

IoT – BASED SMART PARKING MANAGEMENT SYSTEM

Pranav Chougule¹, Tejas Aute¹, Harsh Pendke¹, Prathamesh Patil¹,

Dr. Mrs. Pratibha Adkar²

¹MCA Department, PES's Modern College of Engineering, Pune, India

¹PES's Modern College of Engineering, Pune, India

Abstract : This research presents a smart parking solution that uses Internet of Things (IoT) technology to automate parking-space monitoring and simplify parking operations. The system detects the availability of parking slots using **HC-SR04 ultrasonic sensors** connected to an **ESP32 microcontroller** and provides real-time parking information to users through a web-based application. Users can register, log in, view available parking slots, reserve a slot, cancel reservations, and manage parking-related payments. The system also provides an administrative interface for monitoring parking slots and managing users, reservations, entry and exit information, and payment records. The ESP32 collects parking-slot status and communicates the information to the backend system through Wi-Fi. The parking information is processed and stored using a **Python API and SQLite database**, allowing the system to maintain organized parking records.

The system is intended to help drivers locate vacant parking spaces more easily, limit unnecessary vehicle movement, make better use of available parking capacity, and simplify the management of parking facilities.

IndexTerms – Smart Parking Architecture, working of the system, smart parking management, real-time parking availability, parking slot reservation, online payment, applications, advantages.

1. INTRODUCTION

Managing parking facilities in cities is increasingly difficult as vehicle numbers grow faster than the available parking capacity. When drivers cannot identify vacant spaces quickly, they may spend additional time moving through parking areas, contributing to congestion, higher fuel consumption, and delays. Therefore, an efficient system that provides real-time information about parking-space availability can help improve parking management.

The **IoT-Based Smart Parking Management System** is proposed to monitor parking-space occupancy and provide real-time parking information to users. The system uses **HC-SR04 ultrasonic sensors** connected to an **ESP32 microcontroller** to detect whether individual parking spaces are occupied or available. The collected sensor data is transmitted through Wi-Fi to the backend system, where it is processed and made available through a web-based interface.

Alongside current occupancy information, the application can maintain past parking records associated with their respective dates and times. The collected data can be analyzed to identify parking-usage patterns and used for developing **machine-learning models to predict future parking availability**. The web dashboard can provide both current parking status and predicted availability to assist users in identifying suitable parking spaces.

The proposed system is initially implemented as a **small-scale, low-cost prototype** using ESP32, HC-SR04 ultrasonic sensors, LEDs, a breadboard, jumper wires, and a power supply. The system also provides facilities such as parking-slot viewing, reservation, reservation cancellation, and online payment. The modular design allows the system to be extended to larger parking areas and additional smart parking features in the future.

2. LITERATURE SURVEY

Smart parking has emerged as an important component of Intelligent Transportation Systems (ITS) and smart-city infrastructure because increasing vehicle ownership and limited parking capacity create congestion, fuel consumption, pollution and user frustration. The reviewed research shows a clear transition from conventional parking management toward sensor-enabled, connected and increasingly intelligent systems. Early studies mainly focused on detecting whether a parking space was occupied, whereas later research introduced reservation, mobile applications, automated access, optimization, computer vision, prediction, edge computing and security mechanisms.

The literature indicates that no single technology completely solves the smart parking problem. Wireless sensor networks provide direct occupancy information but can require large-scale installation and maintenance. Mobile and cloud systems improve accessibility and reservation, but may depend strongly on network availability. Computer-vision approaches can cover multiple spaces using fewer physical sensors, although lighting, occlusion, image-processing complexity and data transmission remain concerns. Recent research therefore combines IoT with artificial intelligence, edge/fog computing and secure communication to improve accuracy, scalability and responsiveness.

Cabri et al. (2026). The authors address a major weakness of reservation-based parking: a user may reserve a space but find it occupied because the previous vehicle has overstayed. Their Reservation Module maintains a dynamic buffer of non-reservable spaces so that an arriving user can still be accommodated. A reputation-based Reward System encourages punctual departure through incentives and penalties. Simulation using the SUMO urban simulator indicates that the dynamic-buffer strategy provides

a better trade-off between parking availability and reservation success. The study addresses both technical reliability and human behavior, but further work is required to combine the approach with real-time sensor verification and predictive demand models.

Mohammed et al. (2025). The study proposes a real-time smart parking architecture using IoT and fog computing. Parking information is processed closer to the source to reduce latency and network usage. The authors evaluate fog and cloud environments using latency, cost, execution time, network usage and energy consumption, including a practical university parking case study.

Sunil et al. (2025). The proposed Android-based system combines IoT and image processing with real-time parking information, advance booking, shortest-route navigation using Google Maps, automated entrance management, dynamic pricing and digital payment. The system integrates many functions but does not establish a strong historical-data-based predictive layer for future parking availability. The combination of image processing, navigation, automated gates and payment also increases implementation complexity.

