Smart Parking System
Capstone 2024
Team DaVinci Code

Introduction

Finding parking daily is a significant hassle for drivers. Precious **time**, **fuel**, and **patience** are often wasted in the frustrating search for an **available spot**. **The Smart Parking System** is a groundbreaking solution transforming the parking experience. The system provides **real-time information** on available parking bays, ensuring drivers find a parking spot **quickly and effortlessly**. Furthermore, our system allows drivers to book parking **slots ahead of time**, giving them **secure parking** and saving them valuable time.

Not only will the system save its users precious time from searching for a parking space, but it will also save drivers precious fuel costs from driving around while searching for an available space, thus **reducing the carbon emissions** from vehicles which will have a **net positive effect on the environment**. This system will be especially useful in **urban areas** where the density of vehicles and parking areas are the highest, effectively **revolutionizing the parking experience** for all urban drivers.

Additionally, use cases for the system will also be able to extend into **Universities** where the issue of finding and reserving parking is rather serious. This will enable university students and staff to **reserve parking ahead** of time and give them access to **real-time available parking spaces** which will significantly **reduce traffic** in university settings leading to happier, more productive students and staff!

With user-friendly navigation, seamless booking processes, and optimized parking management, The Smart Parking System is designed to make every parking experience smooth and stress-free.

User Characteristics

1. Urban Residents:

- Role: Primary users who will receive notifications about suspicious activities in their area.
- Technology Use: Likely to use mobile and web applications regularly.
- Behaviour: Often in a hurry and looking for quick and reliable parking options.

2. University Members:
    - Role: Reliable parking spots, especially during peak hours.
    - Technology Use: Frequent use of mobile devices for various applications, including parking reservations.
    - Behaviour: Often plan their schedules in advance and appreciate the ability to reserve parking spots beforehand.
3. Authorities and Parking Management:
    - Role: Efficient management of parking facilities and enforcement of parking regulations.
    - Technology Use: Use of backend systems for monitoring and data analysis.
    - Behaviour: Focused on maintaining order and optimizing parking resources.

User Stories

As an urban resident:

1. I want to be able to register my vehicle onto the system by entering my vehicle details such as license plate number, make, model, and color.
2. I want to be able to search for the location I intend to go to by entering the address or selecting it from a map interface within the app.
3. I want to view the available parking slots at my destination in real time through the app.
4. I want to reserve my desired parking slot in advance by selecting the specific spot and time frame so that I can be assured of having a parking space when I arrive at my destination.
5. I want to specify the duration of my parking session, including start and end times.
6. I want to see the parking rates displayed within the app for each parking location and slot, including any time-based or dynamic pricing.
7. I want to be able to book an available parking slot in real time.
8. I want predictive parking availability based on historical data, events (e.g., concerts, conferences), and time of day.

9. I want to be able to choose the floor and row of my parking slot when available.
10. I want turn-by-turn directions within the parking facility.
11. I want to be notified of newly available parking slots via push notifications or alerts, especially in high-demand areas.
12. I want to be able to add my payment details to the system securely, including credit/debit card information or mobile wallet integration.
13. I want to be able to pay for the booked parking slot directly through the app using my stored payment details, ensuring a seamless and cashless transaction process.
14. I want to view all my booked parking slots in a dedicated section of the app, listing upcoming and past reservations.
15. I want to be able to view the details of each booked slot, including the location, time, duration, and cost.
16. I want to view my regular parking destinations, such as frequently visited locations, in a convenient list or map format, allowing me to quickly make new reservations at familiar places.
17. I want to view my parking profile within the app, which includes my vehicle details, payment methods, and preferences so that I can easily manage and update my information as needed.
18. I want to see my parking history records, detailing all my past parking sessions, locations, durations, and costs.
19. I want to be notified of any parking violations associated with my account, including details of the infraction and any fines or penalties so that I can address them promptly.
20. I want to know when parking penalties have been enforced on my account, including the reason and amount, so that I can take the necessary actions to resolve any issues.
21. I want to be able to cancel a booked parking slot through the app if my plans change, with clear information on any cancellation policies or fees.
22. I want to be able to report parking violations, such as unauthorized use of my reserved slot or illegal parking, through the app.
23. I want to receive reminders before my reserved parking session starts to ensure I don’t miss my slot.

As a University Member:

1. I want to add my University to the system.
2. I want to be able to register my vehicle onto the system, so I can use the parking services provided by the university.
3. I want to be able to search for available parking slots near my lecture halls or offices.

4. I want to view the available parking slots in real time to find a spot quickly.
5. I want to reserve my desired parking slot in advance to ensure I have a place to park when I arrive.
6. I want to specify the duration of my parking session to manage my time effectively.
7. I want to be able to book an available parking slot in real time for spontaneous visits.
8. I want predictive parking availability based on historical data, events (e.g., concerts, conferences), and time of day.
9. I want to be able to choose the floor and row of my parking slot for convenience.
10. I want turn-by-turn directions within the parking facility.
11. I want to see the parking rates so I can plan my budget.
12. I want to be able to add my payment details to the system for seamless transactions.
13. I want to be able to pay for the booked parking slot through the system.
14. I want to be notified of newly available parking slots in my preferred areas.
15. I want to be notified of any parking violations or penalties enforced on my account.
16. I want to receive reminders before my reserved parking session starts to ensure I don’t miss my slot.
17. I want to view all my booked parking slots to keep track of my reservations.
18. I want to be able to view the details of each booked slot, including time, date, and location.
19. I want to view my regular parking destinations for quick access and booking.
20. I want to view my parking profile, including vehicle details and payment information.
21. I want to see my parking history records to monitor my parking habits and expenses.
22. I want to be able to cancel a booked parking slot if my plans change.
23. I want to be able to report parking violations to maintain a fair parking system on campus.
24. I want to have access to exclusive parking areas reserved for university staff and students, ensuring priority over general public users.
25. I want to validate my university credentials within the app to gain access to these exclusive parking areas.
26. I want the system to provide directions within the campus to guide me to my reserved parking spot, reducing the time spent searching for it.
27. I want to see a map of the campus parking facilities with real-time availability updates, to help me plan my parking strategy.

