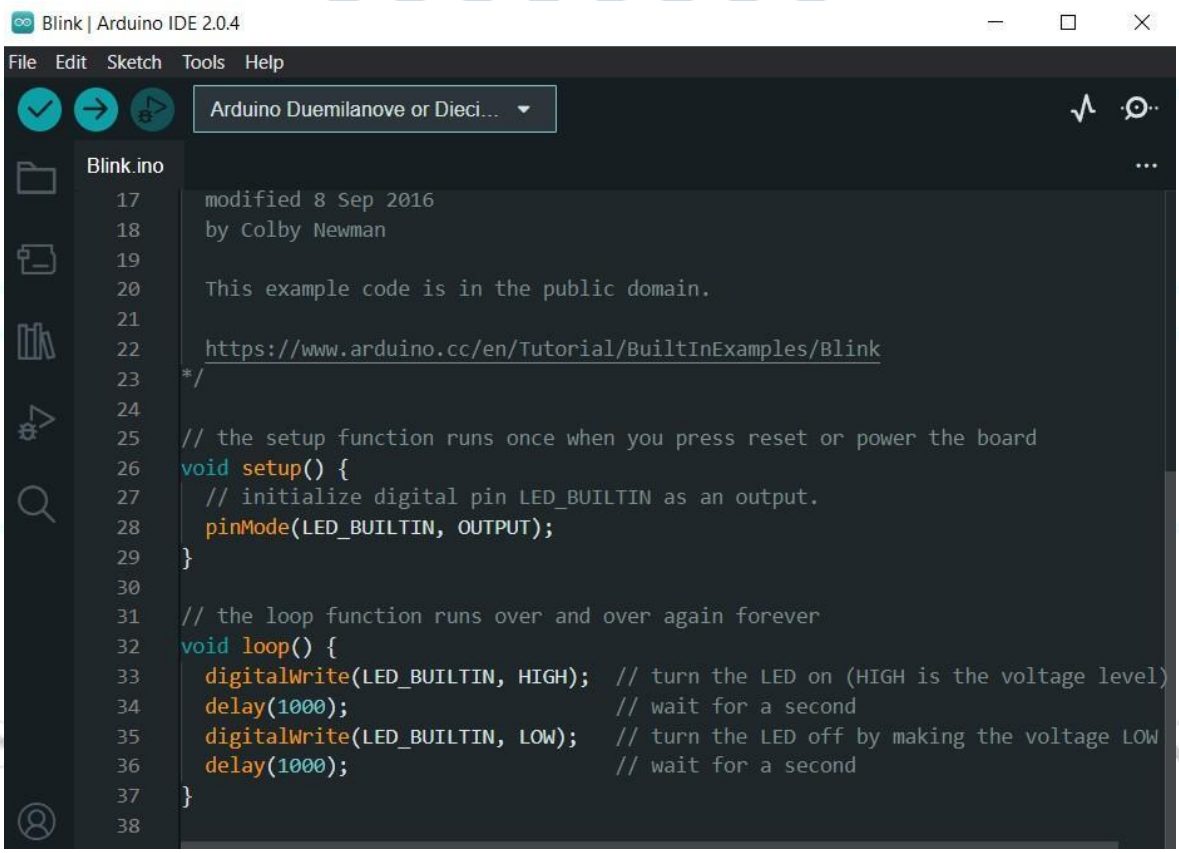

FIG-16

Arduino IDE is the software environment used to write, compile and upload the program to the Arduino UNO.

Software requirements:

1. Arduino IDE.
2. Arduino UNO board package.
3. USB communication driver, if required.
4. Arduino C/C++ programming language.
5. Serial Monitor for observing sensor measurements.

11.2 Software Functions

The program performs the following tasks:

- Initializes the sensor and output pins.
- Sends ultrasonic trigger pulses.
- Measures the ECHO pulse duration.
- Calculates the distance.
- Calculates water-level percentage.
- Compares the water level with threshold values.
- Controls LEDs and buzzer.
- Controls the pump through the relay.
- Displays measurements through the Serial Monitor.
- Detects invalid sensor readings and enters a safe pump-off condition.

