Smart Parking Management System Using IOT For Both Ev's and Non-Ev's

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Abstract – With the rapid increase in urban populations and the corresponding rise in the number of vehicles, efficient parking management has become a critical challenge. Traditional parking systems are not equipped to handle the demands of modern cities, leading to traffic congestion, inefficient space utilization, and a lack of infrastructure for electric vehicle (EV) charging stations. The Smart Parking Management System using IoT for both EVs and Non-EVs aims to address these challenges by integrating Internet of Things (IoT) technology, data analytics, and real-time monitoring. The proposed system utilizes ultrasonic sensors, ESP8266 microcontrollers to detect and manage parking space occupancy while providing real-time updates to users. Additionally, the system includes provisions for managing EV charging stations efficiently. By optimizing space utilization and minimizing the time spent searching for parking spots, this system enhances user convenience, reduces congestion, and contributes to a more sustainable urban environment.

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Keywords: *Smart Parking, Internet of Things (IoT), Electric Vehicles (EV), Non-Electric Vehicles (Non-EV), Ultrasonic Sensors, ESP32, Urban Mobility, Real-time Monitoring*

I. INTRODUCTION

As urbanization increases, the demand for efficient and smart parking solutions has become crucial. Conventional parking systems suffer from various inefficiencies, such as lack of real-time data, congestion, and unoptimized use of parking spaces. Additionally, the rise of electric vehicles (EVs) presents another challenge, as they require designated charging slots that need to be efficiently allocated and monitored. This project proposes a Smart Parking Management System using IoT technology, which provides real-time data on available parking slots and optimizes space usage for both EVs and Non-EVs. By leveraging ultrasonic sensors, ESP8266 microcontrollers, the system can detect occupied parking spaces and provide live updates via a mobile or web-based interface. The integration of LED indicators for EV charging slots ensures that electric vehicle users can efficiently locate and use available charging points. This smart system aims to significantly reduce traffic congestion, fuel wastage, and driver frustration, ultimately contributing to smarter, greener cities.
solution is designed to be portable, cost- effective, and user-friendly. The AI - powered approach enhances text recognition accuracy, making it useful in various environments, from reading printed documents to navigating public spaces. This system can greatly benefit visually impaired individuals by providing a seamless way to interpret written content in real time.

1. *Objective: Develop an IoT-based Smart Parking Management System to optimize space utilization for both EVs and Non-EVs, reduce congestion, and enhance user convenience.*
2. *Function: Detect vehicle presence using ultrasonic sensors, manage parking slots via ESP8266 microcontrollers, and provide real-time updates through a mobile or web-based interface.*
3. *Technology: Utilizes IoT, ESP8266 microcontrollers, ultrasonic sensors, LED indicators, and a mobile/web application for real-time parking slot monitoring and EV charging management.*
4. *Processes: The system detects occupied parking spots, updates a central database, displays availability via LEDs, and allows users to check and reserve parking slots through an app.*
5. *Implementation: Hardware components (ESP8266, sensors, LEDs) are integrated with software and IoT platforms to enable real-time parking monitoring and user interaction via a mobile application.*
6. *Benefits: Reduces traffic congestion, minimizes fuel wastage, improves parking efficiency, enhances EV charging accessibility, and contributes to sustainable urban mobility.*

II. LITERATURE SURVEY

Paper1: The research paper "Smart Parking System Based on IoT" presents an IoT-based parking management system designed to address urban parking shortages. The system utilizes sensors, cloud computing, and a mobile application to provide real-time parking availability updates, enable online booking and digital payments, and facilitate automated gate

access via QR codes. Implemented using Arduino Uno, NodeMCU ESP8266, and infrared sensors, it minimizes human intervention and helps reduce traffic congestion. The study highlights enhanced convenience and efficiency in parking management, with future improvements focused on AI integration and security enhancements.

