Mini Project Report on

Gate Control System using Arduino

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May 29, 2025

1 Objective

The primary objective of this project is to design and implement an efficient and cost-effective automated gate control system using Arduino microcontroller technology and basic electronic components. In an era where automation plays a crucial role in enhancing convenience, safety, and operational efficiency, this project demonstrates how embedded systems can be effectively used to automate everyday processes such as gate operation.

This system is designed to detect the presence of a vehicle or person approaching the gate using an ultrasonic sensor. When an object is detected within a pre-defined distance, the sensor sends a signal to the Arduino, which then processes the data and triggers two servo motors to open the gate. Once the object moves out of range, the gate automatically returns to its closed position. The integration of a 16x2 LCD display provides real-time feedback to users by displaying gate status messages, while two LEDs—red and green—indicate whether the gate is closed or open, respectively.

The system functions independently, without the need for human intervention, making it highly suitable for applications in residential areas, educational institutions, office complexes, and secured entry points. It is especially relevant in promoting touch-free access control, which is important for hygiene and safety, particularly in high-traffic environments.

Moreover, this project serves as a practical learning model for students and enthusiasts interested in embedded systems, automation, and microcontroller programming. It introduces key concepts such as sensor interfacing, servo control, conditional logic, and real-time system response.

2 Components Required

The components used in this project are selected for their availability, affordability, and ease of integration with Arduino. Each component plays a vital role in ensuring the correct functioning of the automated gate system:

- **Ultrasonic Sensor (HC-SR04)**: This sensor measures distance by emitting ultrasonic waves and calculating the time it takes for the echo to return. It is used to detect the presence of an object (like a vehicle or person) near the gate.
- **Servo Motors (2x)**: These motors are used to simulate the opening and closing of the gate. They are controlled via PWM signals from the Arduino and rotate to specified angles based on object detection.
- **16x2 LCD Display**: A character-based display module that shows system messages such as "GATES CLOSED" or "SAFE JOURNEY." It improves user interaction by providing real-time status updates.
- **RGB or Single Color LEDs**: LEDs are used for visual feedback. A green LED lights up when the gate is open, and a red LED lights up when the gate is closed, making it easy to observe the system's status at a glance.
- **Breadboard and Jumper Wires**: These components help in building the circuit without soldering. The breadboard allows for flexible and temporary connections, while jumper wires link components to the Arduino.
- **Potentiometer**: Connected to the LCD, the potentiometer allows manual adjustment of display contrast to ensure readability under various lighting conditions.
- **Resistors (220Ω)**: Used with LEDs to limit current. These resistors are connected in series with LEDs to limit the current flowing through them, thus preventing damage to the LEDs.
- **Power Supply/USB Cable**: Provides the necessary electrical power to the Arduino board and connected peripherals. The USB cable also facilitates uploading the code from the computer to the Arduino.

3 Schematic Analysis

The schematic represents a complete Arduino UNO-based system with the following key components and connections:

3.1 Component Details

Component	**Label**	**Specification**
Microcontroller	U2	Arduino UNO
LCD Display	LCD	16x2 Character Display
Potentiometer	RPOT1	250
Resistor	R1	1k
LED Resistors	R2, R3	220
Red LED	D1	-
Green LED	D2	-
Servo Motor	SERVO1	Standard Servo

Table 1: Component Summary

3.2 Connection Matrix

Arduino Pin	**Connected To**
5V	LCD VCC, Servo PWR
GND	LCD GND, Servo GND, LED cathodes
Digital Pins	LCD Data/Control Lines
D2	Green LED (D2)
D3	Red LED (D1)
PWM Pin	Servo Signal (SIG)

