
QR CODE BASED SMART VEHICLE PARKING MANAGEMENT SYSTEM

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ABSTRACT

Parking space management has become an important issue in modern urban environments due to the rapid increase in the number of vehicles. Traditional parking systems often depend on manual verification or expensive hardware technologies such as RFID readers and sensor networks, which increase operational complexity and installation cost. To overcome these limitations, this research proposes a QR Code-Based Smart Vehicle Parking Management System that automates the process of vehicle identification and parking access using a web-based platform. In the proposed system, users can register their vehicles through an online interface, after which a unique QR code is generated and linked to the vehicle information stored in the database. This QR code acts as a digital parking pass that can be scanned at the parking entrance for verification. The system is implemented using Python and the Flask framework, while SQLite database is used to store user details, vehicle information, and parking logs. The application also maintains real-time parking records and ensures secure vehicle authentication.

KEYWORDS: *QR Code, Smart Parking System, Automated Vehicle Entry, Real-Time Slot Monitoring, Parking Management.*

INTRODUCTION

The rapid growth of urban populations and the increasing number of vehicles have created significant challenges in parking management. Drivers often spend considerable time

searching for available parking spaces, which leads to traffic congestion, fuel wastage, and frustration among users. Efficient parking management has therefore become an essential requirement for modern cities and commercial infrastructures. Conventional parking systems typically rely on manual ticketing or hardware-based technologies such as RFID readers and sensor networks. Although these systems offer certain levels of automation, they require expensive installation, frequent maintenance, and complex infrastructure. In many cases, such systems are not feasible for small or medium-scale parking facilities due to their high implementation cost. With the advancement of digital technologies, smart parking solutions are being developed to improve parking efficiency and enhance user convenience. Among these technologies, **Quick Response (QR) codes** provide a simple and economical method for vehicle identification and access control. QR codes can store vehicle information digitally and can be easily scanned using cameras or mobile devices.

LITERATURE SURVEY

Smart parking management has gained significant attention in recent years due to the increasing number of vehicles in urban areas and the limited availability of parking spaces. Researchers have proposed various technologies to improve parking efficiency, reduce traffic congestion, and provide better user convenience. Several approaches such as sensor-based systems, IoT-based platforms, RFID authentication, and QR code technologies have been studied for parking management solutions.

Sensor-Based Parking Systems

Many early smart parking solutions rely on sensors such as ultrasonic or infrared sensors to detect whether a parking slot is occupied or vacant. These sensors are installed in individual parking spaces and continuously send occupancy information to a central monitoring system.

IoT-Enabled Parking Solutions:

With the advancement of Internet of Things (IoT) technology, several researchers have developed smart parking systems that use connected sensors and cloud platforms. These systems allow users to check parking availability through mobile applications and reserve slots remotely.

RFID-Based Vehicle Authentication:

Radio Frequency Identification (RFID) technology has also been widely used for automated vehicle identification and access control in parking facilities. In RFID-based systems, each

vehicle is assigned an RFID tag that is detected by RFID readers installed at entry and exit gates.

Gap in Existing Works:

Although many smart parking solutions have been proposed, most of them depend heavily on hardware devices such as sensors, RFID readers, or IoT modules. These technologies increase system cost and complexity, especially in smaller parking facilities. There is a need for a simpler and more affordable parking management approach that can still provide automation and efficient vehicle verification.

Our Contribution:

To address these limitations, this research proposes a **QR Code-Based Smart Vehicle Parking Management System** that uses a web-based platform for vehicle registration, QR code generation, and parking access verification. The system reduces hardware dependency by using QR codes for vehicle authentication and database management for parking records. This approach provides a cost-effective, scalable, and user-friendly solution suitable for various parking environments such as malls, offices, and residential complexes.

PROBLEM FORMULATION

Parking management in urban areas has become increasingly difficult due to the rapid growth in the number of vehicles and the limited availability of parking spaces. In many locations, drivers spend a considerable amount of time searching for available parking slots, which leads to traffic congestion, fuel wastage, and user frustration. Traditional parking systems often depend on manual monitoring or physical ticket-based methods, which are time-consuming and inefficient.