As Parking Management:

1. I want to monitor real-time parking occupancy and status through a centralized dashboard.
2. I want to oversee and manage all parking reservations, including modifying, canceling, and reallocating slots as necessary, to ensure optimal utilization of parking resources.
3. I want to access detailed reports on parking usage patterns, peak times, and revenue generated.
4. I want to use historical data to predict parking demand during specific events or times, allowing me to plan for additional resources or adjustments and prevent overcrowding.
5. I want to receive alerts for any unauthorized parking or security breaches.
6. I want to set and adjust dynamic pricing for parking spots based on demand, maximizing revenue during peak hours and offering incentives during off-peak times
7. I want to manage user roles and permissions within the system, ensuring that only authorized users have access to certain features or areas.
8. I want the parking management system to integrate with other smart city systems, such as traffic management and public transportation.
9. I want to handle user complaints, feedback, and queries through the app, providing a channel for communication.
10. I want to track and manage all financial transactions within the system.
11. I want the parking management system to be scalable, allowing it to handle an increasing number of users and parking lots as the demand grows, ensuring long-term sustainability.
12. I want to collect and analyze user feedback regularly, using it to make continuous improvements to the parking management system.

Functional Requirements

1. **Facilitate user registration and authentication**
    1.1 Allow users to register by providing vehicle and personal details:
        1.1.1 Vehicle information:
            1.1.1.1 License plate number
            1.1.1.2 Make
            1.1.1.3 Model
            1.1.1.4 Color
        1.1.2 Payment details.
            1.1.2.1 Credit/Debit Card Information

1.1.2.2 Billing Address
1.1.3 Personal details
1.1.3.1 Name
1.1.3.2 Surname
1.1.3.3 Email
1.1.3.4 Address
1.2 Enable users to log in using their email and password.
1.3 Provide options for password recovery and resetting.

2. **Vehicle Management**
   2.1 Enable users to add and update their vehicle details.
   2.2 Maintain a profile for each vehicle registered by the user.
3. **Parking Slot Search and Reservation**
   3.1 Allow users to search for parking locations by entering an address or selecting from a map interface.
   3.2 Display available parking slots in real-time for selected locations.
   3.3 Provide predictive parking availability based on:
      3.3.1 Historical data
      3.3.2 Events
      3.3.3 Time of day.
   3.4 Enable users to reserve parking slots in advance by specifying:
      3.4.1 Slot
      3.4.2 Floor
      3.4.3 Row
      3.4.4 Time frame
   3.5 Allow users to specify the start and end time of their parking session.
4. **Parking Slot Booking**
   4.1 Display the availability of parking slots in real time.
   4.2 Enable real-time booking of available parking slots.
   4.3 Allow users to choose the floor and row of their parking slot when available.
   4.4 Provide directions within the parking facility to guide users to their reserved or available parking spots.
   4.5 Allow users to cancel a reserved parking slot and view cancellation policies and fees.
5. **Payment and Pricing**
   5.1 Enable users to add and store payment details securely, including credit/debit card information and mobile wallet integration.
   5.2 Allow users to pay for booked parking slots directly through the app.
   5.3 Display parking rates for each location and slot, including dynamic pricing based on demand.

5.4 Provide demand-based pricing with higher rates during peak hours and lower rates during off-peak times.

6. **User Profile and History**
   6.1 Allow users to view and update:
      6.1.1 Their profile
      6.1.2 Vehicle details
      6.1.2 Payment methods
      6.1.3 Preferences
   6.2 Provide a record of all booked parking slots
   6.3 Allow users to view past:
      6.3.1 Parking sessions
      6.3.2 Locations
      6.3.3 Durations
      6.3.4 Costs
7. **Notifications and Alerts**
   7.1 Send notifications to users before their reserved parking session starts.
   7.2 Notify users of newly available parking slots, especially in high-demand areas.
   7.3 Notify users of any parking violations or penalties associated with their account.
8. **University-Specific Features**
   8.1 Allow users to add their university to the system.
   8.2 Enable university members to search for available parking slots near lecture halls or offices.
   8.3 Provide access to exclusive parking areas for university staff and students.
9. **Parking Management**
   9.1 Allow parking management to monitor real-time parking occupancy and status through a centralized dashboard.
   9.2 Enable management to oversee and modify parking reservations, ensuring optimal utilization.
   9.3 Allow management to set and adjust dynamic pricing for parking spots.
   9.4 Implement role-based access control, ensuring only authorized users have access to specific features or areas.
   9.5 Enable users to report parking violations through the app.
10. **Security and Data Privacy**
   10.1 Encrypt all user data stored in databases using industry-standard encryption algorithms.
   10.2 Secure data transmitted between the client (app or web interface) and the server using Transport Layer Security (TLS).

