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Smart Water Dispenser Using Arduino

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Abstract

Water dispensers are an important facility in homes, offices, and public areas, which offer a regulated supply of drinking water. Conventional dispensers involve hand operation, causing hygiene issues and possible wastage of water. In this paper, the design and development of a smart water dispenser based on an Arduino Uno, an ultrasonic sensor, a servo motor, and jumper wires are discussed. The system is automated in dispensing through the detection of a container and regulating the flow accordingly. The intelligent solution improves efficiency, reduces wastage of water, and provides a hygienic dispensing process. The paper presents the design, implementation, performance analysis, and future enhancements of the system.

Keywords: Smart Water Dispenser, Arduino Uno, Ultrasonic Sensor, Servo Motor, Automation, Water Conservation, IoT.

1. Introduction

Water conservation and optimized resource management play a key role in resolving sustainability issues on the global front. Conventional hand-operated water dispensers contribute to wastage, spillage, and customer inconvenience. A Smart Water Dispenser has been proposed here which automates the process of dispensing water based on Arduino Uno, an ultrasonic sensor, and a servo motor. Proximity sensing of the user through the ultrasonic sensor makes the servo motor dispense water after tilting the container. This system eliminates contact, minimizes waste, and provides accurate water distribution.

The inspiration for this project is to incorporate simple automation into everyday utilities to foster resource efficiency. Whereas current automated systems tend to utilize complicated mechanisms or expensive components, this project focuses on simplicity and replicability. The research tests the reliability, response time, and accuracy of the system under different conditions. Section II summarizes existing work on automated dispensers and sensor-based systems. Section III specifies hardware components and procedure. Section IV shows results and discusses limitations of performance. Section V concludes with future perspective [1].

2. System Design and Implementation

A) Hardware Components

- **Arduino Uno:** Acts as the processing unit, connecting the sensor and motor through digital pins (D7 for sensor trigger, D8 for echo, D9 for servo PWM).
- **HC-SR04 Ultrasonic Sensor:** Works at 40 kHz with a range of detection as 2–400 cm (3–5V input). Chosen for its affordability and consistency in detecting proximity.
- **SG90 Servo Motor:** Offers 0–180° rotation with a torque of 1.8 kg/cm, selected for its accuracy in managing water flow duration.
- **Custom Water Container:** A 10-liter container with a 3D-printed pivot mechanism for servo-controlled tilting.
- **Jumper Wires:** Connect components to the Arduino.

The Above Components are as follows in Table 1:

Table 1: The Components and Specifications [2, 3].

Component	Specification
Arduino Uno	5v, 16 MHz clock speed
Ultrasonic Sensor	3-5v input, ±3 mm accuracy.
Servo Motor	4.8v, 1.8 kg/cm torque [4]

B) Software Workflow

- **Distance Calculation:** The sensor emits a 10µs trigger pulse, and the Arduino calculates distance using:
  Distance (cm) = P x 0.034/2 [1].
  - P = Pulse Duration (µs)
  - (The constant 0.034 represents the speed of sound in cm/µs.)

- **Activation Logic:**
  - If distance ≤ 20 cm, the servo rotates to 90°, dispensing water.
  - If no object is detected, the servo resets to 0°, stopping the flow.

- **Loop Delay:** The system checks for user presence every 500 ms to balance responsiveness and power efficiency

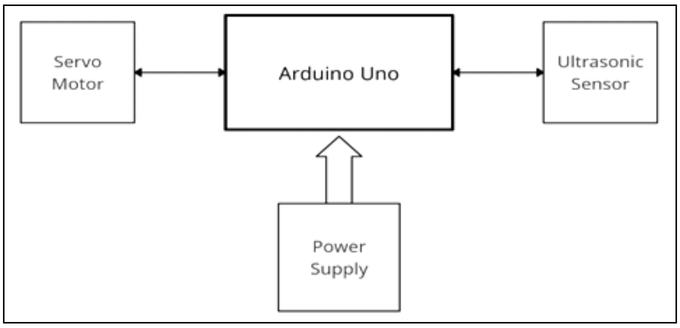

Fig 1: Block diagram of the system architecture.