Mamun et al. (2024). The study extend the IoT approach by combining IR sensors with DHT22 temperature-humidity sensors, MQ-2 gas sensors, Arduino UNO, Raspberry Pi, servo motors, an OLED display and MQTT communication. The system detects parking occupancy while also monitoring environmental conditions and controlling ventilation and gates. This represents a broader interpretation of smart parking in which safety and environmental monitoring are integrated with parking management. Practical limitations include sensor calibration, sensor reliability, network dependence and setup complexity.

Nikhath et al. (2023). The paper presents an automated smart parking system for multi-storey facilities. IR sensors detect occupied and vacant spaces, visual indicators guide drivers, and a web application supports advance reservation. The system provides real-time detection and reservation but does not incorporate advanced prediction of future parking demand. Sensor-based detection also creates installation and maintenance requirements as the number of parking spaces increases.

Alam et al. (2023). Alam and colleagues provide a comprehensive survey of IoT-driven smart parking management. The study develops a taxonomy covering parking types, sensors, storage methods, communication protocols, system services and security. Important functions identified include online reservation, parking guidance, online payment, authentication, monitoring and automated access control. The review also emphasizes challenges involving sensor limitations, communication, scalability, security and implementation cost. Its future research agenda supports the need for integrated and more intelligent parking platforms rather than isolated sensing solutions.

Nik et al. (2022). The project uses ultrasonic sensors and Raspberry Pi to detect vehicles. Parking information is stored in a database and displayed through a web dashboard. Users can view availability, select spaces and make reservations. Payment integration was also investigated. The system provides monitoring and reservation but lacks predictive parking-demand analysis and intelligent recommendation. The payment component also illustrates the complexity of integrating peripheral services.

Shahzad et al. (2022). The authors propose a smart autonomous-vehicle parking architecture using fog computing and blockchain. Fog nodes move computation closer to IoT devices, reducing dependence on centralized cloud processing. A lightweight integrated blockchain and cryptography mechanism provides authentication, authorization, privacy and transaction integrity. The proof-of-concept evaluates response time, efficiency, privacy and security. The study demonstrates how distributed technologies can address scalability, latency and security challenges in future smart parking. However, blockchain and fog architectures can introduce additional computation, communication and deployment complexity.

Ali et al. (2020). Ali and colleagues introduce a deep Long Short-Term Memory (LSTM) approach for parking-availability prediction. Using the Birmingham parking dataset, the study predicts parking availability according to location, day and hour. LSTM is appropriate because parking occupancy is a time-series problem in which current conditions are influenced by previous events. The reported results show that the proposed deep LSTM model outperformed state-of-the-art prediction models. The study therefore changes smart parking from a reactive system that reports current availability into a predictive decision-support system. A key limitation is that the prediction does not comprehensively include contextual variables such as weather, social events, traffic conditions or roadside availability.

Elsonbaty and Shams (2020). Elsonbaty and Shams propose an IoT-based Smart Parking Management System using Arduino, infrared sensors, Wi-Fi communication, server or cloud components and an Android application. The system allows users to identify available spaces and reserve a parking spot through a mobile interface. The architecture separates sensing, communication, processing and user interaction, providing a practical foundation for smart parking. Its limitations include dependence on physical sensors and communication infrastructure and the absence of advanced prediction and demand analysis.

Amira and Mahmoud (2020). The proposed IoT-based system uses Arduino, IR sensors, Wi-Fi, server/cloud infrastructure and an Android application. Users can view available spaces and reserve parking through the mobile application. : The system mainly provides current availability and reservation. It does not include advanced parking-demand prediction or intelligent recommendation, and physical sensors and communication infrastructure introduce maintenance and scalability considerations.

Luque-Vega et al. (2020). The study introduce SPIN-V, a visual-aided smart vehicle presence sensor integrating a single-board computer, distance sensor, camera, LED indicator and buzzer. The complete architecture combines parking-space sensing, a mobile application and a monitoring center. It supports real-time availability, reservations, vehicle identification and route recommendations. The work demonstrates the value of combining sensing with visual identification and centralized management. At the same time, camera processing and specialized infrastructure increase system complexity and deployment cost.

Ke et al. (2019/2020). The authors propose an edge-AI architecture for real-time parking surveillance. Camera feeds are processed near the source using IoT devices, reducing the amount of raw video transmitted to a centralized server. The system combines background-based detection with an enhanced Single Shot Multi box Detector (SSD), while tracking and occupancy judgement are handled at the server. Field testing in a real parking garage demonstrated more than 95% detection accuracy. The major contribution is architectural as well as algorithmic: edge processing improves efficiency and reduces communication requirements. Nevertheless, lighting, occlusion, camera placement, computation and maintenance remain concerns.

Zhao et al. (2017). The authors formulate parking planning as a linear assignment problem by treating vehicles as jobs, parking spaces as agents, and distance between vehicles and spaces as the assignment cost. Their method improves upon a simple nearest-space greedy strategy by considering multiple parking requests together. A Hungarian-method-based solution and a reduced candidate-space strategy are proposed to make assignment practical for real-time operation. The study is important because it treats parking allocation as an optimization problem rather than only a vacancy-detection task. However, the approach mainly optimizes assignment distance and does not incorporate user preferences, historical demand, reservation behavior or predictive availability.

