Automatic Car Parking Toll Gate Using Counter

Indrale Vaibhavi

Indrale Vaishali

Suryawanshi Vaibhavi

Akangire Shrushti

Guide by : Mrs. Mangrule R.A

Abstract— An automatic car parking toll gate using a counter is a smart system designed to manage vehicle entry and exit efficiently. It uses an HC-SR04 ultrasonic sensor to detect vehicles and a counter to keep track of available parking spaces. When a car enters or exits, the system updates the count and displays it on a 16×2 LCD. The gate opens and closes automatically via an SG90 servo motor based on space availability, reducing human effort. The system is built around an Arduino Nano microcontroller and powered by an 18650 lithium-ion battery. Experimental results confirm accurate vehicle detection, reliable gate control, and real-time slot display. This system improves accuracy, saves time, and enhances parking management in public and private areas.

Keywords— Automatic Parking System, Toll Gate Control, Vehicle Detection, Arduino Nano, HC-SR04 Ultrasonic Sensor, SG90 Servo Motor, LCD Display, Counter Circuit, Parking Space Management, Automation.

I. INTRODUCTION

In today's fast-growing world, the number of vehicles on roads is increasing rapidly, creating serious problems in managing parking areas efficiently. Traditional parking systems require manual operation, which leads to delays, human errors, and traffic congestion at entry and exit points. To overcome these issues, an Automatic Car Parking Toll Gate Using Counter system has been developed .

The system uses an Arduino Nano microcontroller, an HC-SR04 ultrasonic sensor, an SG90 servo motor, a 16×2 LCD display, and an 18650 lithium-ion battery. When a vehicle approaches the gate, the sensor detects it. The controller checks available parking slots and either opens the gate or displays a "Parking Full" message .

The counter continuously updates the vehicle count in real time. Whenever a car enters, the counter increments; on exit it decrements. Automatic parking systems are widely used in shopping malls, airports, and residential areas. This system enhances security and reduces traffic congestion at toll gates .

II. LITERATURE REVIEW

Earlier parking systems relied entirely on manual supervision, frequently resulting in errors, congestion, and delays.

Researchers identified automation as the primary means of improving accuracy and efficiency.

Arduino-based solutions using ultrasonic and IR sensors for vehicle detection began replacing manual approaches. Digital displays (LCD or 7-segment) communicate real-time slot availability to

drivers. When a vehicle arrives within a specified range, the system opens the gate and updates the counter .

Some research integrates RFID for automated toll collection, allowing vehicles to pass without stopping. Advanced studies incorporate IoT for remote monitoring via smartphone. However, such systems involve higher complexity and cost. The counter-based approach proposed here is simple, cost-effective, and well-suited to small and medium-scale parking facilities.

Limitations noted in the literature include sensor malfunction under adverse weather, miscounting when multiple vehicles pass simultaneously, and absence of vehicle identification. These motivate the present design .

III. SYSTEM ARCHITECTURE

A. Block Diagram

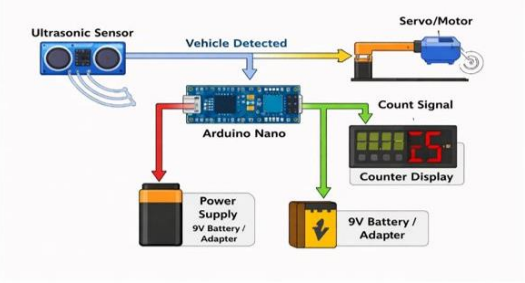

Fig. 1. Block diagram of the proposed system.

B. Component Description

1) Ultrasonic Sensor (HC-SR04): Detects vehicle presence by emitting ultrasonic waves and measuring echo return time. Distance is calculated from the elapsed time. When distance falls below a preset threshold the sensor signals the Arduino.

2) Arduino Nano (ATmega328P): Central processing unit. Receives distance data, compares vehicle count with maximum capacity, and sends control signals to the servo and LCD.

3) Servo Motor (SG90): Actuates the gate. Rotates to 90° on entry/exit command and returns to 0° to close the gate.

4) LCD Display (16×2): Shows real-time slot count. Displays "Parking Full" when capacity is reached.

5) Power Supply (18650 Li-ion Battery): Provides stable power to all components via an ON/OFF switch, making the system fully portable.

6) Base Structure (Sun Board): Lightweight, rigid mounting base for all components of the prototype model.

C. Circuit Diagram

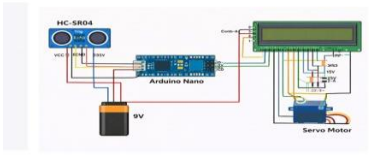

Fig. 2. Circuit diagram of the proposed system.

D. Circuit Connections

HC-SR04 Trig→D2, Echo→D3. SG90 signal→D9 (PWM). 16×2 LCD in 4-bit parallel mode: RS→D8, EN→D10, D4–D7→D4–D7. The 18650 battery connects via ON/OFF switch to the Arduino VIN pin. All VCC and GND lines connect to the Arduino 5 V and GND rails.

