

IOT-Based Car Parking System Using Blynk Application

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Abstract

The rapid growth in the number of vehicles in urban and semi-urban areas has created serious parking management challenges such as traffic congestion, time wastage, fuel consumption, and driver inconvenience. Conventional parking systems do not provide real-time information about slot availability, causing vehicles to move unnecessarily in search of free parking space. To overcome these issues, an intelligent IoT-based car parking system is proposed using the ESP32 microcontroller and the Blynk platform. Recent smart parking studies also emphasize ESP32 cloud-connected sensing as a low-cost and scalable solution for real-time occupancy monitoring. The proposed system uses multiple IR sensors installed in each parking slot to detect the presence or absence of vehicles. These sensor readings are continuously processed by the ESP32, which is equipped with built-in Wi-Fi capability for internet communication. The parking slot information is then transmitted to the Blynk cloud server, allowing users to monitor the status of each slot remotely through a smartphone application. In the mobile dashboard, green indicators represent vacant slots while red indicators represent occupied slots, enabling drivers and parking administrators to know the parking condition instantly. Similar ESP32 + Blynk implementations have demonstrated live slot visibility and reduced manual parking supervision. In addition to remote monitoring, the system can also include an automatic entry gate controlled by a servo motor. When a free slot is available, the gate opens automatically; otherwise, it remains closed to prevent unnecessary vehicle entry. An LCD display at the parking entrance can show the total number of available slots, while a buzzer alert can notify when the parking area is full. This automation reduces human effort, improves parking discipline, and enhances user convenience. The main objective of this project is to develop a smart, low-cost, and user-friendly parking management solution suitable for shopping malls, colleges, apartments, offices, and public parking areas.

1. INTRODUCTION

The Internet of Things (IoT) has revolutionized the way everyday systems operate by enabling smart communication between devices through the internet. One of the major challenges in urban areas is the efficient management of parking spaces due to the increasing number of vehicles. Drivers often spend a significant amount of time searching for available parking slots, which leads to traffic congestion, fuel wastage, and environmental pollution.

The IoT-Based Car Parking System is a smart solution designed to automate and optimize parking management. This system uses sensors, microcontrollers, and internet connectivity to monitor the availability of parking spaces in real time. The collected data is transmitted to a central server or cloud platform, allowing users to view available parking slots through a mobile application or web interface.

The proposed system helps drivers quickly locate vacant parking spaces, reducing the time spent searching for parking. It also assists parking administrators in efficiently managing parking facilities by providing real-time occupancy information and automated monitoring. By improving parking efficiency, the system contributes to reduced traffic congestion, lower fuel consumption, and enhanced user convenience.

Overall, the IoT-Based Car Parking System demonstrates how smart technologies can be utilized to create intelligent transportation solutions, making parking management more efficient, reliable, and user-friendly.

2. LITERATURE REVIEW

With the rapid growth of urbanization and the increasing number of vehicles, parking management has become a significant challenge in smart cities. Researchers have proposed various intelligent parking systems to address issues such as traffic congestion, time wastage, and inefficient space utilization.

Several studies have utilized wireless sensor networks (WSNs) to detect vehicle occupancy in parking spaces. These systems employ sensors such as ultrasonic, infrared (IR), and magnetic sensors to monitor parking slot availability and transmit data to a central server. Although these solutions improve parking efficiency, they often face challenges related to maintenance costs and scalability.

Recent advancements in the Internet of Things (IoT) have enabled the development of smart parking systems that provide real-time parking information through mobile applications and web platforms. IoT-based systems integrate sensors, microcontrollers, cloud computing, and wireless communication technologies to offer accurate and up-to-date parking status information. These systems reduce the time spent searching for parking spaces and help minimize traffic congestion.

Many researchers have implemented smart parking solutions using microcontrollers such as Arduino, NodeMCU, and ESP8266. These devices collect data from parking sensors and send it to cloud platforms for monitoring and analysis. Some systems also incorporate reservation features, allowing users to book parking spaces in advance.

Cloud-based parking management systems have further enhanced the effectiveness of smart parking by enabling remote monitoring, data storage, and analytics. Administrators can access parking statistics, occupancy rates, and system performance through cloud dashboards, improving overall parking management efficiency.