Fraifer and Fernström (2016). Fraifer and Fernström provide an early review of smart parking systems and the technologies used to support them. Their work discusses sensing methods, communication technologies, parking guidance and management approaches, while highlighting practical concerns such as cost, reliability, scalability, circuit complexity, accuracy, installation and usability. The study is significant because it shows that technical functionality alone is insufficient for successful smart-parking deployment. The review also establishes the importance of evaluating systems from the perspectives of both users and parking operators.

3. RESEARCH GAPS

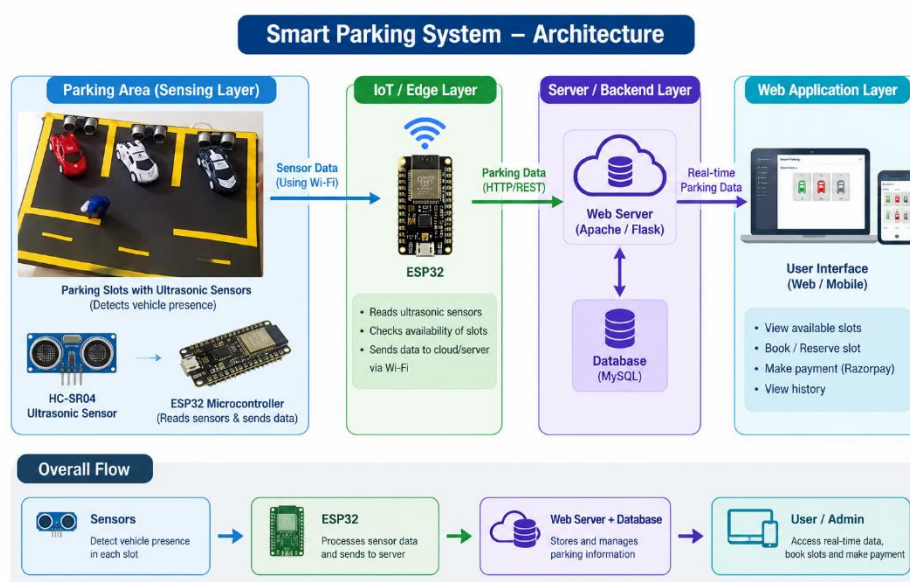
The reviewed studies show that most smart parking systems focus on detecting vacant and occupied parking spaces and providing real-time parking information. Several systems also include additional features such as reservation, mobile applications, navigation, payment, and automated access control. However, many systems primarily focus on the current parking status and provide limited support for centralized management of parking activities such as reservations, entry and exit, and payment information.

Some studies use advanced technologies such as LSTM, computer vision, edge AI, fog computing, and blockchain to improve prediction, processing speed, security, and scalability. Although these technologies provide additional capabilities, they can also increase system complexity, computational requirements, deployment cost, and maintenance requirements. Prediction-based systems also depend on the availability and quality of historical parking data.

The literature therefore indicates a need for a **practical and modular smart parking system** that provides real-time parking-slot monitoring along with reservation and centralized parking management features. The proposed system addresses this gap by combining **IoT-based parking detection using HC-SR04 ultrasonic sensors, ESP32-based communication, a Python API, SQLite database management, and a web-based interface**. The system provides real-time parking-slot information and supports reservation, cancellation, entry/exit monitoring, payment management, and administrative management of the parking facility. The collected parking data can also provide a foundation for **future enhancements**, including historical-data analysis and machine-learning-based parking-availability prediction.

4. ARCHITECTURE

The proposed **IoT-Based Smart Parking Management System** is designed using a modular and layered architecture that integrates IoT sensors, a backend application, database management, analytics, machine-learning-based prediction, and a web-based interface. The architecture enables real-time monitoring of parking spaces while providing separate functionalities for users and administrators.



The **IoT Layer** consists of **HC-SR04 ultrasonic sensors** connected to an **ESP32 microcontroller**. The sensors detect the presence or absence of vehicles in individual parking slots. The ESP32 processes the sensor readings and transmits the parking-status data to the backend application through **Wi-Fi**.

The **Communication and Backend Layer** consists of the web server, **Python Flask backend application**, and **SQLite database**. The backend receives and processes sensor data, determines the occupancy status of parking slots, and manages communication between the IoT hardware, database, and web interface. It also handles user authentication, parking-slot management, reservations, reservation cancellation, and payment-related operations.

The **Analytics and Prediction Layer** uses historical parking data to identify occupancy patterns based on factors such as time, day, and parking availability. The machine-learning module can use this historical data to predict future parking availability. The predicted information can be provided through the web interface to support better parking management.

The **Application Layer (Web Interface)** provides separate interfaces for users and administrators. Users can register and log in, search for parking areas, view parking slots and their real-time availability, reserve parking slots, cancel reservations, and make parking payments. Administrators can manage parking areas, parking slots, users, reservations, and payments, and can view parking-related reports and analytics.

