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Smart Car Parking Management System with Real Slot Time Detection and Online Intergration

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ABSTRACT: The rapid increase in the number of vehicles has created major parking problems in urban areas, leading to traffic congestion, fuel wastage, and difficulty in finding vacant parking spaces. To overcome these issues, this project proposes a Smart Car Parking Management System with real-time slot detection and online integration using IoT technology. The system uses IR sensors to detect vacant and occupied parking slots and updates the parking status continuously through a microcontroller such as Arduino or Node MCU. The parking information is transmitted to the cloud server through Wi-Fi connectivity, allowing users to view slot availability using a mobile or web application. The system also supports online parking slot booking and digital payment integration for improved user convenience. Automatic gate control is achieved using a servo motor, while the LCD display shows real-time parking availability. The proposed system reduces manual parking management, minimizes traffic congestion, saves time and fuel, and improves parking efficiency in smart city environments.

I. INTRODUCTION

In today's rapidly growing urban environment, the number of vehicles has increased significantly, leading to major challenges in parking management.

Traditional parking systems often cause traffic congestion, time wastage, fuel consumption, and difficulty in finding available parking spaces. Manual parking monitoring also requires additional manpower and lacks real-time tracking capabilities. To overcome these problems, smart parking systems using IoT technology have become an effective solution for modern parking management.

The Smart Car Parking Management System with Real-Time Slot Detection and Payment Integration is an IoT-based automated parking solution designed to improve parking efficiency, security, and user convenience. The system uses ultrasonic sensors to detect vehicle presence and monitor parking slot availability in real time. RFID technology is used for secure vehicle authentication, while a servo motor automates the opening and closing of the parking gate. An LCD display provides instant information regarding slot availability and parking status for drivers entering the parking area.

The ESP32 microcontroller acts as the core processing unit of the system and controls all connected devices and sensors. The collected parking data is transmitted through Wi-Fi to a Firebase dashboard for real-time monitoring and data management. The Firebase dashboard displays live parking slot status, vehicle entry and exit records, RFID authentication details, and payment information. This cloud-based monitoring system allows users and administrators to access parking information instantly from anywhere, improving efficiency and reducing manual work.



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The proposed smart parking system provides several advantages such as reduced traffic congestion, automated parking operations, secure access control, efficient parking space utilization, and real-time monitoring. The integration of Firebase cloud technology enhances data storage, accessibility, and system reliability. This system can be widely implemented in shopping malls, hospitals, airports, colleges, office buildings, and smart city infrastructures to provide an intelligent and user-friendly parking management solution.

II. LITERATURE REVIEW

The rapid growth of vehicles in urban areas has created serious parking problems such as traffic congestion, fuel wastage, and time consumption. Traditional parking systems do not provide real-time information about vacant parking slots, causing inconvenience to drivers. To overcome these issues, researchers introduced Smart Parking Management Systems using Internet of Things (IoT) technology for efficient parking monitoring and management.

Many research works focused on real-time parking slot detection using sensors such as IR sensors, ultrasonic sensors, RFID, and camera-based systems. These sensors help in identifying vacant and occupied parking spaces accurately. The collected data is transmitted through wireless communication technologies like Wi-Fi and GSM to cloud servers or mobile applications for live monitoring and user access.

Several studies also proposed mobile and web application integration for smart parking systems. Through these applications, users can view available parking slots, reserve parking spaces online, and make digital payments.

Online integration improves user convenience, reduces manual work, and helps in better parking management. Some systems also provide automatic vehicle entry and exit monitoring using RFID technology.

From the literature review, it is observed that existing systems mainly focus on either slot detection or online reservation separately. Therefore, the proposed Smart Car Parking Management System combines real-time slot detection, IoT communication, cloud connectivity, and online payment integration into a single platform. This system aims to reduce traffic congestion, save time, and improve parking efficiency in smart city environments.

III. PROBLEM STATEMENT

In modern urban areas, the rapid increase in the number of vehicles has created major parking challenges such as traffic congestion, fuel wastage, and difficulty in finding vacant parking spaces. Traditional parking systems require drivers to manually search for available slots, which consumes more time and increases stress for users. Lack of proper parking management also leads to inefficient space utilization and unnecessary vehicle movement inside parking areas.

Existing parking systems often do not provide real-time slot availability or online booking facilities. In many places, drivers are unable to know whether parking spaces are available before entering the parking area. Manual fee collection methods may also cause delays, errors, and inconvenience for both users and parking administrators.

To overcome these problems, there is a need for an efficient Smart Car Parking Management System with real-time slot detection and online integration. The proposed system uses IoT technology and sensors to monitor parking slot availability in real time and provides users with online parking reservation and payment facilities. This helps reduce traffic congestion, save time, improve parking efficiency, and enhance user convenience.

