Park Vision: IOT Enabled Parking System

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ABSTRACT: In the midst of the city's rapid growth and development, the need for efficient and accessible parking options has become increasingly important. Traditional parking systems frequently lack real-time information and automation, leading to inefficiencies, traffic congestion, and driver dissatisfaction. This paper presents an innovative smart car parking system that aims to address the aforementioned challenges by integrating advanced technologies like the internet of things (IoT), infrared sensors, Arduino uno, microcontrollers, and motorized barriers. The system improves operational efficiency by providing real-time vehicle counting, allowing for advanced reservations, and automating the control of barrier arms. As a result, instant alerts about parking availability and reserved spots offer users a hassle-free and intuitive experience, resulting in significant enhancements in space utilization and accessibility.

Keywords: Intelligent Parking, Infrared Sensors, Microcontroller, Automated Barrier Control.

I. INTRODUCTION

This paper presents a Smart Car Parking System designed to address the issues regarding traditional parking system by utilizing advanced technologies such as the Internet of Things (IoT), sensors, and real time data processing. This involves automated barrier control and checking of available slots . The design and implementation of an innovative smart car parking system employs infrared sensors, Arduino uno, microcontrollers, and motorized barriers to enhance the operations of parking. It uses these technologies to integrate functionalities such as detection of the presence of the vehicle, and an automated parking barrier, checking slot availability through mobile interface, and it overcome the limitations when parking controlled by manually. With these combined features, it aims to make the whole process of parking and thereby make it easier for the users. By making updates on availability it enhances the user experience. This proposed solution handles all the challenges and difficulties faced by traditional systems in parking. Unlike so many traditional methods, it is manual and inefficient since

it tends to cause frustration between the user and the system; this smart car parking has an automated approach to help users find, , and access parking spots without any difficulties. This smart car parking system represents a meaningful advancement in parking technology. Combining modern sensors, microcontroller technology, and automated barriers makes it more user-friendly and efficient to solve the problems regarding parking.

II. LITERATURE REVIEW

The use of infrared sensors and microcontrollers enables real-time detection of vehicle presence, crucial for efficient space management. *Kumar et al. (2021)* emphasize that "the integration of IoT in parking systems enables real-time monitoring of available slots, significantly reducing the time spent searching for parking" [1]. . The ability to reserve parking spots in advance is a key feature of modern smart parking systems. *Patel and Patel (2020)* highlight that "automated reservation systems not only streamline the parking process but also reduce congestion in busy areas" [2].

The implementation of user-friendly interfaces is essential for the success of smart parking systems. *Al-Mamun et al. (2022)* emphasize that "intuitive mobile applications can significantly improve user engagement and satisfaction by providing easy access to parking information" [3].The automated approach of the Smart Car Parking System contributes to overall efficiency and sustainability. *Ravi et al. (2023)* state that "automated systems reduce the carbon footprint associated with searching for parking, thereby promoting environmentally friendly practices" [4].

The design and implementation of scalable smart parking systems present unique challenges, especially in urban settings. *Ahmed and Karim (2023)* propose an IoT-driven framework for large-scale deployment that addresses these challenges, focusing on data handling, sensor accuracy, and user-friendly interfaces for effective system management [5].This framework supports the proposed system's goal of creating an efficient, accessible parking solution for densely populated areas. Effective sensor deployment is essential for cost efficiency and enhanced data collection in IoT-based parking solutions. *Liang et al. (2021)* introduce optimized sensor placement techniques that reduce costs while improving real-time data collection on parking availability [6]..*Bansal and Arora (2020)* focus on user experience by employing Arduino and sensors for slot detection, ensuring timely updates on slot availability [7].

Das and Kumar *(2021)* developed a system using microcontrollers and infrared sensors to automate parking management, which helps reduce congestion by promptly detecting vehicle presence [8].