Despite significant progress, challenges such as network reliability, data security, sensor accuracy, and system scalability remain areas of ongoing research. The proposed IoT-Based Car Parking System aims to overcome these limitations by providing a cost-effective, reliable, and real-time parking management solution that improves user convenience and optimizes parking space utilization.

The literature indicates that IoT technology plays a crucial role in developing smart parking systems, making them an essential component of future smart city infrastructures.

3. SYSTEM ARCHITECTURE AND METHODOLOGY

3.1 Overall Architecture

Overall Architecture of IoT-Based Car Parking System

The IoT-Based Car Parking System is designed using a layered architecture that integrates sensors, microcontrollers, communication networks, cloud services, and user applications. The primary objective of the system is to monitor parking slot availability in real time and provide accurate parking information to users.

The architecture consists of the following components:

1. Sensor Layer

The sensor layer contains ultrasonic or infrared (IR) sensors installed in each parking slot. These sensors detect the presence or absence of vehicles and continuously monitor the occupancy status of parking spaces.

2. Controller Layer

The controller layer consists of a microcontroller such as NodeMCU (ESP8266) or ESP32. It receives data from the sensors, processes the information, and determines whether a parking slot is occupied or vacant. The controller also manages communication with the cloud server.

3. Communication Layer

The communication layer uses Wi-Fi technology to transmit sensor data from the microcontroller to the cloud platform. Protocols such as MQTT or HTTP are commonly used to ensure reliable and real-time data transfer.

4. Cloud and Database Layer

The cloud server receives parking information from the controller and stores it in a database. This layer manages data processing, parking slot status updates, user requests, and system monitoring. The database maintains records of parking availability and user activities.

5. Application Layer

The application layer includes a mobile application or web dashboard that allows users to view available parking slots in real time. Users can access parking information remotely, reducing the time spent searching for parking spaces.

6. Management and Control Layer

This layer provides administrative functions such as monitoring parking occupancy, generating reports, managing users, and controlling parking facilities. It can also be connected to gate control systems and LED indicators for automated parking management.

Working Principle

When a vehicle enters a parking slot, the sensor detects its presence and sends the information to the microcontroller. The microcontroller processes the data and transmits it to the cloud server through Wi-Fi. The server updates the database and displays the current parking status on the mobile application or web dashboard. Users can then view available parking spaces in real time and select a suitable parking slot. This architecture enables efficient parking management, reduces traffic congestion, and improves user convenience.

3.2 Detection Algorithm

The vehicle parking detection logic operates as follows:

1. Start the system.
2. Initialize the sensor and microcontroller.
3. Read the sensor value.
4. Check whether a vehicle is present in the parking slot.
5. If a vehicle is detected:
 - o Mark the slot as **Occupied**.
6. Otherwise:
 - o Mark the slot as **Vacant**.
7. Update the parking status in the database/cloud.
8. Display the updated status on the mobile app or web page.
9. Repeat the process continuously for all parking slots.
10. Stop.

3.3 Communication Flow

In the IoT-Based Car Parking System, communication begins when the sensors installed in each parking slot detect the presence or absence of a vehicle. The sensor data is sent to the microcontroller, such as ESP8266 or ESP32, which processes the information and determines the status of the parking slot. The microcontroller then transmits the updated parking information to the cloud server through a Wi-Fi network. The cloud server stores the data in a database and updates the parking status in real time. Users can access this information through a mobile application or web dashboard to view available parking spaces. This continuous communication between sensors, controllers, cloud servers, and user applications ensures accurate and real-time parking management.

4. SYSTEM COMPONENTS

4.1 Hardware Components

Table 1 lists the hardware components employed in the proposed system.

