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Smart Park Management System: A Web-Based Application for Parking Reservation and Management

Dr. Trupti Meshram¹, Shahid Khan², Vaibhav Pardhi³, Krunal Katolkar⁴, Srujal Verma⁵, Jay Warade⁶, Piyush Malewar⁷

Department of Computer Science and Engineering, G.H Rasoni University, Amravati, India

Abstract: Finding suitable parking in crowded areas can be inconvenient because drivers often have limited information about where they can park before reaching their destination. This work introduces the Smart Park Management System, a web-based application developed to make the parking process more organized and convenient. The platform allows users to create accounts, explore parking facilities, check slot availability, reserve a space, make payments, and view the location of the selected parking area. A separate administrative interface is provided for managing users, parking locations, slots, bookings, payments, and system records. The system also supports the addition of privately available parking spaces, allowing owners to make their spaces accessible to potential users. React is used to develop the user interface, while Java Spring Boot manages the application services and MySQL stores the required data. Secure JWT authentication is implemented to control access according to user roles. A location feature is also incorporated to make parking facilities easier to identify. Unlike solutions that depend on sensors, IoT devices, or AI-based prediction, the proposed system follows a software-focused approach that can be implemented with comparatively lower infrastructure requirements. The overall system is intended to provide a practical parking management solution for small and medium-sized facilities while improving the interaction between parking users and parking providers.

Keywords: Smart Parking System, Web Application, Parking Reservation, React, Spring Boot, JWT Authentication, Parking Management

I. INTRODUCTION

The increasing number of vehicles and growing activity in cities have made parking a common problem. People often spend a lot of time looking for an available parking space, especially near hospitals, markets, colleges, offices, and other busy places. A parking management system can help solve this problem by allowing users to check parking locations and reserve a space before reaching the destination.

Different smart parking systems have been developed using technologies such as sensors, cameras, wireless networks, mobile applications, and AI. However, every parking facility does not require such advanced or expensive technologies. For small and medium-sized parking facilities, a simple web-based system can provide useful features such as user registration, secure login, parking location management, slot management, booking, online payment records, and reports without using physical sensors.

Our proposed Smart Park Management System is a web-based application developed to make parking management easier for both users and administrators. Users can find available parking spaces, view their locations, and book a suitable space. Administrators can manage users, parking locations, slots, bookings, payments, and reports.

Another important feature of our system is that private parking-space owners can add their available parking spaces to the platform. This allows them to make better use of their unused parking space and earn income from it. In this way, the proposed system is not limited to one parking facility but provides a platform that connects parking users, parking owners, and administrators in a simple and organized manner.

II. RELATED WORK

Existing parking management systems mainly focus on providing information about parking spaces and helping users find available slots. Some systems allow users to search for parking locations, while others provide features such as slot booking and online payment. However, many existing solutions are designed around parking facilities that are already owned and managed by a particular organization.

Previous studies have proposed web-based parking reservation systems with features such as slot availability, online booking, user authentication, payment and administrator management.

Abhiinanth and Vishnu Priya [1] developed a web-based parking reservation system with separate user and administrator modules. Gujar et al. [2] focused on real-time slot availability and advance booking. Rambhapure et al. [3] presented a software-based approach for efficient parking management. Bhavana A. et al. [4] developed a system using React, Spring Boot and MySQL, which is technically similar to the proposed system.

Žemla and Cigánek [6] incorporated parking-space management, reservation and online payment. Kotwal et al. [7] proposed Parkify for online parking booking and payment. However, the proposed system focuses on integrating parking-space management, user/admin role-based access, booking, payment, location-based identification and administrative reporting in a single web application without IoT or AI dependency.

Our proposed Smart Car Parking Management System addresses this limitation by allowing private parking owners to register and list their parking spaces on the platform. Users can view the available locations, check parking details, book a suitable space, and complete payments through the system. The system also provides separate user and administrator functionalities for better management and security. In addition, location and map-based information helps users identify the parking area more easily. Unlike systems that depend on IoT sensors or AI-based technologies, our project focuses on a simple web-based management solution without requiring additional hardware.