Overall, the architecture establishes communication between the **HC-SR04 sensors, ESP32, Wi-Fi network, Flask backend, SQLite database, analytics and prediction module, and web interface**. This integration enables parking operations to be monitored and managed digitally, reducing manual effort and improving the efficiency of parking-space management.

5. WORKING OF THE SYSTEM

The **IoT-Based Smart Parking Management System** automates the detection, monitoring, and management of parking spaces. The system integrates **HC-SR04 ultrasonic sensors, an ESP32 microcontroller, a Flask-based backend, a database, and a web-based interface** to provide real-time parking information. The system also supports parking-slot reservation, cancellation, payment, and administrative management.

5.1 Vehicle Detection

Each parking slot is equipped with an **HC-SR04 ultrasonic sensor** to detect the presence or absence of a vehicle. The sensor measures the distance between the sensor and the vehicle. Based on the sensor reading, the parking slot is identified as **occupied or available**.

5.2 Data Collection Using ESP32

The **ESP32 microcontroller** acts as the main controller of the IoT system. It receives readings from the ultrasonic sensors, processes the readings, and determines the current status of each parking slot. The ESP32 transmits the parking-status information to the backend through **Wi-Fi**.

5.3 Backend Processing

The **Flask-based backend** receives the parking-status information from the ESP32 and processes the received data. It updates the corresponding parking-slot information in the database and manages system operations such as user requests, slot availability, reservations, cancellations, payments, and administrative functions.

5.4 Database Management

The database stores important information related to **users, parking areas, parking slots, occupancy status, reservations, and payments**. When the status of a parking slot changes, the corresponding information is updated in the database, allowing the system to maintain the latest parking information.

5.5 Real-Time Parking Information

The web application retrieves the latest parking information from the backend and displays the current status of parking slots. Users can identify **available and occupied slots** through the web interface, reducing the need to search manually for an available parking space.

5.6 Parking Slot Reservation

Users can select an available parking slot and reserve it through the web application. The backend verifies the slot availability and stores the reservation details in the database. The reservation status is then reflected in the system to help prevent conflicting reservations.

5.7 Parking and Vehicle Entry

When a reserved vehicle reaches the parking area and occupies the selected slot, the ultrasonic sensor detects its presence. The ESP32 sends the updated sensor information to the backend, and the slot status is updated from **Available/Reserved** to **Occupied**.

5.8 Vehicle Exit

When the vehicle leaves the parking slot, the ultrasonic sensor detects the absence of the vehicle. The ESP32 sends the updated information to the backend, which updates the parking slot as **Available**. The updated status is then reflected in the web application.

5.9 Payment and Parking History

The system provides an **online payment facility** for applicable parking reservations. After the payment process, the payment status and transaction-related information are stored in the database. Users can also view their previous reservation and payment information through the parking history section.

5.10 Admin Monitoring

The administrator can monitor and manage the parking system through the admin interface. The administrator can manage **parking areas, parking slots, users, reservations, and payments**, and monitor the current status of parking spaces.

5.11 Overall System Workflow

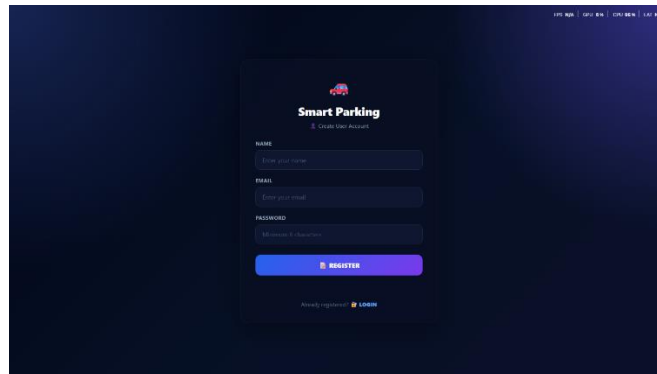
The complete working of the system can be summarized as:

Vehicle Detection → HC-SR04 Sensor → ESP32 → Wi-Fi → Flask Backend → Database → Web Application → User/Admin

The sensors continuously detect the occupancy status of parking slots. The ESP32 collects and transmits the sensor information to the Flask backend through Wi-Fi. The backend processes the received data and updates the database. The web application retrieves the updated information and displays the current parking status to users and administrators. Users can then view available slots, make reservations, cancel reservations, and complete payments, while administrators can monitor and manage the parking system. Thus, the proposed system provides an **automated and real-time approach to parking management**, helping reduce the time required to find available parking spaces and improving the management and utilization of parking facilities.

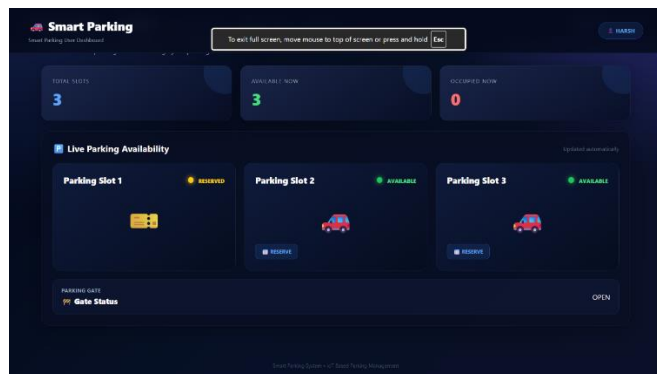
6. SYSTEM SCREENS

Login Page – User/Admin login using registered credentials.

