UNIVERSITI KUALA LUMPUR

Malaysian Institute of Information Technology

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Title : Automated Bus Waiting Area Entrance System

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Prepared by:

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Introduction

The purpose of this project is to develop an automated system to manage access to a bus waiting area, ensuring safe and controlled entry and exit of passengers. The system uses ultrasonic sensors to detect individuals at the entrance and exit gates, servo motors to automate gate operations, and an LCD display to show the current number of people inside the waiting area. This system is designed to reduce manual supervision, enhance safety, and provide real-time monitoring of the waiting area's occupancy. The project builds on the principles of embedded systems and automation, integrating hardware components such as Arduino Uno, ultrasonic sensors, servo motors, and an LCD. It is particularly beneficial in limiting the number of people allowed into the waiting area at any given time, ensuring compliance with capacity restrictions and providing a more comfortable and organized environment for passengers. This innovation is essential for urban bus terminals, where high foot traffic often leads to overcrowding, operational inefficiencies, and safety concerns.

Background

The "Automated Bus Waiting Area Entrance System" is designed to improve the management and accessibility of bus waiting areas, particularly in crowded or high-traffic public transportation hubs. The system aims to regulate entry and exit in an organized manner, enhancing user experience and safety. By utilizing ultrasonic sensors, servo motors, and an LCD display, this system automates the control of entrance and exit gates while tracking the number of people inside the waiting area. This product is particularly beneficial for public transportation users, transportation authorities, and bus terminal operators. It ensures that the waiting area is not overcrowded, promotes social distancing, and provides real-time updates about the number of people present. This system is highly relevant in urban areas where large crowds at bus terminals can lead to chaos, discomfort, and safety concerns.

Problem Statement

Crowded bus waiting areas have long been a challenge in public transportation systems, especially in urban environments. Overcrowding can lead to numerous issues, including:

- Lack of Safety and Comfort: Overcrowded spaces may lead to accidents, theft, or discomfort for passengers waiting for buses.
- Inefficient Management: Without an organized system, managing the flow of people in and out of the waiting area becomes difficult.
- Limited Real-Time Information: Authorities and passengers lack a reliable way to monitor the number of people in the waiting area.

These problems highlight the need for a smarter, automated solution to monitor and manage the bus waiting area efficiently.