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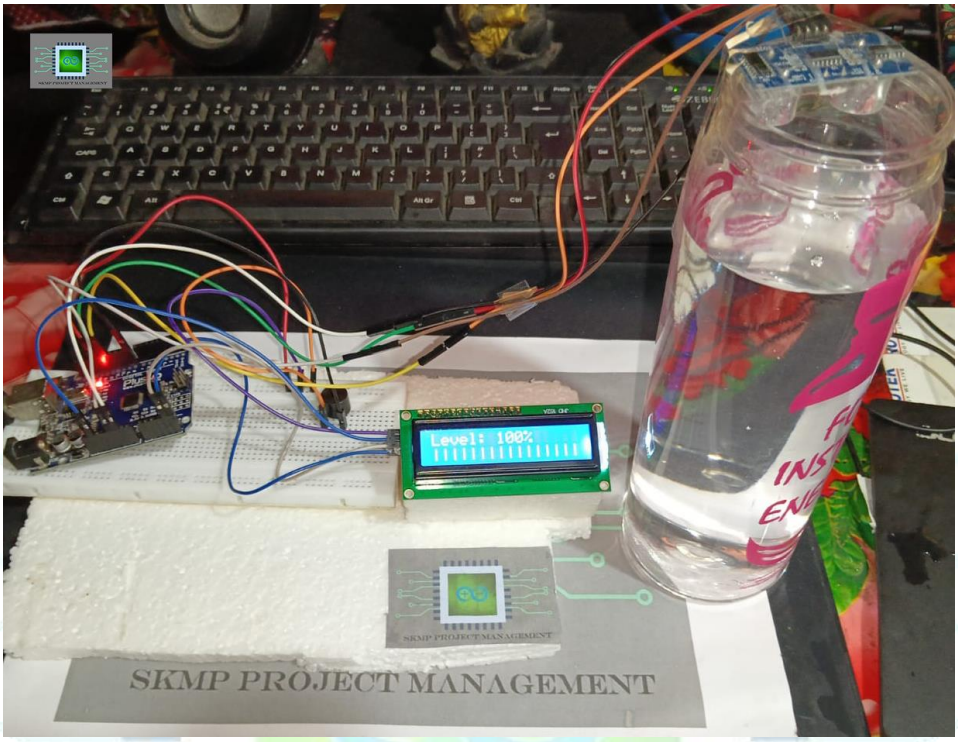
12. Water-Level Detection Logic



The system divides the tank into four operating conditions.

The following thresholds are example values and can be modified according to the tank's dimensions and requirements.

Water level	Condition	LED	Buzzer	Pump
0–49%	Low/normal	Green	OFF	ON
50–79%	Medium	Green	OFF	ON
80–94%	Warning	Yellow	Intermittent	ON
95–100%	Tank full	Red	ON	OFF

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A practical design should use a cutoff threshold below the physical brim. This leaves a safety margin to account for pump stopping delay, water already travelling through the pipe and sensor uncertainty.