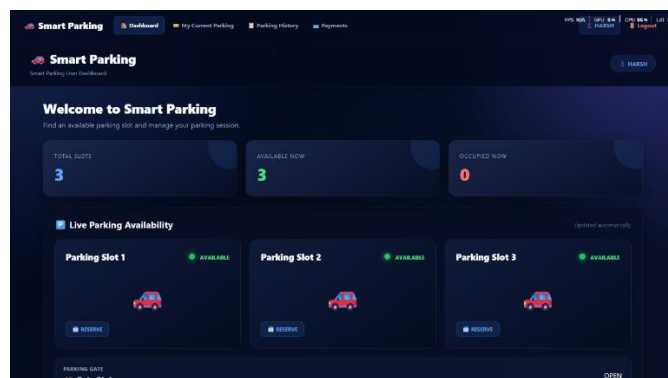


User Dashboard

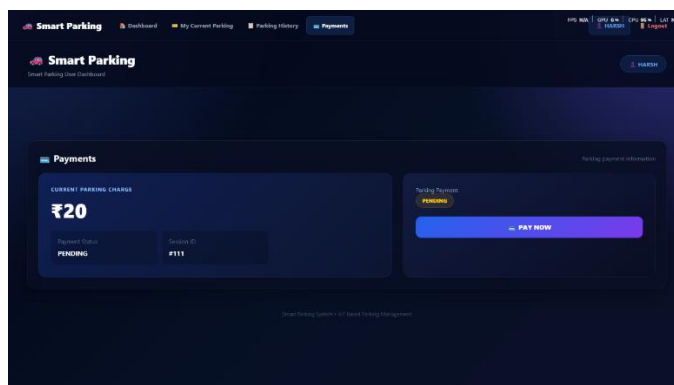
The User Dashboard displays total, available, and occupied parking slots. It provides real-time status of individual parking slots so users can identify available spaces.



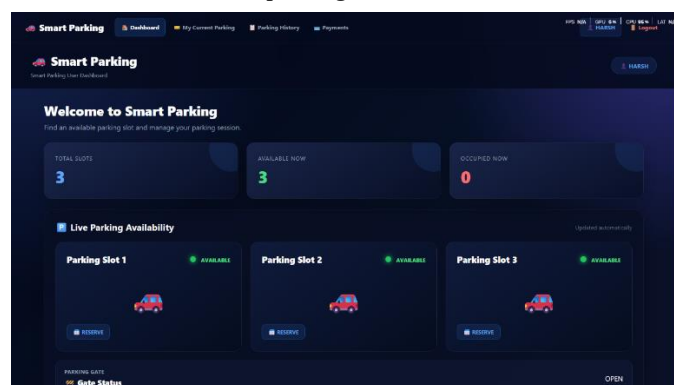
Parking Slot Page – Shows parking slots with their real-time availability status.



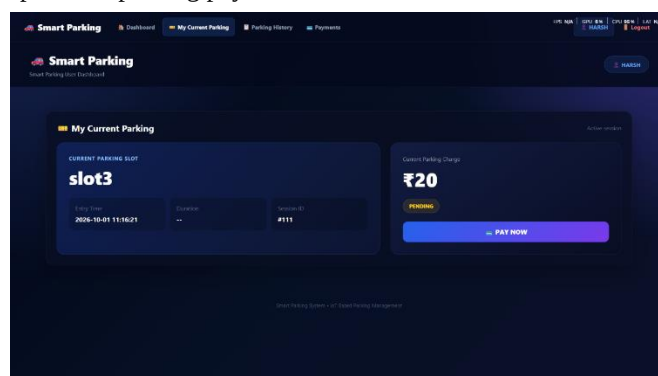
Payment Page – Allows users to make parking payments.



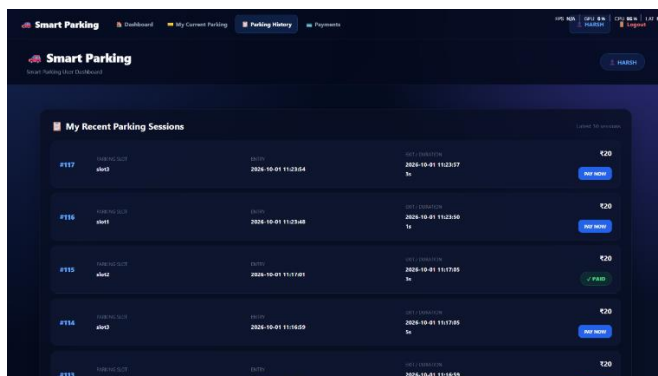
Reservation Page – Allows users to reserve an available parking slot.