PROBLEM DEFINITION

In many urban environments, existing parking systems rely on manual supervision or hardware-intensive technologies such as RFID readers and sensor networks. These methods often involve high implementation costs, complicated setup procedures, and regular maintenance requirements. As a result, managing parking facilities efficiently becomes difficult for administrators, and users experience delays during vehicle entry and exit.

OBJECTIVE OF PROJECT

- To design and develop a smart parking management system using QR code technology.

- To automate the process of vehicle entry and exit using QR code scanning.
- To provide a web-based platform for vehicle registration and parking management.
- To maintain a database of users, vehicles, and parking records for efficient monitoring.
- To reduce manual verification and improve parking space utilization.
- To provide a cost-effective and scalable solution for modern parking facilities.

SCOPE OF PROJECT

The QR Code-Based Smart Vehicle Parking Management System can be implemented in various environments such as shopping malls, corporate offices, residential complexes, airports, and educational institutions. The system improves parking efficiency by automating vehicle identification and maintaining digital parking records. Since the system is implemented using web technologies, it can be easily deployed and accessed through standard web browsers. The use of QR codes eliminates the need for expensive hardware infrastructure, making the system suitable for both small and large-scale parking facilities. Furthermore, the system can be extended in the future to support mobile applications, online payments, and smart city integrations.

DRAWBACKS OF EXISTING SYSTEM

- Traditional parking systems often rely on manual monitoring, which results in slow verification and longer waiting times for vehicles at entry and exit points.
- Many automated parking solutions depend on hardware technologies such as sensors, RFID readers, or surveillance cameras, which increase installation and maintenance costs.
- Most existing systems do not provide drivers with real-time information about parking slot availability, causing unnecessary time spent searching for spaces.
- Inefficient management of parking slots may lead to poor utilization of available space within the parking facility.
- Manual record keeping and lack of automation can increase the chances of human errors, mismanagement, and traffic congestion in parking areas.

PROPOSED SYSTEM

The proposed **QR Code-Based Smart Vehicle Parking Management System** aims to improve parking efficiency by introducing a digital and automated parking management approach. The system combines web technologies, database management, and QR code

authentication to simplify vehicle identification and parking operations. Through the web application, users can register their personal and vehicle information and receive a unique QR code linked to their vehicle details. This QR code functions as a digital parking pass that can be used for verification at the parking entrance. When the QR code is scanned at the gate, the system retrieves the corresponding data from the database and records the vehicle entry automatically.

KEY FEATURES OF THE PROPOSED SYSTEM

1. QR Code-Based Vehicle Identification

- Each registered user receives a unique QR code that serves as a digital identity for vehicle authentication during parking entry and exit.

2. Slot Reservation Facility

- Users can check the availability of parking spaces through the web application and reserve a slot before arriving at the parking location.

3. Automatic Entry Recording

- When the QR code is scanned at the entrance, the system automatically records the vehicle entry in the database, minimizing manual intervention.

4. Real-Time Data Monitoring

- The system continuously updates information about registered users, available slots, and parking activities within the database.

5. Cost-Effective and Scalable Design

- Since the system mainly depends on software components and QR codes instead of expensive hardware devices, it can be implemented easily in different parking environments.

6. User-Friendly Interface

- The web-based platform provides a simple interface that allows users to register, book parking slots, and access parking services quickly and conveniently.

SYSTEM DESIGN

The system design focuses on creating an automated parking management solution that uses QR code technology and a web-based platform to simplify vehicle registration, slot booking, and entry verification. The system architecture integrates a backend framework, a database management system, and QR code generation technology to ensure efficient parking operations.

Key Components

- **Flask Web Application:** Acts as the backend framework that manages user authentication, QR code creation, slot booking, and parking log management.
- **Database (SQLite):** Stores important system data including user information, vehicle details, parking slot availability, and entry or exit records.
- **QR Code Generator:** Creates a unique QR code for every registered vehicle. This code is used for verification and access control at the parking entrance.