12.1 Flowchart

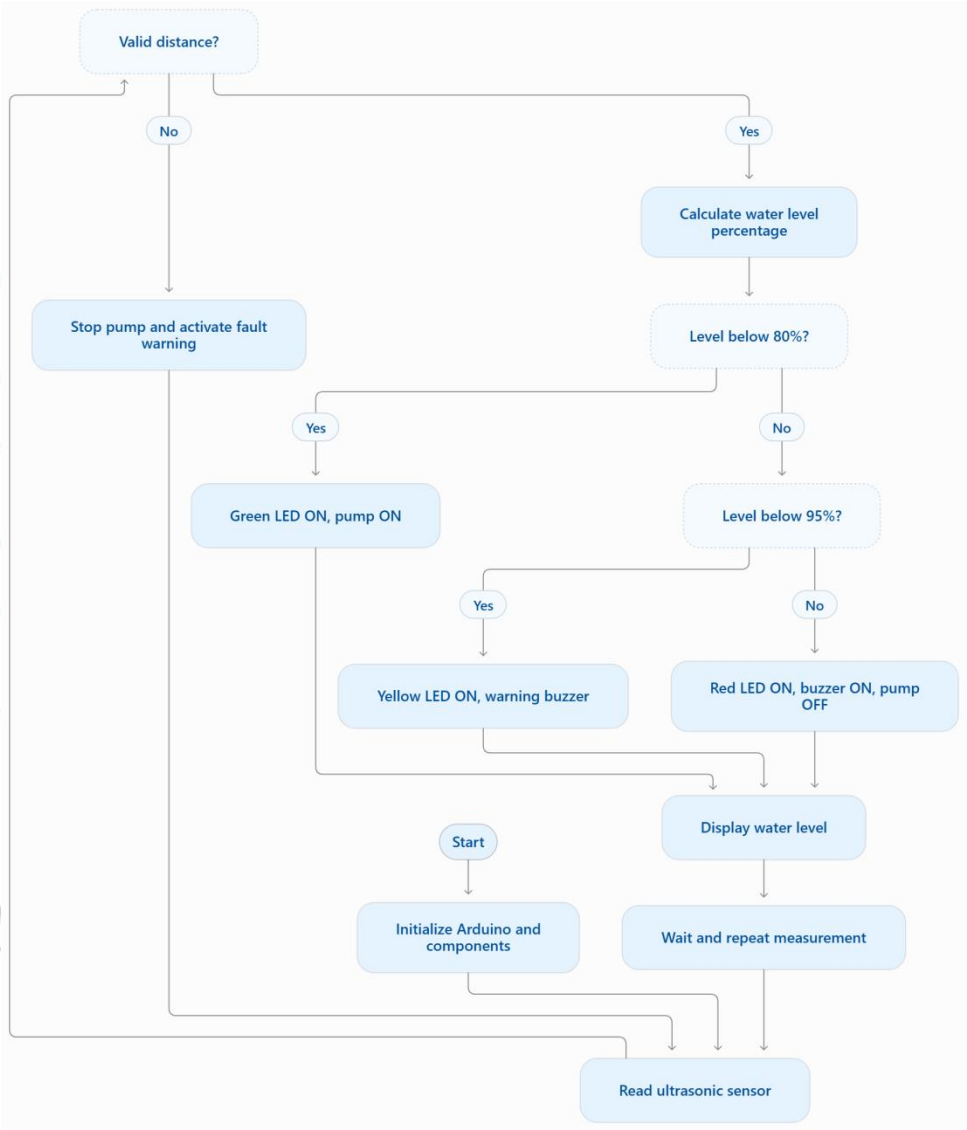

FIG-17

13. Arduino Source Code

The following program provides the primary implementation of AquaAlert.

The code uses:

- Arduino UNO.
- HC-SR04 ultrasonic sensor.
- One-channel relay module.
- Three LED indicators.
- Active buzzer.

The relay logic below assumes an active-HIGH relay module: HIGH energizes the relay and LOW releases it. If the selected module is active-LOW, reverse the relay control logic.

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h> // Include the I2C library for the LCD
#include <NewPing.h>           // Library for Ultrasonic sensor

// Define pins for the ultrasonic sensor
#define trigPin 12
#define echoPin 13

// Buzzer pin
#define buzzer 8

// Maximum distance of the water tank (in cm) and the distance threshold for the buzzer
const int maxTankDepth = 100; // Set this to the height of your water tank
const int buzzerThreshold = 80; // Buzzer should activate when the tank is 90% full

// LCD setup for I2C (address 0x27)
LiquidCrystal_I2C lcd(0x27, 16, 2); // Update with the correct address if different

// Setup NewPing library (trig pin, echo pin, max distance)
NewPing sonar(trigPin, echoPin, maxTankDepth);
```

```
void setup() {
  // Initialize the LCD with columns, rows, and character size
  lcd.begin(16, 2); // Adjust if necessary
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("Water Level");
  lcd.setCursor(0, 1);
  lcd.print("Measurement");

  delay(2000);  // Wait 2 seconds before starting measurement

  // Set up the pin modes
  pinMode(buzzer, OUTPUT);
  digitalWrite(buzzer, LOW); // Ensure buzzer is off at the start

  // Begin serial communication (optional, for debugging)
  Serial.begin(9600);
}

void loop() {
  // Get the distance measured by the ultrasonic sensor
  int distance = sonar.ping_cm();

  // Calculate the water level as a percentage (0% = empty, 100% = full)
  int waterLevel = map(distance, 0, maxTankDepth, 100, 0);

  // Ensure the water level is within a valid range (0 to 100%)
  waterLevel = constrain(waterLevel, 0, 100);

  // Print the water level to the Serial Monitor for debugging
  Serial.print("Distance: ");
  Serial.print(distance);
  Serial.print(" cm, Water Level: ");
  Serial.print(waterLevel);
  Serial.println(" %");