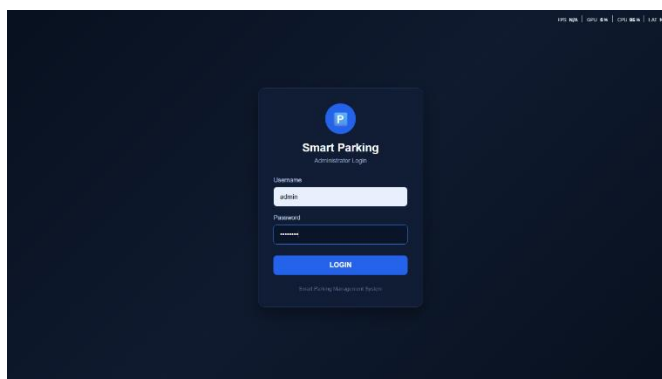
Payment History Page : Displays previous parking payment records.



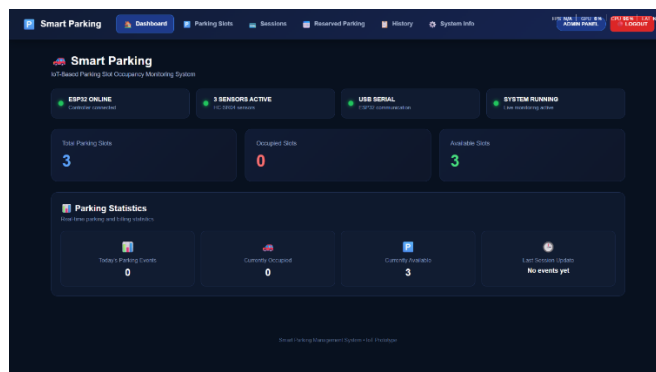
User Parking History Page:



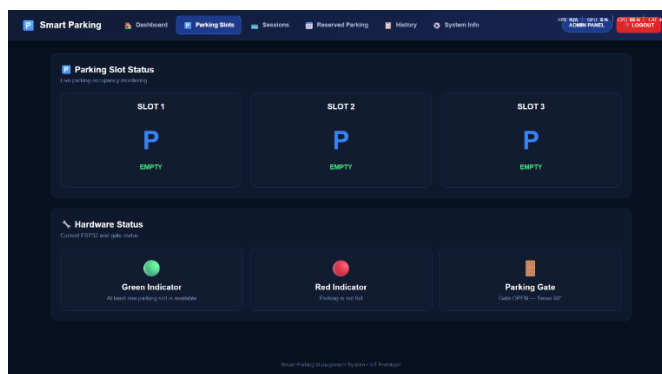
Login Page – User/Admin login using registered credentials.



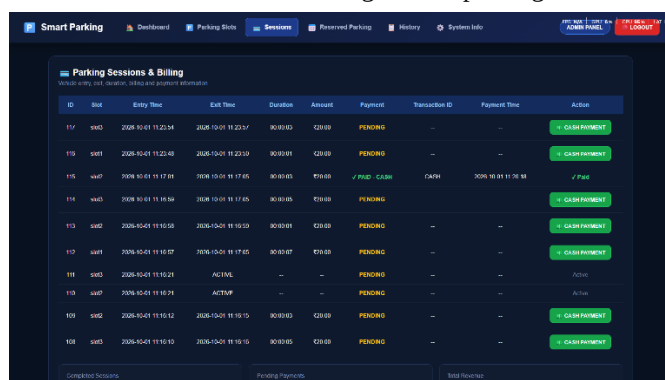
Admin Dashboard – Provides an overview of parking system activities.



Admin Parking Slot : Shows parking slots with their real-time availability status.



Admin Session Page: Enables the administrator to view and manage active parking sessions and their details.

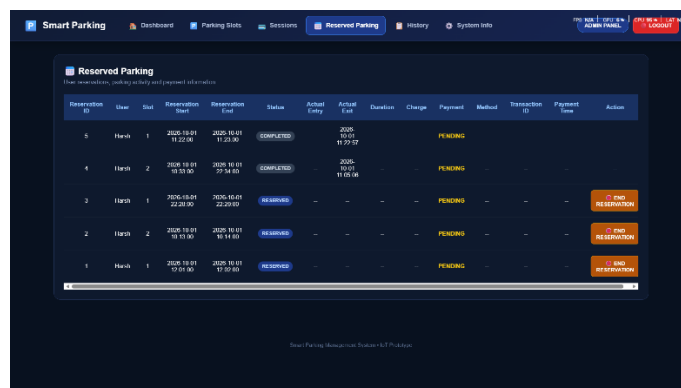


The image shows the 'Smart Parking' Admin Session page. It features a dark blue background with a navigation bar at the top. The page displays a table of parking sessions and billing information. The table has columns for ID, Slot, Entry Time, Exit Time, Duration, Amount, Payment, Transaction ID, Payment Time, and Action. The table shows several rows of data, including sessions that are 'PENDING' and 'ACTIVE'.