Architecture

- **User Registration:**

Users create an account on the web platform by providing personal information and vehicle details.

- **QR Code Generation:**

Once registration is completed, the system automatically generates a unique QR code associated with the registered vehicle.

- **Slot Booking:**

Users can view current parking slot availability and reserve a slot through the application interface.

- **Parking Entry:**

At the parking gate, the QR code is scanned and verified with the database to confirm vehicle identity and record entry.

- **Parking Logs:**

All parking activities, including entry and exit details, are stored in the system database for monitoring and management purposes.

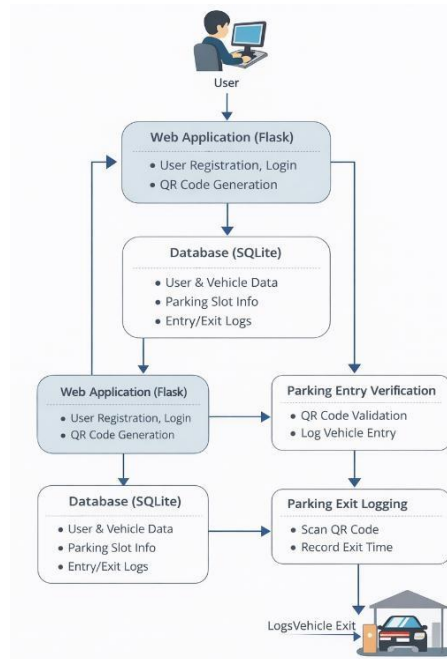


FIG 1: ARCHITECTURE DIAGRAM.

Workflow

1. The user registers in the system and receives a unique QR code.
2. The user can reserve a parking slot in advance or arrive directly at the parking area.
3. The QR code is scanned at the parking entrance for verification.
4. After verification, the system records the vehicle entry in the database.
5. The user can view slot details, booking information, and parking logs through the dashboard.

METHODOLOGY

The QR Code–Based Smart Vehicle Parking Management System is developed using a systematic approach to ensure efficient design, development, and operation. Conventional parking systems often require manual monitoring and make it difficult for drivers to quickly identify available parking spaces. The main objective of the proposed system is to simplify parking management by automating the process of slot identification and maintaining updated information about parking space usage.

The system integrates QR code technology, a web-based application, and a database to manage parking activities effectively. Users first register their vehicle details in the application, after which a unique QR code is generated for identification purposes. The backend of the system is implemented using Python with the Flask framework, while the user

interface is developed using HTML, CSS, and JavaScript. A database such as SQLite or MySQL is used to store vehicle information, slot details, and parking records.

During system development, the database structure is designed to maintain information about parking slots, user data, and entry or exit logs. QR codes are generated dynamically using Python libraries and are linked with the respective vehicle or slot information stored in the database. The web application allows users to scan QR codes, check parking availability, and access parking-related information. An administrative dashboard is also provided to monitor and manage parking activities in real time.

Testing is carried out to ensure that QR codes are generated correctly and can be scanned without errors. The system is also tested to verify that parking slot availability is updated accurately in the database and that the dashboard reflects the current parking status. In addition, user testing is conducted to evaluate the registration process, scanning functionality, and overall ease of use.

In practical operation, when a vehicle arrives at the parking area, the user scans the QR code using the system interface. The application checks the database to verify the availability of the parking slot and allows the vehicle to enter if the slot is free. Once the vehicle is parked, the system updates the slot status as occupied. When the vehicle exits the parking area, the system records the exit time and updates the slot status as available again. Finally, feedback from users is considered to further improve system performance and usability.

IMPLEMENTATION

The QR Code-Based Smart Vehicle Parking Management System is implemented using a web-based architecture that integrates QR code technology with database management. The system automates vehicle identification, parking verification, and record management through a web application.

1. User Registration

- A registration module is developed to allow users to create an account in the system.
- Users enter their personal details such as name, email, password, and vehicle number.
- The information is securely stored in the system database for authentication and parking management.

