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IOT Based Car Parking System

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ABSTRACT

Car-parking shortages in urban areas create significant congestion, fuel waste, and inconvenience for drivers searching for available spaces. To address these growing challenges, this paper proposes an Iot-based smart parking system designed for large parking lots, aimed at optimizing parking management and improving user experience. The system provides real-time information on the nearest available parking slot, helping drivers quickly locates a free space and reducing traffic caused by parking searches.
The proposed design integrates an Arduino microcontroller, infrared (IR) detectors, a servo motor, and a 16x2 I2C display. The Arduino functions t the central controller, managing sensor data and operating the entry and exit mechanisms. IR sensors are used
To detect vehicle movement at the gates and determine slot occupancy within the parking lot. A servo motor controls the automated opening and closing of entry and exit gates based on sensor input. At the parking lot entrances, the I2C display shows the number of available slots, enabling drivers to make informed decision before entering.
By combining Iot technology with real-time monitoring, this system reduces congestion, saves time, and enhances parking efficiency, offering a practical and scalable solution for modern urban environments.

1.1 INTRODUCTION

With rapid urbanization and the continual rise in the number of vehicles, the demand for efficient parking management systems has increased significantly. Traditional parking method often results in challenges such as unnecessary congestion, time wastage, manual dependence, and inefficient space utilization. To address these issues, automation has become an essential requirement in modern parking infrastructure. The integration of microcontroller-based systems provides a cost-effective and reliable solution to this growing problem. This research focuses on the development of an **Arduino-based Automatic Car Parking System** using infrared (IR) sensors, a servo-operated gate mechanism, and an exit by analysing the sequences of IR sensor activations. Based on this sequence, the microcontroller updates the availability of parking slots while controlling the gate's opening and closing mechanism. The implementation demonstrates how embedded systems and basic automation can significantly improve parking efficiency, reduce human intervention, and prevent unauthorized access.
The project offers a simple yet effective prototype that can be scaled for smart parking applications in commercial complexes, residential buildings, shopping malls, and public parking facilities. Through this research, we aim to highlight the potential 0ppof low-cost microcontroller technologies in building automated, energy-efficient, and user-friendly parking systems that contribute toward smart city development.

1.2 LITERATURE REVIEW

The growth of urban transportation and increasing vehicle density has led to a significant demand for automated parking solutions. Many researchers have explored different technologies to make parking system more reliable, efficient, and user-friendly. Early studies primarily focused on manual parking management, where security person is responsible for monitoring vehicle movement and maintaining records. However, these systems were often prone to human error, delays, and inefficiency in handling park traffic conditions.

Subsequent research introduced infrared (IR) sensor-based vehicle detection, which improved accuracy compared to manual observation. IR sensors became widely used because of their low cost, simple implementation, and reliable object detection capability. Several studies demonstrated that IR sensor-based systems could successfully detect entry and exit of vehicles; however, many early models lacked proper sequence detection an were unable to differentiate between incoming and outgoing vehicles, leading to incorrect slot counting further advancement explored the use of RFID (Radio Frequency Identification) and camera-based image processing for vehicle detection and authentication. RFID methods provided improved security and automation but required RFID-tagged vehicles, making them expensive for large-scale deployment. Camera-based system offered high accuracy but were limited by lighting conditions, required high processing hardware, and were not suitable for low budget prototypes or small private parking areas.

Recent studies have highlighted the effectiveness of microcontroller-based solutions, especially those built using Arduino, due to their simplicity, low cost, and flexibility. Arduino-based parking models in earlier research successfully utilized ultrasonic or IR sensors to count vehicles and servo-driven barriers. However, many of these implementations lacked smooth gate control, bidirectional sensing, or real-time display systems.

The literature clearly shows gap in low cost, accurate, bidirectional car detection systems that can handle both entry and exit events using simple hardware. To address this gap, the present research integrates IR sequence detection, smooth servo actuation, and LCD-based slot display to develop a more efficient and reliable parking system. This approach aligns with current trends in smart city development while maintaining affordability and ease of implementation.