ID	Slot	Entry Time	Exit Time	Duration	Amount	Payment	Transaction ID	Payment Time	Action
117	slot2	2026-10-01 11:22:34	2026-10-01 11:22:37	00:00:03	₹0.00	PENDING	---	---	CASH PAYMENT
118	slot1	2026-10-01 11:22:48	2026-10-01 11:22:50	00:00:01	₹0.00	PENDING	---	---	CASH PAYMENT
119	slot2	2026-10-01 11:17:04	2026-10-01 11:17:05	00:00:01	₹0.00	PAID / CASH	CASH	2026-10-01 11:17:04	PAID
114	slot3	2026-10-01 11:16:59	2026-10-01 11:17:05	00:00:05	₹0.00	PENDING	---	---	CASH PAYMENT
112	slot2	2026-10-01 11:16:58	2026-10-01 11:16:59	00:00:01	₹0.00	PENDING	---	---	CASH PAYMENT
113	slot1	2026-10-01 11:16:57	2026-10-01 11:17:05	00:00:07	₹0.00	PENDING	---	---	CASH PAYMENT
111	slot2	2026-10-01 11:16:21	ACTIVE	---	---	PENDING	---	---	Active
110	slot2	2026-10-01 11:16:21	ACTIVE	---	---	PENDING	---	---	Active
109	slot2	2026-10-01 11:16:12	2026-10-01 11:16:15	00:00:03	₹0.00	PENDING	---	---	CASH PAYMENT
108	slot3	2026-10-01 11:16:10	2026-10-01 11:16:15	00:00:05	₹0.00	PENDING	---	---	CASH PAYMENT

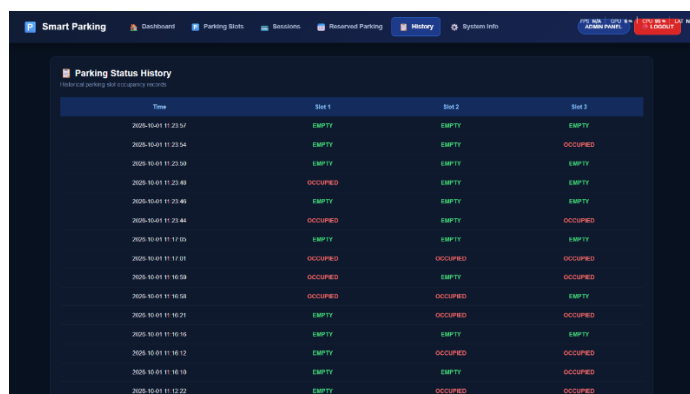
Completed Sessions: 105 Pending Payments: 102 Total Revenue: ₹0.00

Admin reserved parking: Displays all reserved parking slots along with booking details and reservation status.



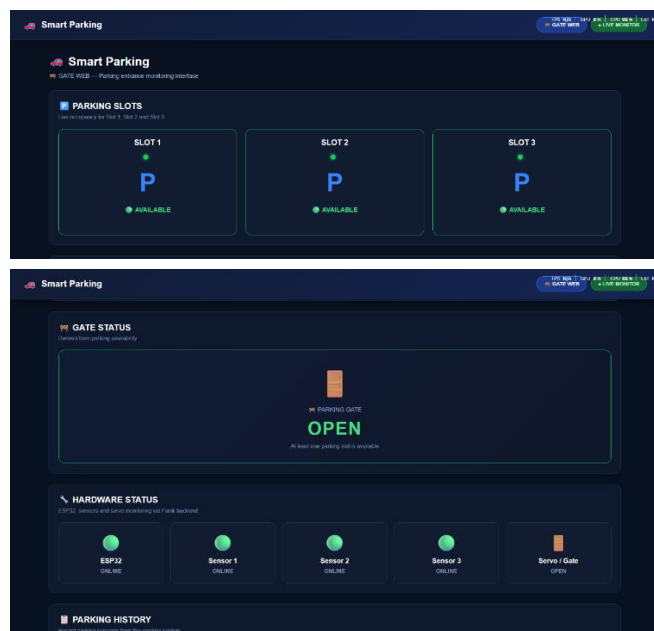
Reservation ID	User	Slot	Reservation Start	Reservation End	Status	Actual Entry	Actual Exit	Duration	Charge	Payment	Method	Transaction ID	Payment Time	Action
5	Hars	1	2025-10-01 11:21:54	2025-10-01 17:21:54	COMPLETED	2025-10-01 11:21:57	2025-10-01 17:21:57			PENDING				
4	Hars	2	2025-10-01 16:53:30	2025-10-01 22:53:30	COMPLETED		2025-10-01 16:53:30			PENDING				
3	Hars	1	2025-10-01 22:20:20	2025-10-01 22:20:20	RESERVED					PENDING				END RESERVATION
2	Hars	2	2025-10-01 16:53:30	2025-10-01 16:53:30	RESERVED					PENDING				END RESERVATION
1	Hars	1	2025-10-01 17:01:50	2025-10-01 17:01:50	RESERVED					PENDING				END RESERVATION

Admin Parking History Page: Shows the history of completed parking sessions, including vehicle entry and exit times, and payment information.



