“Parko: The Complete Parking Solution”

A

Project Report

submitted in partial fulfillment of the

requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

in

COMPUTER SCIENCE & ENGINEERING

by

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Dec – 2023

CANDIDATE'S DECLARATION

I/We hereby certify that the project work entitled **"Parko: The Complete Parking Solution"** in partial fulfilment of the requirements for the award of the Degree of BACHELOR OF TECHNOLOGY in COMPUTER SCIENCE AND ENGINEERING with specialization in DevOps and submitted to the Department of Cybernetics, School of Computer Science, University of Petroleum & Energy Studies, Dehradun, is an authentic record of my/ our work carried out during a period from **Aug**, **2023** to **Dec**, **2023** under the supervision of **Dr. Hitesh Kumar Sharma, Professor, Cybernetics Cluster, School of Computer Science**.

The matter presented in this project has not been submitted by me/us for the award of any other degree of this or any other University.

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This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

Date: 11 Dec, 2023

Dr. Hitesh Kumar Sharma
Project Guide

ACKNOWLEDGEMENT

We wish to express our deep gratitude to our guide **Dr. Hitesh Kumar Sharma** , for all advice, encouragement and constant support he has given us throughout our project work. This work would not have been possible without his support and valuable suggestions.

We sincerely thank our respected **Dr. Hitesh Kumar Sharma, Head Department of Cybernetics Cluster ,** for his great support in doing our project**.**

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ABSTRACT

"Facing parking challenges, UPES introduces 'Parko,' an innovative application redefining the parking experience. Beyond conventional solutions, Parko utilizes AI to provide real-time updates, predictive analytics, and efficient navigation. Users can pre-reserve parking spots within a specific radius, ensuring a seamless experience. The integration of security cameras and QR/NFC tags enhances accuracy in reflecting real-time availability.

Parko extends its impact beyond user convenience by offering actionable insights derived from analyzing parking space utilization patterns. This comprehensive solution marks a transformative shift in parking management at UPES, promising not just efficiency but also strategic optimization of parking infrastructure. With its multifaceted approach, Parko emerges as a game-changer in alleviating parking frustrations for students, staff, and visitors."

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1. INTRODUCTION

In the modern world, where urban spaces are burgeoning and mobility is an integral part of daily life, the quest for convenient and efficient parking has become an increasingly pressing concern. The University of Petroleum and Energy Studies (UPES) is no stranger to the challenges posed by parking woes. The current token system, once intended to streamline the parking process, has inadvertently led to a situation where parking availability has become a bottleneck, causing frustration and inconvenience for students, staff, and visitors alike.

Recognizing the need for a transformative solution, a paradigm shift in the way we approach parking is in order. Enter "Parko" – an innovative application poised to revolutionize the parking experience at UPES. Parko is not merely an app; it's a comprehensive answer to the longstanding parking issues faced not only by the university but also by commercial parking facilities. With its intuitive design and technology, Parko promises hassle-free parking, uncongested parking lots and search for parking spots easily.

Using Parko users will have the ability to access real-time parking availability updates on their mobile phones. Parko would empower them with the information they need to make informed decisions before even arriving at the parking lot. By offering the unique advantage of reserving parking spaces in advance, when you're in a certain radius of the campus, the app ensures a guaranteed spot upon arrival.

Behind the scenes, Parko employs advanced AI/ML models to analyze historical parking data and predict future availability trends.[2] This predictive capability allows the app to offer tailored recommendations and insights to users, further enhancing the parking experience. But the innovation doesn't stop there – Parko is seamlessly integrated with security cameras strategically placed throughout the parking area. These cameras work in tandem with QR/NFC tags placed at each parking spot, keeping the system updated in real time and ensuring accuracy in reflecting availability status.

Drivers can confidently navigate to their chosen parking spots using Parko's efficient navigation system, guided by the app's routing system. Also, by analyzing the utilization patterns of the parking spaces over time, Parko equips UPES with actionable insights for optimizing its parking infrastructure.

In conclusion, Parko is not just an app; it's a game-changer. It's a comprehensive solution that promises to transform the way we think about parking.[1][2] By leveraging AI, real-time updates, and predictive analytics, Parko offers a holistic approach to parking woes, enhancing convenience, reducing stress, and ultimately creating a smoother, more efficient parking experience for all its users.

