Automated Water Level Monitoring and Control System with OLED Display

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1. Introduction to Water Level Monitoring and Control Systems:

Water is a critical resource in both residential and industrial environments, making its monitoring and control essential. The need for automated systems to manage water levels is paramount to ensure efficiency, prevent overflow, and avoid shortages. Traditional manual methods are prone to errors and inefficiencies. Therefore, automation provides a reliable, consistent, and scalable solution to water management.

2. Project Overview:

The 'Automated Water Level Monitoring and Control System with OLED Display' is designed to monitor the water level in a tank, provide real-time feedback via an OLED display, and automate the control of water flow using a relay-controlled water pump. The system alerts users with a buzzer when the water level is critically low or at risk of overflowing. The automation can operate in both manual and automatic modes, offering flexibility in operation. LEDs are used to visually indicate the water level, and a mute function is provided to temporarily silence the buzzer.

3. System Architecture:

This project integrates an ultrasonic sensor to measure the water level, an OLED display to visualize the data, a relay to control a water pump, and a buzzer to signal critical conditions. The system can be operated in two modes: manual and automatic.

- **Automatic Mode:** The system automatically turns the pump on or off based on predefined water level thresholds.
- **Manual Mode:** The user manually controls the pump, but the system still monitors and provides alerts.

The mute function ensures that the buzzer can be silenced temporarily when the water level is within critical ranges. The system is built on an Arduino microcontroller, which processes inputs from the sensors and manages outputs to the display, relay, buzzer, and LEDs.

4. Features and Functionalities:

- **Real-time Water Level Monitoring:** The ultrasonic sensor continuously measures the water level, and the data is displayed on an OLED screen.
- **Visual Indicators:** An LED array provides a quick visual representation of the water level.
- **Automated Control:** The relay is automatically controlled based on water level thresholds.
- **Critical Alerts:** The buzzer sounds an alert when the water level is too low or too high.
- **Manual Override:** The system allows manual control of the pump with a slide switch.
- **Mute Function:** Users can mute the buzzer during critical water levels, with automatic reactivation if the level changes.

Bill of Materials (BOM):

Component	Quantity	Description
Arduino Uno R3	1	Microcontroller for processing and control
Ultrasonic Sensor (HC-SR04)	1	Measures the distance to the water surface
OLED Display (128x64, SSD1306),0.96 inch	1	Displays water level and system status
Single Channel Relay Module	1	Controls the water pump based on water level
Buzzer	1	Alerts user during critical water levels
LEDs (Blue, Green, Yellow, Orange, Red)	5	Visual indication of water levels
Resistors (220Ω, 1kΩ)	10	Current limiting resistors for LEDs and pull-up resistors
Push Button	1	Used for mute functionality
6 pin Toggle Switch	1	Used for mode selection
Slide Switch	1	Used for manual mode control
Jumper Wires	40+ (each)	For connecting components

Breadboard	2	For prototyping and testing
12V Power Supply	1	Powers the Arduino and peripherals
Water Pump with pipe	1	For refilling purposes in automation
Buzzers	1	For warning indication
9V external battery	1	For supplying power to the pump.