Paper 2: The research paper "Review Paper on Smart Parking System" discusses an IoT-based smart parking system designed to address urban parking challenges. The system utilizes Arduino components, ultrasonic sensors, and a mobile application to detect and manage parking slots efficiently One limitation of Arduino Uno in a smart parking system is its limited processing power and memory. Since the Uno has only 2KB of SRAM and 32KB of flash memory, it may struggle to handle multiple sensors, real-time data processing, and cloud communication simultaneously. This makes it less efficient for complex IoT applications compared to more powerful microcontrollers

Paper 3: The research paper presents a smart parking tracking system using ultrasonic sensors (HC-SR04) and NodeMCU ESP8266 with IoT integration. The system provides real-time parking slot availability through a web-based application, allowing users to check, book, and track parking spaces remotely. It improves traffic flow, reduces search time, and enhances user convenience. However, the web interface is optimized for desktops, limiting mobile accessibility. Future improvements could include mobile app support, AI-based predictions, and GPS integration for better efficiency.

Paper 5: The research paper presents a Smart Parking System using ESP8266, IR sensors, and a mobile app for real-time parking updates, online reservations, and automated entry/exit. It reduces traffic congestion and parking search time while enabling digital payments and 24/7 booking. Admins can list available spaces, and IR sensors control gate operations. While it improves efficiency, it depends on internet connectivity and may have high implementation costs. Future enhancements include AI-based slot predictions and GPS integration. One limitation of this project is that it relies on internet connectivity for real-time updates and booking. If the network is slow or unavailable, users may face delays in accessing parking information, making reservations, or processing payments.

Paper 6: The research paper presents a Smart Parking System using ultrasonic and infrared sensors, Arduino Mega 2560, NodeMCU ESP8266, and RFID technology. It enables real-time parking slot detection, automated entry using RFID, and IoT-based mobile access. The system helps drivers quickly find parking, reduces congestion, and minimizes environmental impact by efficiently managing available spaces.

One limitation of this project is that it relies on RFID access control, which may cause delays if a user forgets their RFID card or if the reader malfunctions. This could lead to inconvenience and slow down the parking process, especially in high-traffic areas.

Paper 7: The research paper presents a Smart Parking Management System (SPMS) using IoT, Arduino components, infrared sensors, and a mobile application to improve parking efficiency. The system allows users to check available parking slots, reserve spaces, and make digital payments through a mobile application. Infrared sensors detect vacant spots, and the data is transmitted via Wi-Fi to a cloud server, which updates the real-time status for users. One limitation of the system is its dependence on internet connectivity for real-time data updates. If the network is slow or unavailable, users may face difficulties in checking parking availability, making reservations, or processing payments.

Paper 9: The research paper proposes an IoT-based Smart Parking System using NodeMCU ESP8266, IR sensors, an ultrasonic sensor, and servo motors to automate parking slot detection and management. The system allows users to check parking slot availability online and book spaces via a mobile application. IR sensors detect vehicle entry and exit, while an ultrasonic sensor monitors slot occupancy. The NodeMCU ESP8266 communicates with a Google Firebase database to provide real-time updates on parking slot status. One limitation of using IR sensors in the smart parking system is that they can be affected by environmental conditions such as sunlight, dust, fog, or dirt accumulation. This can lead to inaccurate detection of vehicles, causing false occupancy readings or failure to detect an available parking spot, ultimately affecting the system's reliability. One limitation of this system is its dependence on an internet connection for real-time updates. If the connection is weak or unavailable, users may face delays in receiving parking slot information or booking reservations.

Paper 10: The research paper presents an IoT-based Smart Parking System using Arduino, NodeMCU ESP8266, IR sensors, servo motors, and a mobile application. The system provides real-time parking slot availability updates, allowing users to check and reserve slots remotely via an online platform. IR sensors detect vehicle presence, and servo motors automate gate entry and exit. The NodeMCU ESP8266 updates the parking status on a cloud server, ensuring real-time monitoring and efficient parking space utilization. One limitation of this system is its dependency on IR sensors, which can be affected by external factors such as sunlight, dust, and weather conditions. This may result in inaccurate slot detection, leading to false occupancy readings or missed detections of available parking spaces.