1.2 PURPOSE OF PROJECT

To resolve all the parking related problems be it checking the spot availability, prebooking spots, navigating to the desired spot or locating your vehicle. Users will be able to accomplish all these with our application, eliminating the current token system and providing a hassle-free, user-oriented experience.[3] In addition to this, the data collected from the application would be a great resource for the university to take informed decisions to improvise the current parking infrastructure, saving time of faculties and staff.

1.3 TARGET BENEFICIARY

The target beneficiaries of the proposed application are UPES faculties, GateKeepers and Administration. Faculties would be making use of our application to ease out their parking struggles, GateKeepers who have to manually hand out tokens to each vehicle and mark their entry down in their registers would be relieved of this task & University Administration can also make use of the data to improvise the architecture. In the future, this system can be leveraged for commercial parkings in malls and other public places who also use the manual token system.

1.4 PROJECT SCOPE

The scope of our project is to minimize the struggles of faculties and gatekeepers regarding parking which is quite a non-productive task and automate it completely to allow for a system where there's minimal interaction of the user. Monitoring and improvement of the current infrastructure is another important goal we wish to tackle as part of our project.

1.5 AIMS AND OBJECTIVES

The project aims to have the following features:-

- To provide a full fledged parking solution to fulfill UPES parking needs.
- Replace token system and automate the complete parking allocation process.
- Allow users to check the live status of parking spots availability on their devices.
- Provide ability to pre-book parking spots when reaching near UPES Campus.
- Eliminate the need to manually look for parking spots.
- Implementing DevOps tools and principles.
- Image processing for parking space allocation using live-cameras.
- Provide real-time navigation for assigning parking spaces.
- Real time data updates to end users.
- Provide parking data to the admin to make decisions to improvise the parking infrastructure

2. PROJECT DESCRIPTION

2.1 DATA STRUCTURES

- **Graph:** It is a fundamental data structure with numerous applications in various fields, including computer science, networks, recommendation systems, and more. Graphs consist of two main components - Edges & Vertices.
- **Multidimensional Array**: Based on parking scheme factors – Block, Floor, Range, & Parking Spot Number.

2.2 ALGORITHMS

- YOLO Algorithm [v8s]
- YOLO v8s
- Bounding Box Detection
- FNC CRR - (detection)
- Dijkstra
- A* Algorithm
- S3E Algorithm - Smart Spot Suggestion Engine

2.3 SWOT ANALYSIS

Strengths :

- **Innovative Concept:** Parko introduces an innovative solution to address parking issues, which can set it apart from traditional approaches.
- **Real-Time Updates:** The ability to provide real-time parking availability updates is a significant strength, enhancing user convenience.
- **Advanced Technology:** The use of AI/ML (OpenCV) for image processing and predictive analytics showcases the project's technological sophistication.
- **Integration:** Seamless integration with security cameras and QR/NFC tags improves data accuracy and reliability.
- **Efficient Navigation:** The navigation system helps users locate and reach parking spots efficiently.
- **Data-Driven Insights:** The project offers actionable insights to optimize parking infrastructure, which can benefit the university.

Weakness :

- **Development Challenges:** Developing and maintaining the technology components, such as the image processing system, may be complex and require ongoing resources.
- **Dependency on Data:** The system heavily relies on accurate data from security cameras, which can be vulnerable to technical issues or tampering.
- **Cost:** Implementing and maintaining such a system can be expensive, and the return on investment may take time to realize.

- **Architectural Constraints:** The Effectiveness of the initial Adoption of the solution may depend on the existing parking architecture.

Opportunities :

- **Market Expansion:** Parko's technology could potentially be scaled and offered to other universities or commercial parking facilities, creating a revenue stream.
- **Partnerships:** Collaborating with local authorities or businesses for parking solutions can lead to broader adoption and support.
- **Data Monetization:** The collected parking data and analytics can be leveraged for research or shared with external parties for revenue.
- **Sustainability:** Promoting efficient parking can contribute to reduced congestion and emissions, aligning with sustainability goals.

