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SMART PARKING USING QR CODE

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ABSTRACT

Smart Parking Using QR Code is an intelligent parking management system designed to simplify and automate the process of vehicle parking and space management. The system uses **QR code technology** to provide users with a convenient method for parking registration, slot allocation, and entry and exit verification. Users can scan a QR code to access parking information, check available slots, reserve a suitable parking space, and receive parking details digitally. The system maintains parking slot information and updates availability based on vehicle entry and exit activities. Administrators can monitor parking spaces, manage vehicle records, and track parking transactions through a centralized interface. QR-based verification helps reduce manual record keeping, minimize entry and exit delays, and improve parking security. The proposed system can also support digital payment integration and automated parking notifications. The **Smart Parking Using QR Code** system aims to provide a cost-effective, user-friendly, and efficient solution for managing parking facilities in shopping malls, offices, educational institutions, hospitals, and other high-traffic locations. By integrating QR code technology with digital parking management, the system improves space utilization, reduces congestion, and enhances the overall parking experience.

Keywords: Smart Parking, QR Code, Parking Management System, Slot Allocation, Vehicle Tracking, Digital Parking, Reservation System, Parking Automation, IoT, Web Application.

I. INTRODUCTION

The rapid growth of urbanization and vehicle ownership has created significant challenges in managing parking facilities efficiently. Conventional parking systems generally depend on manual registration, physical tokens, security personnel, and paper-based records. These approaches can result in long waiting times, inaccurate parking records, inefficient utilization of available spaces, and congestion at parking entrances and exits. Smart parking systems provide a digital solution by integrating information technology with parking management. The use of QR codes offers a simple and low-cost mechanism for identifying users, vehicles, parking reservations, and parking transactions. A QR

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code can be scanned using a smartphone to access the parking system without requiring specialized hardware at every stage of the process.

The proposed **Smart Parking Using QR Code** system provides digital parking registration, slot availability checking, slot reservation, QR-based verification, and parking transaction management. When a user accesses the system, available parking spaces can be displayed through a web or mobile interface. After selecting a suitable slot, the system generates or associates a QR code with the parking transaction. The QR code can subsequently be used for entry verification and parking identification. The system also provides an administrative interface for monitoring parking slots, vehicle information, reservations, and entry-exit transactions. Slot status is updated whenever vehicles enter or leave the parking facility. This improves parking-space utilization and reduces dependence on manual record keeping. The main objective of the proposed system is to develop a cost-effective and user-friendly parking management solution that reduces congestion, improves parking security, minimizes manual intervention, and provides users with convenient digital access to parking services.

II. LITERATURE REVIEW / RELATED WORK

Several researchers have investigated smart parking systems using IoT, wireless communication, computer vision, mobile applications, and cloud-based technologies. Traditional parking management approaches mainly depend on manual monitoring and physical parking tokens. Although simple to implement, these systems have limitations in terms of scalability, real-time availability information, and transaction management.

IoT-based smart parking systems have been proposed to detect vehicle occupancy using sensors installed in individual parking spaces. Such systems can provide real-time slot information but may require considerable hardware installation and maintenance. Sensor failure, wiring requirements, and infrastructure cost can also affect system reliability. Mobile-based parking applications have introduced digital reservation and payment mechanisms. These systems allow users to search for parking spaces before reaching a destination. However, complex registration procedures or dependency on dedicated mobile applications can reduce accessibility for some users.

QR-code-based systems provide an alternative identification and verification mechanism. QR codes can store or represent transaction identifiers and can be scanned using commonly available smartphones. This reduces the requirement for dedicated identification hardware and enables quick verification at parking entry and exit points. The proposed system combines QR-code verification with digital slot management. Instead of relying only on physical tokens or expensive sensor infrastructure, the system maintains parking records through a centralized application and uses QR codes to simplify vehicle and reservation identification.

III. PROPOSED METHODOLOGY

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The proposed Smart Parking Using QR Code system consists of several interconnected modules responsible for user registration, parking-slot management, reservation, QR-code generation, verification, and transaction monitoring.

A. User Registration

Users register with basic information such as name, mobile number, email address, vehicle registration number, and other required details. The registered information is stored in the system database.

B. Parking Slot Management

The administrator creates and manages parking slots according to the physical parking facility. Each slot is assigned a unique identifier such as P01, P02, P03, and so on. The slot status can be maintained as **Available, Reserved, Occupied, or Completed**.

C. Slot Availability

The system retrieves the latest slot information from the database and displays available spaces to users. This enables users to select a suitable parking slot before entering the facility.

D. Parking Reservation

After selecting an available slot, the user provides the required parking details and confirms the reservation. The system creates a unique parking transaction associated with the selected slot and vehicle.

E. QR Code Generation

After successful reservation, a unique QR code is generated for the parking transaction. The QR code can contain or represent a unique transaction ID, reservation ID, vehicle ID, and parking-related information.

F. Entry Verification

At the parking entrance, the user presents the generated QR code. The QR code is scanned and validated against the database. If the reservation is valid, the system authorizes entry and changes the corresponding slot status.