Therefore, the proposed system provides a practical platform connecting parking users with parking space owners while making parking management more convenient and organized.

III. PROBLEM STATEMENT

Finding a parking space has become difficult in busy areas where many people visit every day. Our project aims to solve this problem by providing a web-based platform where users can find parking locations, check available spaces, and book them in advance. The system also allows private parking owners to list their spaces and earn income. This can make parking more organized, reduce unnecessary traffic caused by parking searches, and provide a convenient solution for both users and parking-space owners.

In busy areas like New Mankapur, finding a convenient parking place can be a difficult task, particularly near locations such as Max Hospital where a large number of people visit throughout the day. Drivers may have to move around the area to find an empty space, and vehicles waiting or stopping near the roadside can add to congestion on the main road. This situation can cause delays and inconvenience for patients, visitors, local residents, and other commuters. Another issue is that people usually have no simple way to know about parking availability before reaching the location. At the same time, privately owned spaces that could be used for parking may remain vacant because owners have no easy platform to offer them to users. The proposed Smart Park Management System is intended to address these issues through a web-based parking platform. It allows users to discover suitable parking locations and reserve available spaces, while private owners can register their parking spaces on the platform. The system therefore aims to improve parking accessibility, reduce unnecessary searching on busy roads, and provide a more organized connection between parking users and space owners.

IV. OBJECTIVES

The main objective of our project is to make finding and managing parking spaces easier and more convenient. Many people waste time and fuel and creates traffic while searching for an available parking space, especially in busy areas. Our system allows users to check available parking spaces, book them in advance, and make payments online. It also helps private parking space owners list their unused spaces and earn income from them. Overall, our aim is to provide a simple and efficient platform that makes the parking process easier for both users and parking owners.

- To develop an easy-to-use online system that helps people find suitable parking spaces.
- To give users a convenient way to check parking details and book a space according to their needs.
- To protect the system by providing separate and controlled access for users and administrators.
- To make it easier for administrators to add, modify, remove, and organize parking-related information.
- To keep important details such as users, bookings, payments, and parking data properly organized in one database.
- To help administrators keep track of parking activities and understand the overall system operation through reports.
- To make parking facilities easier to locate by showing useful map and location details.
- To create an opportunity for private parking owners to offer their unused spaces to users and earn from them.

V. PROPOSED SYSTEM

The proposed Smart Park Management System is a web-based Application developed to make parking easier to find, book, and manage. The system brings parking users, private parking owners, and administrators together on one platform. Users can create an account, explore available parking locations, check slot information, select a suitable space, and complete the booking and payment process (as shown in Fig 2). Private owners can add their parking spaces to the system and manage the spaces they offer to users, providing an opportunity to generate income from available parking areas. Administrators have a separate dashboard through which they can manage users, locations, slots, bookings, payments, and reports (as shown in Fig 1).

