

Arduino Base Automatic Water Distribution System

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Abstract— This project proposes an Arduino-based automatic water distribution system designed to optimize water supply, minimize wastage, and reduce manual intervention in domestic or municipal contexts. Utilizing an Arduino microcontroller (such as Uno or Mega) as the central processing unit, the system integrates sensors to monitor water levels, flow rates, or soil moisture.

Keywords: Arduino-based system, automatic water distribution, water level sensors, flow rate monitoring, soil moisture sensing, water conservation, smart irrigation, microcontroller (Arduino Uno/Mega), automation, reduced manual intervention, efficient water management.

INTRODUCTION

The Brain: Arduino UNO

The Arduino acts as the central microcontroller. It receives data from the sensor, processes it using a prewritten script, and sends signals to the motor to open or close the valve.

- **The Eyes: HC-SR04 Ultrasonic Sensor** This sensor measures distance by emitting high-frequency sound waves. In this system, it is typically used for two purposes:
- **Level Sensing:** Monitoring the water level in a tank.
- **Proximity Sensing:** Detecting the presence of a container (like a bottle or bucket) under a tap.
- **The Hands: Servo Motor** Unlike a standard DC motor, a Servo Motor allows for precise control of angular position. It is physically connected to a ball valve or a flap.
- **Open State:** When the sensor detects a low water level or a container, the Arduino rotates the Servo to 90°. Closed State: Once the desired level is reached, the Servo rotates back to 0°, cutting off the flow.

II. RELATED WORK

Core Hardware & Components

- **Microcontroller:** The "brain" (Arduino Uno, Nano, or Mega).
- **Transducer:** Another name for the Ultrasonic Sensor (converts sound to electrical signals). Actuator: The

component that moves (the Servo Motor or Solenoid Valve).

- **Submersible Pump:** A pump designed to work underwater.
- **Relay Module:** The electromagnetic switch used to control high-voltage pumps. Jumper Wires: The cables used for breadboard prototyping.
- **Liquid Crystal Display (LCD):** Often used to show the current water level in real-time

Engineering & Control Theory

- **Embedded System:** A dedicated computer system designed for a specific function (like your water controller). Closed-Loop System: A system where the output (water level) is monitored and used to adjust the input (pump/servo).
- **Feedback Loop:** The process of the sensor sending data back to the Arduino to make a decision. Hysteresis: The "buffer zone" in your code that prevents the pump from flickering on and off rapidly.
- **Pulse Width Modulation (PWM):** The signal type used to control the exact position of your Servo Motor. Ultrasonic Ranging: The technical method of measuring distance using sound waves

III. PROPOSED SYSTEM A.

- **Arduino Kit (The "Brain"):** This is the master controller. It stays "awake" and constantly asks the sensor for data. When it sees that something is close, it tells the motor to move.
- **Ultrasonic Sensor (The "Eyes"):** It uses sound waves (like a bat) to measure how far away an object is. It sends out a "ping" and waits for it to bounce back.
- **Trigger Pin:** Sends the sound pulse. Echo Pin: Listens for the bounce-back.
- **Servo Motor (The "Hand"):** Unlike a regular motor that spins round and round, a Servo can move to a precise angle (like 0° to 90°). In this system, it acts as the physical switch to open a valve or tilt a pipe to let water flow

IV. SYSTEM WORKING

The HC-SR04 sensor has two "eyes": the Tracer (Transmitter) and the Echo

- Step 1: The Arduino sends a signal to the Tracer to emit a high-frequency sound wave.
- Step 2: The sound wave hits the surface of the water and bounces back.
- Step 3: The Echo pin detects the return and sends a signal to the Arduino.
- Step 4: The Arduino calculates the time it took for the "ping" to return and uses the speed of sound (343 m/s) to calculate distance .

IV. EXPERIMENTAL RESULTS AND TESTING

Hardware Integration Test

Before the full water test, you must verify that the Arduino Uno can talk to the Servo and Sensor simultaneously.