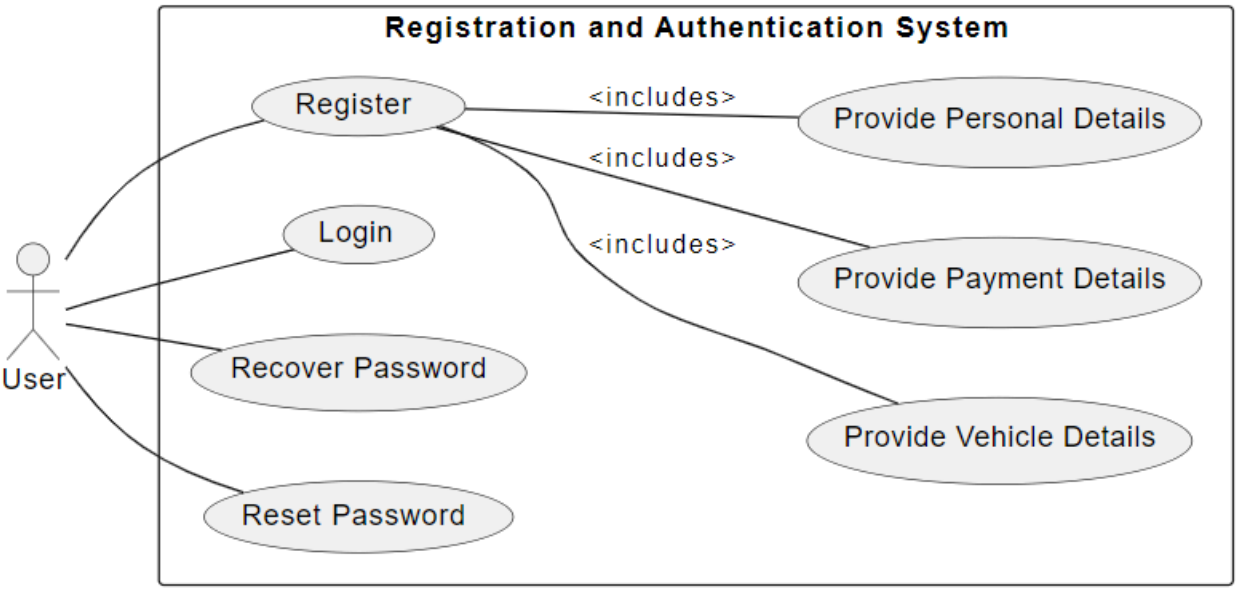
10.3 Provide optional 2FA using SMS, email, or authenticator apps for an added layer of security.
10.4 Implement RBAC to ensure only authorized users and system components can access or modify vehicle data.

Subsystems

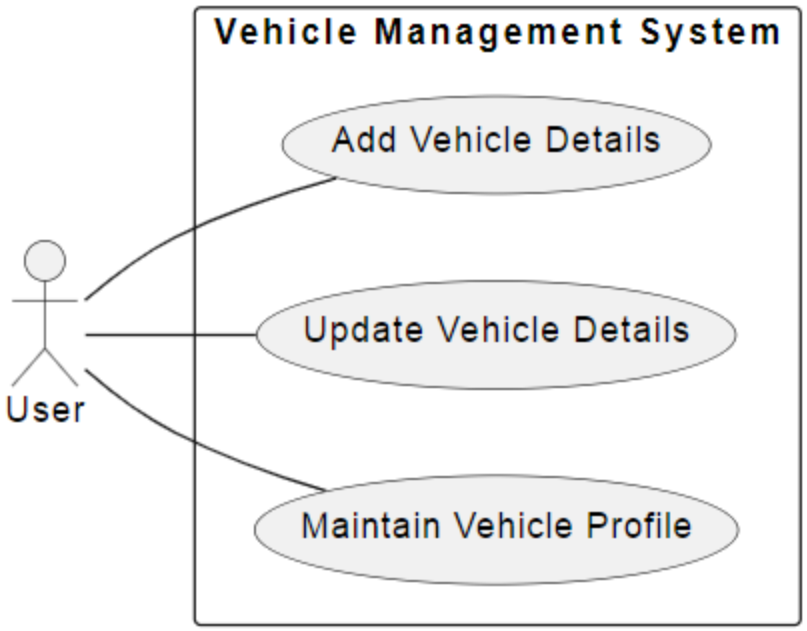
1. Registration and Authentication
2. Vehicle Management
3. Parking Slot Search and Reservation
4. Parking Slot Booking
5. Payment and Pricing
6. User Profile and History
7. Notifications and Alerts
8. University-Specific Features
9. Parking Management
10. Security and Data Privacy