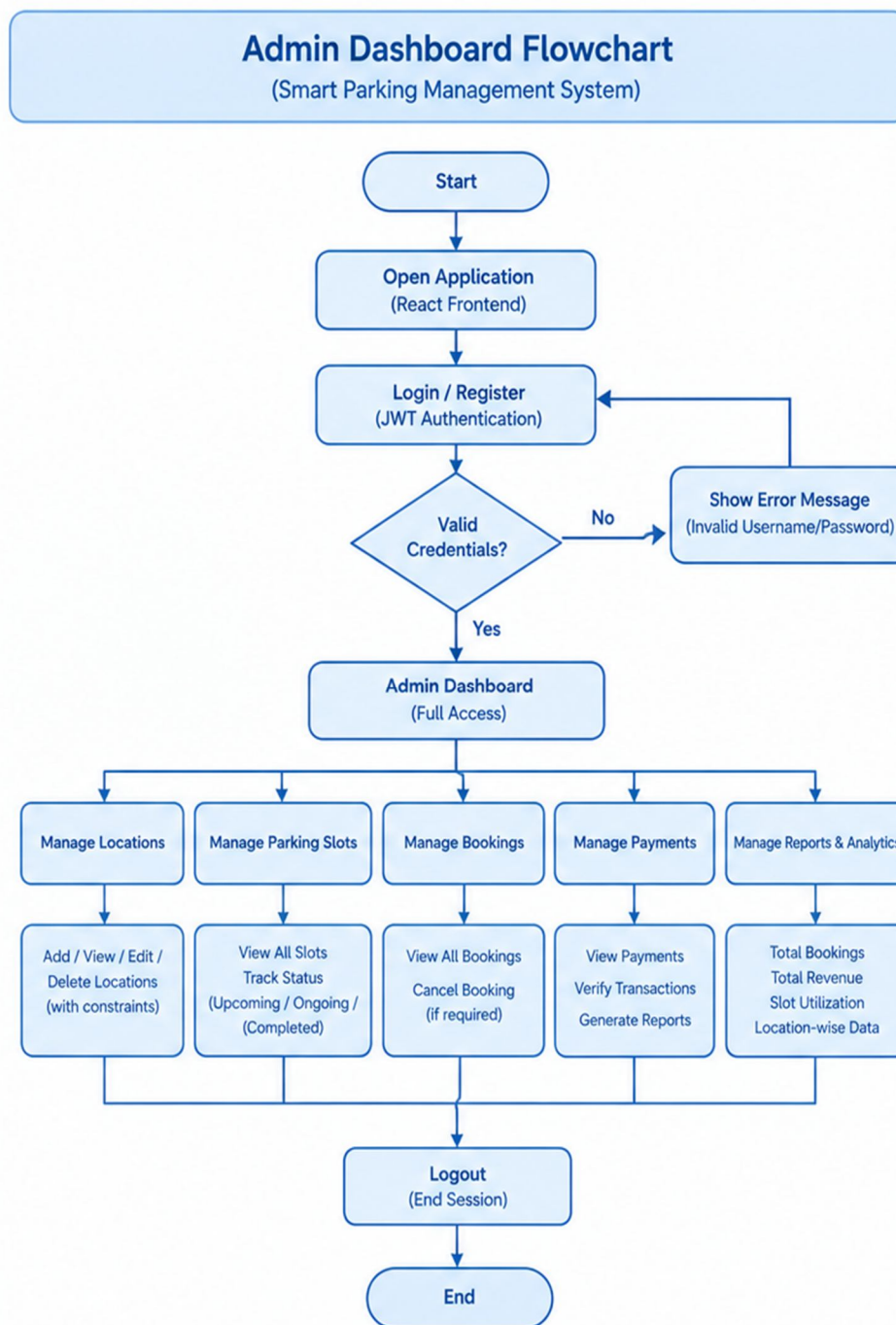


Fig 1. Admin dashboard flowchart

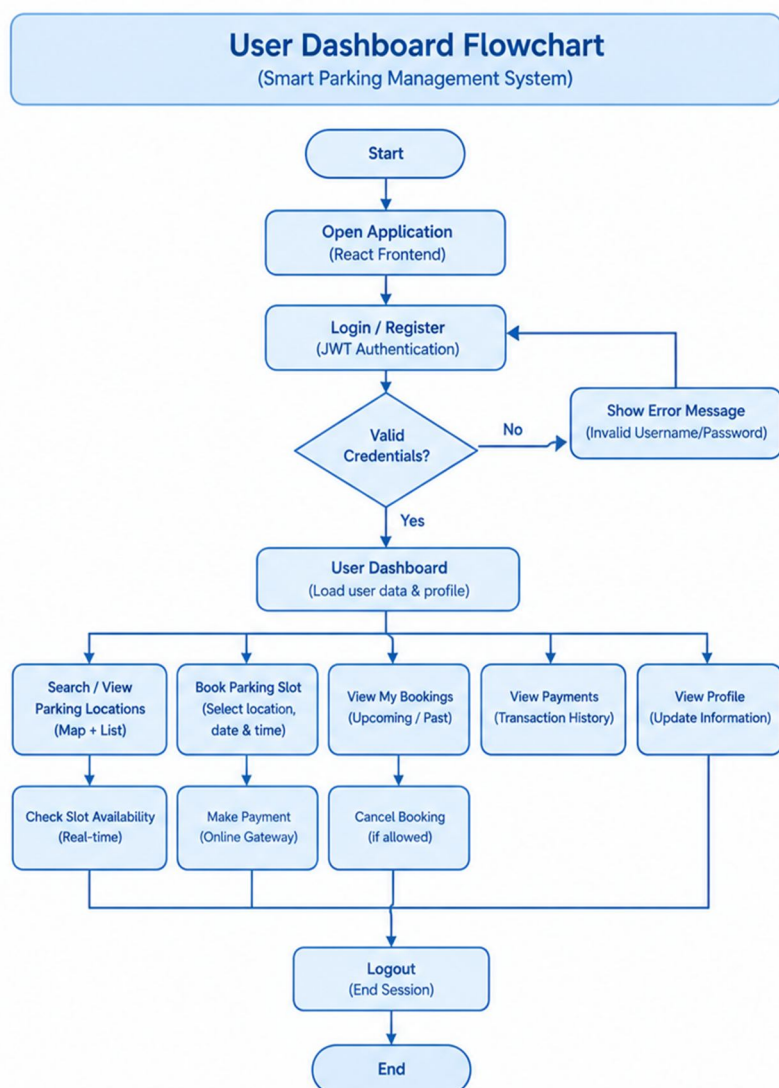


Fig 2. User dashboard flowchart

VI. SYSTEM ARCHITECTURE

The overall architecture consists of the following components:

- User Interface Layer: React components provide login pages, dashboards, parking-location views, slot selection, booking pages, payment pages, and reports.
- Authentication and Authorization Layer: The Spring Boot backend verifies user credentials and issues JWT-based authentication information. The application checks the user's role before permitting protected operations.
- Business Logic Layer: REST APIs process registration, login, location management, slot management, bookings, payments, and reporting requests.
- Database Layer: MySQL stores persistent records. Tables are connected through relationships such as user-to-booking, location-to-slot, and booking-to-payment.
- Location Service: A map image with an exact address of the location and live pictures of the location. The feature helps users identify the physical facility.

This architecture separates the frontend, backend, and database responsibilities. Such separation makes the application easier to maintain and allows individual layers to be modified without redesigning the complete system.

VII. METHODOLOGY

The Smart Park Management System was developed step by step by dividing the application into different modules. The initial stage involved identifying the main requirements of both users and administrators and deciding what information needed to be stored in the system. Based on these requirements, the database was prepared to handle details related to accounts, parking areas, slots, reservations, payments, and other system records. The backend was then developed using Java Spring Boot, where different REST APIs were created to perform the required operations. The React frontend communicates with these APIs and provides the screens through which users and administrators interact with the application.

Security was considered during the development of the login and access-control modules. When a new user creates an account, the required details are saved in the database and checked during login. After successful authentication, the system generates a JWT token that allows the authenticated user to access the appropriate features. The application also checks the user's role so that administrative functions are not available to normal users.