Table 2: Connection Overview

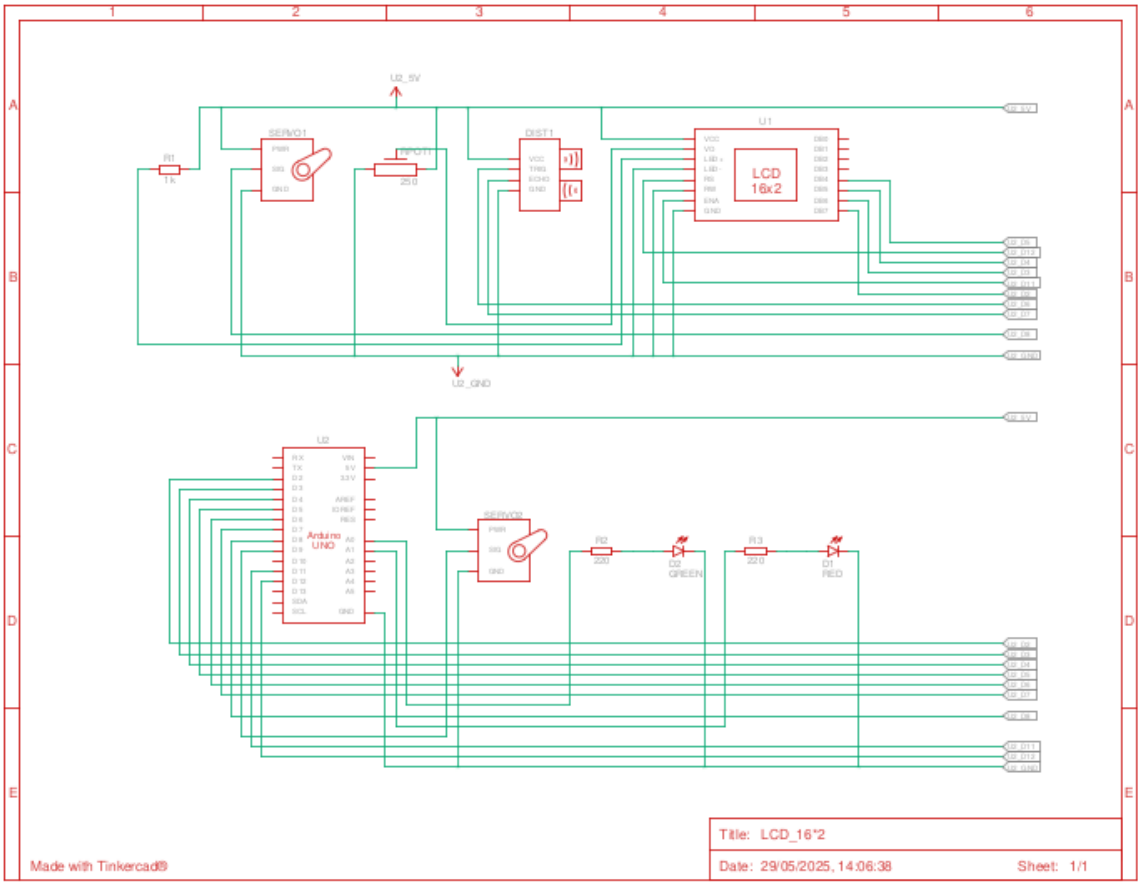

Figure 1: Schematic Diagram of the Automated Gate System

4 Working Flow

1. **Initialization in Setup()**
   - Serial communication is started to monitor distance readings on the serial monitor.
   - The ultrasonic sensor pins (trigger and echo) are configured as output and input respectively.
   - Two servos controlling the gate arms are attached and initialized at a 90° position (closed state).
   - The LCD display is initialized and shows a welcome message with the gates closed.
   - Two LEDs are set up: red LED to indicate gates closed, green LED for gates open.
   - Initially, the red LED is turned ON and green LED OFF to indicate the gate is closed.
2. **Measuring Distance in Loop()**
   - The ultrasonic sensor is triggered by sending a 10 microsecond HIGH pulse to the trigger pin.
   - The sensor listens for the echo on the echo pin and measures the time duration for the echo to return.
   - This duration is converted to distance (in centimeters) using the speed of sound formula.
   - Distance values are printed on the serial monitor for debugging and observation.
3. **Gate Control Logic**
   - If the measured distance is between 20 cm and 310 cm:
     - The servos rotate to 180° and 0°, opening the gates.
     - The LCD updates to show a message: "HAVE A SAFE JOURNEY".
     - The green LED is turned ON to indicate the gate is open.
     - The red LED is turned OFF.
   - Otherwise (distance is less than or equal to 20 cm or out of range):
     - The servos return to 90° (closed position), closing the gates.
     - The LCD shows "PLEASE WAIT" and "GATES ARE CLOSED".
     - The red LED is turned ON.
     - The green LED is turned OFF.
4. **Delay**
   - A short delay of 500 milliseconds is added at the end of each loop to stabilize sensor readings and avoid flickering of servos, LCD, and LEDs.