  // Display the water level on the LCD
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Water Level: ");
  lcd.print(waterLevel);
  lcd.print("%");

  // Display a simple bar indicator for the water level
```

```
  lcd.setCursor(0, 1);
  int bars = map(waterLevel, 0, 100, 0, 16); // 16 character spaces on the LCD
  for (int i = 0; i < bars; i++) {
    lcd.print("|");
  }

  // Check if the water level is 90% or higher, and sound the buzzer for 3 seconds
  if (waterLevel >= buzzerThreshold) {
    digitalWrite(buzzer, HIGH);  // Activate buzzer
    delay(3000);                 // Keep it on for 3 seconds
    digitalWrite(buzzer, LOW);   // Turn off buzzer
  }

  // Wait before taking the next measurement (adjust as needed)
  delay(1000);
}
```

13.1 Explanation of the Program

Step 1: Pin Configuration

The program assigns Arduino pins to the ultrasonic sensor, LEDs, buzzer and relay.

Step 2: Sensor Initialization

The TRIG pin is configured as an output and the ECHO pin as an input.

Step 3: Distance Measurement

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The Arduino sends a 10-microsecond trigger pulse and measures the returned echo duration using `pulseIn()`.

Step 4: Water-Level Calculation

The measured distance is subtracted from the calibrated tank height.

Step 5: Threshold Comparison

The calculated water-level percentage is compared with the warning and full-level thresholds.

Step 6: Output Control

The Arduino activates the appropriate LED, buzzer and relay.

Step 7: Continuous Monitoring

The loop repeats so that the system continuously observes changes in the water level.

13.2 Important Implementation Improvements

The example code is suitable for initial demonstration, but a production-quality controller should also include:

- Non-blocking buzzer operation.
- Hysteresis to prevent relay switching near a threshold.
- Independent high-level float-switch protection.
- Sensor plausibility checks across multiple readings.
- A maximum pump-running timer.
- Manual override and maintenance mode.
- Proper startup and power-failure handling.

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The full-tank condition should remain latched until the water level falls below a separately configured reset threshold, if the pump is to restart automatically. This prevents rapid ON/OFF switching.

14. Construction and Implementation Procedure

The construction of AquaAlert involves hardware assembly, software development, sensor calibration and system testing.

Step 1: Component Collection

Collect all required components, including Arduino UNO, HC-SR04, relay module, buzzer, LEDs, resistors, jumper wires and a suitable water container.

Step 2: Arduino Setup

Connect the Arduino UNO to a computer using a USB cable. Install Arduino IDE and select the correct board and communication port.

Step 3: Ultrasonic Sensor Installation

Mount the HC-SR04 sensor above the water tank with its transmitter and receiver facing the water surface.

The sensor should be positioned vertically and should not be exposed to splashing water.

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Step 4: Circuit Assembly

Connect the ultrasonic sensor, LEDs, buzzer and relay module according to the connection table.

Check all connections before applying power.

Step 5: Software Development

Write or copy the AquaAlert program into Arduino IDE.

Compile the program and correct any errors.

Step 6: Program Upload

Upload the compiled program to Arduino UNO.

Open the Serial Monitor and set the baud rate to 9600.

Step 7: Sensor Calibration

Measure the actual distance between the sensor mounting reference and the empty and maximum usable water surfaces.

Enter the correct calibrated tank height in the program.

Step 8: Functional Testing

Gradually increase the water level and observe the sensor readings, LED indications, buzzer and relay operation.

Step 9: Pump Integration