The application is organized into three main layers. The first layer is the React-based interface, which handles the screens and user interaction. The second layer is the Spring Boot application, which processes requests, performs system operations, and applies the required business rules. The third layer is the MySQL database, which keeps the application's information in an organized manner. This separation makes the different parts of the application easier to manage and maintain.

From the user's perspective, the process starts with account creation and login. Once the login is successful, the user can enter the dashboard and explore the parking facilities available through the system. The user can view information about a location, check its parking options, select a suitable slot, and submit a booking request. The booking details are then recorded in the database and can be accessed later through the user's booking history. This step-by-step process provides a straightforward way for users to interact with the parking platform.

VIII. FUNCTIONAL MODULES

- User Registration and Login: Users create accounts and authenticate through the web application.
- Admin Login and Dashboard: Administrators access protected management functions through a separate interface (as shown in Fig 5).
- Parking Location Management: Administrators can add, update, view, and manage parking locations.
- Slot Management: Slots are associated with parking locations and their booking status is managed through application records.
- Booking Management: Users select parking locations and slots and create reservations. Administrators can monitor booking records.
- Payment Management: Payment information is associated with bookings so that transactions and records can be monitored.
- Map and Location Feature: Parking facilities can include a map image and exact address of the location with live pictures.
- Reports and Analytics: Administrative views can summarize users, locations, bookings, payments, and parking activity (as shown in Fig 6).