2. QR Code Generation

- After successful registration, the system automatically generates a unique QR code for each user.

- The QR code contains the vehicle identification information stored in the database.
- This QR code acts as a digital parking pass that can be used for entry verification.

3. User Login and Dashboard

- Registered users can log in to the system using their credentials.
- After login, the dashboard displays the user details, vehicle number, and generated QR code.
- Users can also view their parking history and booking information through the dashboard.

4. QR Code Scanning and Verification

- At the parking entrance, a QR code scanning interface is used to read the user's QR code.
- The scanned data is sent to the backend application for verification.
- The system compares the scanned QR code with the information stored in the database.

5. Parking Entry Logging

- If the QR code is valid, the system records the vehicle entry time in the parking log database.
- The entry record includes user details, vehicle number, and timestamp information.
- This process helps maintain an accurate record of all parking activities.

6. Database Management

- The system uses SQLite database to store all application data.
- The database maintains tables for users, vehicles, parking slots, and parking logs.

7. System Integration

- The backend application is developed using Python and Flask framework.
- The frontend interface is created using HTML, CSS, and JavaScript.
- All modules communicate with the database to ensure real-time updates of parking records.

7. Testing

- The system is tested to ensure that QR codes are generated correctly and can be scanned successfully.

- Database operations are verified to confirm that parking entry and exit records are stored properly.

1. User interface testing ensures that registration, login, dashboard, and QR scanning features work smoothly.

User Registration Algorithm

1. Start the system.
2. Display the registration form to the user.
3. User enters personal details and vehicle number.
4. System checks whether the entered details already exist in the database.
5. If the user is new, store the details in the database.
6. Generate a unique QR code linked to the vehicle number.
7. Save the generated QR code in the system.
8. Display a successful registration message.
9. End the process.

2. User Login Algorithm

1. Start the login process.
2. Display the login page to the user.
3. User enters email and password.
4. System verifies the credentials with the database.
5. If the details match, allow the user to access the dashboard.
6. If the details are incorrect, display an error message.
7. End the login process.

3. QR Code Generation Algorithm

1. Start the QR code generation process.
2. Retrieve the registered user and vehicle information from the database.
3. Convert the vehicle identification data into QR code format.
4. Generate the QR code using a QR code library.
5. Save the generated QR code image in the system.
6. Display the QR code on the user dashboard.
7. End the process.

4. QR Code Verification Algorithm

1. Start the scanning process.
2. Scan the QR code at the parking entrance.
3. Extract the encoded information from the QR code.
4. Send the extracted data to the backend system.

5. Compare the scanned data with records stored in the database.
6. If the data matches, allow parking entry.
7. If the data does not match, deny access.
8. End the verification process.

5. Parking Entry Logging Algorithm

1. Start the parking entry process.
2. Scan the user QR code at the parking gate.
3. Verify the QR code with the database.
4. If verification is successful, record the vehicle entry time.
5. Store the entry details in the parking log database.
6. Update the parking status in the system.
7. End the process.

RESULT

The QR Code-Based Smart Vehicle Parking Management System was successfully developed and evaluated. The system fulfills its primary goal of simplifying the parking process by introducing automation and improving convenience for users. By combining QR code technology with database management and real-time data updates, the system provides an organized approach to parking slot allocation and vehicle verification.

The application generates QR codes dynamically through the backend. These QR codes contain information related to the user and parking access details. When users arrive at the parking facility, they scan the QR code at the entrance for authentication. This process helps reduce manual verification and minimizes waiting time at the entry point.

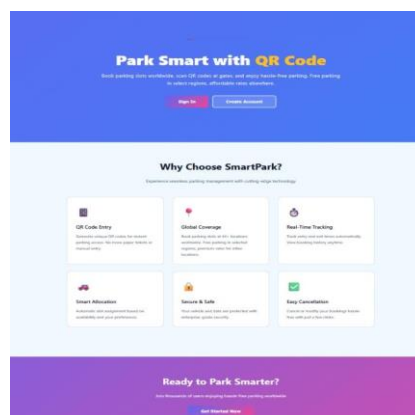


FIG 2: HOME PAGE.