G. Parking Monitoring

The administrator can monitor active reservations, occupied slots, vehicle details, and parking transactions through a centralized dashboard.

H. Exit and Slot Release

When the vehicle leaves the parking facility, the QR code or transaction information can be verified again. The system records the exit time, calculates the parking duration where required, and changes the slot status back to **Available**.

I. Digital Payment

The proposed system can optionally integrate digital payment services. Parking charges can be calculated according to parking duration, vehicle type, or predefined tariff rules.

IV. SYSTEM ARCHITECTURE

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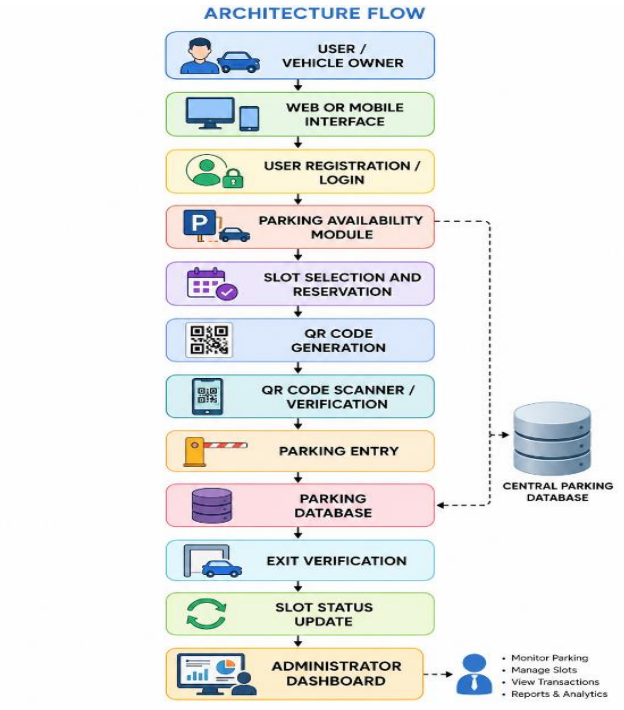
The system architecture consists of the user interface, application server, QR-code module, parking management module, database, and administrator interface.



The architecture enables communication between users and the centralized parking management system. The application server processes reservation and verification requests, while the database maintains user, vehicle, parking-slot, and transaction information.

Major Components

1. **User Interface:** Provides registration, login, slot search, reservation, and parking-status information.
2. **QR Code Module:** Generates and validates unique QR codes.
3. **Application Server:** Processes user requests, reservations, verification, and parking transactions.
4. **Parking Management Module:** Maintains real-time slot states.
5. **Database:** Stores user, vehicle, reservation, slot, and transaction records.
6. **Administrator Dashboard:** Enables administrators to manage parking facilities and monitor transactions.
7. **Payment Module:** Supports optional digital payment processing.

V. IMPLEMENTATION

The proposed system can be implemented as a web-based application using a modern frontend, backend server, database, and QR-code processing library.

A. Frontend

The frontend provides an interactive interface for users and administrators. It can include pages for registration, login, parking availability, slot reservation, QR-code display, transaction history, and administration.

B. Backend

The backend manages application logic and communication between the frontend and database. APIs can be implemented for user authentication, parking-slot management, reservation creation, QR-code validation, vehicle entry, and vehicle exit.

C. Database

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The database contains tables or collections for:

- User information
- Vehicle information
- Parking slots
- Reservations
- QR transactions
- Entry and exit records
- Payment records
- Administrator information

D. QR Code Generation

After successful reservation, the backend generates a unique transaction identifier. This identifier is encoded into a QR code and presented to the user digitally. The system does not need to store large amounts of information inside the QR code; instead, a unique transaction ID can be used to retrieve the corresponding record securely from the database.

E. QR Code Verification

During entry or exit, the QR scanner reads the transaction identifier. The backend checks whether the QR code exists, whether the reservation is valid, and whether the transaction status permits the requested operation. Valid transactions are accepted, while invalid or expired transactions are rejected.

F. Administrator Module

The administrator dashboard provides information about:

- Total parking slots
- Available slots
- Reserved slots
- Occupied slots
- Completed parking transactions
- Registered vehicles
- Parking revenue
- Entry and exit records

G. Security

Authentication and authorization mechanisms are used to protect user and administrator accounts. QR codes should be associated with unique transaction identifiers, and server-side validation should be performed for every scan. Sensitive information should not be exposed directly through the QR code.

VI. EXPERIMENTAL RESULTS AND DISCUSSION

The proposed system was evaluated using a simulated parking environment containing multiple parking slots and test vehicle transactions. The evaluation focused on slot allocation, QR-code verification, reservation processing, entry-exit management, and database updating.