Threats :

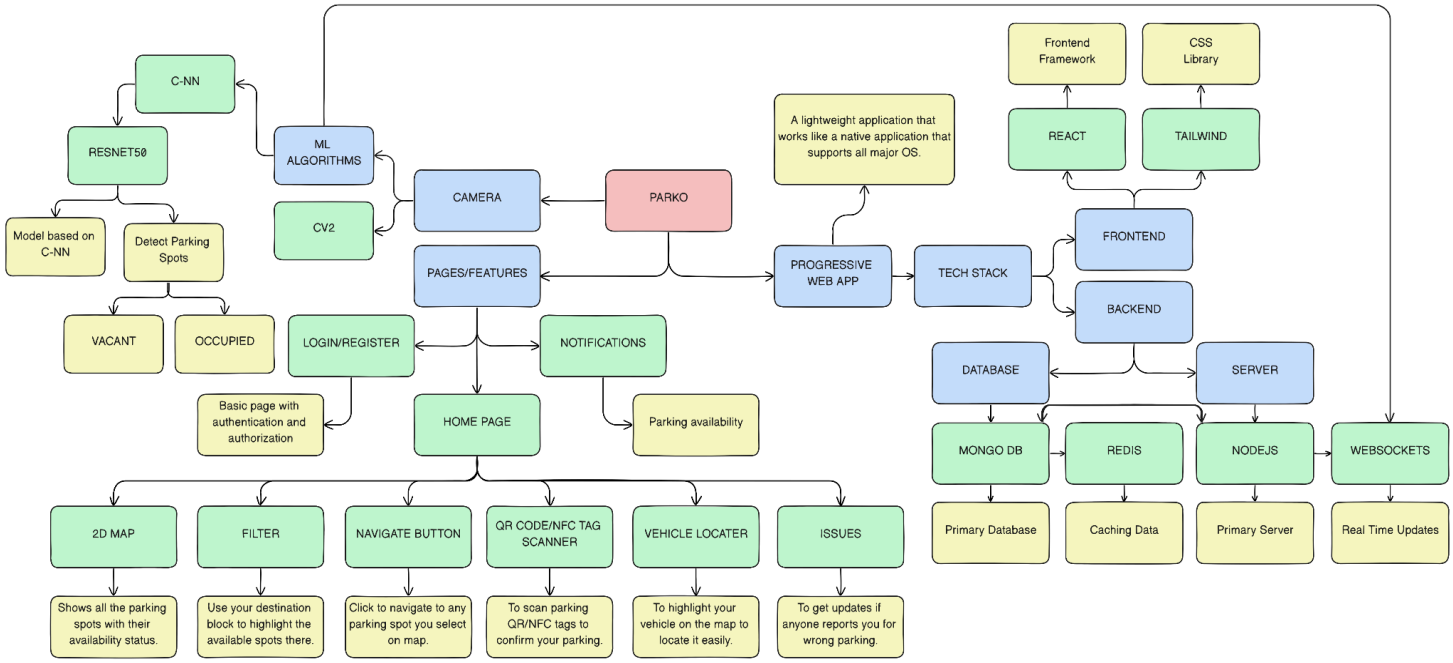
- **Competitive Market:** The parking industry has competition, including established companies and other startups with similar innovations. (parkable, parkalot)
- **Privacy Concerns:** Collecting and using data from security cameras may raise privacy issues and legal challenges.
- **Technical Issues: [5]**System failures, software bugs, or cyberattacks can disrupt the service and erode user trust.
- **Regulatory Changes:** Changes in parking regulations or data privacy laws could impact the project's operations.
- **User Resistance:** Users may resist changes to their parking habits or may not trust the system's accuracy initially.