Use Cases

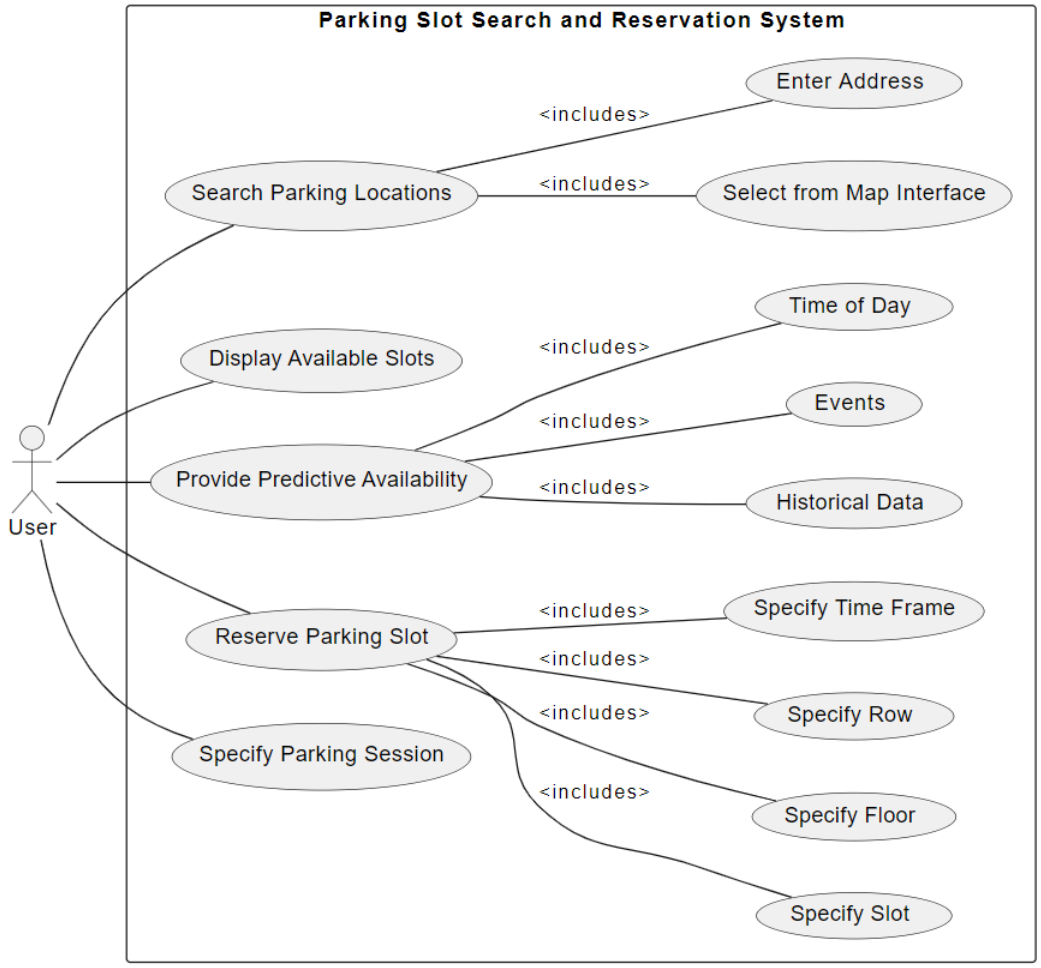
1. Registration and Authentication



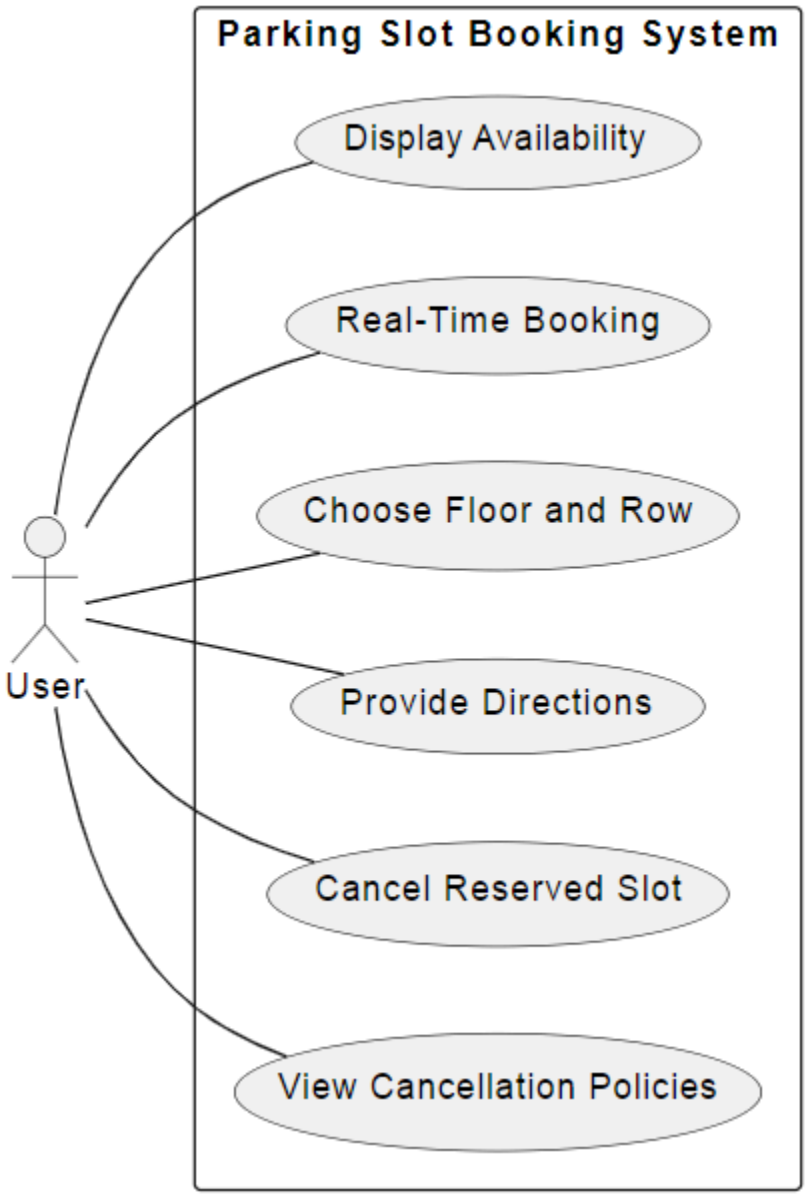
2. Vehicle Management