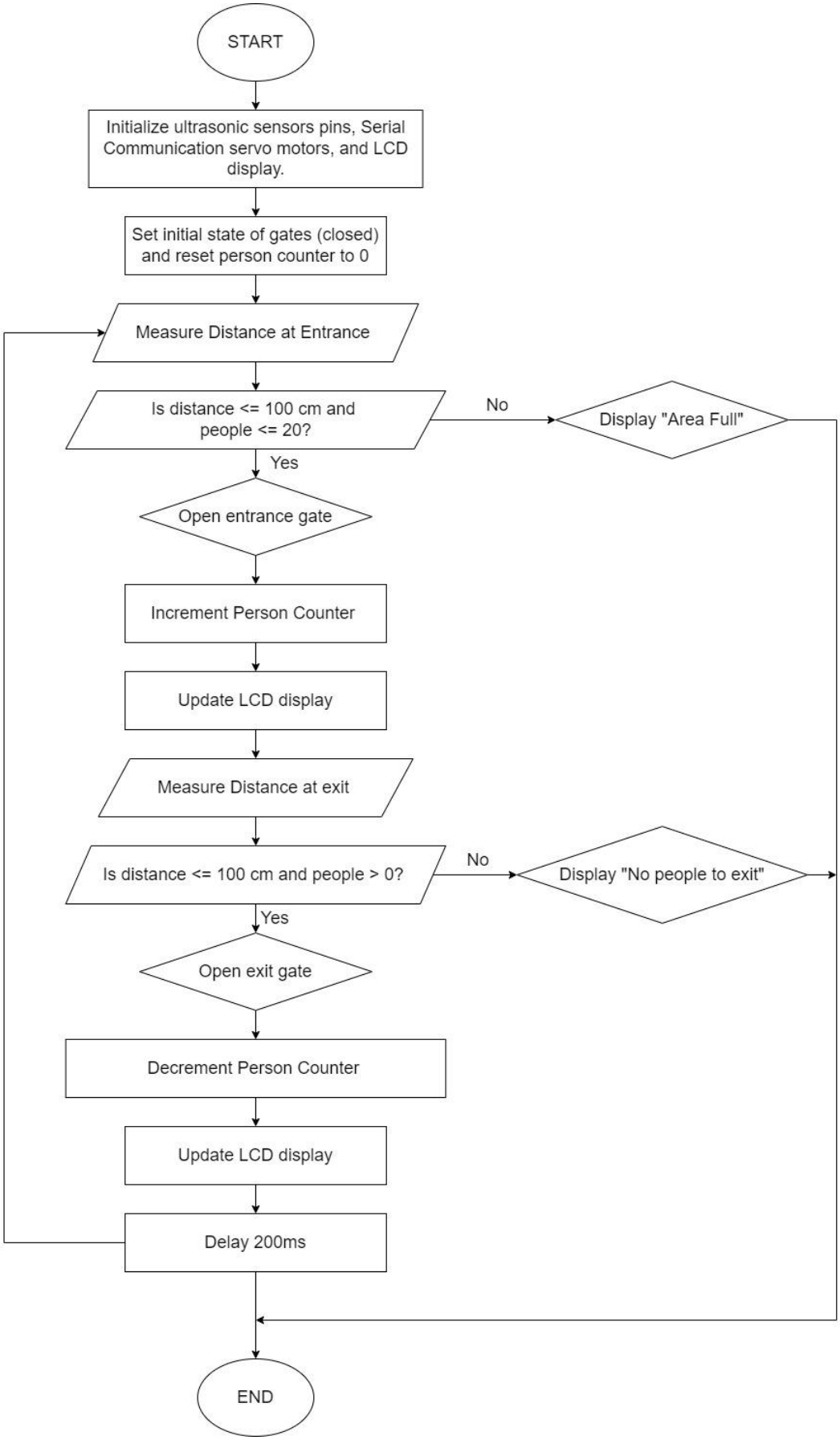
Rationale for Topic Selection

This topic was selected as it addresses a significant real-world challenge within public transportation systems, utilizing engineering principles and automation to provide an innovative and practical solution. The project integrates multiple technologies, such as sensors, servo motors, and microcontroller programming, to provide a seamless user experience. Moreover, the project allows us to apply theoretical knowledge to a tangible application, solving a relevant societal problem. It also contributes to fostering safer and more efficient public transportation infrastructure.

Methodology

1. Hardware Components:
    - Arduino Uno: Acts as the controller for the entire system.
    - Ultrasonic Sensors: Used to detect the presence of people at the entrance and exit.
    - Servo Motors: Operates the entrance and exit gates.
    - LCD Display: Displays the current count of people in the waiting area.
2. Software:
    - Arduino IDE: Used to program the microcontroller.
    - Libraries: Includes Servo.h and LiquidCrystal_I2C.h for controlling servo motors and the LCD, respectively.
3. Design Process:
    - Configure the ultrasonic sensors to measure distance and detect movement.
    - Program the servo motors to open/close the gates based on sensor input.
    - Implement a counter system to track the number of people in the waiting area.
    - Display the count on an LCD screen for real-time updates.
4. Testing:
    - Validate the accuracy of the ultrasonic sensors in detecting individuals.
    - Test the functionality of the servo motors to ensure smooth gate operation.
    - Simulate different scenarios to ensure the system responds correctly under varying conditions.

Flow Chart


START
Initialize ultrasonic sensors pins, Serial Communication servo motors, and LCD display.
Set initial state of gates (closed) and reset person counter to 0
Measure Distance at Entrance
Is distance <= 100 cm and people <= 20?
No
Display "Area Full"
Yes
Open entrance gate
Increment Person Counter
Update LCD display
Measure Distance at exit
Is distance <= 100 cm and people > 0?
No
Display "No people to exit"
Yes
Open exit gate
Decrement Person Counter
Update LCD display
Delay 200ms
END

Code

```
// Arduino project for bus waiting area management using two ultrasonic sensors and two servo motors
#include <Servo.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// Define pins for ultrasonic sensors
#define TRIG_PIN_1 2
#define ECHO_PIN_1 3
#define TRIG_PIN_2 4
#define ECHO_PIN_2 5

// Define the servo motor pins
#define SERVO_PIN_1 6
#define SERVO_PIN_2 7

// Define the distance threshold for person detection
#define DISTANCE_THRESHOLD 100

// Create servo objects
Servo gateServo1;
Servo gateServo2;

// Initialize the I2C LCD, set address 0x27 and dimensions 16x2
LiquidCrystal_I2C lcd(0x27, 16, 2);

// Person counter variable
int personCounter = 0;

// Maximum number of people allowed
#define MAX_PEOPLE 20

void setup() {
```