Table I. Functional Testing Results

Test Case	Expected Result	Observed Result	Status
User Registration	User account created	Account created successfully	Pass

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User Login	Valid user authenticated	Authentication successful	Pass
Slot Availability	Available slots displayed	Correct slot status displayed	Pass
Slot Reservation	Selected slot reserved	Reservation recorded	Pass
QR Generation	Unique QR generated	QR generated successfully	Pass
QR Verification	Valid QR accepted	Valid QR accepted	Pass
Invalid QR Scan	Invalid QR rejected	Access rejected	Pass
Vehicle Entry	Slot changed to occupied	Status updated	Pass
Vehicle Exit	Slot released	Slot changed to available	Pass
Transaction Storage	Record stored in database	Record stored successfully	Pass

Table II. Sample Parking Performance

Parameter	**Conventional System**	**Proposed QR System**
Manual Record Keeping	High	Low
Slot Availability Information	Limited	Real-time
Entry Verification	Manual	QR-based
Reservation	Manual/limited	Digital
Transaction Tracking	Paper-based	Database-based
Parking Record Retrieval	Slow	Fast
Human Intervention	High	Reduced

The experimental results indicate that QR-based parking management can simplify vehicle identification and parking verification. Digital slot management also reduces the possibility of duplicate allocation because the reservation status is maintained centrally.

The system can improve operational efficiency by reducing manual registration and providing users with parking information before entry. QR scanning provides a relatively fast method for verifying parking transactions using smartphones or QR scanners.

However, system performance depends on network availability, database response time, QR scanning conditions, and the quality of the implementation. For large parking facilities, additional mechanisms such as IoT occupancy sensors, load balancing, caching, and distributed databases can be incorporated.

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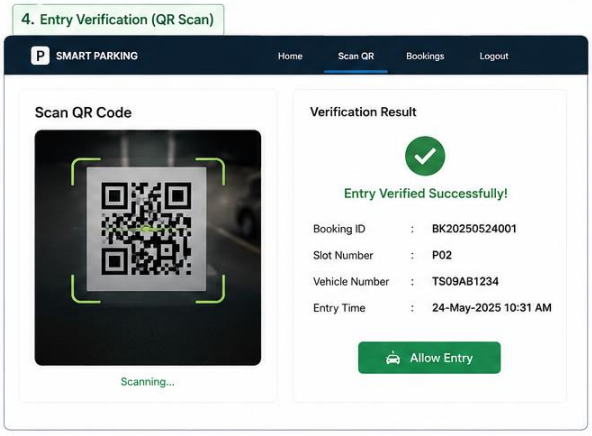

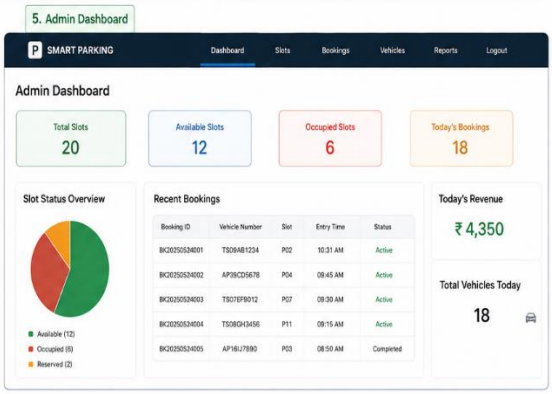

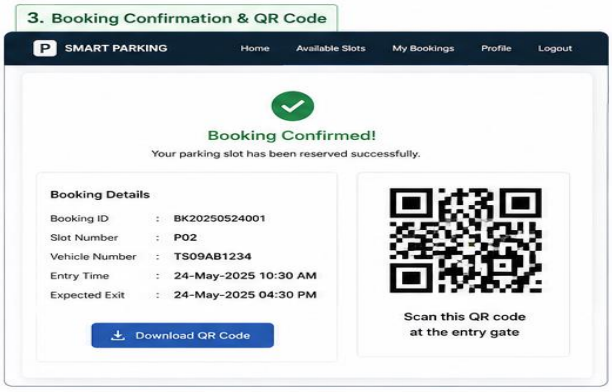

CONCLUSION

The **Smart Parking Using QR Code** system provides an efficient digital approach to parking-space management and vehicle verification. The proposed system integrates QR-code technology with digital reservation, slot allocation, entry-exit verification, and centralized parking records. It reduces dependence on manual parking tokens and paper-based records while improving accessibility and transaction tracking.

The system enables users to view parking availability, reserve slots, receive QR-based parking credentials, and complete parking transactions digitally. Administrators can monitor parking spaces, manage

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vehicle records, and track parking activities through a centralized dashboard. The proposed approach is suitable for educational institutions, offices, hospitals, shopping malls, residential communities, and other parking facilities.

Future Scope

The future version of the system can integrate IoT-based parking sensors for automatic detection of vehicle occupancy. Artificial intelligence and computer vision can be introduced for automatic number plate recognition and vehicle identification. GPS-based navigation can guide users to available parking facilities. Digital payment gateways, dynamic pricing, mobile notifications, and cloud deployment can further improve the system. Predictive analytics can be used to estimate parking demand during peak periods. Integration with smart-city infrastructure could enable centralized management of multiple parking facilities and provide real-time parking information across an entire urban area.

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