IX. SECURITY CONSIDERATIONS

Security is an important consideration in the Smart Park Management System because the application handles user accounts, booking details, payment records, and other system information. To protect access to the application, JWT authentication is used between the React frontend and the Spring Boot backend. After a successful login, the system verifies the user's identity and provides access according to the assigned role. This ensures that administrative functions are available only to authorized administrators.

User passwords should never be kept directly in the database. Instead, they should be stored in a properly hashed form so that the original password cannot be easily obtained. The backend also needs to check the information received from users before processing requests and should block requests from users who do not have the required permissions. Database operations should be performed through secure methods provided by the framework to reduce the risk of unauthorized or unsafe queries. Payment-related information should also be handled carefully, and unnecessary sensitive details should not be stored in the application.

Security checks should be performed mainly on the backend rather than depending only on the frontend. Although frontend restrictions can prevent users from opening certain pages, they alone cannot stop someone from directly sending requests to the server. Therefore, the backend should verify authentication and user permissions for every protected operation. This provides an additional layer of protection and helps keep the system and its stored information secure.

X. RESULTS AND DISCUSSION

The developed Smart Park Management System provides a practical way to manage parking activities through a single web-based platform. During testing, the system was able to handle important functions such as user registration, secure login, parking-location management, slot availability, booking, payment records, and administrative management. Users can access parking information before reaching the location, which can help reduce the time spent searching for a suitable space. The system also gives administrators better control over users, parking locations, bookings, and other records through a separate dashboard.

One of the useful outcomes of the project is the facility for private parking owners to add their available private spaces to the platform, creating an opportunity to use otherwise vacant spaces. The live images and exact location of the parking location feature helps users understand where the parking facility is situated, Since the proposed system works without IoT sensors or AI-based hardware, its implementation is comparatively simple and suitable for small and medium-sized parking facilities.

Overall, the developed system demonstrates that a software-based approach can provide useful parking management and booking facilities while reducing the difficulties faced by users in finding parking spaces.