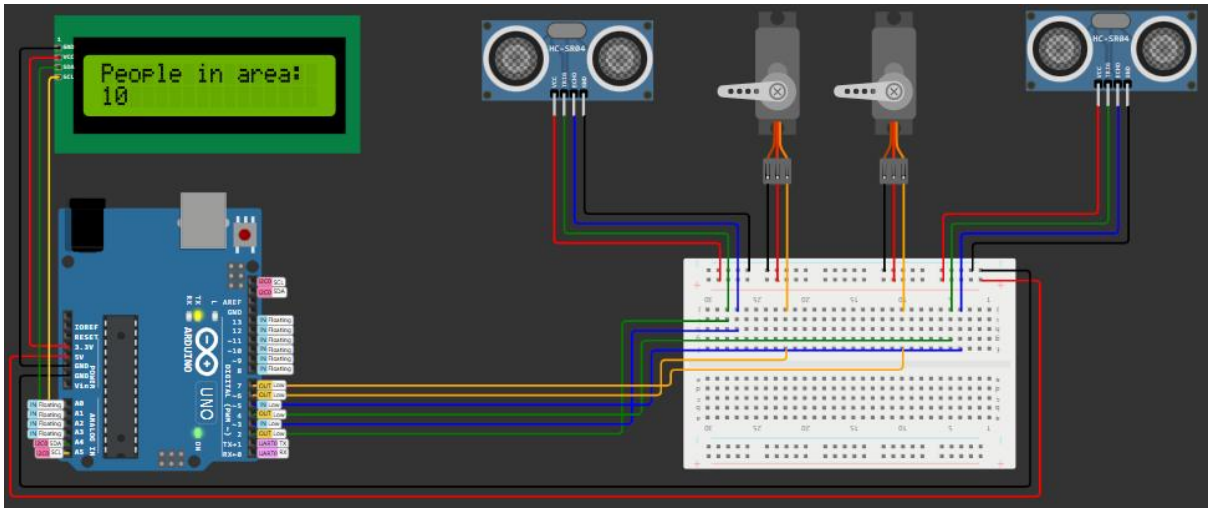
```
void setup() {
  // Initialize serial communication
  Serial.begin(9600);
```

```
  // Set up ultrasonic sensor pins
  pinMode(TRIG_PIN_1, OUTPUT);
  pinMode(ECHO_PIN_1, INPUT);
  pinMode(TRIG_PIN_2, OUTPUT);
  pinMode(ECHO_PIN_2, INPUT);

  // Attach the servo motors
  gateServo1.attach(SERVO_PIN_1);
  gateServo2.attach(SERVO_PIN_2);

  // Close the gates initially
  gateServo1.write(0);
  gateServo2.write(0);

  // Initialize the LCD
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("People in area:");
  lcd.setCursor(0, 1);
  lcd.print(personCounter);
}

// Function to measure distance using an ultrasonic sensor
long measureDistance(int trigPin, int echoPin) {
  // Send a 10us pulse to trigger the ultrasonic sensor
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
```

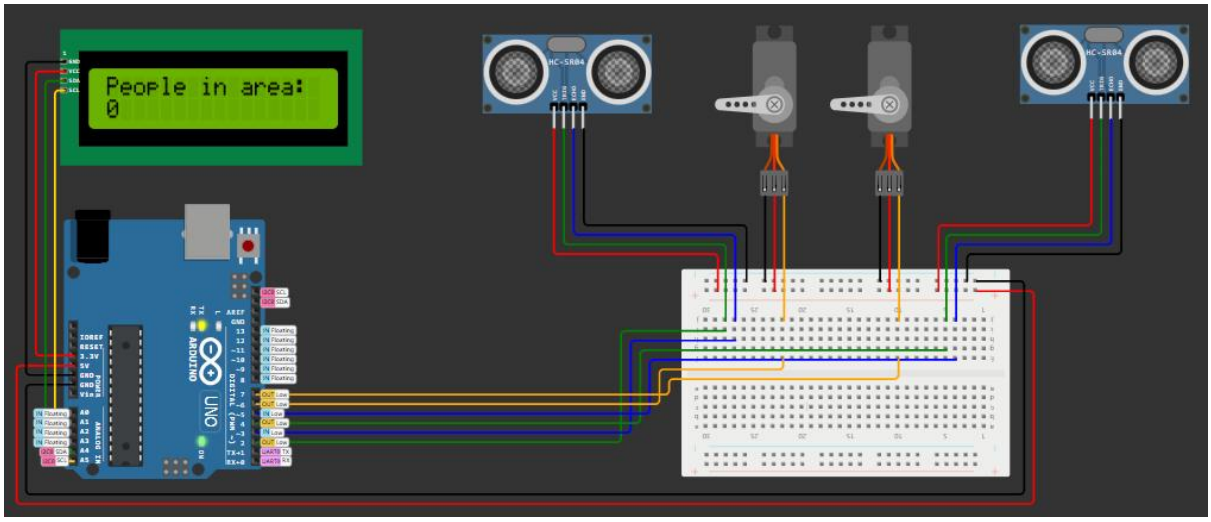
```
  // Measure the duration of the echo pulse
  long duration = pulseIn(echoPin, HIGH);

  // Calculate the distance (in cm)
  long distance = duration * 0.034 / 2;

  return distance;
}

void updateLCD() {
  lcd.setCursor(0, 1);
  lcd.print("                "); // Clear the second line
  lcd.setCursor(0, 1);
  lcd.print(personCounter);
}

void loop() {
  // Measure distance at the entrance
  long distance1 = measureDistance(TRIG_PIN_1, ECHO_PIN_1);

  // Measure distance at the exit
  long distance2 = measureDistance(TRIG_PIN_2, ECHO_PIN_2);

  // Check if the distance at the entrance is below the threshold
  if (distance1 <= DISTANCE_THRESHOLD) {
    if (personCounter < MAX_PEOPLE) {
      Serial.println("=== Entrance Gate ===");
      Serial.println("Person detected. Gate opening...");
      gateServo1.write(90); // Open the entrance gate
      delay(2000); // Keep the gate open for 3 seconds
      gateServo1.write(0); // Close the entrance gate
      personCounter++; // Increment the person counter
      Serial.print("People in area: ");
```

```
      Serial.println(personCounter);
      updateLCD();
    } else {
      Serial.println("=== Entrance Gate ===");
      Serial.println("Area full. No entry allowed.");
    }
  }

  // Check if the distance at the exit is below the threshold
  if (distance2 <= DISTANCE_THRESHOLD) {
    if (personCounter > 0) {
      Serial.println("=== Exit Gate ===");
      Serial.println("Person detected. Gate opening...");
      gateServo2.write(90); // Open the exit gate
      delay(2000); // Keep the gate open for 2 seconds
      gateServo2.write(0); // Close the exit gate
      personCounter--; // Decrement the person counter
      Serial.print("People in area: ");
      Serial.println(personCounter);
      updateLCD();
    } else {
      Serial.println("=== Exit Gate ===");
      Serial.println("No people in area to exit.");
    }
  }

  // Small delay to avoid continuous triggering
  delay(200);
}
```