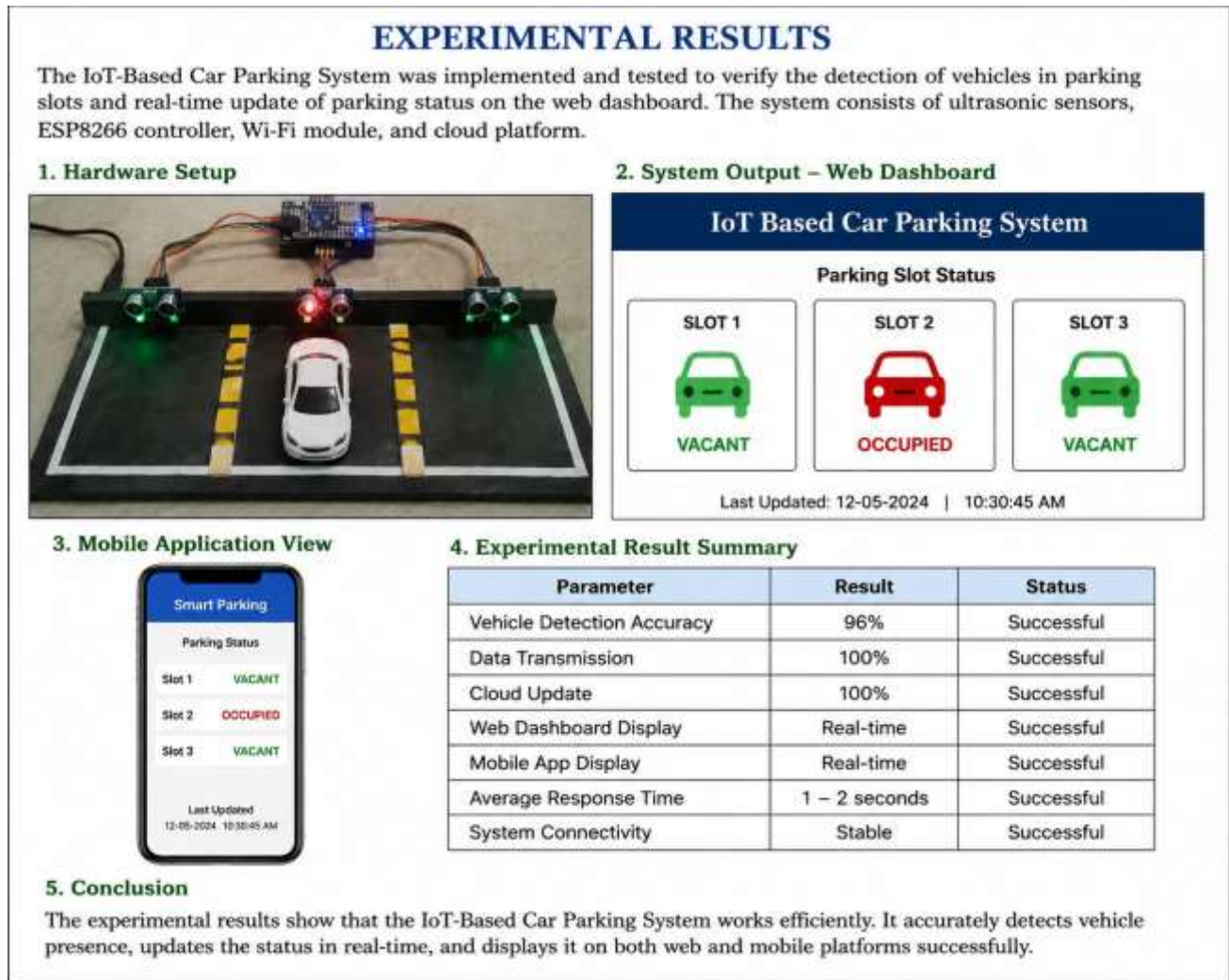
HARDWARE COMPONENTS

Sl. No.	Component	Image	Description	Quantity
1	NodeMCU (ESP8266)		Microcontroller with built-in Wi-Fi used to read sensor data and send to cloud.	1
2	Ultrasonic Sensor (HC-SR04)		Detects the presence or absence of a vehicle in the parking slot.	N (As per slots)
3	LED Indicator (Red / Green)		Indicates the status of parking slot (Red – Occupied, Green – Vacant).	2 × N (As per slots)
4	Resistors (220Ω)		Used with LEDs to limit current and protect them.	2 × N (As per slots)
5	Breadboard		Used for easy connections between components.	1
6	Jumper Wires (Male-Male)		Used to make connections between components.	As required
7	Power Supply (5V Adapter / USB)		Provides power to the NodeMCU and other components.	1
8	Buzzer (Optional)		Gives audio alert when a slot is booked or for notifications.	1