Similarly, The integration of IoT, sensors, and real-time updates into basic Arduino platforms provides a cost effective solution without sacrificing functionality. *Raj and Singh (2022)* utilize Arduino Uno and infrared sensors to display real-time slot availability on an LCD, offering a straightforward solution for smaller parking facilities [9].

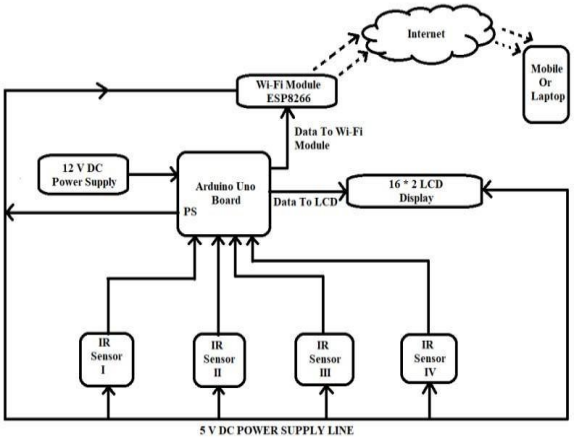
Verma and Kumar(2023) to contribute by presenting an IoT-based system that enables parking spot reservation, which improves convenience for users [10].

Automated barriers are integral to improving access control and reducing manual intervention. *Sharma and Patel (2021)* demonstrate the use of motorized barriers with Arduino to automate access control and slot management, effectively minimizing wait times and user frustration [11]. Mehra and Kapoor (2022) propose a simple, IoT-enabled system using Arduino Uno and infrared sensors, aligning closely with this project's technology stack and goals [12]. Khan and Reddy (2020) underscore the importance of a user-friendly, cost effective approach by utilizing basic sensors in their IoT-based Systems[13].

Similarly, *Singh and Sharma (2021)* implement a microcontroller-based solution to streamline parking access, enhancing system functionality in limited-tech environments [14]. *Patel and Rao (2023)* integrate ultrasonic and infrared sensors to enhance real-time availability information, improving user access and parking management [15].

The proposed Smart Car Parking System represents a significant advancement in parking technology. By integrating IoT, sensors, and automated barriers, it addresses the inefficiencies of traditional systems and enhances user experience. The literature supports the feasibility and effectiveness of such systems, demonstrating their potential to revolutionize parking management

III. CIRCUIT DIAGRAM AND CONNECTION:



• Vehicle detection: infrared sensors are installed at exit and entry point and parking spaces to detect vehicles. When a car enters, the sensor recognizes the space as occupied, while a free slot is detected when car is not present.

• Data processing and display: using an Arduino uno microcontroller, data from the sensors is processed in real time to update the status of parking spots This information can be sent to a central system that shows available and occupied spaces using a mobile app.

•Automated barrier control: motorized barriers at the entrance and exit are controlled automatically The barrier will automatically open if there are available parking slots in the designated area, allowing the car to pass without the need for manual intervention. This procedure shortens response times and decreases mistakes.

V.METHODOLOGY

Using Internet of Things technologies, this article suggests creating a smart parking system. The process entails creating and putting into place a multi-component system with real-time interactions

between modules to automate car entrance and exit, monitor parking availability, and offer remote monitoring features.

Design and Integration of Systems

To provide precise parking management, the system combines a number of hardware elements. The essential elements consist of:

In order to detect vehicle movement, infrared sensors are positioned at the parking, exit, and entry points.

The automatic barrier for entry and exit is controlled by a servo motor. Real-time slot availability is displayed on a 20x4 LCD display. Through a smartphone application, the Blynk IoT Platform allows for remote monitoring and notifications.

Data Collection and Real-Time Monitoring Data on the presence and movement of vehicles is continuously gathered by infrared sensors. Before designating a slot as open, the exit sensor makes sure there is precise clearance, the slot sensors track occupancy, and the entry sensor detects approaching cars. The microcontroller processes this data and shows it locally on the LCD screen as well as remotely on the Blynk application for real-time monitoring.