Result



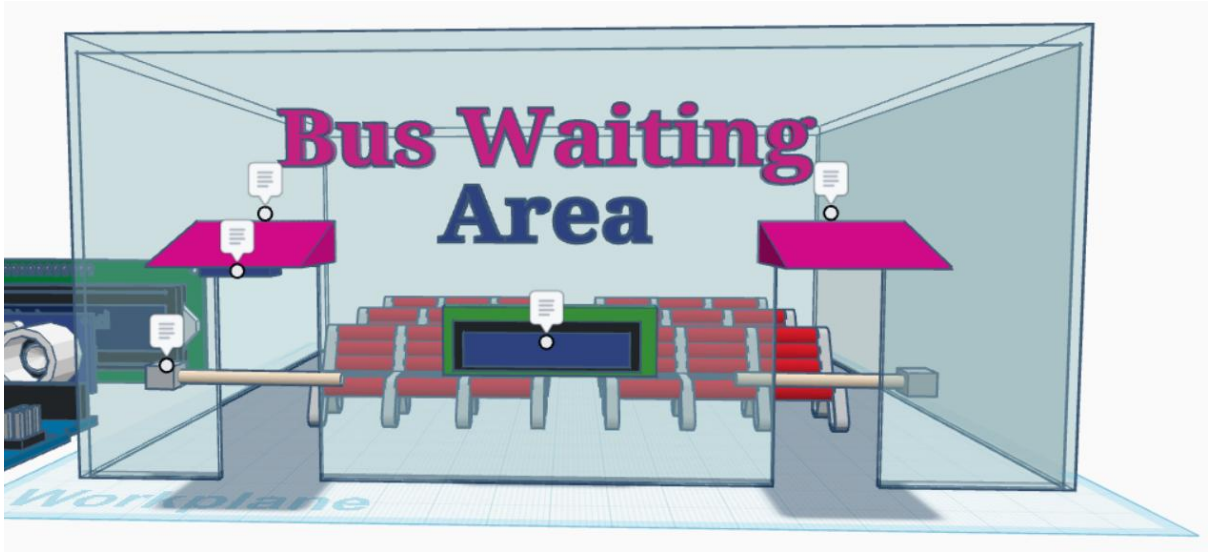

```
=== Entrance Gate ===
P    n    e    . Gate opening...
People in area: 3
=== Entrance Gate ===
Person detected. Gate opening...
People in area: 4
=== Entrance Gate ===
Person detected. Gate opening...
People in area: 5
=== Entrance Gate ===
Person detected. Gate opening...
People in area: 6
=== Entrance Gate ===
Person detected. Gate opening...
People in area: 7
=== Entrance Gate ===
Person detected. Gate opening...
People in area: 8
=== Entrance Gate ===
Person detected. Gate opening...
People in area: 9
=== Entrance Gate ===
Person detected. Gate opening...
People in area: 10
```



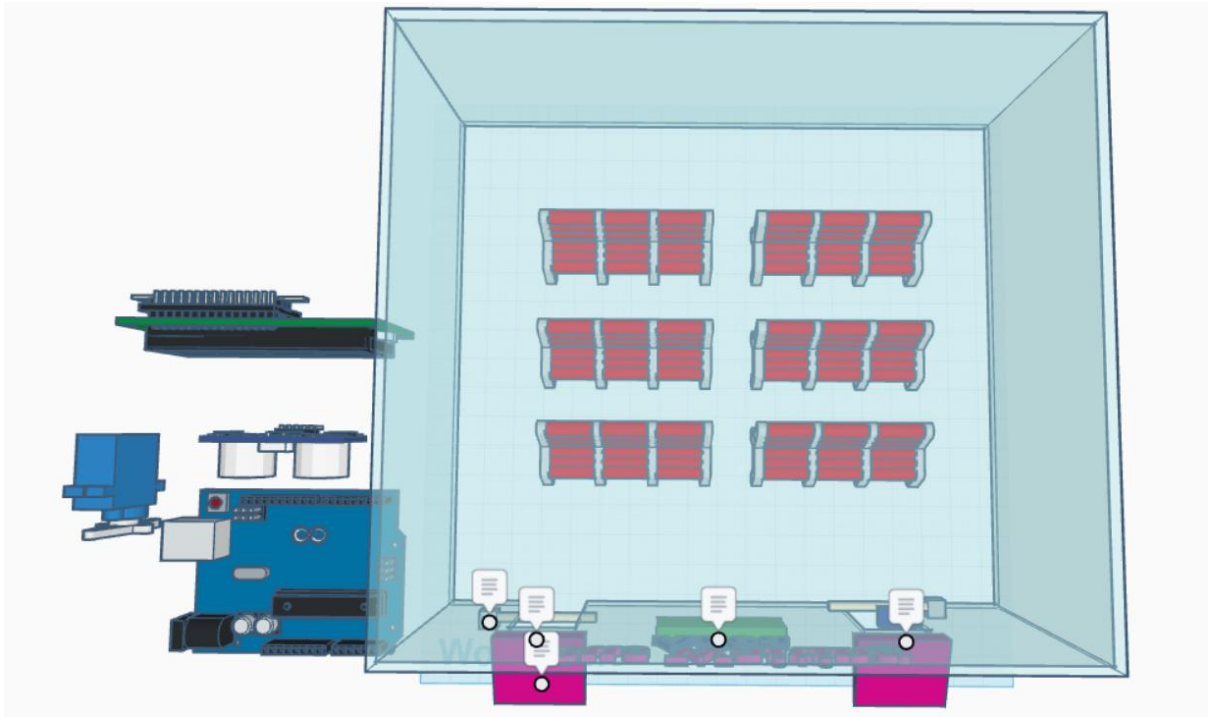

```
=== Exit Gate ===
Person detected. Gate opening...
People in area: 7
=== Exit Gate ===
Person detected. Gate opening...
People in area: 6
=== Exit Gate ===
Person detected. Gate opening...
People in area: 5
=== Exit Gate ===
Person detected. Gate opening...
People in area: 4
=== Exit Gate ===
Person detected. Gate opening...
People in area: 3
=== Exit Gate ===
Person detected. Gate opening...
People in area: 2
=== Exit Gate ===
Person detected. Gate opening...
People in area: 1
=== Exit Gate ===
Person detected. Gate opening...
People in area: 0
```