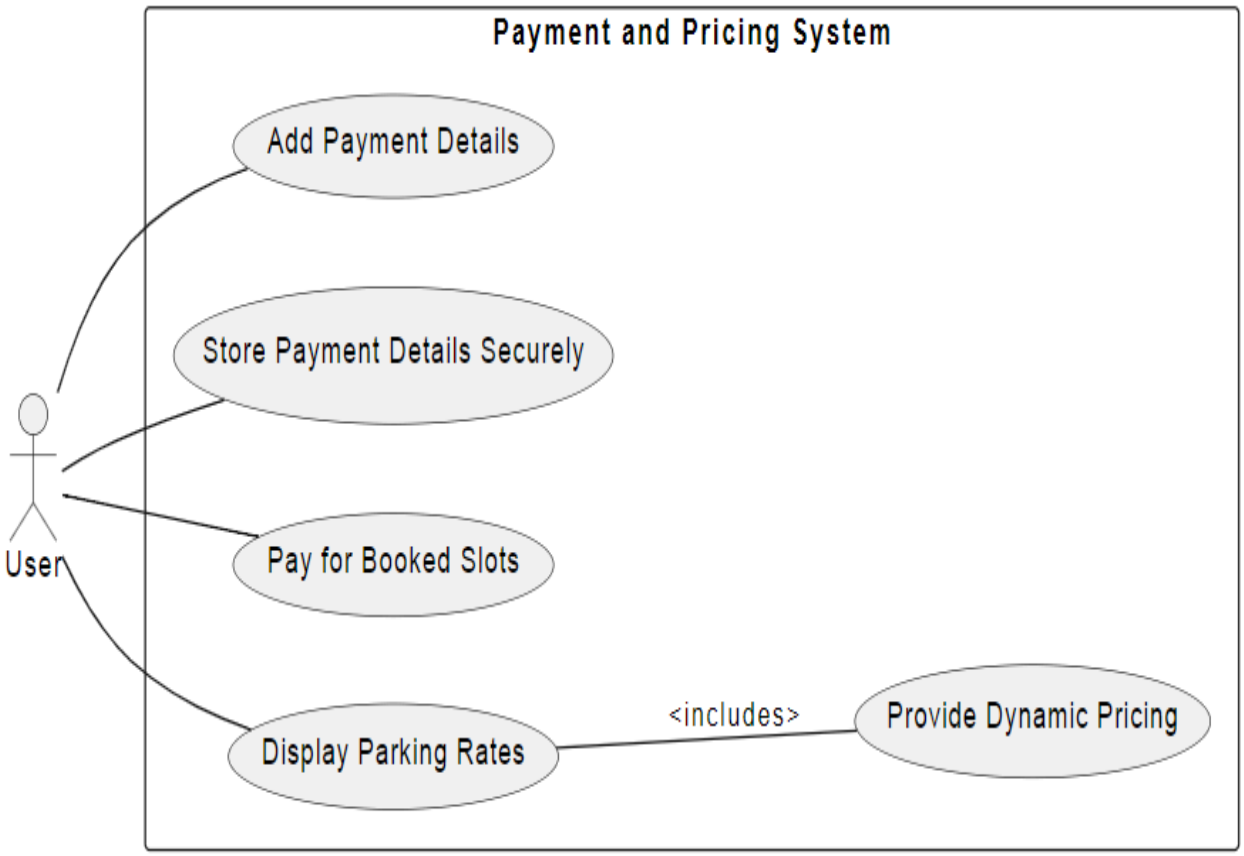
3. Parking Slot Search and Reservation



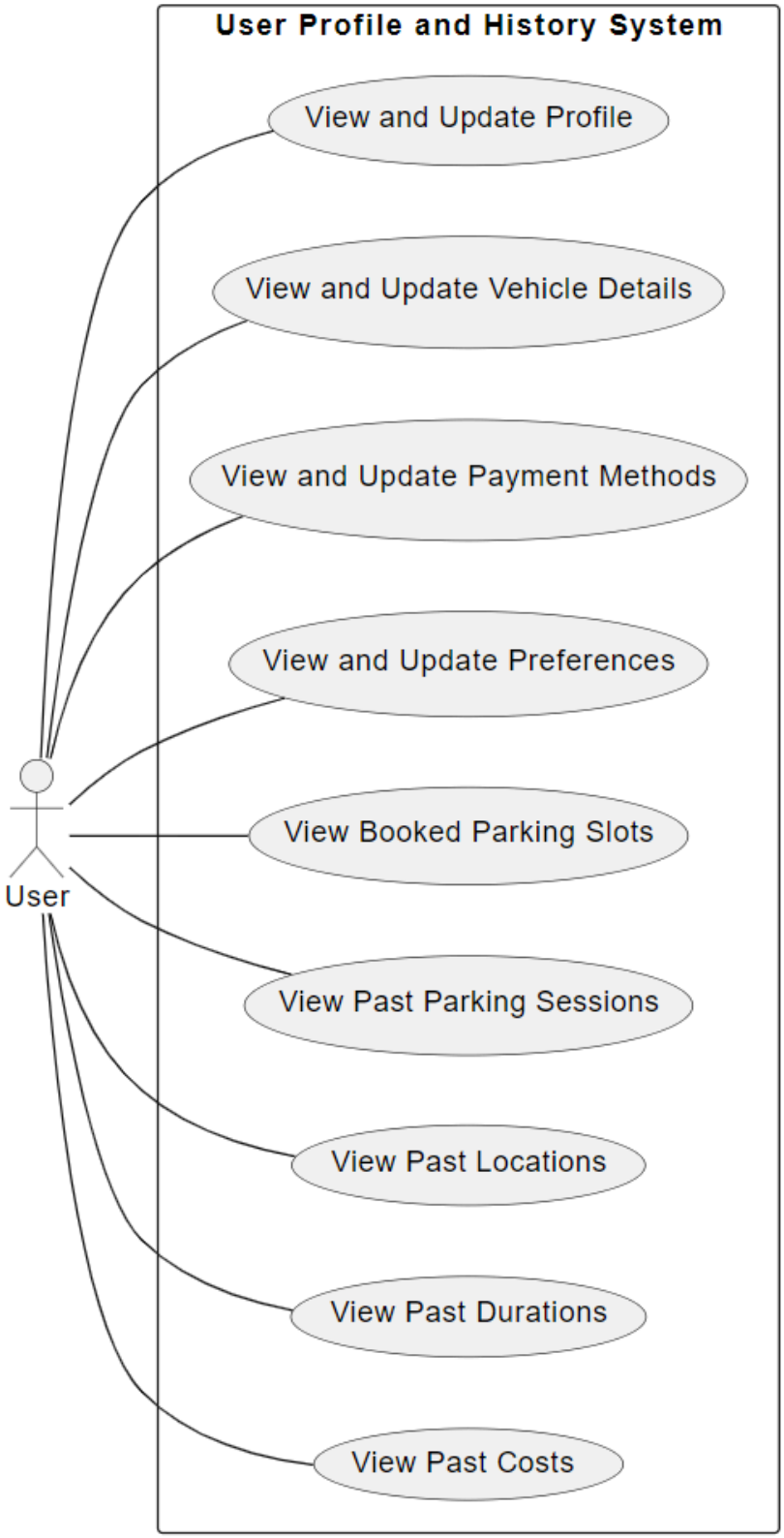
4. Parking Slot Booking