1.3 METHODOLOGY

The system is developed using Arduino, IR sensors, a servo motor, and n LCD display. Two IR sensors re installed at the entry and exit points to detect vehicle movement based on the sequence in which they are triggered. When a car enters, IR1 activates first followed by IR, and the slot count decreases. Similarly, for exit, IR2 triggers before IR1, increasing the slot count.

The Arduino processes these sensor signals and controls the servo motor to open or close the gate automatically. The LCD continuously displays real time information such as available parking slots. A smooth servo rotation function is implemented to ensure controlled and realistic gate movement. All components are connected on a prototype board with proper wiring to ensure stable operation.

After programming the Arduino, the system was tested under different conditions such as single vehicle entry, multiple entries, continuous movement, and sensor misalignment. These tests helped verify the accuracy of vehicle detection, reliability of the counting mechanism, and performance of the parking system.

1.4 CIRCUIT DIAGRAM

The circuit diagram shows how all components are interconnected. The load cell is connected to the HX711 amplifier, which sends digital weight data to the Arduino UNO. The Arduino provides 5V power to the HX711 and the LCD display. The LCD communicates with the Arduino through the I^2C lines (SDA and SCL). A common ground is shared across all components, ensuring stable and accurate operation of the system.

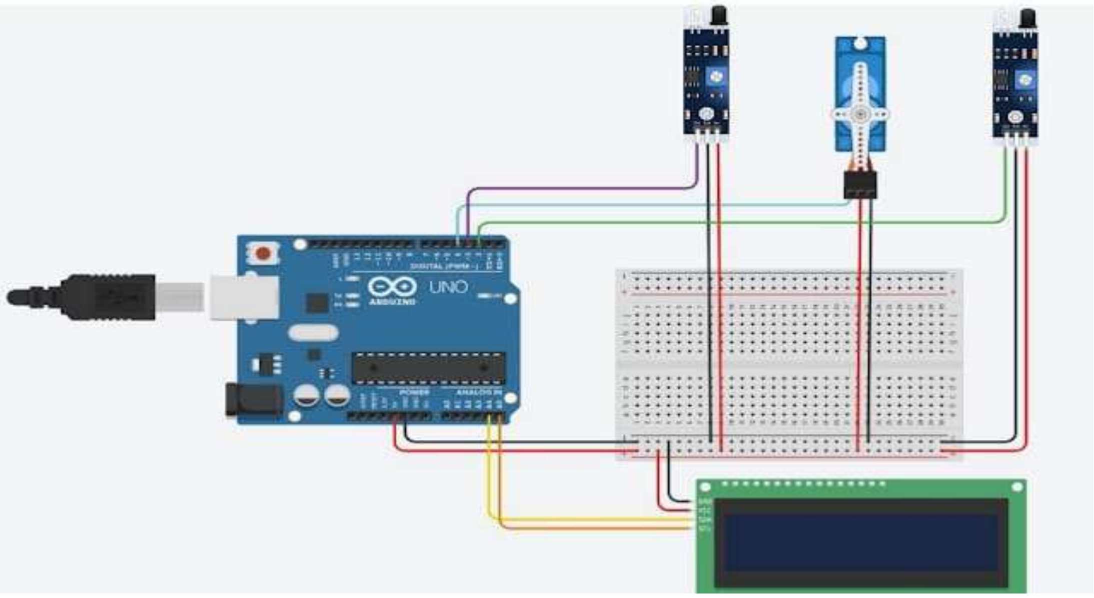

Fig.1 Circuit diagram

1.5 COMPONENTS

1) ARDUINO

The Arduino UNO, shown in fig. 1, is the primary microcontroller used in this system and functions as the central processing unit. It is based on the ATmega328P Microcontroller, which provides 14 digital I/O pins, 6 analog I/O pins, PWM outputs, and a built-in clock. The figure illustrates standard board layout, including the USB interface used for programming and the on-board voltage regulator that ensures stable operation. The Arduino UNO is ideal for embedded system development due to its ease of use, open-source environment and compatibility with wide range of sensors and module. In this project, it performs data acquisition, processing and decision making by reading sensor values, executing control algorithm, and generating outputs accordingly. Its ability to handle real time operations with high reliability makes it suitable for measurement, automation, and monitoring applications. Overall, the Arduino UNO acts as the brain of the entire system.