3D Model Design

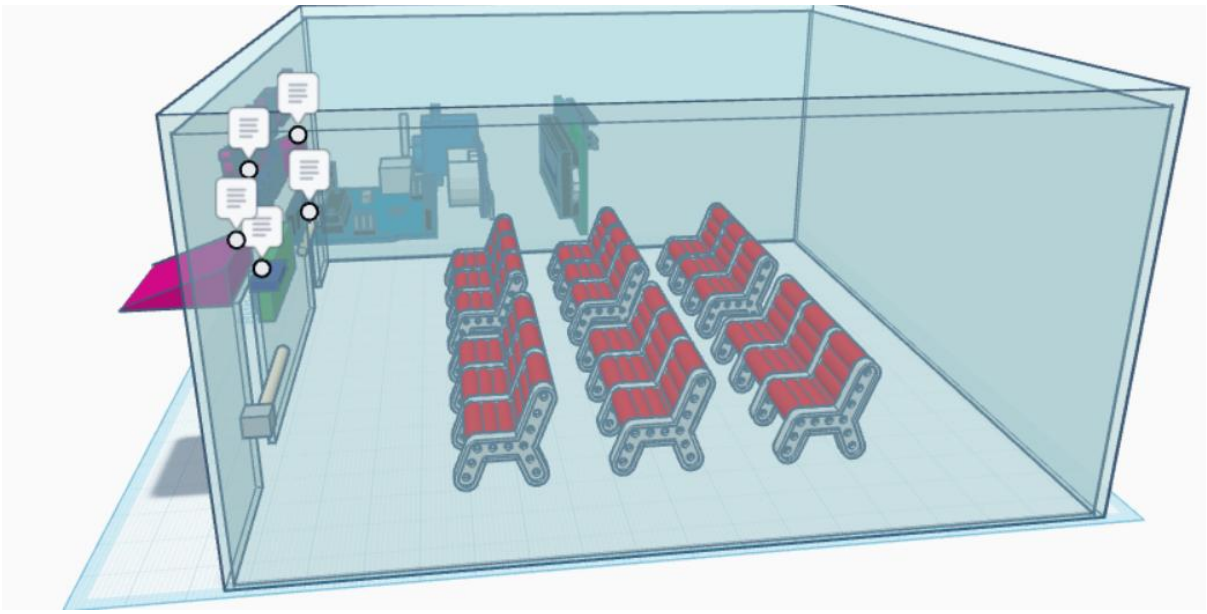
Front view



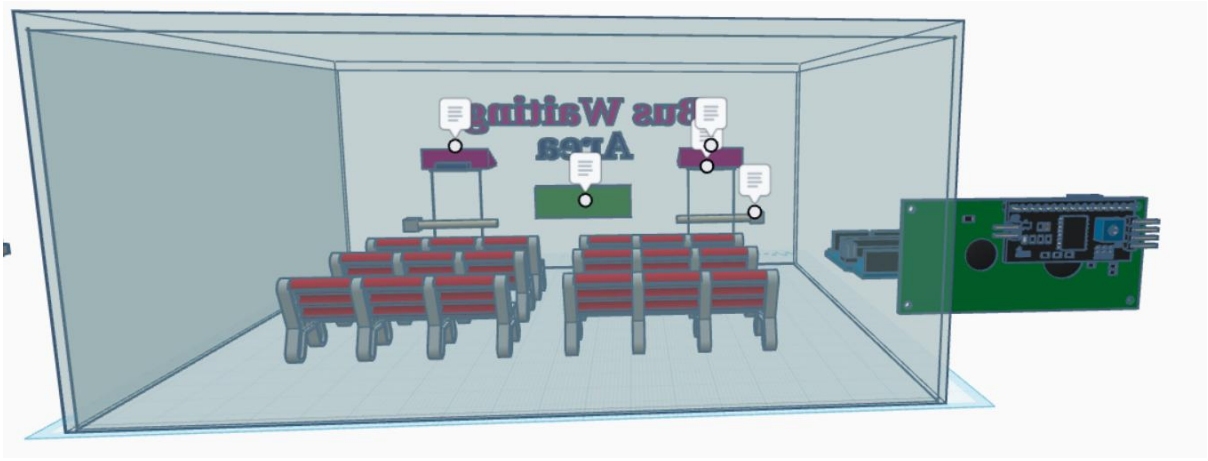
Top View



Side View



Back View



Analysis

The system was successfully implemented and tested. Key results include:

- Detection Accuracy:
  The ultrasonic sensors accurately detected individuals within a range of 2 cm to 100 cm.

- Gate Operation:
  The servo motors reliably opened and closed the gates within 2 seconds, ensuring smooth operation.

- Capacity Management:
  The counter system effectively tracked the number of people in the waiting area and denied entry when the maximum capacity (20 people) was reached.

- LCD Display:
  The LCD provided clear and real-time updates on the current count, enhancing usability.

Table : Summary of Results

Parameter	Value Achieved
Detection Range	2 cm – 100 cm
Gate Response Time	2 seconds
Maximum Capacity	20 people
Delay to avoid continuous triggering	200 milliseconds
Detection Accuracy	100 %

Discussion

The Automated Bus Waiting Area Entrance System successfully addresses the problem of overcrowding in public transportation facilities. By integrating ultrasonic sensors, servo motors, and an Arduino microcontroller, the system provides an efficient and reliable solution. However, the system's performance is influenced by environmental factors such as sensor placement and external noise, which may slightly affect detection accuracy.

Conclusion

The project demonstrates the feasibility of automating access control in bus waiting areas. It enhances commuter safety, improves operational efficiency, and reduces the need for manual supervision. Future enhancements could include:

- Integrating a mobile app for real-time monitoring and control.
- Using advanced sensors for improved accuracy.

References

1. Arduino Documentation. (n.d.). Retrieved from https://www.arduino.cc/
2. LiquidCrystal_I2C Library Guide. (n.d.). Retrieved from https://github.com/johnrickman/LiquidCrystal_I2C
3. Servo Motor Control with Arduino. (n.d.). Retrieved from https://www.learnrobotics.org/blog/servo-motor-tutorial/
4. Ultrasonic Sensor Datasheet. (n.d.). Retrieved from https://www.micropik.com/PDF/HCSR04.pdf

Link to wokwi project : https://wokwi.com/projects/416279650721709057

Link to 3D Design : https://wokwi.com/projects/416279650721709057

Automated Skateboard Park Entrance System

1. Introduction

The purpose of this project is to develop an automated system to manage access to a skateboard park, ensuring safe and controlled entry and exit of skaters. The system uses ultrasonic sensors to detect skaters at the entrance and exit gates, servo motors to automate gate operations, and an LCD display to show the current number of skaters inside the park. This system is designed to reduce manual supervision and provide real-time monitoring of park occupancy. The project builds on the principles of embedded systems and automation, integrating hardware components like Arduino Uno, ultrasonic sensors, servo motors, and an LCD. It is particularly beneficial in limiting the number of skaters allowed into the park at any given time, thereby enhancing safety and ensuring compliance with capacity restrictions.

2. Background

Skateboard parks are popular recreational spaces that often face challenges in managing the number of users within the facility. Overcrowding not only diminishes the skating experience but also increases the risk of accidents. Traditional methods of monitoring park capacity, such as manual counting or ticket systems, are prone to errors and inefficiencies. Automation offers a modern solution by providing real-time, accurate, and hands-free management of park access. This project leverages readily available components to create a cost-effective system suitable for small to medium-sized skateboard parks.

3. Key Concepts

- **Embedded Systems:** Integration of hardware and software to perform specific tasks.
- **Ultrasonic Sensing:** Using sound waves to detect object proximity.
- **Servo Motor Control:** Precise movement of gates for entry and exit management.
- **Real-Time Monitoring:** Displaying live updates of park occupancy on an LCD.

4. Methodology

4.1 Hardware Setup:

- **Arduino Uno**: Serves as the microcontroller to coordinate the system.
- **Ultrasonic Sensors**: Two HC-SR04 sensors are positioned at the entrance and exit gates to detect skaters based on distance.
- **Servo Motors**: Two servo motors control the movement of the gates, opening and closing based on sensor inputs.
- **LCD Display**: A 16x2 I2C LCD is used to display the current number of skaters inside the park.
- **Power Supply**: The components are powered through the Arduino board and an external power source.

4.2 Software Implementation:

- The system is programmed using the Arduino IDE. The code uses libraries for servo motor control and I2C communication with the LCD.
- Ultrasonic sensors measure the distance to detect skaters within a predefined threshold.
- The servo motors open the gates when a skater is detected, incrementing or decrementing the skater count based on the gate (entrance or exit).
- The LCD display updates in real time to show the current number of skaters.

