Parking Slot Detection System Using Web Interface/Android Application

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Abstract— **The rapid increase in the number of vehicles in urban areas has created significant challenges in parking management, leading to traffic congestion, time wastage, and increased fuel consumption. To address these issues, this project proposes an IoT-based Parking Slot Detection System that enables real-time monitoring and efficient utilization of parking spaces through a web interface and Android application.**

The system is implemented using an Arduino Uno, IR sensors, an ESP8266 Wi-Fi Module, LCD display, and LED indicators. IR sensors are installed in each parking slot to detect the presence or absence of vehicles. The collected data is processed by the Arduino and transmitted to the cloud via the ESP8266 module for remote access and monitoring.

The parking status is displayed on both a web interface and an Android application, allowing users to check slot availability in real time. Additionally, an LCD display at the parking entrance provides up-to-date information on available parking spaces, while red and green LEDs indicate the occupancy status of individual slots, improving user convenience and navigation.

The proposed system aims to reduce the time spent searching for parking, minimize traffic congestion, and optimize the use of available parking resources. By integrating IoT technologies with real-time monitoring and control, this project presents a cost-effective, scalable, and user-friendly smart parking solution suitable for modern urban environments.

I. INTRODUCTION

The rapid growth in urbanization and the increasing number of vehicles have created serious challenges in managing parking spaces efficiently. In many cities, drivers spend a considerable amount of time searching for available parking slots, which leads to traffic congestion, fuel wastage, and environmental pollution. Traditional parking systems lack real-time monitoring and do not provide users with information about slot availability, making the process inefficient and time-consuming.

To overcome these challenges, the concept of smart parking systems has emerged as a part of the Internet of Things (IoT). IoT enables communication between physical devices and digital systems, allowing real-time data collection, monitoring, and control. By integrating sensors, microcontrollers, and wireless communication modules, parking systems can be automated and made more efficient.

This project presents an IoT-based Parking Slot Detection System that uses an Arduino, ESP8266, IR sensors, LCD display, and LED indicators to detect and display parking slot availability. The IR sensors are used to identify whether a parking slot is occupied or vacant. The Arduino processes this data and sends it to a web server through the ESP8266 module. Users can then access this information through a web browser or Android application.

Furthermore, an LCD display at the parking area shows the number of available slots, while red and green LEDs provide a visual indication of each slot's status. This system helps drivers quickly identify available spaces, thereby reducing search time and improving traffic flow.

Overall, the proposed system aims to provide a smart, efficient, and cost-effective parking solution by leveraging IoT technology, enhancing user convenience, and contributing to better urban traffic management.

II. REVIEW LITERATURE SURVEY

Several researchers have proposed smart parking systems to address the growing challenges of vehicle congestion and inefficient parking management in urban areas. Sapitri et al. (2025) developed an IoT-based parking system using IR and ultrasonic sensors to detect vehicle presence and provide real-time updates through a mobile application. Their system demonstrated high accuracy and fast response time,

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making it effective for real-time monitoring. However, the use of multiple sensors increases the overall deployment cost, especially for large-scale implementations.

Bansal et al. (2024) presented a cost-effective smart parking system based on the Arduino Uno and IR sensors. Their system displays parking availability through a web interface and emphasizes ease of implementation and affordability. While the system is suitable for small-scale applications, it faces limitations in scalability when deployed in larger parking environments.

Singh et al. (2023) introduced an advanced parking system integrating RFID technology with IoT for automated vehicle entry, exit, and slot monitoring. This approach enhances security and tracking capabilities but increases system complexity and infrastructure cost due to the inclusion of RFID components.

Zhang et al. (2025) proposed a vision-based parking detection system using deep learning techniques such as convolutional neural networks (CNNs). The system uses cameras to monitor parking slots and detect vehicle occupancy with high accuracy. Although this method reduces the need for physical sensors, it is highly dependent on environmental conditions such as lighting and requires significant computational resources.

Kumar and Patel (2022) designed a sensor-based parking system using ultrasonic sensors and IoT communication protocols. Their work focused on efficient data transmission and energy optimization, which are crucial for large-scale deployments. However, sensor maintenance and reliability remain challenges in outdoor environments.

Sharma et al. (2023) developed a smart parking system incorporating Automatic Number Plate Recognition (ANPR) and digital payment integration. This system improves user convenience and automation but introduces higher implementation costs and system complexity.

Overall, the literature indicates that while existing smart parking systems provide effective solutions using IoT, sensors, and computer vision, they suffer from limitations such as high cost, scalability issues, and environmental dependency. Therefore, there is a need for a cost-effective, scalable, and user-friendly system that integrates real-time monitoring with both web and Android platforms. The proposed system addresses these gaps by utilizing IR sensor-based detection, IoT communication, and an integrated user interface for efficient parking management.