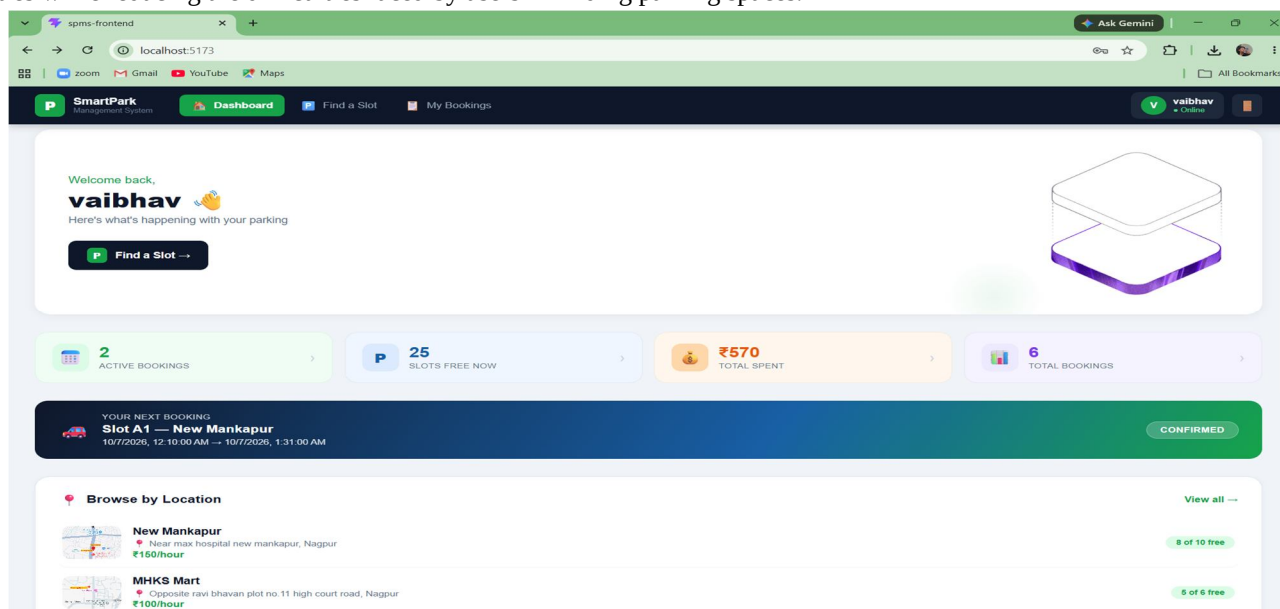


Fig 3. User dashboard and location based slot browsing with real time availability.

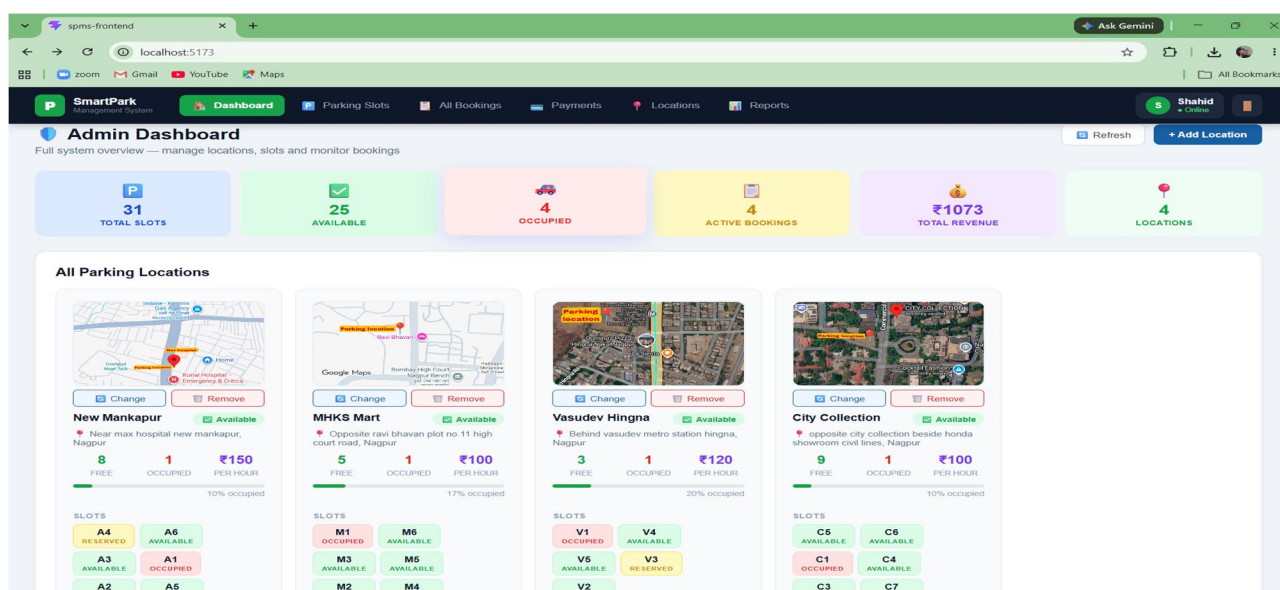


Fig 4. Admin dashboard with statistics along with the location wise slot status and management controls.