4.3 Operational Logic:

- At the entrance gate, if a skater is detected and the park is not full, the gate opens, the skater count increments, and the gate closes.
- At the exit gate, if a skater is detected, the gate opens, the skater count decrements, and the gate closes.
- If the park is full, the entrance gate remains closed, and an alert is shown on the Serial Monitor.

5. ALP Code

```
        // Arduino project for car parking using two ultrasonic sensors and two servo motors

#include <Servo.h>

#include <Wire.h>

#include <LiquidCrystal_I2C.h>



// Define pins for ultrasonic sensors

#define TRIG_PIN_1 2

#define ECHO_PIN_1 3

#define TRIG_PIN_2 4

#define ECHO_PIN_2 5
```

```
// Define the servo motor pins

#define SERVO_PIN_1 6

#define SERVO_PIN_2 7
```

```
// Define the distance threshold for skater

#define DISTANCE_THRESHOLD 100
```

```
// Create servo objects

Servo gateServo1;

Servo gateServo2;
```

```
// Initialize the I2C LCD, set address 0x27 and dimensions 16x2

LiquidCrystal_I2C lcd(0x27, 16, 2);
```

```
// Skater counter variable

int skaterCounter = 0;
```

```
// Maximum number of skaters allowed

#define MAX_SKATERS 10
```

```
void setup() {

  // Initialize serial communication

  Serial.begin(9600);
```

```
  // Set up ultrasonic sensor pins

  pinMode(TRIG_PIN_1, OUTPUT);

  pinMode(ECHO_PIN_1, INPUT);

  pinMode(TRIG_PIN_2, OUTPUT);

  pinMode(ECHO_PIN_2, INPUT);
```

```
  // Attach the servo motors
  gateServo1.attach(SERVO_PIN_1);
  gateServo2.attach(SERVO_PIN_2);
```

```
  // Close the gates initially
  gateServo1.write(0);
  gateServo2.write(0);
```

```
  // Initialize the LCD
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("Skaters in park:");
  lcd.setCursor(0, 1);
  lcd.print(skaterCounter);
}
```

```
// Function to measure distance using an ultrasonic sensor
long measureDistance(int trigPin, int echoPin) {
  // Send a 10us pulse to trigger the ultrasonic sensor
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
```

```
  // Measure the duration of the echo pulse
  long duration = pulseIn(echoPin, HIGH);
```

```
  // Calculate the distance (in cm)
  long distance = duration * 0.034 / 2;
```

```
  return distance;
}
```

```
void updateLCD() {
  lcd.setCursor(0, 1);
  lcd.print("                "); // Clear the second line
  lcd.setCursor(0, 1);
  lcd.print(skaterCounter);
}
```

```
void loop() {
  // Measure distance at the entrance
  long distance1 = measureDistance(TRIG_PIN_1, ECHO_PIN_1);


  // Measure distance at the exit
  long distance2 = measureDistance(TRIG_PIN_2, ECHO_PIN_2);
```

```
  // Check if the distance at the entrance is below the threshold
```

```
if (distance1 <= DISTANCE_THRESHOLD) {

  if (skaterCounter < MAX_SKATERS) {

    Serial.println("=== Entrance Gate ===");

    Serial.println("Skater detected. Gate opening...");

    gateServo1.write(90); // Open the entrance gate

    delay(2000); // Keep the gate open for 3 seconds

    gateServo1.write(0); // Close the entrance gate

    skaterCounter++; // Increment the skater counter

    Serial.print("Skaters in park: ");

    Serial.println(skaterCounter);

    updateLCD();

  } else {

    Serial.println("=== Entrance Gate ===");

    Serial.println("Park full. No entry allowed.");

  }

}
```

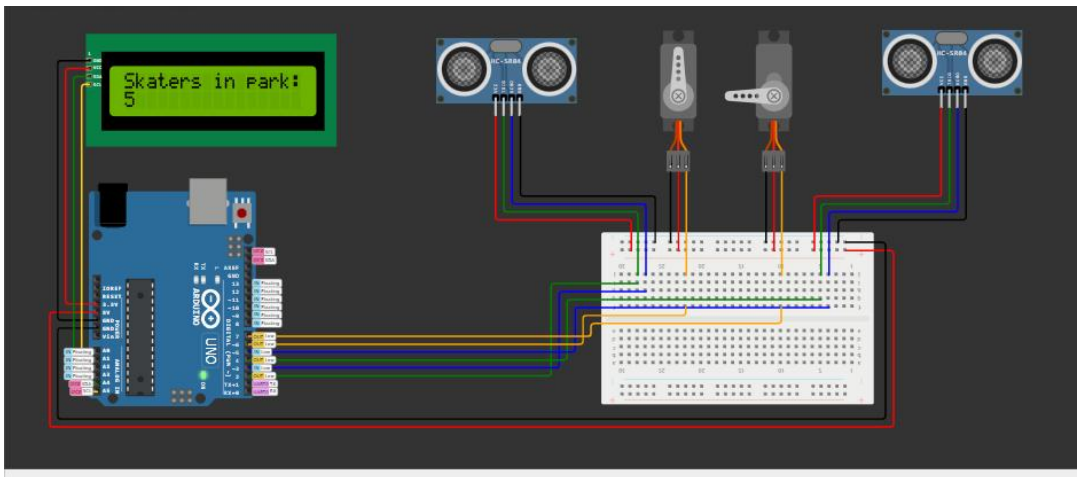
```
// Check if the distance at the exit is below the threshold

if (distance2 <= DISTANCE_THRESHOLD) {

  if (skaterCounter > 0) {

    Serial.println("=== Exit Gate ===");

    Serial.println("Skater detected. Gate opening...");

    gateServo2.write(90); // Open the exit gate

    delay(2000); // Keep the gate open for 3 seconds

    gateServo2.write(0); // Close the exit gate

    skaterCounter--; // Decrement the skater counter

    Serial.print("Skaters in park: ");
```

```
      Serial.println(skaterCounter);

      updateLCD();

    } else {

      Serial.println("=== Exit Gate ===");

      Serial.println("No skaters in park to exit.");

    }

  }
```

```
  // Small delay to avoid continuous triggering

  delay(100);

}
```