Time	Slot 1	Slot 2	Slot 3
2025-10-01 11:21:57	EMPTY	EMPTY	EMPTY
2025-10-01 11:23:04	EMPTY	EMPTY	OCCUPIED
2025-10-01 11:23:39	EMPTY	EMPTY	EMPTY
2025-10-01 11:23:49	OCCUPIED	EMPTY	EMPTY
2025-10-01 11:23:49	EMPTY	EMPTY	EMPTY
2025-10-01 11:23:44	OCCUPIED	EMPTY	OCCUPIED
2025-10-01 11:17:05	EMPTY	EMPTY	EMPTY
2025-10-01 11:17:01	OCCUPIED	OCCUPIED	OCCUPIED
2025-10-01 11:16:59	OCCUPIED	EMPTY	OCCUPIED
2025-10-01 11:16:58	OCCUPIED	OCCUPIED	EMPTY
2025-10-01 11:16:21	EMPTY	OCCUPIED	OCCUPIED
2025-10-01 11:16:16	EMPTY	EMPTY	EMPTY
2025-10-01 11:16:12	EMPTY	OCCUPIED	OCCUPIED
2025-10-01 11:16:10	EMPTY	EMPTY	OCCUPIED
2025-10-01 11:12:21	EMPTY	OCCUPIED	OCCUPIED

Gate status: Displays the current status of the parking gate, indicating whether it is open or closed.



Slot	Status
SLOT 1	AVAILABLE
SLOT 2	AVAILABLE
SLOT 3	AVAILABLE

Gate Status
OPEN

Hardware Status	Status
ESP32	ONLINE
Sensor 1	ONLINE
Sensor 2	ONLINE
Sensor 3	ONLINE
Servo / Gate	OPEN

7. APPLICATIONS

1] Shopping Malls and Commercial Complexes: The system can be used to monitor and manage parking spaces in shopping malls, providing customers with real-time information about available parking slots.

2] Hospitals and Healthcare Centers: Smart parking can help patients, visitors, and hospital staff quickly identify available parking spaces, reducing unnecessary vehicle movement within hospital premises.

3] Educational Institutions: Colleges and universities can use the system to manage limited parking areas for students, faculty, and visitors and maintain organized parking facilities.

4] Corporate Offices and IT Parks: The system can be implemented in corporate parking areas to monitor employee parking, identify vacant spaces, and improve efficient utilization of parking capacity.

5] Railway Stations and Airports: Smart parking management can assist passengers in finding available parking spaces near transportation hubs, reducing congestion and parking search time.

6] Public Parking Areas: Municipal authorities can implement the system in public parking facilities to provide real-time parking information and improve overall parking management.

8. ADVANTAGES

1] Real-Time Parking Monitoring: The system continuously monitors parking slots using IoT sensors and provides updated information about available and occupied spaces.

2] Reduced Parking Search Time: Users can identify available parking spaces through the web interface, reducing the time and effort required to search manually.

3] Automation: Automatic detection of vehicle occupancy reduces the need for manual monitoring and management of individual parking spaces.

4] Efficient Space Utilization: The system provides accurate information about parking availability, helping organizations utilize available parking capacity more effectively.

5] Improved User Experience: The system provides a simple and convenient way for users to check parking availability and, where implemented, reserve suitable parking spaces.

6] Reduced Traffic and Fuel Consumption: By minimizing unnecessary circulation of vehicles while searching for parking, the system can help reduce congestion, fuel consumption, and associated emissions.

7] Scalability: The system can be extended by adding more sensors and parking slots, making it suitable for small parking areas as well as larger parking facilities.

9. LIMITATIONS

1] Internet Dependency: The web-based system requires a stable network connection for communication between the IoT device, backend server, database, and user interface.

2] Sensor Accuracy: The accuracy of parking-slot detection depends on the proper functioning, positioning, and calibration of the sensors.

3] Maintenance Requirements: Sensors and other electronic components require periodic inspection and maintenance to ensure reliable operation.

4] Network or Server Failure: Failure of the network or backend server may temporarily prevent users and administrators from accessing updated parking information.

10. CONCLUSION

The **IoT-Based Smart Parking Management System** provides an efficient and automated solution for managing parking spaces using **HC-SR04 ultrasonic sensors, ESP32, Wi-Fi communication, Python Flask, SQLite database, and a web-based interface**. The system detects parking-slot occupancy and provides real-time availability information to users, reducing the time and effort required to find vacant parking spaces.

The web application allows users to **register and log in, search for parking areas, view real-time slot availability, reserve and cancel parking slots, make online payments, and view parking history**. The admin module enables management of parking areas, slots, users, reservations, payments, and system information. By reducing manual monitoring and providing centralized parking information, the system improves convenience and supports better utilization of available parking spaces.

The proposed system can be further enhanced by integrating **mobile applications, automatic number-plate recognition (ANPR), advanced AI/ML-based parking prediction, smart navigation, and integration with larger-scale parking infrastructure**. These enhancements can improve the system's scalability, automation, and applicability in real-world smart-city environments.

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