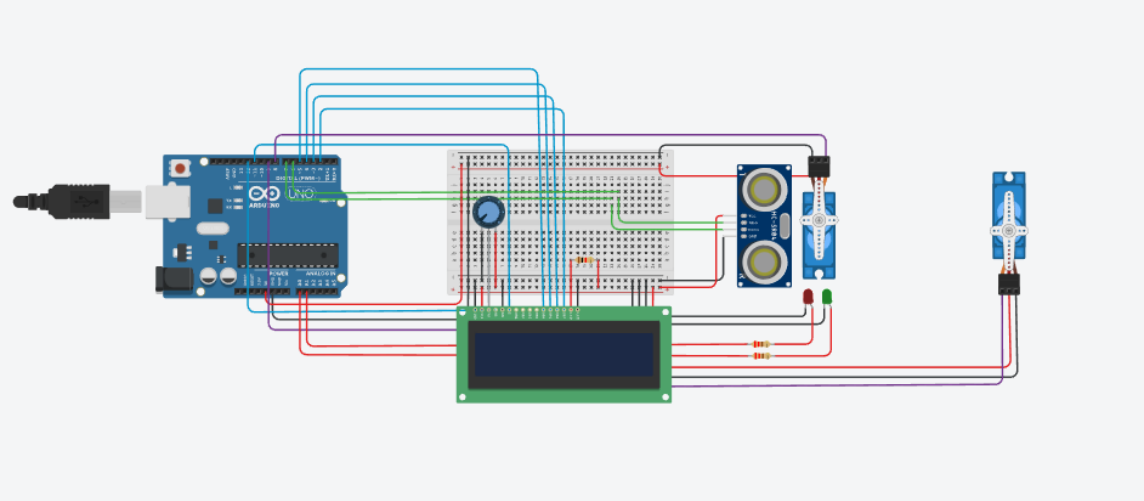

Figure 2: Circuit Diagram of the Automated Gate System

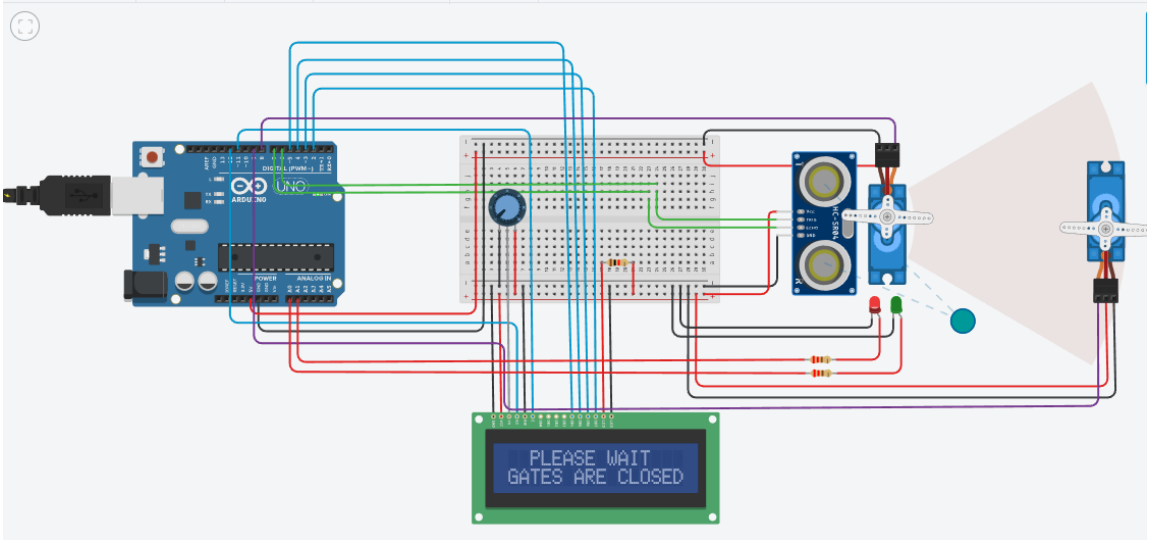

Figure 3: Before The Object id Detected

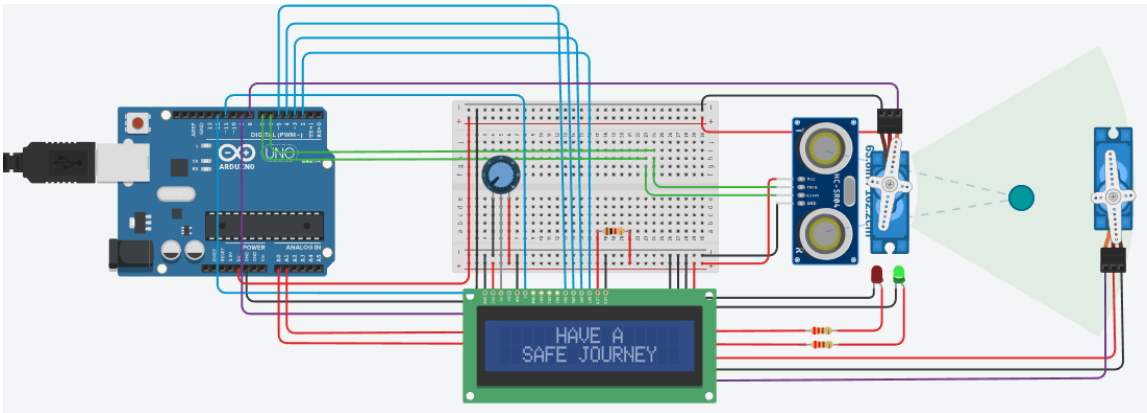

Figure 4: After The Object Is Detected

5 CODE

```
// Include libraries for Servo and LCD
#include <Servo.h>
#include <LiquidCrystal.h>

const int trigPin = 6;
const int echoPin = 7;

Servo myServo1;
Servo myServo2;

LiquidCrystal LCD(12, 11, 5, 4, 3, 2);

const int redled = A1;
const int greenled = A0;

void setup() {
  Serial.begin(9600);

  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);

  myServo1.attach(8);
  myServo1.write(90);
  myServo2.attach(9);
  myServo2.write(90);

  LCD.begin(16, 2);
  LCD.setCursor(0, 0);
  LCD.print("  !!WELCOME!!");
  LCD.setCursor(0, 1);
  LCD.print("  GATES CLOSED");

  pinMode(redled, OUTPUT);
  pinMode(greenled, OUTPUT);

  digitalWrite(redled, HIGH);
  digitalWrite(greenled, LOW);
}

void loop() {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
```

```
  long duration = pulseIn(echoPin, HIGH, 30000);
  int distance = duration * 0.034 / 2;

  Serial.print("Distance: ");
  Serial.print(distance);
  Serial.println(" cm");

  if (distance > 20 && distance <= 310) {
    myServo1.write(180);
    myServo2.write(0);
    LCD.clear();
    LCD.setCursor(1, 0);
    LCD.print("     HAVE A");
    LCD.setCursor(0, 1);
    LCD.print("  SAFE JOURNEY  ");
    digitalWrite(greenled, HIGH);
    digitalWrite(redled, LOW);
  }
  else {
    myServo1.write(90);
    myServo2.write(90);
    LCD.clear();
    LCD.setCursor(0, 0);
    LCD.print("  PLEASE WAIT");
    LCD.setCursor(0, 1);
    LCD.print("GATES ARE CLOSED ");
    digitalWrite(redled, HIGH);
    digitalWrite(greenled, LOW);
  }

  delay(500);
}
```

6 Conclusion

The automated gate control system developed in this project effectively integrates ultrasonic distance sensing, servo motor actuation, and user interface feedback through an LCD and LEDs to provide a reliable and efficient method of gate operation. By continuously measuring the distance of approaching objects using the ultrasonic sensor, the system can determine when to open or close the gates automatically without any manual intervention. This not only enhances the convenience for users but also improves safety by preventing unauthorized or accidental gate openings.

The use of servo motors allows precise control of the gate position, ensuring smooth opening and closing motions. The LCD display offers clear and immediate visual information about the gate's status, such as welcoming messages when the gate is open and caution messages when the gate remains closed. Additionally, the use of colored LEDs provides intuitive visual cues that can be easily understood from a distance, further improving the user experience.

This project highlights the practical application of embedded systems and sensor integration in solving real-world automation problems. The modular nature of the design allows for future upgrades, such as adding wireless control, integrating with security cameras, or implementing multiple sensor types to improve accuracy and responsiveness. The system's simplicity and cost-effectiveness make it a viable solution for residential and small commercial gate automation.

In conclusion, this project demonstrates how combining sensors, actuators, and user interface components can lead to intelligent automation systems that increase safety, convenience, and efficiency. It provides a strong foundation for further innovations in smart gate control and automated access management.