The system also includes a homepage that serves as the initial interface for users. This page provides basic information about the parking management system and allows users to easily navigate to the registration and login sections. The homepage is designed with a simple layout to ensure smooth access to the main features of the application.

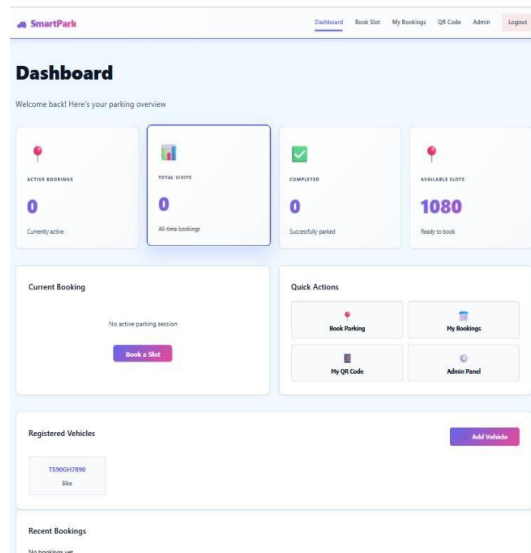


FIG 3: DASHBOARD PAGE.

The dashboard is displayed after the user successfully logs into the system. It provides important information such as the user's vehicle details, generated QR code, and parking-related data. Through the dashboard, users can easily view their parking information and access system features in a single interface.

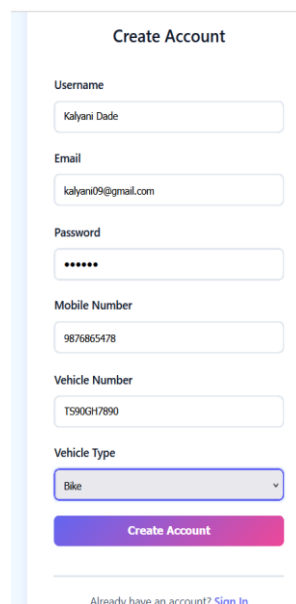
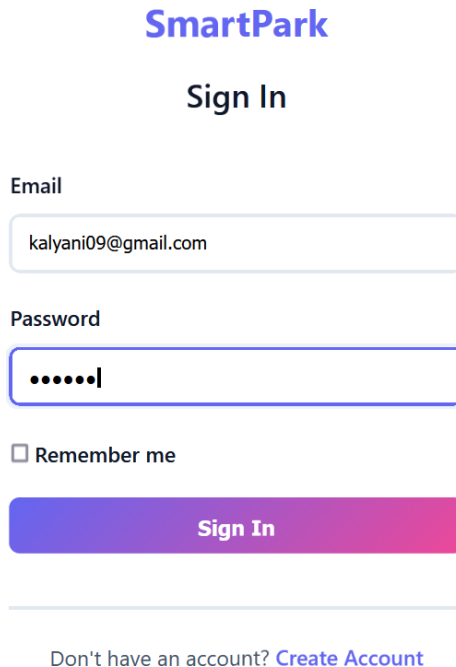


FIG 4: REGISTRATION PAGE.

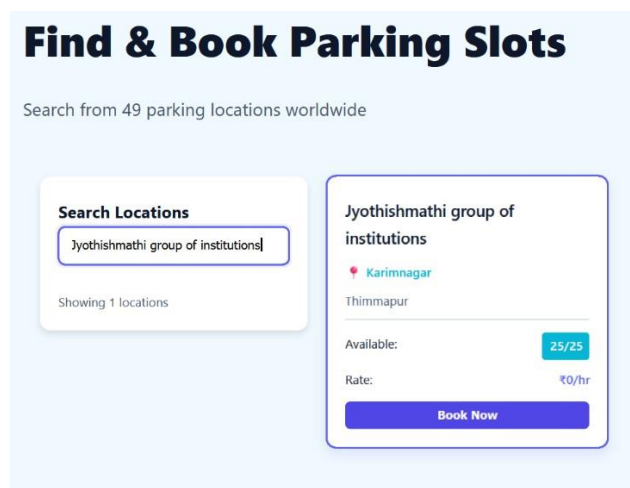
The registration page allows new users to create an account in the parking management system. Users are required to enter their personal details and vehicle information in the registration form. After submitting the form, the system stores the data in the database and creates a user account for future access.