2.4 IMPLEMENTATION CONSTRAINTS

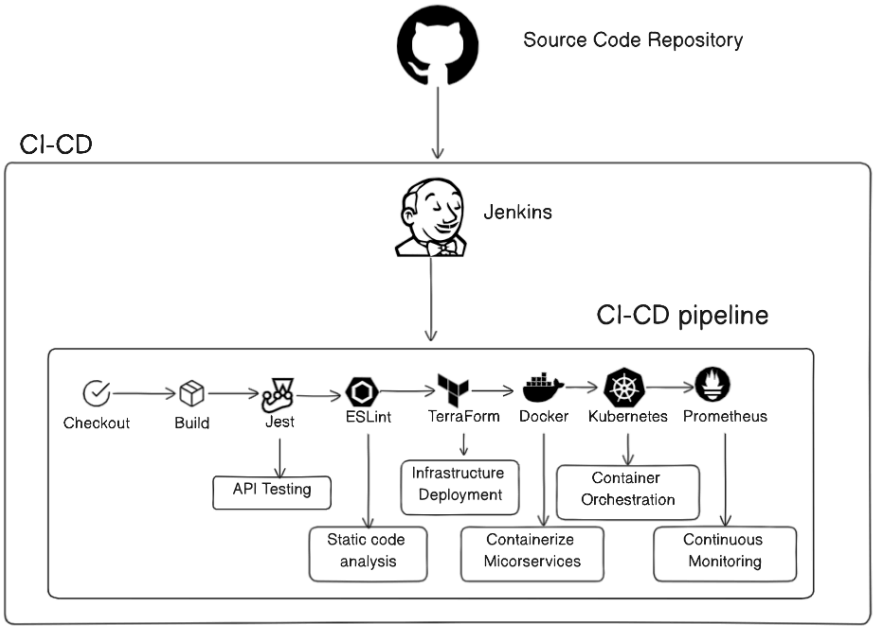
- IOT Integration
- Multi video stream management and processing.