IV. OBJECTIVES

To develop a Smart Car Parking Management System using IoT technology. To detect vacant and occupied parking slots in real time using sensors.

To reduce traffic congestion and time consumption caused by manual parking search. To provide online parking slot booking and reservation facilities for users.

To integrate digital payment methods for easy and secure parking fee collection. To improve parking space utilization and parking management efficiency.

To provide real-time parking information through mobile or web applications.

To reduce fuel wastage and environmental pollution caused by unnecessary vehicle movement.



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V. PROPOSED SYSTEM

The proposed system is an intelligent IoT-enabled Smart Car Parking Management System designed using the ESP32 platform for real-time parking slot detection, automated vehicle access control, and payment integration. The system uses ultrasonic sensors to continuously monitor parking slot availability and RFID technology for secure vehicle authentication. A servo motor is used to automate the parking gate, while an LCD display provides instant parking status information.

VI. MATERIALS AND METHODS

Materials Used

Hardware Requirements

- Arduino / Node MCU Microcontroller
- IR Sensors for vehicle detection
- Wi-Fi Module for internet connectivity
- Servo Motor for automatic gate control
- LCD Display for slot status indication
- RFID Module for vehicle identification (optional)
- Power Supply Unit
- Connecting Wires and Breadboard

Software Requirements

- Arduino IDE for programming
- Embedded C Programming Language
- IoT Cloud Platform / Database
- Mobile or Web Application for online monitoring and payment Dataset

VII. IMPLEMENTATION

The implementation of the Smart Car Parking Management System is carried out using IoT technology, sensors, and online integration modules. IR sensors are installed in each parking slot to detect the presence or absence of vehicles. These sensors continuously monitor the parking area and send the slot status data to the microcontroller.

A Arduino or Node MCU microcontroller is used as the main control unit of the system. The microcontroller processes the sensor data and updates the parking slot availability in real time. Through Wi-Fi connectivity, the information is transmitted to the cloud server and displayed in the mobile or web application.

The system also includes online integration features such as parking slot reservation and digital payment. Users can check available slots, book parking spaces, and make online payments through the application. A servo motor is used for automatic gate control during vehicle entry and exit operations.

An LCD display is connected to the system to show the number of vacant parking slots at the parking entrance. The complete implementation helps reduce manual parking management, minimizes traffic congestion, and improves parking efficiency and user convenience.

VIII. METHODOLOGY

The proposed Smart Car Parking Management System is developed using IoT technology for real-time parking slot monitoring and online integration. The methodology begins with installing IR sensors in each parking slot to detect vehicle presence. These sensors continuously monitor whether the parking slots are occupied or vacant.

The sensor data is collected and processed using a Arduino or Node MCU microcontroller. Based on the sensor readings, the system updates the parking slot status in real time. The processed data is then transmitted to the cloud server using Wi-Fi communication for remote monitoring and data storage.



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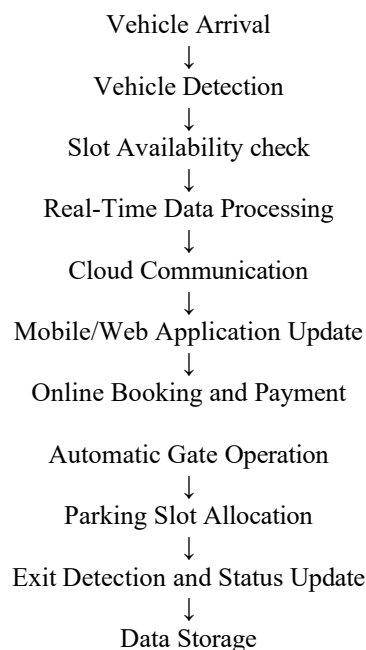
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Users can access parking information through a mobile or web application. The application displays available parking slots, supports online reservation, and enables digital payment integration. When a vehicle enters or exits the parking area, the system automatically updates the slot availability and controls the entry gate using a servo motor.

The overall methodology improves parking efficiency by reducing manual work, minimizing traffic congestion, saving time, and providing a user-friendly smart parking solution for modern urban environments.

IX. ACTUAL PROJECT MODEL

System Workflow



Explanation

The Smart Car Parking Management System is developed using IoT technology to improve parking management and reduce traffic congestion. In this system, IR sensors are placed in each parking slot to detect whether the slot is occupied or vacant. The sensor data is continuously collected and processed by the Arduino or Node MCU controller.

The updated parking information is transmitted to the cloud server through Wi-Fi connectivity, allowing users to view real-time parking availability through a mobile or web application. The system also provides online slot booking and digital payment facilities for user convenience.

A servo motor is used for automatic gate control during vehicle entry and exit operations, while the LCD display shows the number of available parking spaces. This complete system helps save time, reduce fuel wastage, and improve parking efficiency in smart city environments.