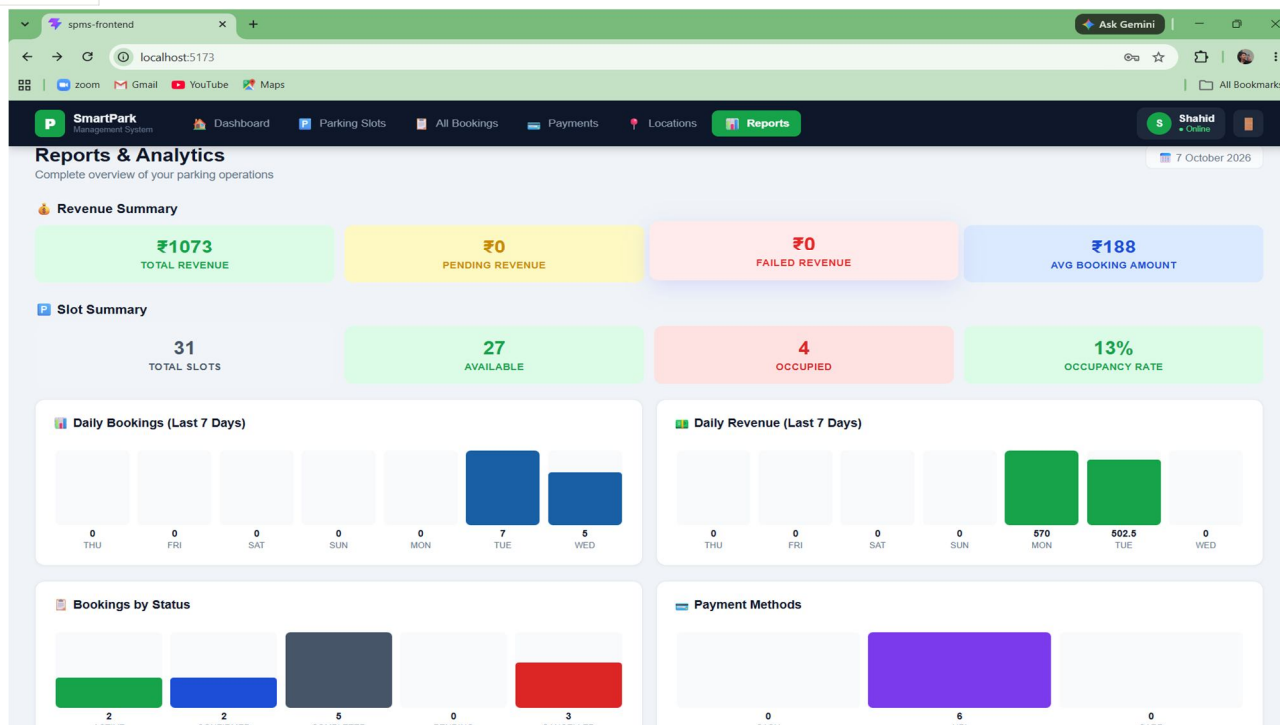


Fig 5. Shows the reports and analytics of the admin dashboard which contains revenue, slot summary.

XI. LIMITATIONS AND FUTURE SCOPE

The present version of the Smart Park Management System is mainly focused on software-based parking management, so it has some limitations. Since physical IoT sensors are not included, the system cannot automatically identify when a vehicle enters or leaves a parking space. The availability of a slot therefore depends on updates made through the application. The system also does not currently use artificial intelligence to study parking patterns or predict future demand.

In the future, the system can be improved by adding technologies such as real-time parking sensors, camera-based vehicle detection, mobile applications, online payment services, QR-based entry, and automatic notifications. AI and data analysis can also be introduced to understand parking usage and estimate demand during busy periods. Additional security features, such as multi-factor authentication and stronger API protection, can be added to improve data safety. The application could also be deployed on cloud infrastructure to support a larger number of users and multiple parking locations.

Another possible improvement is to develop the private parking feature into a complete parking marketplace. In such a system, parking owners could add their spaces, set prices, specify when the spaces are available, and receive booking details directly through the platform. This would allow the application to connect users with parking spaces from different owners and locations, making the system more flexible and useful as it grows.