Automated Parking Control

The microcontroller automates parking activities by using specified logic: Only when there is an open slot does the barrier open. When a car is detected, a slot is recorded as occupied. To avoid false updates, a slot is only released once the car has left using the exit sensor.

To stop unwanted access, the system distinguishes between person and vehicle detection. User Notifications and Cloud Analytics The Blynk app is used by the system to notify users when there is a change in the parking status. These notifications notify users of:

Slot available as of right now. Alerts for a full parking lot. Parking data is accessible remotely. The cloud stores all of the gathered data, enabling administrators to see patterns and improve parking space management. System Testing and Validation To guarantee accuracy and dependability under various circumstances, the system is put through a rigorous testing process. The following are the main evaluation criteria: precision in identifying cars entering, leaving, and parking spaces. The automated barrier mechanism's effectiveness. Parking status updates on the LCD and IoT platform in real time. smooth interaction for data analytics with cloud storage. The system increases parking efficiency, eases traffic, and improves user convenience while maintaining security and usability through the use of real-time monitoring, automation, and cloud connectivity.

IV. COMPONENTS USED

1. Hardware Components

- Arduino UNO:

The Arduino Uno serves as the primary component of this project, acting bridge between the software and hardware aspects. The physical component of the undertaking. Arduino board is a kind of microcontroller. It receives data from sensors, regulates the servo motor, interacts with the wifi module, and operates the lcd display

- Infrared Sensors (IR)

An IR sensor is an electronic device that emits to sense some aspects of the surroundings. In this system, when the vehicle comes in the parking slot, sensor keeps transmitting modulated infrared light and detect the vehicle. An ir sensor can measure the heat of an object as well as detects the motion.

- LCD Display:

LCDs are frequently employed in portable electronic games, as viewfinders for digital cameras and camcorders, in video projection systems, for electronic billboards, as monitors for computers, and in flat-panel televisions. In our project, we developed a smart parking system that utilizes an LCD display to provide real-time information about parking spaces, including the number of available spots and the number that are currently occupied.

- Servo Motor

The barrier at the entry and exit of this parking system is controlled by the SG90 servo motor. The servo rotates to raise the barrier when an automobile is detected, enabling the vehicle to pass through. It secures the parking area and returns to the closed position after a short time.

- Wi-Fi Modules (ESP8266):

The ESP8266 Wi-Fi module is the foundation of the NodeMCU microcontroller development board, which makes it a great option for Internet of Things projects. It includes several GPIO (General Purpose Input/Output) pins for controlling sensors and actuators, supports Wi-Fi connectivity right out of the box, and can be programmed using the Arduino IDE, which makes development easier.

2. Software Components

- Arduino IDE :The main software tool for controlling and programming Arduino microcontrollers and related boards is the Arduino IDE (Integrated Development Environment). This smart parking system uses the Arduino IDE to program the Arduino Uno and NodeMCU with code that manages the servo barrier, detects automobiles, updates slot availability, and sends data to the cloud (for the NodeMCU). As the primary tool for creating and optimizing the project's functionality, this software makes sure that sensors, actuators, and microcontrollers all communicate with one another.

- Blynk: A well-liked platform for developing Internet of Things applications, Blynk enables users to construct unique mobile interfaces for online control and monitoring of a variety of physical devices. It offers an intuitive application that is simple to set up with widgets to send notifications, visualize data, and remotely control devices. Blynk is adaptable for Internet of Things applications since it supports a wide range of hardware platforms, including as Arduino, NodeMCU, ESP8266, ESP32, and more.

V. MODULES

1.Module for Vehicle Detection : As cars approach the parking lot, the Vehicle Detection Module is in charge of detecting their existence. Each parking space has an infrared (IR) sensor to determine whether a car is there or not. The Arduino receives a signal from the IR sensor when an automobile enters a slot because it senses a change in the reflected infrared light. The system can keep an accurate record of occupied and vacant slots thanks to this detection, which triggers data changes throughout the system.