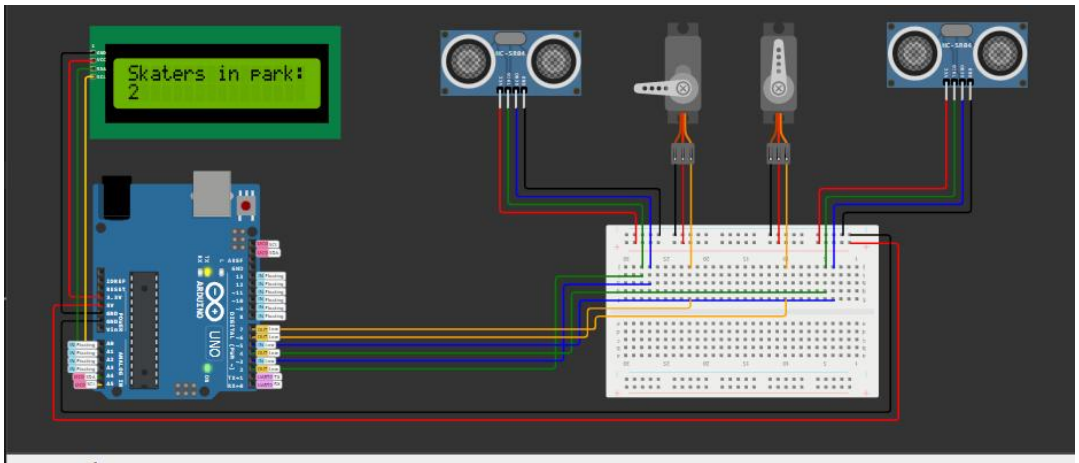
6. Results

6.1 Entrance Gate




```
=== Entrance Gate ===
Skater detected. Gate opening...
Skaters in park: 1
=== Entrance Gate ===
Skater detected. Gate opening...
Skaters in park: 2
=== Entrance Gate ===
Skater detected. Gate opening...
Skaters in park: 3
```

6.2 Exit Gate




```
=== Exit Gate ===
Skater detected. Gate opening...
Skaters in park: 5
=== Exit Gate ===
Skater detected. Gate opening...
Skaters in park: 4
=== Exit Gate ===
Skater detected. Gate opening...
Skaters in park: 3
=== Exit Gate ===
```

7. Analysis

7.1 System Testing:

- The ultrasonic sensors successfully detected skaters within a distance of 15 cm to 100 cm.
- The servo motors reliably opened and closed the gates within a delay of 2 seconds, ensuring smooth operation.
- The LCD displayed accurate skater counts throughout the tests, updating instantly after gate operations.

7.2 Key Observations:

- The system prevented entry when the park reached its maximum capacity (10 skaters).
- False triggers due to environmental noise (e.g., wind or objects) were minimized by setting an appropriate distance threshold.
- The delay between operations ensured that multiple skaters did not trigger the sensors simultaneously.

8. Discussion

The automated skateboard park entrance system demonstrated effective management of skater flow using ultrasonic sensors and servo motors. The use of an LCD provided real-time updates, ensuring transparency and convenience. By automating the gate operations, the need for manual intervention was eliminated, making the system both cost-efficient and user-friendly.

7.1 Future Improvements:

- Use RFID tags to uniquely identify skaters for more precise monitoring.
- Implement a wireless notification system to alert park administrators of capacity status.
- Add weatherproofing for outdoor operation.

9. Conclusion

This project successfully showcased the integration of hardware and software for an automated solution. The system ensures safe and efficient park management, reduces human errors, and enhances user satisfaction. With minor enhancements, it can be adapted for larger or more complex applications, offering scalability and versatility for modern recreational facilities.

10. References

1) Arduino.cc. (n.d.). *Arduino Reference*. Retrieved from [https://www.arduino.cc/reference/en/]
2) HC-SR04 Ultrasonic Sensor Datasheet. (n.d.).
3) Servo.h Library Documentation. (n.d.).

4) LiquidCrystal_I2C Library Documentation. (n.d.).
5) Link to wokwi website : https://wokwi.com/projects/416279650721709057
6) Link to 3D model design : https://www.tinkercad.com/things/43yh4v5d0SF-skateboard-park-counter/edit?returnTo=https%3A%2F%2Fwww.tinkercad.com%2Fdashboard

11.Appendix (3D Model)