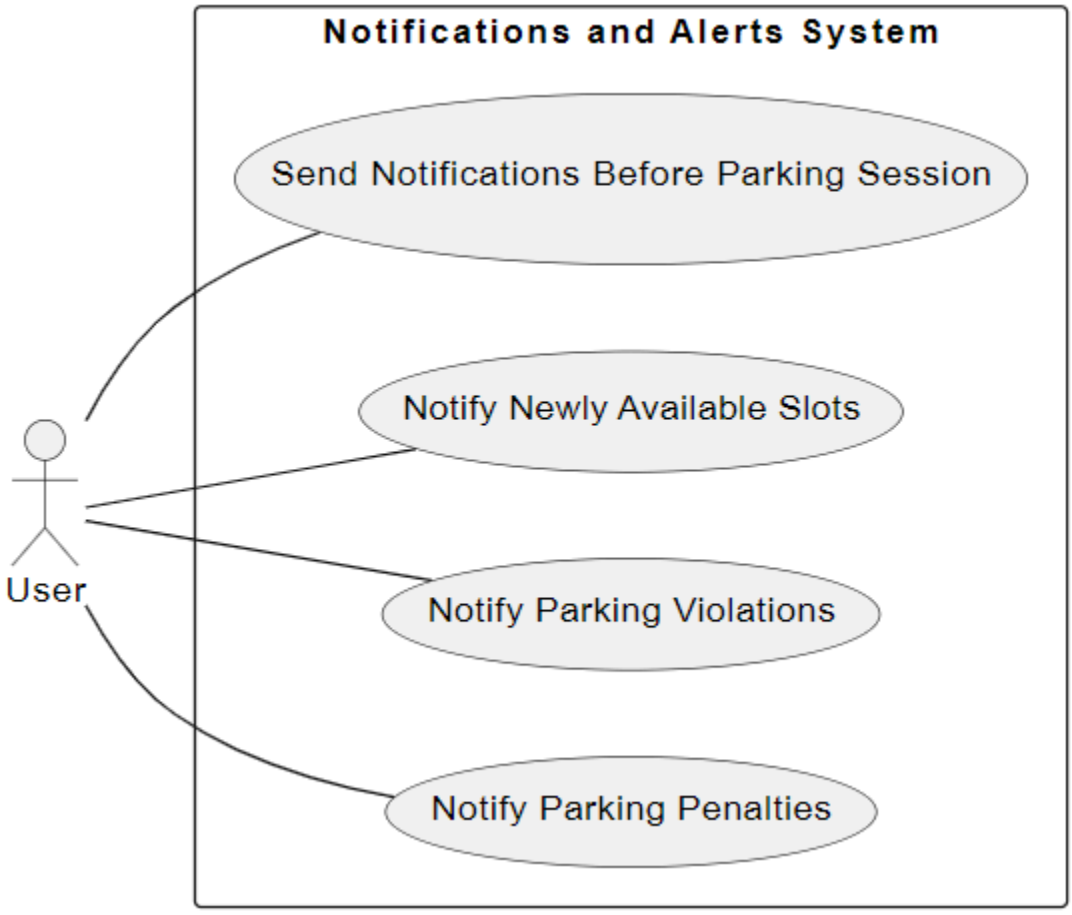
5. Payment and Pricing



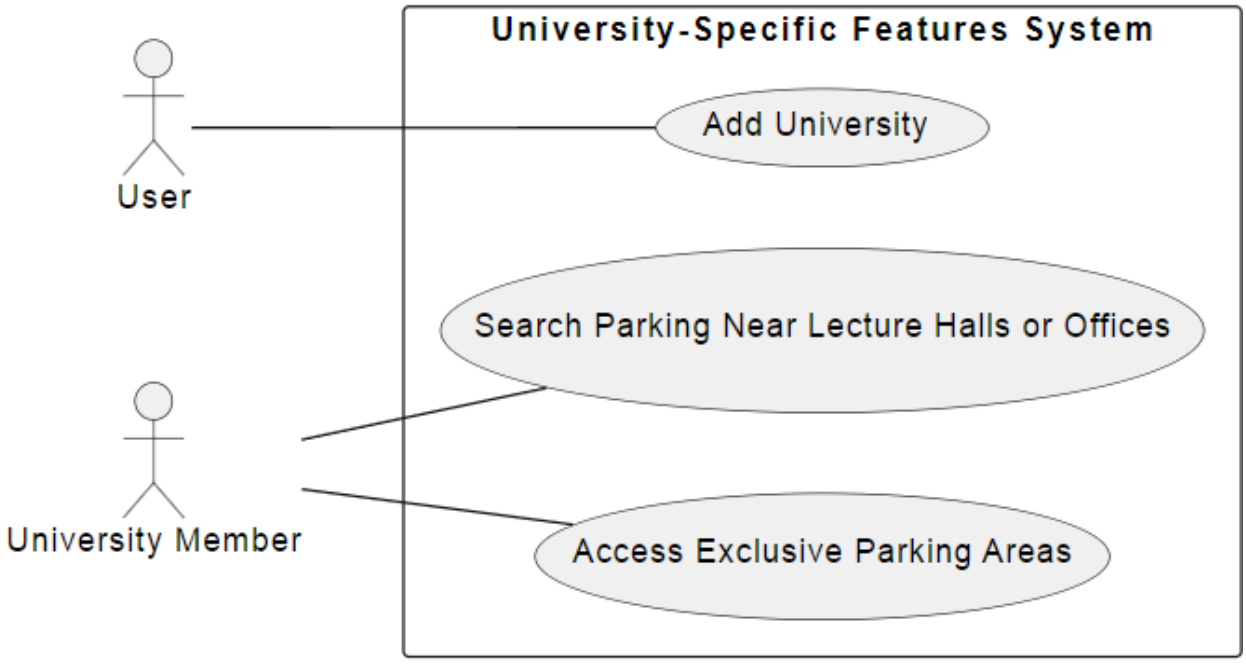
6. User Profile and History



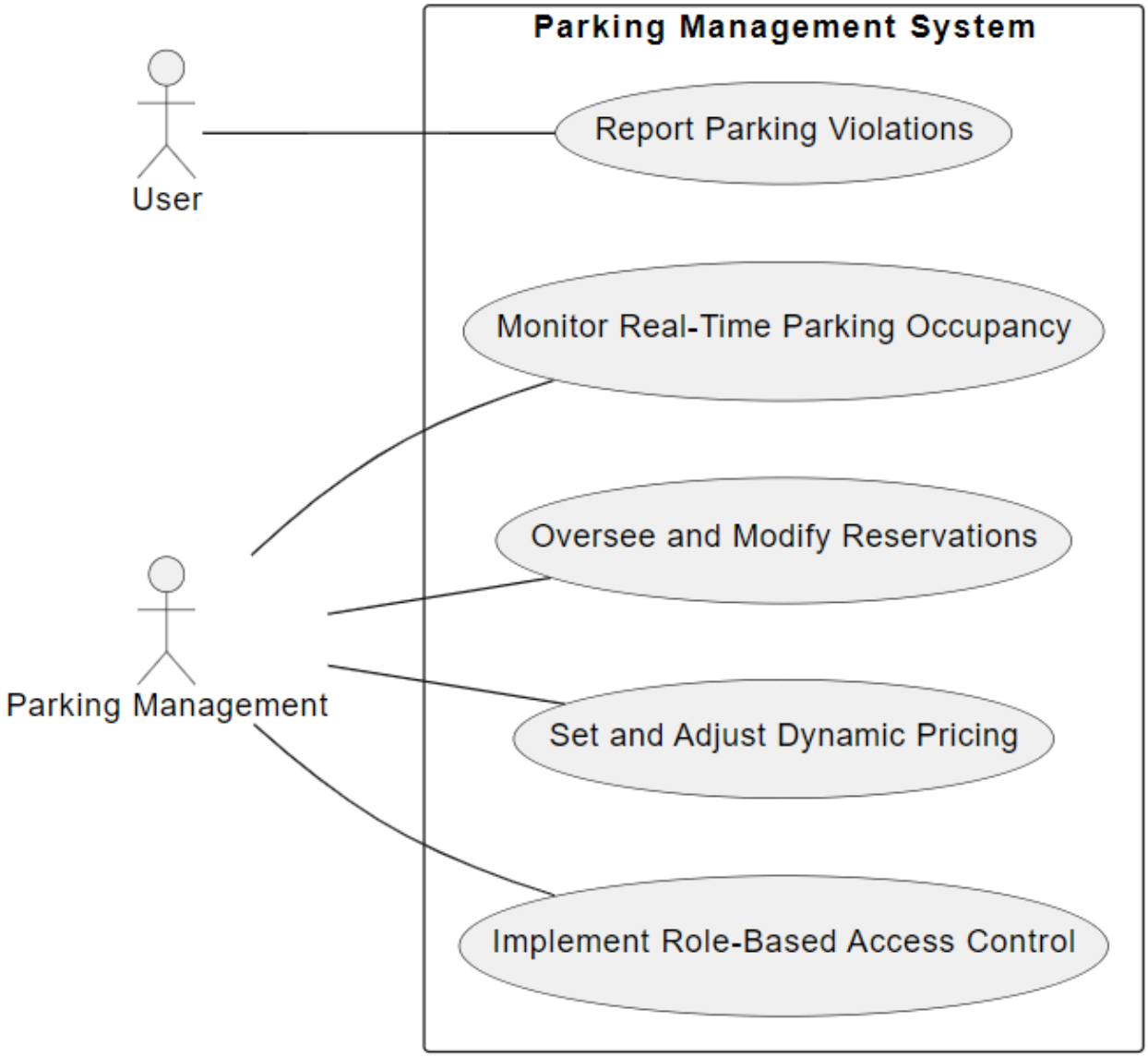