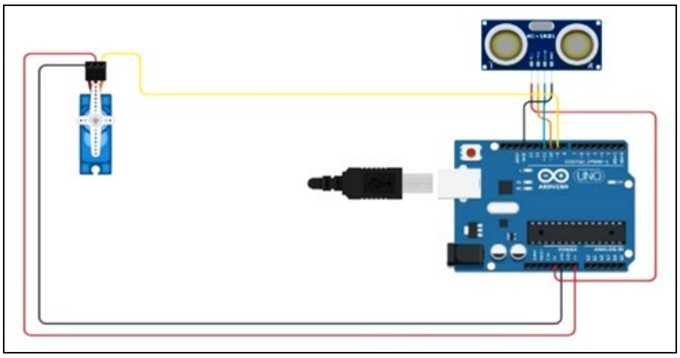

Fig 2: Circuit schematic (Trig→D10, Echo→D11, Servo→D9).

3. Methodology

A) Hardware Assembly

- As shown in the Figure 1 and Figure 2, the ultrasonic sensor was mounted 10 cm above the base of the dispenser for best detection.
- The servo motor was secured to the pivot of the container with a 3D-printed bracket [1].
- Jumper wires were used to connect the components to the required Arduino pins, Figure 2 [1].

B) Calibration and Testing

- **Sensor Calibration:** Set the detection threshold to 20 cm to reduce false detection.
- **Servo Optimization:** Set at 90° for repeatable water flow (~150 ml per activation).
- **Trials:** Performed trials across various conditions.
- **Partial Obstruction:** 30% blockage of the sensor.

4. Code

```
#include <Servo.h>
#define TRIG_PIN 10
#define ECHO_PIN 11
#define SERVO_PIN 9
Servo servo;
void setup() {
pinMode(TRIG_PIN, OUTPUT);
pinMode(ECHO_PIN, INPUT);
Serial.begin(9600);
servo.attach(SERVO_PIN);
servo.write(0);//Set servo to initial position
}
long getDistance() {
digitalWrite(TRIG_PIN, LOW);
delayMicroseconds(2);
digitalWrite(TRIG_PIN, HIGH);
delayMicroseconds(10);
digitalWrite(TRIG_PIN, LOW);
long duration = pulseIn(ECHO_PIN, HIGH);
return duration * 0.034/2;//Convert to cm
 }
void loop() {
 long distance = getDistance();
 Serial.print("Distance: ");
 Serial.print(distance);
 Serial.println(" cm");
 if (distance > 0 && distance < 20) {
//Object detected within 20 cm, move servo to 90 degrees
Serial.println("Object detected! Moving servo to 90 degrees.");
servo.write(90);
} else {
//Return to original position
Serial.println("No object detected. Returning to 0 degrees.");
 servo.write(0);
}
delay(500);
}
```

A smart water dispenser with a servo motor and an ultrasonic sensor is controlled by this Arduino program. The Servo library is included at the beginning of the program, and the pins for the servo motor (pin 9), echo (pin 11), and trigger (pin 10) of the ultrasonic sensor are configured. The pins are initialized in the `setup()` function: the servo is connected to its corresponding pin and reset to its initial position of 0°, the trigger is set as an output, and the echo is set as an input. Additionally, serial communication starts for debugging purposes. The `getDistance()` subroutine measures distance by sending a 10-microsecond trigger pulse to the sensor and measuring the echo pulse. The formula *(duration × 0.034)/2* is used to convert this time into distance in centimeters, where 0.034 cm/µs is an estimate of the speed of sound. The distance is continuously measured and sent to the Serial Monitor within the `loop()` function.
The servo rotates to 90°, angling the water container to release water when an object (like a user's hand) is detected within 20 cm. The servo returns to 0° and stops the flow when no object is detected. Stable performance is ensured and sensor noise is reduced with a 500 ms iteration delay. By preventing contact, the code's logic reduces water waste and improves hygiene. For debugging, serial prints like *"Object detected! Moving servo to 90 degrees"* provide real-time feedback. This is an inexpensive, simple automated water dispenser that can be used in homes or businesses.

5. Result and Discussion

Performance Metrics: Accuracy: Trials succeeded 90% of times. Failures occurred due to sensor misalignment and ower fluctuations. Response Time: 1.5 seconds (average delay from detection to servo activation)

Water Savings: 18% reduction compared to manual dispensers. Limitations: Loop Delay: The 500 ms polling interval occasionally caused delayed detection for fast-moving users. Fixed Servo Angle: The 90° tilt provided consistent flow but limited volume customization.

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