XII. CONCLUSION

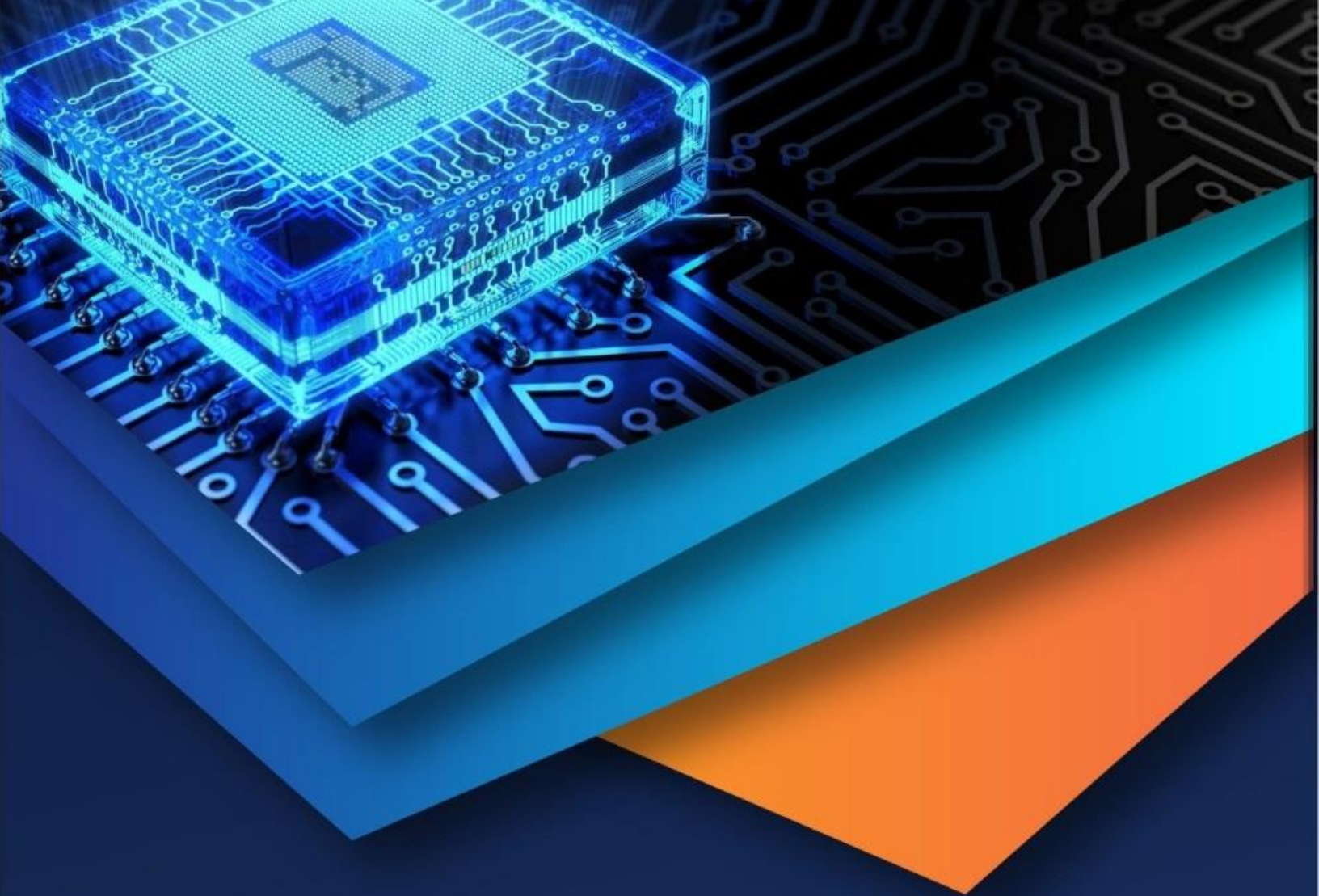
The Smart Park Management System provides a simple web-based solution for handling common parking-related activities in an organized way. The application brings together important functions such as parking-location management, slot information, bookings, payments, and administrative control in one platform. React, Java Spring Boot, and MySQL are used to build the main parts of the system, while JWT authentication helps control access for different types of users.

The system is designed to make parking information easier to access before users reach a particular location. By providing booking facilities and map-based location details, it can help users choose a suitable parking space with less effort. The inclusion of private parking owners also makes the platform more useful by allowing available private spaces to be offered to people looking for parking.

Overall, the project shows that a software-based approach can provide useful parking management features without depending on IoT devices or AI technologies. The current system can serve as a foundation for further development, including mobile support, real-time parking updates, advanced data analysis, online services, and deployment across multiple parking facilities.

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