7. Notifications and Alerts



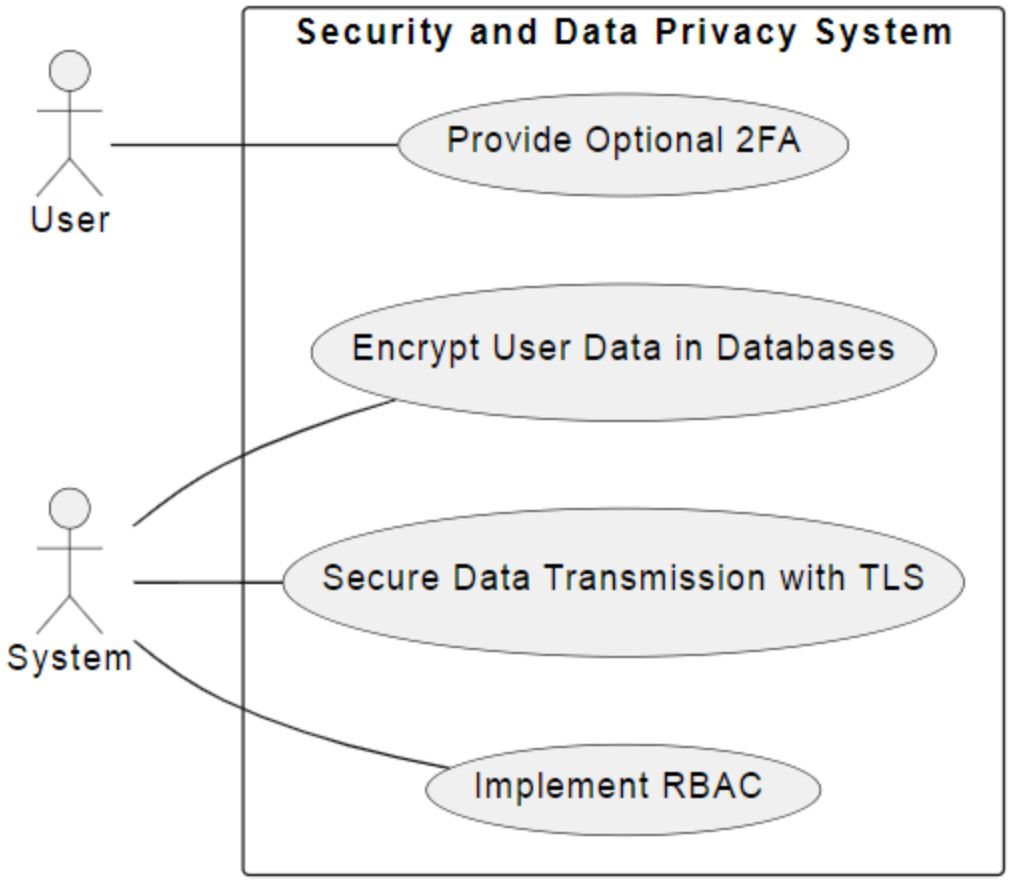
8. University-Specific Features



9. Parking Management



10. Security and Data Privacy


Security and Data Privacy System
User
Provide Optional 2FA
Encrypt User Data in Databases
System
Secure Data Transmission with TLS
Implement RBAC