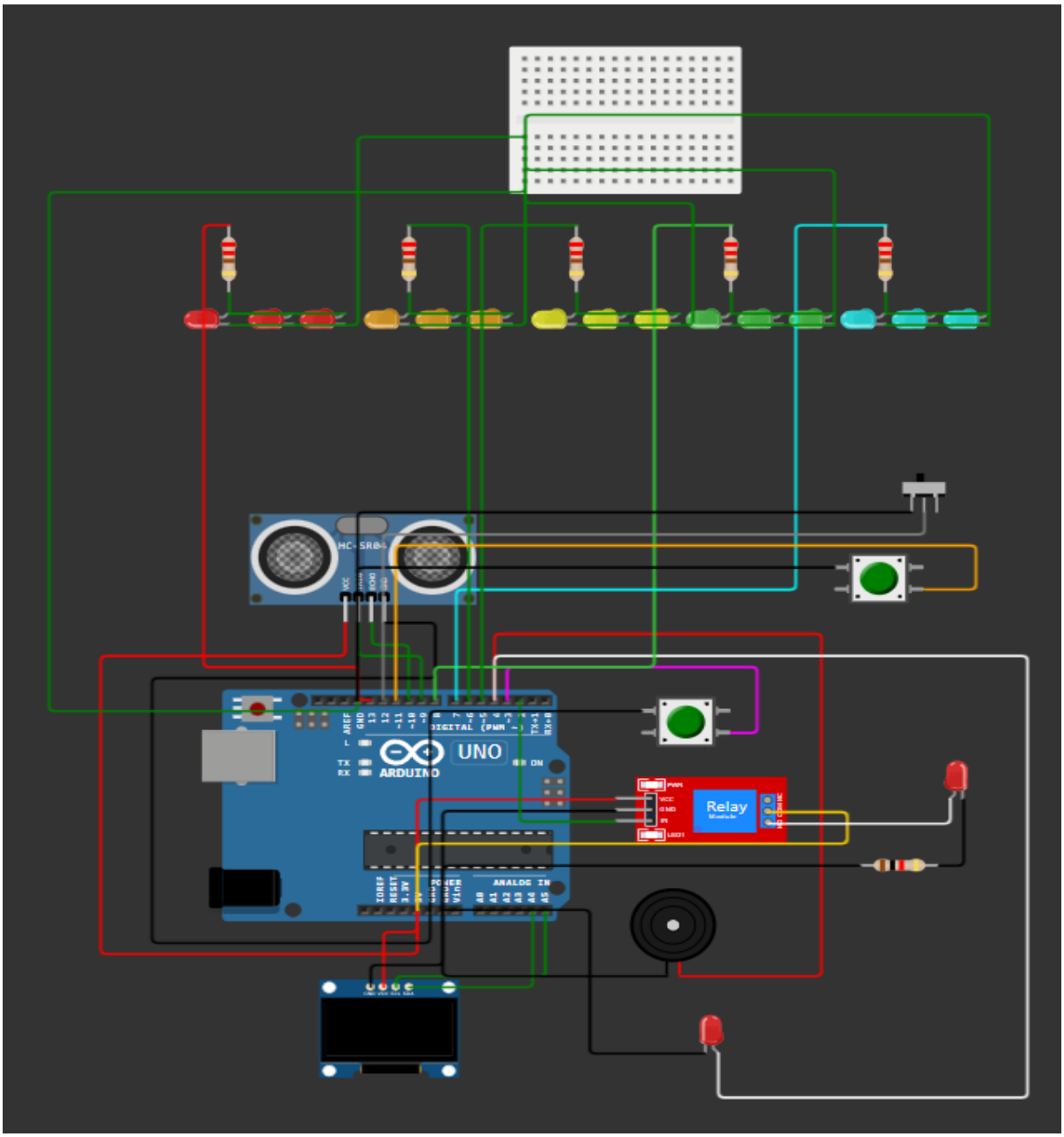
5. Circuit Connections:

- **Ultrasonic Sensor:**
  - Trig Pin: Connected to Arduino digital pin 9
  - Echo Pin: Connected to Arduino digital pin 10
  - VCC: Connected to 5V
  - GND: Connected to GND
- **OLED Display:**
  - SCL: Connected to Arduino A5 (SCL)
  - SDA: Connected to Arduino A4 (SDA)
  - VCC: Connected to 3.3V
  - GND: Connected to GND
- **Relay Module:**
  - IN: Connected to Arduino digital pin 2
  - VCC: Connected to 5V
  - GND: Connected to GND
  - NOC: Connected to GND

- **Buzzer:**
  - Positive: Connected to Arduino digital pin 4
  - Negative: Connected to GND
- **LEDs:**
  - Red (RDP): Connected to Arduino digital pin 13
  - Yellow: Connected to Arduino digital pin 6
  - Orange: Connected to Arduino digital pin 5
  - Green: Connected to Arduino digital pin 8
  - Blue: Connected to Arduino digital pin 7
- **Mode Toggle Button:**
  - One Side: Connected to Arduino digital pin 11
  - Other Side: Connected to GND
- **Mute Button:**
  - One Side: Connected to Arduino digital pin 3
  - Other Side: Connected to GND
- **Slide Switch:**
  - One Side: Connected to Arduino digital pin 12
  - Other Side: Connected to GND
- **Water Pump:**
  - Positive Side: Connected to COM port of Relay
  - Negative Side: Connected to GND
- **Relay output connections for external 9V battery:**