III. RESEARCH METHODOLOGY

The proposed IoT-based Parking Slot Detection System is designed to monitor and manage parking space availability in real time using sensor-based detection and wireless communication technologies. The system integrates hardware components such as the Arduino Uno, IR sensors, an ESP8266 Wi-Fi Module, LCD display, and LED indicators with software platforms including a web interface and Android application.

The methodology begins with the deployment of IR sensors in each parking slot to detect the presence or absence of vehicles. These sensors operate by emitting infrared signals and detecting reflections; when a vehicle occupies a slot, the reflected signal changes, indicating occupancy. The sensor data is continuously collected and sent to the Arduino Uno, which acts as the central processing unit of the system. The microcontroller processes the input signals and determines the status of each parking slot as either occupied or vacant.

Once the occupancy status is determined, the processed data is transmitted to a cloud-based server using the ESP8266 Wi-Fi module. This module enables wireless communication, allowing real-time data updates to be shared with remote users. The cloud platform stores and manages the parking data, ensuring accessibility and synchronization across multiple user interfaces.

On the user side, a web interface and an Android application are developed to display parking availability in real time. These interfaces provide a user-friendly dashboard where users can view the status of individual parking slots before entering the parking area. Additionally, an LCD display installed at the parking entrance shows the number of available slots, helping drivers make quick decisions. LED indicators are also placed at each parking slot, where green LEDs indicate vacant slots and red LEDs indicate occupied ones, providing visual guidance to drivers within the parking area.

The system operates in a continuous loop, where sensor data is periodically updated, processed, and transmitted to ensure accurate real-time monitoring. This methodology ensures

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efficient utilization of parking resources, reduces the time spent searching for parking, and minimizes traffic congestion.

Overall, the proposed methodology emphasizes a cost-effective, scalable, and user-friendly approach by combining IoT hardware with real-time software applications, making it suitable for smart parking management in urban environments.

IV. PROPOSED METHODOLOGY

The proposed system presents an IoT-based smart parking solution designed to provide real-time parking slot detection and efficient space management through a combination of hardware and software technologies. The system is developed using the Arduino Uno as the core processing unit, integrated with IR sensors, an ESP8266 Wi-Fi Module, LCD display, and LED indicators.

In the proposed methodology, IR sensors are installed in each parking slot to continuously monitor the presence or absence of vehicles. These sensors detect occupancy based on the reflection of infrared signals. When a vehicle occupies a parking slot, the sensor output changes, and this information is transmitted to the Arduino Uno. The microcontroller processes the sensor inputs and determines the status of each slot in real time.

The processed data is then sent to a cloud server using the ESP8266 Wi-Fi module, enabling wireless communication and remote accessibility. The cloud platform acts as a centralized system for storing and updating parking information. This allows users to access real-time parking availability through a web interface and an Android application. The user interfaces are designed to be simple and intuitive, displaying the status of each parking slot and helping users make informed decisions before entering the parking area.

Additionally, the system incorporates an LCD display at the parking entrance, which shows the total number of available parking spaces. LED indicators are placed at each parking slot to provide immediate visual feedback; green LEDs indicate vacant slots, while red LEDs indicate occupied ones. This dual-level information system (local display and remote access) enhances user convenience and reduces the time spent searching for parking.

The proposed system follows a continuous data acquisition and update mechanism, ensuring that parking information remains accurate and up to date. Compared to existing systems, this approach focuses on cost-effectiveness, ease of implementation, and scalability. By integrating IoT technology with real-time monitoring and user-friendly interfaces, the system provides an efficient and practical solution to modern parking challenges.

V. WORKING PRINCIPLE

The working principle of the proposed IoT-based Parking Slot Detection System is based on real-time sensing, data processing, and wireless communication to monitor parking slot availability. The system utilizes IR sensors, a Arduino Uno, and an ESP8266 Wi-Fi Module to detect and transmit parking status information.

Initially, IR sensors are installed in each parking slot to continuously monitor the presence or absence of vehicles. These sensors emit infrared rays and detect their reflection. When a parking slot is vacant, the infrared rays do not reflect back significantly, indicating an empty slot. When a vehicle occupies the slot, the rays reflect back to the sensor, signaling that the slot is occupied.

The sensor outputs are sent to the Arduino Uno, which processes the signals and determines the status of each parking slot. Based on this input, the microcontroller categorizes each slot as either “occupied” or “vacant.” This processed data is then used for both local display and remote monitoring.

For local visualization, LED indicators are used at each parking slot, where green LEDs indicate available slots and red LEDs indicate occupied slots. Additionally, an LCD display installed at the parking area entrance shows the total number of available parking spaces, enabling drivers to quickly assess parking availability.