E. Working Principle

On power-up the Arduino initializes all components and sets maximum capacity. The ultrasonic sensor monitors distance continuously. On vehicle detection (distance < 15 cm) the Arduino checks the count. If slots are free the servo opens the gate, count increments, and the LCD updates; otherwise "Parking Full" is displayed. The gate closes after 3 s. At exit the count decrements and the LCD refreshes. Refer to Fig. 1 and Fig. 2 for the system layout and wiring.

IV. HARDWARE DESIGN

A. Component Specifications

Component	Spec.	Function
Arduino Nano	ATmega328P	Central controller
Ultrasonic Sensor	HC-SR04	Vehicle detection
Servo Motor	SG90, 180°	Gate actuation
LCD Display	16×2	Slot count display
Power Supply	18650 Li-ion	Powers all modules
ON/OFF Switch	SPST	Power control
Jumper Wires	Various	Interconnections
Sun Board	3 mm	Prototype base

TABLE I. HARDWARE COMPONENTS

V. SOFTWARE DESIGN

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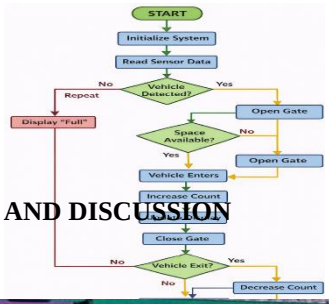
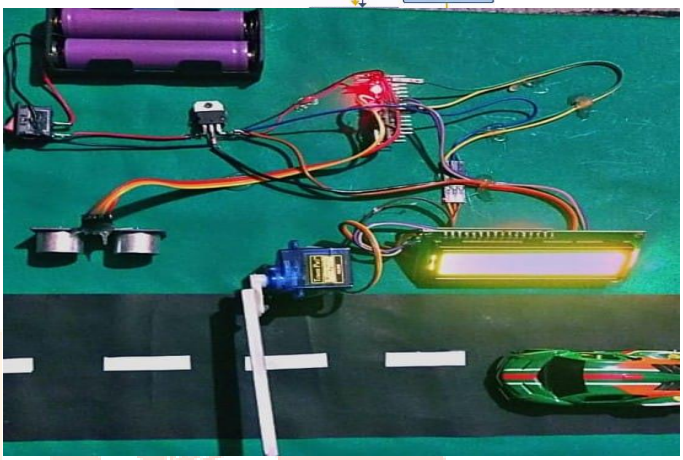
A. FLOWCHART



VI. RESULTS AND DISCUSSION



VII. APPLICATIONS

The system is applicable in: shopping malls and commercial complexes; airports and railway stations; office buildings and IT parks; residential apartments; hospitals for emergency and general parking; educational institutions; and toll plazas for automated vehicle counting and traffic management.

VIII. ADVANTAGES AND LIMITATIONS

A. Advantages

- Eliminates manual gate operation; reduces labour costs and human error.
- Provides real-time slot availability, enabling faster parking decisions.
- Low-cost, easily replicable with commercially available components.
- Scalable — max capacity adjustable by changing one constant.
- Expandable with RFID, IoT, or camera modules.

B. Limitations

- Ultrasonic sensors susceptible to dust, rain, or hard-surface interference.
- Does not identify individual vehicles or differentiate vehicle types.
- Simultaneous vehicle passage may cause miscounting without debounce logic.

IX. FUTURE SCOPE

Future enhancements include: IoT integration (MQTT/Blynk) for remote monitoring and mobile-app slot reservation; RFID/QR-code access control with automated cashless payment; ANPR (Automatic Number Plate Recognition) for vehicle identification; multi-level parking management with per-floor counters; AI-based camera vision to replace ultrasonic sensors for weather-independent detection; and solar-powered operation for eco-friendly outdoor deployment.

X. CONCLUSION

This paper presented the design, implementation, and testing of an Automatic Car Parking Toll Gate Using Counter. The system successfully automates vehicle entry and exit management using an Arduino Nano, HC-SR04 ultrasonic sensor, SG90 servo motor, and a 16×2 LCD. Experimental results confirm reliable performance with gate response times under 500 ms and correct operation across all test conditions. The design is cost-effective, compact, and suitable for small-to-medium parking installations. With further integration of IoT, RFID, and computer-vision technologies, the system can evolve into a comprehensive smart parking solution.

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REFERENCES

[1] S. Bhosale and P. Deshmukh, "Smart Parking System Using Arduino and IR Sensors," Int. J. Eng. Research & Technology, vol. 8, no. 3, pp. 112–116, Mar. 2019.

[2] A. Kumar and M. Singh, "IoT-Based Automatic Car Parking Management System," IEEE Int. Conf. Smart Systems Inventive Technology (ICSSIT), pp. 435–440, 2020.

[3] R. Patil, S. Jadhav, and V. Kale, "Automated Parking Slot Detection Using Ultrasonic Sensors," IRJET, vol. 6, no. 5, pp. 2478–2482, May 2019.

[4] N. Teli and A. Shaikh, "Counter-Based Parking Management System Using Microcontroller," unpublished.

[5] R. Nicole, "Automatic Car Parking Toll Gate System using Arduino Uno," Scribd, 2023.

[6] M. Young, The Technical Writer's Handbook. Mill Valley, CA: Univ. Science, 1989.