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After validating the low-voltage prototype, integrate a suitably rated pump-control circuit with appropriate electrical protection.

Step 10: Final Demonstration

Demonstrate automatic monitoring, high-level warning and pump shutdown.

15. System Operation

The operational sequence of AquaAlert can be explained as follows:

1. The system receives power.
2. Arduino UNO initializes the connected components.
3. The ultrasonic sensor measures the distance to the water surface.
4. The Arduino calculates the water-level percentage.
5. The system identifies the current water-level condition.
6. The appropriate LED is activated.
7. The buzzer generates a warning when the configured warning level is reached.
8. When the tank reaches the full-level threshold, the relay switches off the water pump.
9. The system continues monitoring the water level.
10. The pump can restart when the water level falls below the configured restart threshold, provided automatic restart is enabled.

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16. Testing and Performance Evaluation

Testing is an essential stage of the AquaAlert development process. It verifies whether the hardware and software operate according to the intended design.

The following tests should be performed before considering the prototype complete.

16.1 Unit Testing

Test	Component	Expected result
1	Arduino UNO	Board starts and executes the program
2	Ultrasonic sensor	Produces distance readings
3	Green LED	Turns on in normal condition
4	Yellow LED	Turns on during warning condition
5	Red LED	Turns on at full level
6	Buzzer	Generates an audible alert
7	Relay	Changes switching state correctly
8	Power supply	Provides stable operating voltage

16.2 Integration Testing

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Integration testing verifies that all components work together.

For example, when the ultrasonic sensor detects a water level of 96%, the Arduino should identify the full condition, activate the red LED, activate the buzzer and switch off the pump.

16.3 Functional Testing

Test condition	Simulated water level	Expected operation
Test 1	10%	Green LED, pump ON
Test 2	45%	Green LED, pump ON
Test 3	65%	Green LED, pump ON
Test 4	82%	Yellow LED, warning
Test 5	90%	Yellow LED, warning
Test 6	96%	Red LED, pump OFF
Test 7	Invalid sensor reading	Pump OFF, fault warning

These are expected test conditions, not claimed experimental measurements. Actual results must be recorded after testing the physical prototype.

16.4 Sensor Accuracy Testing

Sensor accuracy can be evaluated by comparing the ultrasonic sensor reading with a manually measured reference distance.

The percentage error is:

$$Error(\%)=\frac{|D_m-D_r|}{D_r}\times100$$

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Where:

- D_m = Measured distance.
- D_r = Reference distance.

For example, if the reference distance is 50 cm and the sensor reports 51 cm:

$$Error=\frac{|51-50|}{50}\times100$$

\[Error=2\% \]

This is an illustrative calculation, not an actual measured result.

17. Advantages of AquaAlert

17.1 Water Conservation

The automatic cutoff mechanism helps prevent unnecessary water overflow.

17.2 Reduced Human Intervention

Users do not need to continuously monitor the tank during the filling process.

17.3 Affordable Implementation

The system uses widely available electronic components and an inexpensive microcontroller.

17.4 Contactless Measurement

The ultrasonic sensor measures the water surface without requiring direct contact with water.

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17.5 Audible and Visual Alerts

Different warning indicators help users identify the tank condition.

17.6 Automation

The relay-controlled pump can operate automatically according to programmed water-level thresholds.

17.7 Educational Value

The project provides practical learning opportunities in electronics, programming, sensor interfacing and automation.

17.8 Expandability

Additional modules can be integrated to support remote monitoring and advanced control.