For remote monitoring, the Arduino transmits the processed data to a cloud server using the ESP8266 Wi-Fi module. The data is updated in real time and made accessible through a web interface and an Android application. Users can view the current parking status from anywhere, allowing them to plan their parking in advance.

The system operates continuously in a loop, where sensor data is repeatedly collected, processed, and updated. This ensures that the parking information remains accurate and up to date at all times. By combining real-time sensing with IoT-based communication, the system provides an efficient

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and automated solution for smart parking management.

VI. BLOCK DIAGRAM

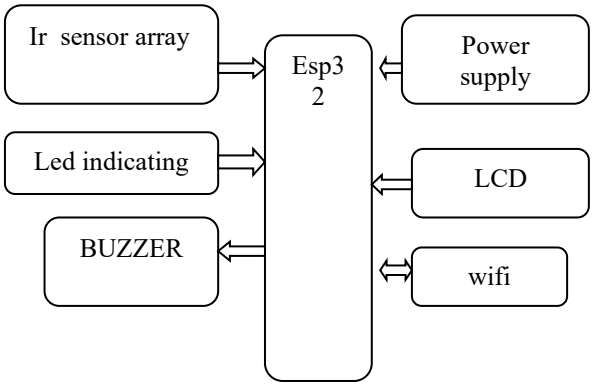

Fig. 6.2. Block Diagram

VII. RESULTS AND OUTCOMES

The proposed IoT-based Parking Slot Detection System was successfully designed and implemented using hardware components such as the Arduino Uno, IR sensors, and the ESP8266 Wi-Fi Module, along with a web interface and Android application. The system was tested under various conditions to evaluate its performance, accuracy, and reliability.

Fig. 1. The results demonstrate that the system is capable of accurately detecting the occupancy status of parking slots in real time. The IR sensors effectively identified the presence and absence of vehicles, and the Arduino Uno processed the sensor data without noticeable delay. The LED indicators responded instantly, providing clear visual feedback at each parking slot, while the LCD display correctly showed the number of available spaces at the parking entrance.

Fig. 2. The integration of the ESP8266 Wi-Fi module enabled seamless transmission of data to the cloud, allowing real-time updates on both the web interface and Android application. Users were able to view parking availability remotely with minimal latency, which significantly reduces the time spent searching for parking spaces. The system maintained consistent performance during continuous operation, indicating good reliability for practical deployment. In terms of outcomes, the project successfully achieved its primary objectives of real-time monitoring, efficient parking management, and user convenience. The system helps reduce traffic congestion within parking areas by guiding drivers directly to available slots. It also minimizes fuel consumption and time wastage associated with manual parking search.

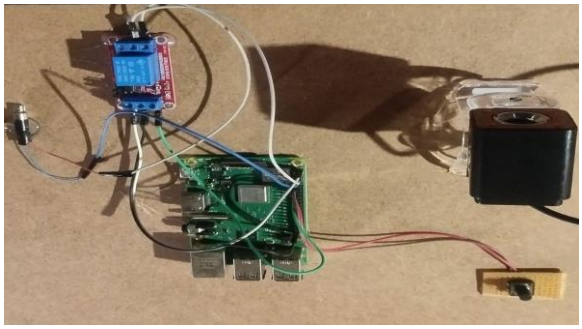

Fig. 7.1. Output1

Fig. 7.2. Output2

Furthermore, the developed system is cost-effective and scalable, making it suitable for implementation in various environments such as shopping malls, office complexes, and residential areas. The integration of IoT technology with user-friendly interfaces demonstrates the potential for future enhancements, including reservation systems,

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automated billing, and smart city integration.Overall, the results confirm that the proposed system provides an efficient, reliable, and practical solution for modern parking management challenges.

VIII.CONCLUSION

The implementation of IR sensors for vehicle detection and the use of wireless communication for data transmission ensure accurate and timely updates of parking availability. The system successfully provides both local and remote access to parking information through LED indicators, an LCD display, and online interfaces, thereby improving user convenience and reducing the time required to locate available parking slots.

The results demonstrate that the system is reliable, cost-effective, and easy to deploy, making it suitable for various real-world applications such as commercial complexes, educational institutions, and residential parking areas. Additionally, the system contributes to reducing traffic congestion, fuel consumption, and environmental impact by optimizing parking space utilization.

In conclusion, the developed smart parking system represents a practical step toward intelligent transportation and smart city development. Future enhancements can include advanced features such as reservation systems, integration with payment gateways, and the use of artificial intelligence for predictive parking analysis, further improving system efficiency and scalability.

IX. CONCLUSION

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