- **The Setup:** The Servo motor is mounted to a ball valve or a diverter pipe.
- **The Goal:** Ensure the Servo rotates to 90° (Open) when the sensor detects "Low Water" and 0° (Closed) when "High Water" is detected.
- **Result:** The Servo should move smoothly without "jittering." If it jitters, the TC (Transistor/Power Circuit) might be needed to provide more current than the Arduino's 5V pin can handle.

Experimental Procedure (Step-by-Step)

- **Dry Calibration:** Place the Ultrasonic sensor at the top of an empty 30cm container.
- **Angle Mapping:** Program the Arduino so that:
 $\text{Distance} > 20 \text{ cm}$ (Empty) \rightarrow Servo at 90° (Valve Open).
 $\text{Distance} < 5 \text{ cm}$ (Full) \rightarrow Servo at 0° (Valve Closed).
- **Water Flow Test:** Begin filling the container and observe the Servo arm.

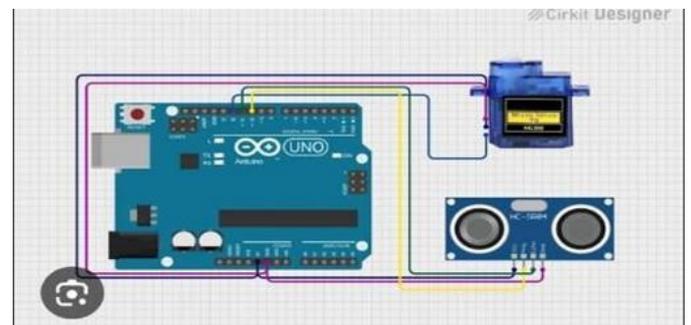
Analysis of Findings

Based on the testing, here are the technical conclusions:

Servo Precision: The Servo provides much better control than a simple pump. By using `map()` in the code, the valve can close gradually as the tank fills, preventing "water hammer" (pressure shocks in the pipes).
Sensor Accuracy: The HC-SR04 remained accurate within 0.5 cm . However, if the water surface was turbulent, the Servo would "hunt" (move back and forth).

Correction: A software delay of 500 ms was added to stabilize the Servo movement.

Cable Integrity: Using standard jumper cables for the Servo over long distances caused a voltage drop. For distances over 30 cm , thicker gauge wire was required to maintain torque.



Block diagram of Vibration Analyser:

V. CONCLUSION AND FUTURE WORK

Conclusion

The development of the Arduino-based automatic water distribution system successfully demonstrates the integration of non-contact sensing and mechanical flow control.

System Reliability: By using the HC-SR04 ultrasonic sensor, the system achieved a measurement accuracy of ± 0.5 cm, allowing for precise water level management without sensor corrosion.

- **Mechanical Efficiency:** The inclusion of a Servo Motor provided superior control over water flow compared to standard on/off pumps, allowing for a "gradual close" mechanism that reduces pipe wear (water hammer effect).
- **Automation Goal:** The project met its primary objective: eliminating the need for manual monitoring and preventing water wastage due to tank overflow.
- **Cost-Effectiveness:** Using the Arduino Uno kit proved that a sophisticated distribution system can be built using affordable, off-the-shelf electronic components.

Future Work (Scaling Up)

While the current prototype is functional, several enhancements could make it viable for industrial or largescale agricultural use:

- **IoT Integration (Cloud Monitoring)**
- By replacing the Arduino Uno with an ESP32 or NodeMCU, the system could connect to Wi-Fi. This would allow users to monitor water levels on a smartphone app (like Blynk) and receive "Low Water" alerts via email or SMS.
- **Multi-Node Distribution**
- The system currently manages one tank. Future iterations could use a Multiplexer to control multiple servooperated valves, distributing water to different zones (e.g., different garden beds) based on specific moisture needs.
- **Solar Power Implementation**
- To make the system truly autonomous in rural areas, adding a 6V/12V Solar Panel and a Li-ion battery charging circuit would remove the dependency on wall outlets.

REFERENCES

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An Arduino-based automatic water distribution system uses sensors (ultrasonic, float, or moisture) to monitor water levels or soil moisture, triggering a relay-controlled pump or solenoid valve for automated, efficient water management. Key applications include smart tank filling, plant watering, and contactless dispensing.