III. PROPOSED SYSTEM

3.1 Methodology

The methodology of the Smart Parking Management System involves three main phases: input, processing, and output. Ultrasonic sensors detect the presence of vehicles in each parking slot and send the data to the ESP8266 microcontroller. The ESP8266 processes the data to determine slot availability and updates the information to a cloud database accessed by a mobile application. It also controls the LCD display to show real-time parking status and activates charging sockets for electric vehicles when needed. Users interact with the system

through a mobile app to check slot availability, make bookings, and request EV charging. This methodology ensures efficient parking management with minimal human intervention.

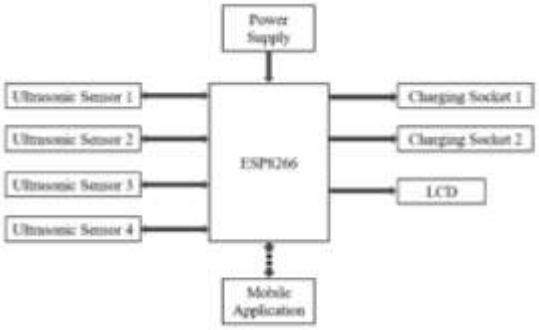


Figure 1: Block Diagram

3.2 Details of Hardware and Software

a) Hardware Components

1) NODE MCU ESP 8266: The ESP8266 module enables microcontrollers to connect to 2.4 GHz Wi-Fi, using IEEE 802.11 bgn. It can be used with ESP-AT firmware to provide Wi-Fi connectivity to external host MCUs, or it can be used as a self-sufficient MCU by running an RTOS-based SDK. The module has a full TCP/IP stack and provides the ability for data processing, reads and controls of GPIOs.

2) Ultrasonic Sensor: The Ultrasonic Sensor is an electronic device that calculates distance by emitting sound waves and collecting their echoes. It can measure objects from up to 4.5 meters away, which makes it a versatile instrument for correctly measuring both short and long distances without making contact with the target object, which is critical in many applications such as obstacle avoidance systems in robotics or autonomous cars.

3) LED: An LED (Light Emitting Diode) is a semiconductor device that emits light when an electric current passes through it. It is energy-efficient, long-lasting, and available in various colours. LEDs are commonly used in indicators, displays, lighting systems, and electronic projects. LEDs can be used to indicate parking space availability or EV charging status.

4) LCD Display: An LCD (Liquid Crystal Display) is an electronic display module commonly used in embedded systems and IoT projects to visually present data such as sensor readings, messages, or system status. It works by manipulating liquid crystals that block or allow light to pass through, creating characters or graphics on the screen. A popular type is the 16x2 LCD, which can display 2 lines with 16 characters each.

b) Software Components

1) Arduino IDE: The Arduino IDE (Integrated Development Environment) is a software platform used to write, compile, and upload code to Arduino boards and compatible microcontrollers like the Node MCU ESP8266. It supports programming in C/C++ and provides a simple interface with features like a code editor, serial monitor, and library manager. The IDE includes built-in libraries for sensors, displays, and Wi-Fi modules, making it easy to develop IoT projects. It is open-source, lightweight, and widely used for prototyping and educational purposes.

2) Node.js: Node.js is an open-source, cross-platform runtime environment that allows developers to run JavaScript code on the server side. It is built on Chrome's V8 engine and is known for its non-blocking, event-driven architecture, which makes it efficient and scalable. Node.js is widely used for building fast, real-time web applications and APIs.

3) Java Script (Programming Language) : JavaScript is a high-level programming language used to create interactive and dynamic content on websites. It runs in web browsers and is essential for modern web development.

3.3 Design Details

1. Input:

- **Ultrasonic Sensors (1 to 4):** These sensors detect the presence or absence of vehicles in each parking slot by measuring the distance between the sensor and any object in front of it. If a vehicle is detected, the sensor sends the information to the ESP8266. Each sensor continuously monitors the respective slot and provides real-time data.
- **Mobile Application (User Input):** Users interact with the system through a mobile application to check slot availability and make parking reservations. The app communicates with the ESP8266 over Wi-Fi for live updates and booking data.
- **Power Supply:** A power source provides the necessary voltage and current to the ESP8266 and all connected components for continuous operation.