X. CIRCUIT DIAGRAM

3.1 CIRCUIT DIAGRAM

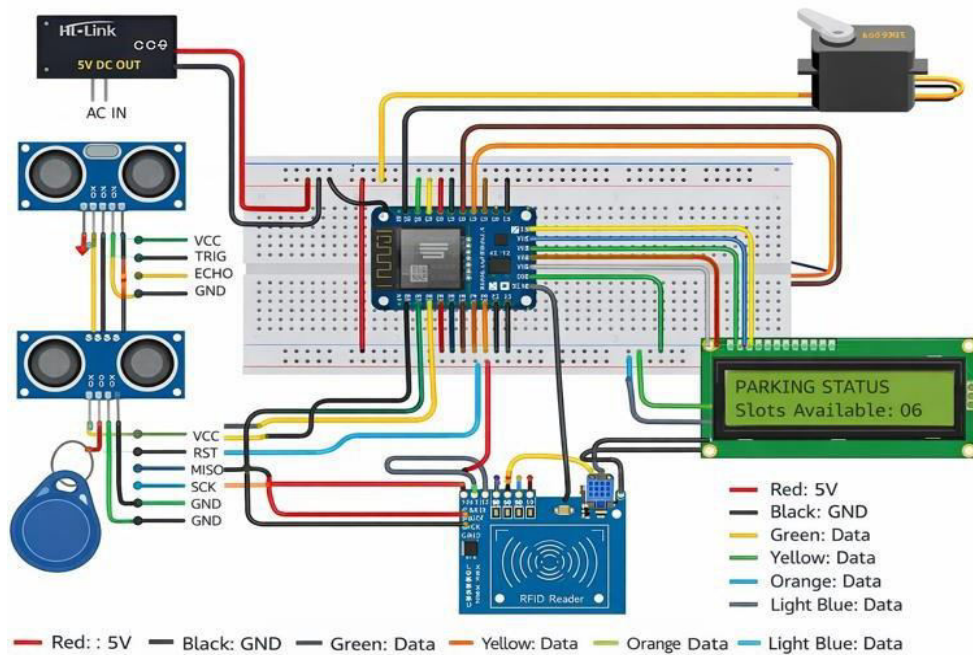


Fig. 3.1 circuit diagram of the system.

XI. RESULTS

The proposed Smart Car Parking Management System successfully detects vacant and occupied parking slots in real time using IoT technology.

The system provides accurate parking availability information through mobile or web applications and supports online booking and digital payment integration.

Automatic gate control and real-time monitoring help reduce traffic congestion, fuel wastage, and manual parking management efforts. The overall system improves parking efficiency, saves time, and enhances user convenience.

Result Analysis

- The system successfully detected vacant and occupied parking slots in real time.
- IR sensors provided accurate vehicle detection with minimal delay.
- IoT communication enabled continuous cloud-based parking status updates.
- The mobile/web application displayed live parking availability effectively.
- Online slot booking and digital payment worked efficiently.
- Automatic gate control reduced manual parking management effort.
- The system minimized vehicle searching time inside the parking area.
- Traffic congestion and fuel wastage were reduced significantly.
- Parking space utilization and management efficiency were improved.
- The proposed system provided a reliable and user-friendly smart parking solution.



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XII. CONCLUSION

The “Smart Car Parking Management System with Real-Time Slot Detection and Payment Integration” using IoT technology provides an efficient and low-cost solution for automated parking management. By integrating the ESP32/Node MCU with ultrasonic sensors, RFID technology, servo motor control, and LCD display, the system successfully monitors parking slot availability, vehicle entry and exit, and secure user authentication in real time. The collected data is processed and transmitted to the Firebase dashboard for continuous monitoring and management.

The system continuously updates parking slot status and generates real-time information regarding available and occupied slots. RFID-based authentication and automated gate control improve parking security and reduce manual intervention. The Firebase dashboard enables remote monitoring of parking activities, vehicle records, and payment details through wireless communication.

This smart parking solution reduces traffic congestion, saves time, improves parking efficiency, and supports the development of smart city infrastructure. The proposed system can be effectively implemented in shopping malls, hospitals, airports, colleges, office buildings, and commercial parking areas.

XIII. FUTURE SCOPE

- The system can be enhanced using AI and machine learning for intelligent parking prediction.
- Camera-based vehicle detection can be added for improved accuracy and security.
- GPS integration can help users navigate directly to vacant parking slots.
- The project can be expanded for smart city and multi-level parking applications.
- Automatic number plate recognition can be implemented for advanced vehicle monitoring.
- Mobile application features can be improved with live notifications and navigation support.
- Solar-powered IoT modules can be used to reduce power consumption.
- Cloud data analytics can be added for better parking management and traffic analysis.
- The system can support multiple digital payment gateways for user convenience.
- Advanced security features and emergency monitoring systems can be integrated in future developments.

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