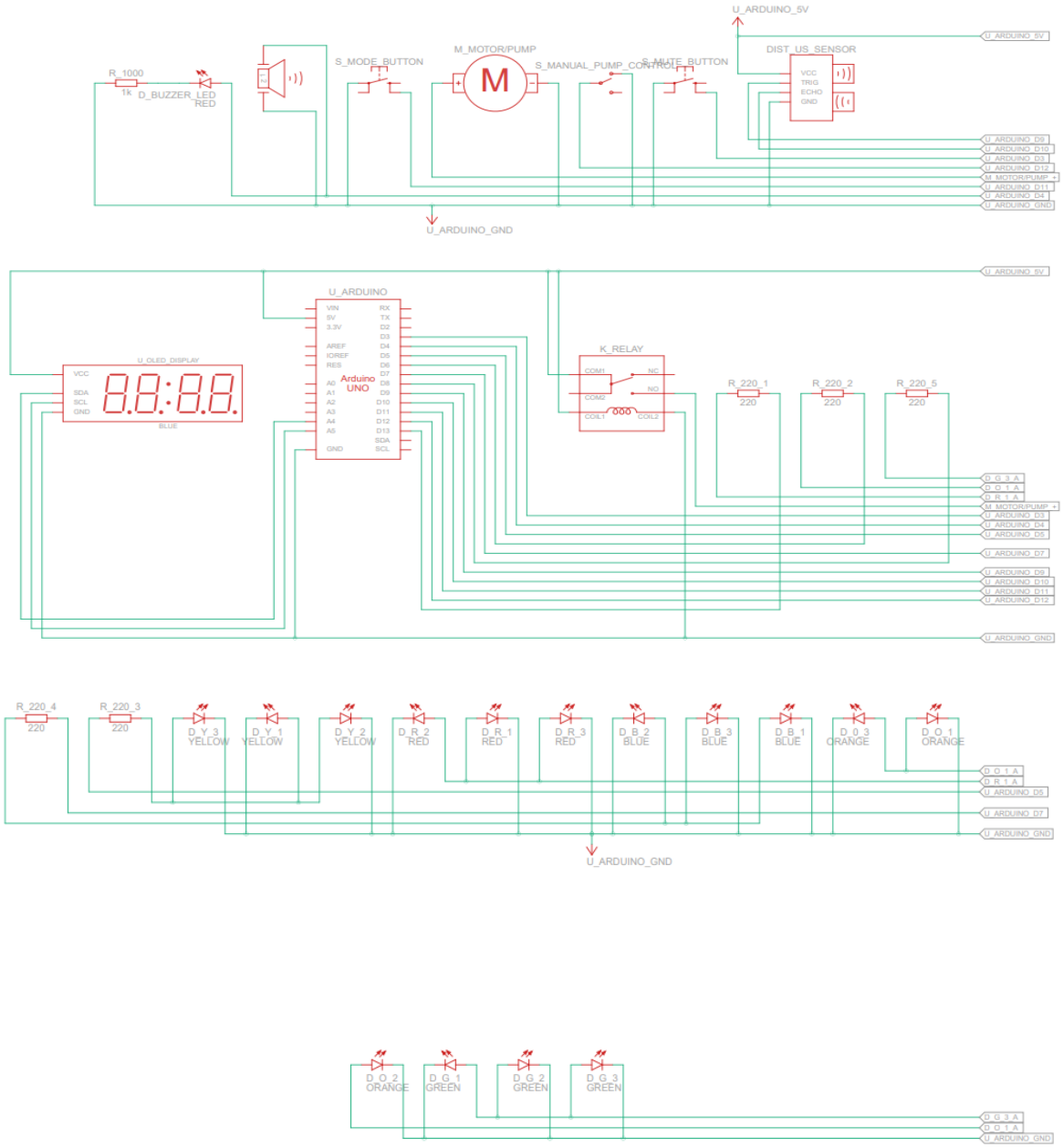
  - Battery Positive Terminal: COM port
  - Battery Negative Terminal: GND

6. Circuit Connections on Wokwi Simulator:



SIMULATION LINK: https://wokwi.com/projects/403604367575169025

7. Schematic Diagram:



8. Software Implementation:

The software is written in C++ using the Arduino IDE. It reads inputs from the ultrasonic sensor and mode switches, processes this data to determine the water level and system mode, and controls outputs to the OLED display, relay, buzzer, and LEDs accordingly. The system uses a debounce technique to ensure reliable button presses.

7. Testing and Validation:

- **Water Level Accuracy:** The ultrasonic sensor was calibrated to ensure accurate water level readings.
- **Relay Control:** The relay was tested to confirm that it properly controls the water pump based on the set thresholds.
- **Buzzer Alerts:** The buzzer's alert functionality was tested across different water levels to ensure it activates under critical conditions and responds correctly to the mute button.
- **Mode Functionality:** Both automatic and manual modes were tested to verify the correct behavior of the relay and alerts.
- **OLED Display:** The display was tested for clear visualization of water levels, mode status, and warnings.

8. Conclusion:

The Automated Water Level Monitoring and Control System with OLED Display successfully provides a reliable and efficient solution for managing water levels in a tank. The system's ability to operate in both automatic and manual modes, combined with its visual and auditory alerts, makes it a versatile tool for various applications. Future improvements could include wireless monitoring capabilities and integration with a mobile app for remote control.