18. Safety and Reliability Considerations

Safety is especially important because the project combines water, electrical components and pump-control equipment.

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The following precautions are recommended:

- Place Arduino and electronic components inside a dry, protected enclosure.
- Keep low-voltage control wiring away from water.
- Use a separate, correctly rated power circuit for the pump.
- Provide overload and short-circuit protection.
- Install an independent high-level float switch as a backup cutoff.

- Use a waterproof industrial-grade sensor for permanent tank installations.
- Implement a maximum pump-running time.
- Stop the pump when sensor readings become invalid.
- Verify relay operation before connecting a real pump.
- Test the system under power interruption and restoration conditions.

Critical engineering recommendation: The software-controlled ultrasonic sensor should not be the only protection against flooding. A separate hardwired high-level cutoff is strongly recommended, especially for unattended installations.

19. Applications of AquaAlert

19.1 Residential Buildings

AquaAlert can help homeowners prevent unnecessary water overflow from rooftop tanks.

19.2 Apartment Complexes

The system can be adapted to monitor individual or shared water storage tanks.

19.3 Educational Institutions

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Schools and colleges can use the system to improve water management and demonstrate practical engineering concepts.

19.4 Hospitals

Water storage tanks in healthcare facilities require reliable monitoring. A suitably engineered and redundant version of AquaAlert could support water management.

19.5 Commercial Establishments

Hotels, restaurants and office buildings can use automatic water-level monitoring to reduce manual supervision.

19.6 Agricultural Applications

The system can be adapted to monitor storage tanks used for irrigation and agricultural water distribution.

19.7 Industrial Applications

With appropriate industrial sensors, control equipment and safety systems, the design concept can be extended to industrial water reservoirs.

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20. Environmental Impact

Water conservation is an important part of sustainable development.

Unnecessary water overflow represents a loss of treated or pumped water and may also increase electricity consumption.

AquaAlert contributes to environmental sustainability through the following mechanisms:

- Helps reduce unnecessary water wastage.
- Encourages responsible water usage.
- Supports efficient water storage.
- Can reduce unnecessary pump operation.
- Promotes awareness of water conservation.
- Demonstrates practical environmental applications of electronics.

The project supports the broader objectives of sustainable water management, particularly Sustainable Development Goal 6 (Clean Water and Sanitation).

It should be understood that AquaAlert does not create additional water resources; it helps manage stored water more efficiently.

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21. Future Scope

AquaAlert has considerable potential for improvement. The basic Arduino-based system can be extended into a connected smart water management platform.

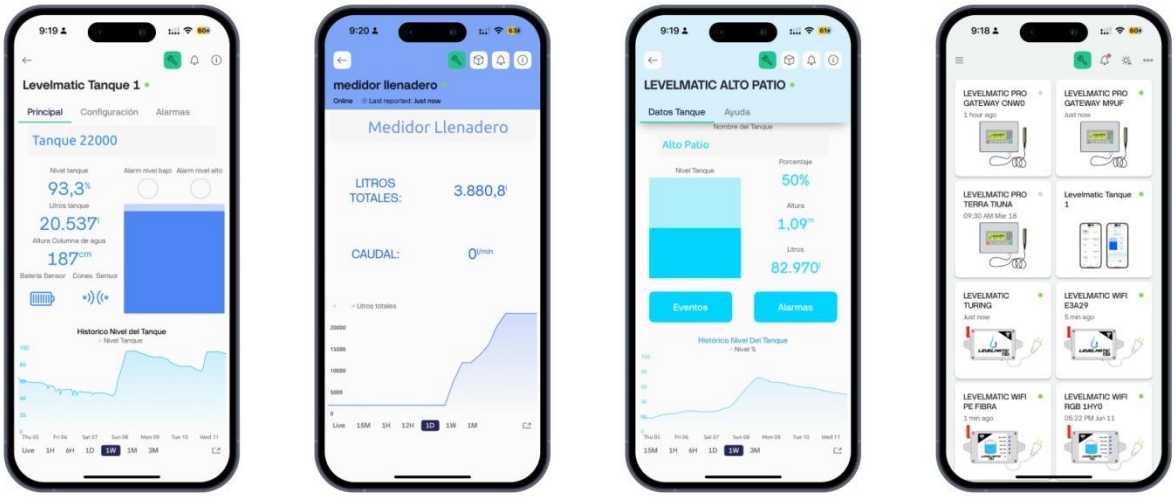
21.1 IoT Integration



An ESP8266 or ESP32 module can be added to provide wireless communication.

The system could send water-level information to a cloud server through Wi-Fi.

21.2 Mobile Application



A mobile application could display:

- Current water-level percentage.
- Estimated water volume.
- Pump ON/OFF status.
- Tank-full notifications.
- Low-water notifications.
- Historical water-level records.

21.3 SMS and Notification Alerts

A GSM module or internet-connected notification service could send alerts to users when the water level reaches a specified threshold.

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21.4 Cloud-Based Monitoring