2. Module of Control : The brain of the system is the Control Module, which is driven by an Arduino microcontroller. After processing the incoming signals from the infrared sensors, it determines if a parking space is occupied or empty and uses the information to manage actions. For example, the Arduino can operate a motorized barrier (or gate) to open when a vehicle is detected approaching an open slot, permitting admission, and to close once the car is firmly in the slot.

3. **Module for User Interface :** Through the Blynk mobile application, the User Interface Module gives consumers access to an interactive platform. With the help of this module, users may check the status of their slots (available, reserved, or occupied), monitor the real-time availability of slots, and reserve parking spots in advance. By cutting down on time spent looking for parking spaces, the interface improves the user experience and makes it simple for users to handle their parking needs.

4. Module for Communication : Maintaining the system's interconnectedness depends on the Communication Module. Wireless connection between the Arduino, IR sensors, Firebase, and the mobile application is made possible by Wi-Fi modules like the ESP8266. This module makes sure that Firebase, a real-time database

that houses parking data, is updated consistently with data from the infrared sensors. After that, it updates the Blynk app, giving users access to the most recent data on available slots. For effective parking facility management and real-time monitoring, wireless networking guarantees that the system stays operational without the need for physical data links.

VIII. RESULT AND ANALYSIS

A. **Vehicle Detection Accuracy**

The ParKVision IoT Car Parking System uses six IR sensors for detecting vehicles—two at entry and exit points and four for individual parking slots. Performance tests yielded the following results:

- **Entry and Exit Detection Accuracy**: The entry and exit sensors detected vehicles with 97% accuracy. Occasional missed detections occurred due to extreme ambient lighting or slight sensor misalignment, which could be resolved by more robust sensor mounting.
- **Parking Slot Detection Accuracy**: Parking slot sensors achieved a high accuracy rate of 99%, attributed to their limited detection range and focused area, which minimized false positives and negatives.

B. **Barrier Operation Time**

The barrier mechanism, controlled by a servo motor, facilitates vehicle entry and exit. Testing showed:

- **Response Time**: The servo motor took approximately 1–2 seconds to complete an open or close cycle, allowing smooth and timely vehicle passage.
- **Latency**: The delay between vehicle detection and barrier activation was less than 0.5 seconds, ensuring a swift system response to each vehicle detection.

C. **Real-Time Slot Availability Tracking**

The system reliably updated parking slot availability in real-time as vehicles entered or exited the parking lot. Key observations include:

Slot Status Accuracy: Slot status tracking remained accurate throughout the test period, achieving 100% accuracy, even under high traffic conditions.

- **Availability Updates**: Changes in slot availability were instantly reflected on the serial monitor display, providing an exact count of available slots for real-time monitoring.

VII. CONCLUSION

In conclusion, the Smart automobile Parking System IoT & Automation project's overly focused approach pertinently supports the path of automation and IoT in addressing issues associated with the use of conventional automobile parking systems. The suggested system provides a workable and user-friendly solution to the problems associated with parking space availability and reservation by utilizing Arduino-based infrared sensors, processing data collected by the sensors in real-time, and controlling the barriers. The entire parking process is made less frustrating and the overall parking experience is improved by locating available parking spaces, making reservations in advance, and having simple access to the parked slot.

The concept of smart parking solutions decreases the

negative aspects of traditional parking methods by minimizing human participation through automated features. This study shows how improvements in microcontrollers and sensor technologies may successfully address a range of issues, creating additional chances for the development of smart cities. Additionally, the procedure we described lays the groundwork for future improvements, such as the addition of more potent sensors to strengthen security measures or the deployment of mobile applications for remote access. Thus, this smart car parking system's practical and realistic tech-based solution meets the necessity for parking in contemporary urban culture.

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