2. Processing:

- **ESP8266 (Node MCU):** This microcontroller acts as the brain of the system. It receives signals from the ultrasonic sensors, processes the distance data to determine slot occupancy, and updates the mobile application accordingly. The ESP8266 also manages communication with the LCD and controls the activation of charging sockets for EVs based on sensor input and booking status. It ensures that data is transmitted over Wi-Fi for real-time monitoring.

3. Output:

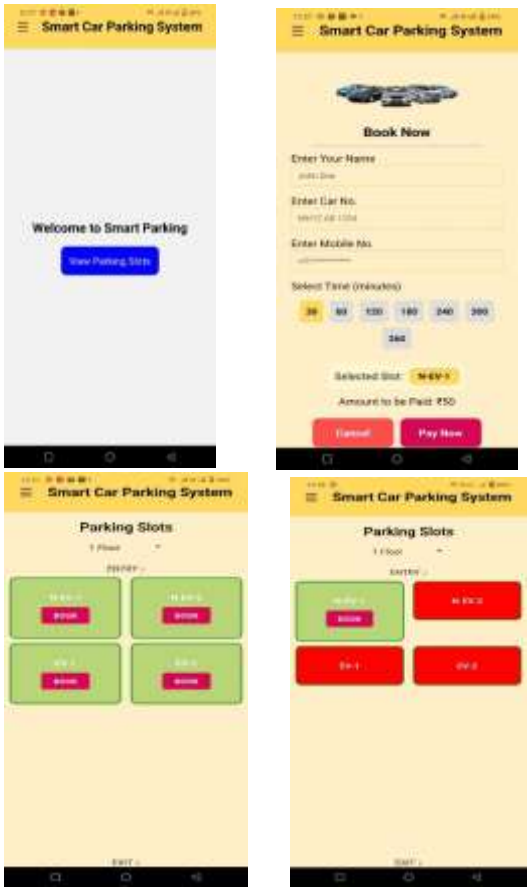
- **Charging Sockets (1 and 2):** These are controlled by the ESP8266. When an EV is detected in a reserved slot, the respective socket is activated to provide

charging. This ensures that only authorized vehicles receive power, improving energy efficiency and security.

- **LCD Display:** The LCD shows real-time parking availability and status of each slot for physical on-site users. It gives a clear indication of which slots are occupied, free, or reserved.
- **Mobile Application (User Output):** The app provides users with live parking status, slot availability, and booking confirmations. It reflects the processed data from the ESP8266, enabling users to plan and reserve parking in advance.

IV. EXPERIMENTAL RESULTS

1. Mobile Application Output:



2. Lcd Display Ouput:

3. System model

CONCLUSION

The Smart Parking Management System using IoT offers an effective and innovative solution to modern parking issues by automating the process of slot detection, reservation, and EV charging management. It reduces human intervention, minimizes traffic congestion, and provides real-time updates through a mobile application. By using components like the Node MCU ESP8266, ultrasonic sensors, LEDs, and LCD display, the system ensures accurate monitoring and efficient space utilization. This project not only improves the overall parking experience but also supports the development of smart cities.

FUTURE WORK

1. **AI Integration**: Implement machine learning algorithms to predict parking space availability based on historical data and peak hours.
2. **GPS Integration**: Add GPS features to guide users to the nearest available parking slot.

3. **Solar-Powered Sensors**: Use solar energy to power IoT sensors for better energy efficiency and sustainability.
4. **Multi-Level Parking Support**: Expand the system to manage multi-level parking structures with floor-wise monitoring and control.

5. **Automatic Number Plate Recognition (ANPR)**: Integrate ANPR cameras to automate vehicle entry/exit without the need for RFID cards.
6. **Blockchain for Payments**: Implement blockchain technology for secure and transparent digital transactions.
7. **Emergency Alert System**: Enable the system to detect unauthorized activities or emergencies and send alerts to authorities.

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