Cloud storage could maintain historical water-level records and provide access from multiple devices.

21.5 Multiple Tank Monitoring

A future version could monitor multiple tanks through a central controller or network of distributed sensors.

21.6 Water Consumption Analysis

By monitoring the water level over time and considering tank geometry, the system could estimate daily water consumption and identify unusual consumption patterns.

21.7 Solar-Powered Operation

A solar panel and suitable battery-management circuit could provide power for installations where conventional electrical power is unreliable.

21.8 AI-Based Water Usage Prediction

Historical consumption data could be analysed to estimate future water requirements and improve pump scheduling.

21.9 Industrial-Grade Waterproof Sensor

An industrial ultrasonic sensor with appropriate ingress protection could replace the basic HC-SR04 to improve suitability for long-term installations.

21.10 Smart Building Integration

Aqua Alert could eventually become part of a building-management system that coordinates water storage, pump operation, energy consumption and maintenance alerts.

SMART PROJECT MANAGEMENT

Conclusion

AquaAlert: Overflow Prevention System with Arduino is an embedded-system-based project developed to address the common problem of water overflow in storage tanks.

The project demonstrates the integration of an ultrasonic sensor, Arduino UNO, relay module, buzzer and LED indicators to create an automated water-level monitoring and control system.

The ultrasonic sensor measures the distance between the sensor and the water surface. The Arduino processes the measurement, calculates the water-level percentage and determines the appropriate operating condition.

When the water reaches a predefined warning threshold, the system activates an audible and visual alert. When the tank reaches its maximum configured filling level, the relay-controlled pump is switched off to prevent further filling.

The project provides several practical benefits, including reduced manual intervention, improved convenience, potential water conservation and an affordable approach to basic automation.

Furthermore, the modular architecture provides opportunities for future development through IoT connectivity, mobile applications, cloud monitoring, multiple-tank management and intelligent water-consumption analysis.

Although the basic prototype has certain limitations related to environmental interference, sensor accuracy and electrical reliability, these can be addressed through appropriate sensor selection, calibration, fault detection and independent safety mechanisms.

In conclusion, AquaAlert demonstrates how electronics, programming and automation can be combined to develop a practical solution to a real-world environmental problem. It also highlights the importance of using modern technology to encourage responsible water management and sustainable resource utilization.

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References

The following technical references provide the foundation for the hardware specifications and operating principles discussed in this report.

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Arduino UNO Rev3 – Official Technical Documentation.

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HC-SR04 Module Datasheet.

5. Arduino Documentation – Programming Reference.
Arduino Documentation Portal.

6. Arduino Language Reference.
Arduino Programming Language Reference.

7. United Nations Sustainable Development Goals – Goal 6: Clean Water and Sanitation.
United Nations SDG 6

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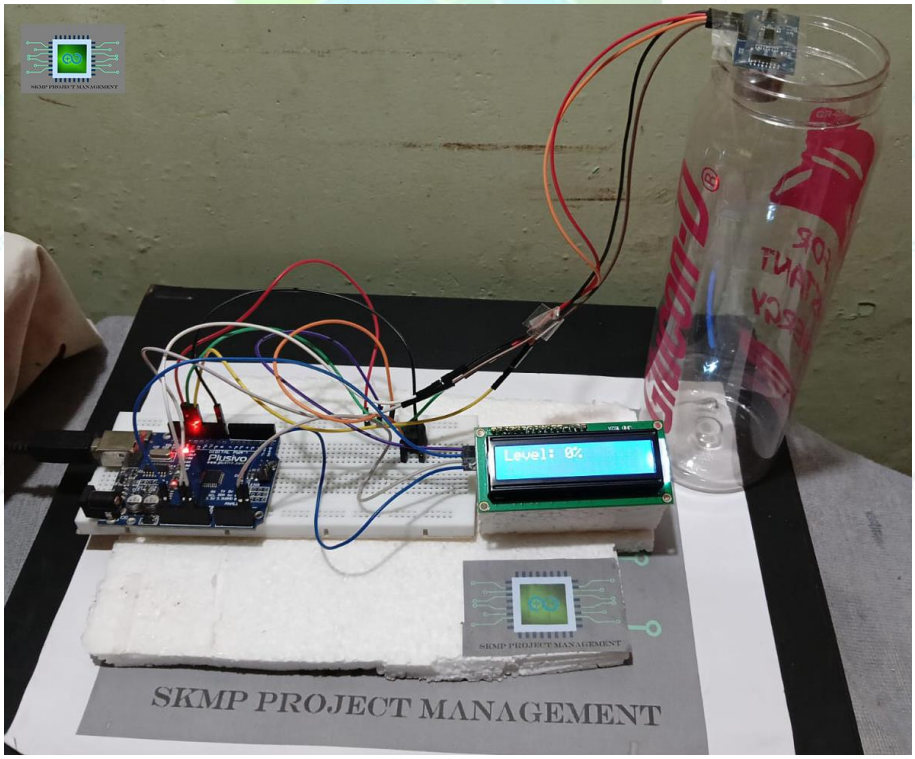
PROJECT LINK

Website lnk:-https://skmp-project-management.vercel.app/

Google Drive Link:-
https://drive.google.com/drive/folders/1WavcFCshPjizwoXr891lxCos4SuS9YVp?usp=sharing

VideoLink:- https://youtu.be/LmR_J-YCVYc?si=yhBtRMieK5V9e6q_







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