The image shows a login page for 'SmartPark'. At the top, the title 'SmartPark' is in blue, followed by 'Sign In' in black. Below this are two input fields: 'Email' with the value 'kalyani09@gmail.com' and 'Password' with masked characters '.....'. There is a 'Remember me' checkbox which is unchecked. A large purple-to-pink gradient button labeled 'Sign In' is positioned below the fields. At the bottom, there is a link that says 'Don't have an account? [Create Account](#)'.

FIG 5 : LOGIN PAGE.

The login page allows registered users to access the system using their credentials. Users enter their email and password to authenticate their identity. After successful verification, the system redirects the user to the dashboard where parking- related information can be viewed.



The image displays a 'Find & Book Parking Slots' interface. It features a search bar with the text 'Jyothishmathi group of institutions' and a 'Search Locations' button. Below the search bar, it says 'Showing 1 locations'. To the right, a card displays details for 'Jyothishmathi group of institutions' in 'Karimnagar', 'Thimmapur'. It shows 'Available: 25/25' and 'Rate: ₹0/hr'. A 'Book Now' button is at the bottom of the card.

FIG 6: BOOKING PAGE.

The booking page allows users to reserve a parking slot through the system. On this page, users can view the available parking spaces and select a slot according to their requirement. After confirming the booking, the system updates the database and reserves the selected slot for the user.

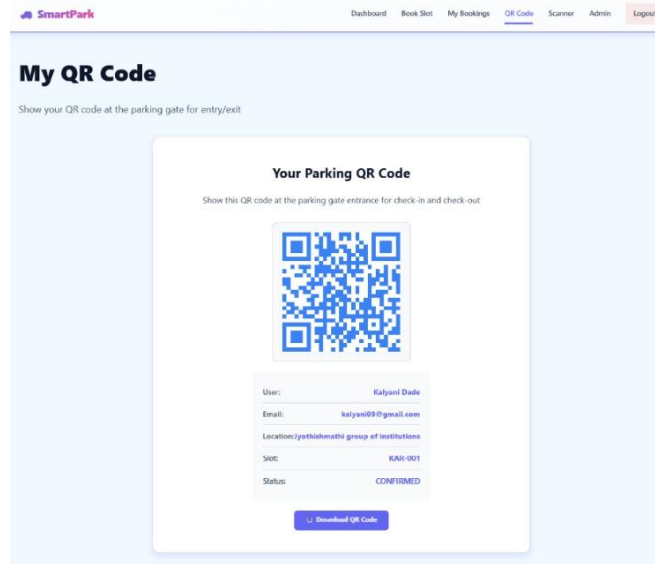


FIG 7: QR CODE GENERATION.

The QR code generation page displays the unique QR code created for the registered user. This QR code contains vehicle identification details that are used for parking verification. Users can present this QR code at the parking entrance for scanning and system authentication.

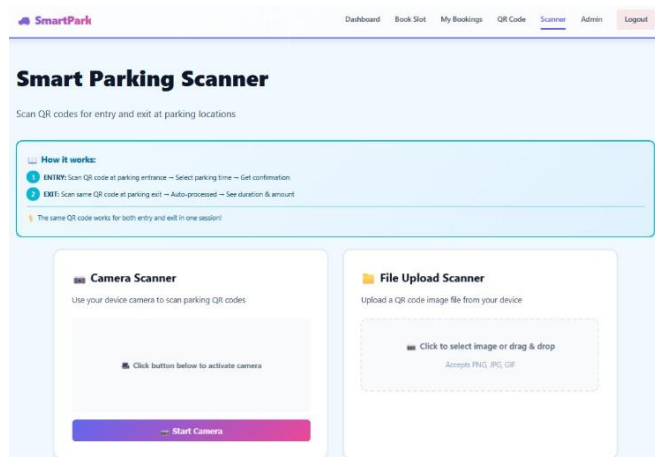


FIG 8: QR SCANNING.