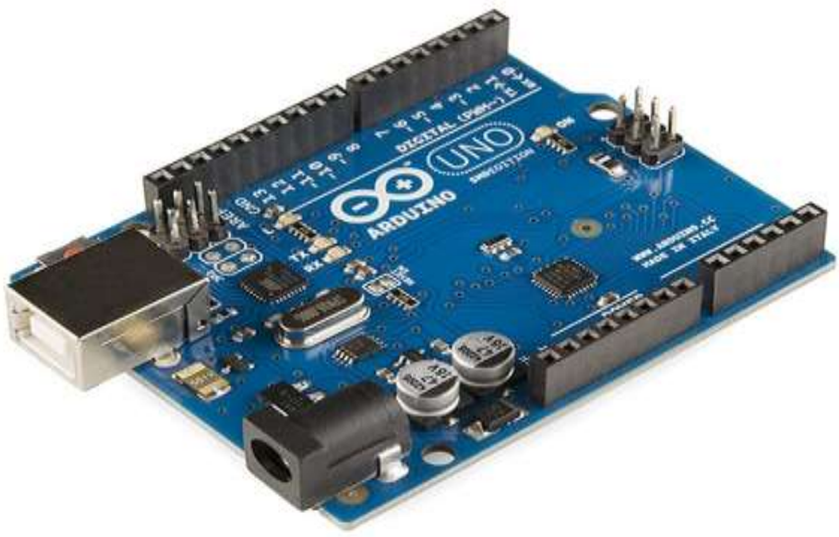

Fig 1: Arduino UNO

2) IR SENSOR

The Infrared (IR) Sensor, shown in Fig. 2, operates on the principle of infrared light transmission and reception. The sensor module typically consists of an IR LED that emits infrared light and a photodiode that detects the reflected light and a photodiode that detects the reflected light. When a vehicle passes in front of the sensor, the reflected IR beam changes, and this variation is converted into a digital signal. In this project, to IR sensors are used-one at the entry gate and another at the exit gate. The Arduino reads their output to determine whether a vehicle is entering or leaving the parking area. Based on these signals, the slot count is updated and the servo-controlled gate is opened or closed. IR sensors are preferred for this application because they are low-cost, reliable, and capable of detecting objects quickly and accurately in real-time environments

Fig.2 IR Sensor

3) SERVO MOTOR

The servo motor, in Fig.3, is an essential component responsible for operating the automatic gate mechanism in parking in the parking system. A servo motor is a closed-loop control device that provides precise angular movement based on the control signal received from the Arduino. It typically consists of a DC motor, a gear system, and a built-in feedback potentiometer that continuously monitors the motor’s position. In this project, the servo is programme to rotate in between 2 specific angles to open and close the gate. When a vehicle is detected by IR sensor at the entrance, the Arduino sends a signal to rotate the servo to 90 degrees, lifting the gate. After the vehicle passes through the second IR sensor, the servo returns to 0 degree, closing the gate. Servo motors are highly reliable, respond quickly, and offer accuracy in movement, making them ideal for automated systems such as barrier control, robotics and parking applications.

Fig.3 Servo Motor

4) LCD

The Liquid Crystal Display (LCD) is used in the project as the primary output device for displaying system information such as slot availability and status messages. A standard 16x2 alphanumeric LCS is employed, which can show sixteen characters pr line across two lines. The display operates on the principle of controlling light through liquid crystal modules when an electric field is applied. To simplify wiring and improve efficiency the LCD is interfaced using the I2C communication moule, which reduces the required connections to only 2 lines. This enables faster data transfer and stable display performance. The LCD offers clear visibility, low power consumption and reliable operation, making it suitable for real-time monitoring applications such as automated parking systems.

