Home Automation Water Refill System

Introduction

The Home Automation Water Refill System is an innovative project designed to automate the process of refilling water in devices such as humidifiers. Using ultrasonic sensing technology, the system accurately measures water levels inside the tank and controls a solenoid valve via a relay to maintain optimal water levels automatically.

This system reduces manual monitoring and refilling, preventing both water shortage and overflow. The combination of sensor data, visual LED indicators, and OLED display interface makes it a comprehensive solution for home automation enthusiasts.

Components Used

Component	Description	Quantity	Purpose
Ultrasonic Sensor (HC-SR04)	Measures distance to water surface with sonar pulses	1	To detect water level in tank
Relay Module	Electrically controls high power devices	1	Controls the solenoid valve to turn water flow ON/OFF
Solenoid Valve	Electrically actuated valve to control water flow	1	Opens/closes water flow during refill
Adafruit NeoPixel LED Strip	Addressable RGB LEDs for visual water level indication	1 strip	Displays water level and error states via colors
OLED Display (SH1106)	Small graphical screen with I2C interface	1	Shows water level, refill status, and errors
Arduino-compatible MCU	Microcontroller board to run code and control peripherals	1	Main controller handling sensor input and output devices
Power Supply	Provides regulated power to all components	1	Powers microcontroller, sensors, and actuators

What It Does

- Measures water level continuously inside a humidifier tank. [Or main Tank Suppose]
- Automatically activates the water refill valve when water level falls below a preset threshold (10%).
- Stops refilling when the water level reaches a safe maximum threshold (90%) to prevent overflow.
- Displays the current water level graphically on an OLED display.
- Uses LED colors to indicate water status: green for sufficient, yellow for low, red for critical/error.
- Provides error detection and visual alerts if sensor readings are invalid or out of range.

What It Helps With

- Eliminates the need for manual monitoring and refilling of water tanks.
- Prevents damage from water overflow or dry running of humidifiers.
- Offers a clear, intuitive user interface to understand water status at a glance.
- Provides safer and more reliable water management in home automation setups.
- Enhances energy efficiency by ensuring water refill is done only when necessary.
- Makes the humidifier or water-dependent device maintenance-free for the user.

Advantages

Advantage	Description
Fully automated operation	Requires no human intervention after setup
Real-time water level visualization	OLED display and LED strip provide instant status updates
Error handling	Stops valve and alerts user in case of sensor failure
Easy to customize thresholds	Water level limits can be adjusted for different tank sizes
Cost-effective components	Uses widely available, inexpensive parts
Compact design	Integrates all hardware into a small, efficient control box
Energy efficient	Valve and sensors consume minimal power, valve only activates when needed

Future Scope & Improvements

Enhancement	Description
Network Connectivity	Add Wi-Fi or Bluetooth module to monitor water levels remotely via app or web dashboard
Mobile Notifications	Send alerts to user's smartphone on low water or refill events
Voice Control	Integrate with Alexa, Google Assistant for voice-activated refill control
Battery Backup	Ensure operation during power failures with backup battery and UPS
Multi-Tank Management	Expand system to handle multiple tanks or water-dependent devices simultaneously
Advanced Analytics	Collect usage data for trend analysis and predictive maintenance
Automatic Calibration	Self-calibrating ultrasonic sensor for higher accuracy and ease of installation
Integration with Other IoT	Connect with smart home ecosystems for unified automation and control

Pin Configuration

Component	Pin	Microcontroller Pin	Description
Ultrasonic Sensor	TRIG_PIN	A3	Trigger signal for distance measurement
Ultrasonic Sensor	ECHO_PIN	A2	Echo response for measuring distance
Relay	RELAY_PIN	A1	Controls solenoid valve ON/OFF
NeoPixel Strip	LED_PIN	A0	Data input for addressable LEDs
Single Indicator LED	LED_PIN_2	D6	Status indication LED
OLED Display	SDA & SCL	Default I2C Pins	Serial Data and Clock for OLED display

💻 Code Structure Overview

1. Setup Initialization
- Initialize serial communication for debugging.
- Initialize NeoPixel LED strips and set brightness.
- Initialize OLED display with welcome screen and startup animations.

2. Main Loop
- Continuously measure water level via ultrasonic sensor.
- Validate sensor data and detect errors.
- Map measured distance to water level percentage.
- Control relay to open/close solenoid valve based on thresholds.
- Update LED strip color and count to reflect water level.
- Show real-time water level and refill status on OLED screen.

3. Functions and Utilities
- Distance measurement function with averaging to avoid spikes.
- Water level calculation from distance data.
- LED animation routines including smooth color transitions and error blink.
- OLED screen drawing utilities to graphically represent water tank and messages.

📈 Water Level Thresholds

Threshold	Action	Description
< 10%	Start Refilling	Relay turns ON, solenoid valve opens to refill tank
> 90%	Stop Refilling	Relay turns OFF, valve closes to prevent overflow
Out of Range	Error State	Stops refill and shows error alerts

Visual User Interface

- OLED Display:
  - Tank outline with dynamic water fill level bar.
  - Textual readout of water level percentage.
  - Refill progress bar during active refill.
  - Error messages when sensor reading is invalid.

- NeoPixel LED Strip:
  - Color coded LEDs showing water level:
  - Blue : Safe water level
  - Gray: Low water warning
  - Red: Critical / Error
  - Blinking pattern for errors and refill activity.

Summary

This Home Automation Water Refill System provides a smart, efficient solution for maintaining water levels in humidifiers or similar tanks without manual intervention. Its combination of sensor-driven automation, visual feedback through LEDs and OLED, and safety features makes it ideal for home automation applications.

The modular design allows easy customization and expansion for future smart home integrations. With its low cost and reliable performance, it significantly improves the convenience and safety of water-dependent devices.

Conclusion

The **Home Automation Water Refill System** designed by Aniket Chowdhury (Hashtag) is an efficient and reliable solution to automate the water refilling process in household humidifiers or similar devices. By integrating ultrasonic sensing with relay-controlled solenoid valves and providing real-time feedback through LED indicators and an OLED display, the system ensures optimal water levels without manual intervention.

This project highlights the importance of smart automation in daily life, reducing the risk of water spillage, minimizing manual monitoring, and enhancing convenience. The use of widely available components and clear programming logic makes the system accessible for DIY enthusiasts and professionals alike.

Future improvements could include wireless monitoring, mobile app integration, and advanced error handling to further increase the system's robustness and user-friendliness.

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