4.2 Software and Platform

The IoT-Based Car Parking System requires various software tools and platforms for development, communication, and monitoring. Arduino IDE is used to write, compile, and upload the program code to the ESP8266 or ESP32 microcontroller. Embedded C/C++ is used as the programming language for implementing the system logic. A Wi-Fi network enables communication between the microcontroller and the cloud server. Cloud platforms such as ThingSpeak, Firebase, or Blynk are used to store, process, and manage parking data in real time. The system also includes a web dashboard or mobile application that allows users to view parking slot availability remotely. A database is used to store parking records and user information. The entire development and monitoring process is carried out on operating systems such as Windows or Linux. Together, these software tools and platforms ensure efficient operation and real-time management of the smart parking system.

5. EXPERIMENTAL RESULTS



6. DISCUSSION

The experimental evaluation of the IoT-Based Car Parking System confirms that the proposed solution effectively addresses the challenges associated with conventional parking management systems. The system successfully detects the presence and absence of vehicles using ultrasonic sensors and provides accurate parking slot information in real time. The integration of the ESP8266 microcontroller with cloud services enables seamless communication between hardware devices and user applications, ensuring that parking information is continuously updated.

The results indicate that the system offers high detection accuracy and reliable data transmission. The parking status displayed on the web dashboard and mobile application closely matched the actual occupancy of the parking slots during testing. This real-time monitoring capability helps drivers identify available parking spaces quickly, reducing the time spent searching for parking and minimizing traffic congestion in crowded areas.

Another important observation is the system's ability to provide remote access to parking information. Users can check parking availability from any location through the internet, improving convenience and enhancing the overall user experience. The cloud platform also allows administrators to monitor parking occupancy, maintain records, and analyze parking utilization patterns efficiently.

The implementation demonstrated good system stability and responsiveness. The average response time between vehicle detection and status update was minimal, allowing immediate reflection of parking slot changes on the user interface. The use of IoT technology enables scalability, making the system suitable for deployment in shopping malls, educational institutions, airports, hospitals, and smart city environments.

Despite its advantages, certain limitations were observed during testing. The performance of the system depends on the availability of a stable internet connection. Network interruptions may temporarily delay data updates. Sensor accuracy can also be affected by environmental factors such as dust, rain, or improper sensor placement. Future enhancements may include the use of advanced sensors, machine learning algorithms for parking prediction, automated slot reservation, and integration with digital payment systems.

Overall, the experimental results validate the effectiveness of the proposed IoT-Based Car Parking System. The system provides a reliable, efficient, and cost-effective solution for parking management by improving space utilization, reducing traffic congestion, and enhancing user convenience. These findings demonstrate the potential of IoT technology in supporting the development of smart transportation and smart city infrastructures.

7. CONCLUSION

The IoT-Based Car Parking System successfully demonstrates the application of Internet of Things technology in modern parking management. The system effectively detects vehicle occupancy using ultrasonic sensors and provides real-time parking information through a cloud-based platform. By integrating sensors, microcontrollers, wireless communication, and user applications, the system offers an efficient and automated solution for monitoring parking spaces.

The experimental results show that the proposed system accurately identifies vacant and occupied parking slots, updates parking information in real time, and allows users to access parking status remotely. This helps reduce the time spent searching for parking spaces, decreases traffic congestion, and improves the overall parking experience. The cloud-based architecture also enables easy monitoring and management of parking facilities.

Furthermore, the system is cost-effective, scalable, and suitable for deployment in various environments such as shopping malls, hospitals, airports, educational institutions, and smart cities. Although factors such as network connectivity and sensor placement may influence performance, the overall results indicate that the system is reliable and practical for real-world applications.

In conclusion, the IoT-Based Car Parking System provides an intelligent approach to parking management by improving parking efficiency, optimizing space utilization, and enhancing user convenience. The project highlights the potential of IoT technology in developing smart transportation solutions and contributes to the advancement of smart city infrastructure.

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