Fig.4 LCD 16x2

5) BREADBOARD AND CONNECTING WIRES

A solderless breadboard is used for prototyping and assembling the entire parking system circuit. It allows easy placement and repositioning of components without permanent soldering, enabling quick testing and modification. The breadboard consists of interconnected rows and columns that provides temporary electrical connection for modules such as the IR sensors, servo motor. Its modular structure supports both power rails and signal lines, ensuring organized and reliable circuit development during experimentation.

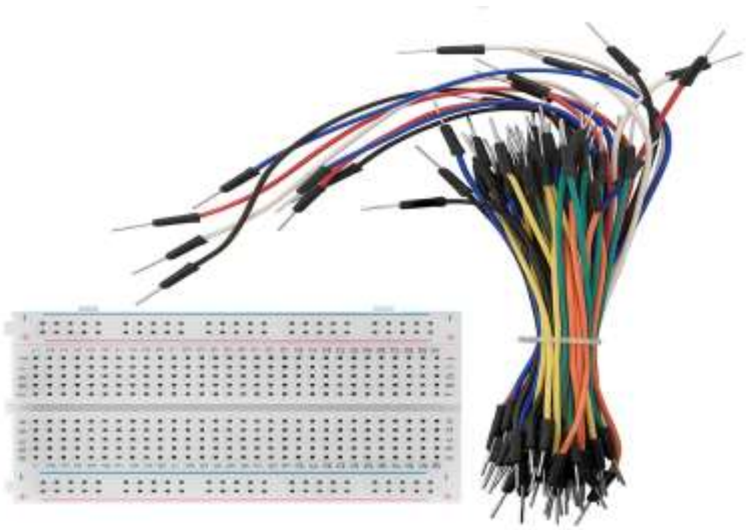

Fig.5 BREADBOARD AND WIRES

Multiple types of jumper wires are uses to interface sensors, modules, and the microcontroller through the breadboard. **Male-to-male wires** enable connections between breadboard nodes, whereas **male-to-female wires** are primarily used to connect modules like the LCD with I2C adapter, servo motor, and IR sensors directly to Arduino pins. These flexible insulated wires ensure stable electrical conduction and support quick reconfiguration of circuit during testing. The use of color-coded wires improves identification, reduces wiring errors, and enhances the overall clarity of the hardware layout.

1.6 WORKING

The automatic parking system operates using a combination of IR sensors, a servo-controlled gate mechanism, and a real-time slot monitoring algorithm implemented on the Arduino. Two IR sensors are placed at the entrance and exit of the parking area. When a vehicle approaches the entry point, the entry IR sensor detects an obstruction in its infrared beam and sends a LOW signal to the Arduino. The system first checks the current availability of parking slots. If at least one slot is free, the Arduino activates the servo motor, which gradually rotates to lift the gate. As the vehicle passes through the entrance, both IR sensors are triggered sequentially, allowing the system to confirm direction and decrement the slot count accurately.

If the parking area becomes full, the system displays **“PARKING FULL”** on the LCD, prevents the servo gate from opening, and activates an LCD to alert incoming drivers. This ensures no additional vehicle enters the area once capacity is reached.

When a vehicle exits, the IR sensor detects movement, and the servo gate opens again. After the vehicle crosses both sensors in the opposite order, the system increments the slot count. Throughout the operation, the LCD continuously updates the number of available slots, ensuring clear communication and smooth parking management. This automated working reduces human intervention and ensures organized vehicle flow in the parking area.

1.7 CONCLUSION

The automated parking system developed in this project successfully demonstrates an efficient and reliable method for managing vehicle entry and exit in confined parking areas. By integrating IR sensors, servo-controlled gate, and an Arduino-based monitoring algorithm, the system ensures accurate detection of vehicle and real-time slot counting. The “parking full” alert mechanism, along with visual display and alarm indication, prevents overcrowding and enhance user safety. The LCD provides continuous updates, making the system easy to understand and operate without human supervision. Overall, the project highlights the potential of low-cost embedded systems to improve automation in public and private parking spaces. The design is simple, scalable, and can be further enhanced with IoT connectivity, RFID access, or mobile- based monitoring, making it a practical solution for modern smart-parking applications.

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