The QR scanning page is used to verify the QR code during parking entry. When the QR

code is scanned, the system retrieves the corresponding user and vehicle details from the database. If the information is valid, the system records the parking entry and allows access to the parking area.

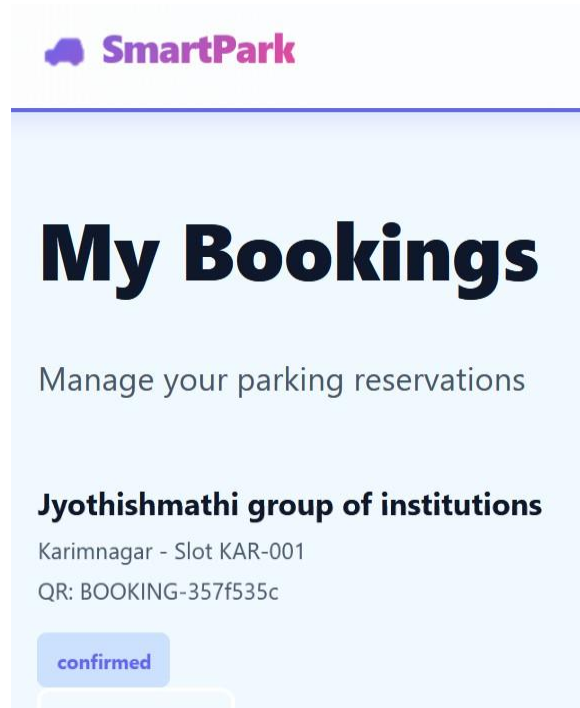


FIG 9: MY BOOKING PAGE.

The My Bookings page allows users to view the details of their reserved parking slots. It displays information such as booking status, slot number, and related parking details. This page helps users easily track their parking reservations and manage their bookings through the system.

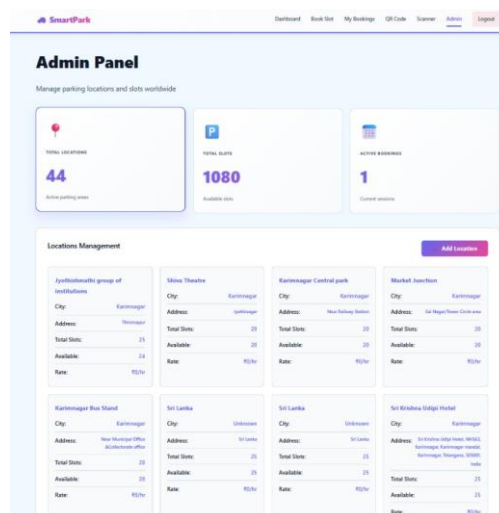


FIG 10: ADMIN PAGE.

The Admin Page provides administrative control over the parking management system. Through this page, the administrator can monitor user activities, manage parking slots, and view parking records stored in the database. It helps in maintaining proper control and efficient management of the parking system.

FUTURE SCOPE

The QR Code-Based Smart Vehicle Parking Management System can be further improved and expanded with additional technologies to enhance its functionality. In the future, the system can be integrated with mobile applications, allowing users to book parking slots, view availability, and manage their bookings directly through their smartphones. Cloud-based storage can also be implemented to handle larger amounts of data and support deployment in multiple parking locations. The system can also be enhanced by including secure QR codes with encryption techniques to improve data protection and prevent unauthorized access. Another possible improvement is the addition of online payment options such as UPI or digital wallets, enabling users to complete parking payments quickly and conveniently. Advanced technologies such as Artificial Intelligence can be incorporated to analyze parking usage patterns and predict parking demand during peak hours. Additionally, license plate recognition systems can be integrated to provide an extra layer of verification for vehicles entering the parking facility.

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