3. DESIGN

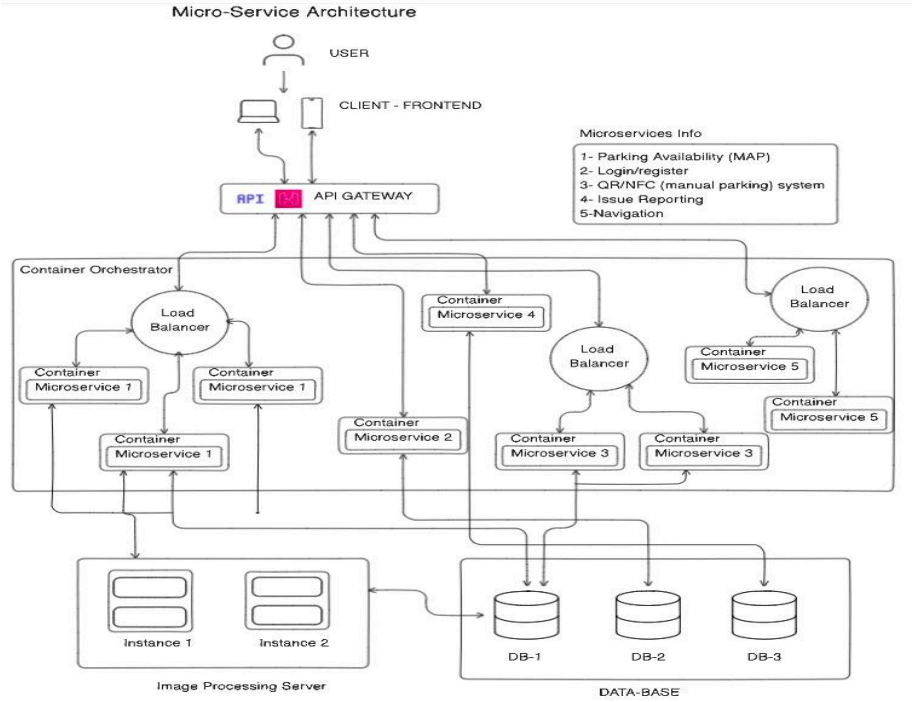
3.1 Application Workflow Diagram



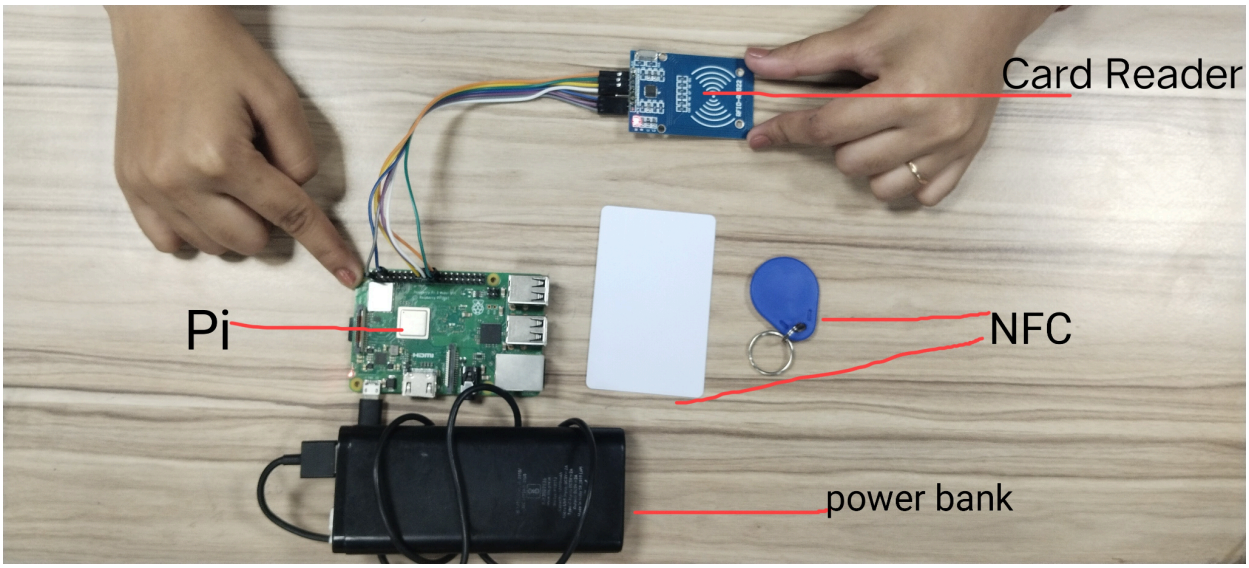
3.2 DevOps Workflow Diagram



3.3 Microservices Architecture



3.4 Raspberry Pi Setup (Image Processing Server)



4. IMPLEMENTATION

4.1 User Interface

Our project provides a user-friendly interface based on React that allows users to see the available parking spots on an interactive 2D map, pre-book spots or let the system assign them one automatically, track their parked vehicle and navigation to their allocated parking spot. We are making use of an IoT based camera to monitor the parking spots and update the availability status while also notifying the user. For the design and implementation of the User Interface, we are using: Visual Studio Code, Figma, Eraser.io, Vite React, Tailwind, Vite-Pwa, etc.
Also an admin dashboard offers the following key actions for managing the parking system:

- **Parking Spots:** Add, edit, or remove parking spots.
- **Manage Users:** Create, update, or deactivate user accounts.
- **Fix False Positives:** Address and correct system errors.
- **Handle User Queries/Issues:** Provide support and resolve user concerns.
- **Send Notifications:** Send important updates to users and stakeholders.

4.2 Backend Server

Our project makes use of a NodeJS Server which is the primary API server with which the user interacts via the Frontend Application. This handles all the user, vehicle and parking related APIs.

4.3 Image Processing Server

We have a FastAPI server that does all the image processing using OpenCV work to monitor the parking spots for availability and communicates with NodeJS Server to keep the database updated.

4.4 DevOps Implementation

Git is used as the Version control system. Jenkins will be used as Continuous Integration and Continuous Deployment (CI/CD) pipeline tool to automate the deployment process. Containerization will be achieved through Docker to package applications and their dependencies in portable, lightweight containers to provide scalability, reliability and portability. These containers will be orchestrated using Kubernetes. Infrastructure as Code (IaC) tools like Terraform facilitate the definition and provisioning of cloud resources. Deployment to platforms like AWS EC2 and EKS ensures applications are hosted and accessible to users. Monitoring and alerting, carried out by tools such as Prometheus, Grafana, Honey Badger, help maintain application health and performance. Backup and recovery mechanisms protect valuable data, while scalability through horizontal scaling ensures the solution can handle increased demand efficiently. These components collectively contribute to a robust and

efficient DevOps pipeline for the parking solution, enhancing development, deployment, and maintenance processes.

4.5 Protocols

- HTTP(S)
- WebSockets
- NFC
- RFID
- IEEE 802.11 (WIFI)
- IEEE 802.15.1 (BLE)

4.6 Algorithms

- YOLO Algorithm [v8s]
- YOLO v8s
- Bounding Box Detection
- FNC CRR - (detection)
- Dijkstra
- A* Algorithm

5. Non Functional Requirements

5.1 Performance Requirements

Following are the basic requirements:

- Authorization & Authentication
- Monitoring & Maintenance
- Configuration & Control
- Reliable Internet Infrastructures

5.2 Security Requirements

Following are the security requirements:

- Admin Accountability
- Private Network Tunnel
- Minimum Physical Access to Hardware modules

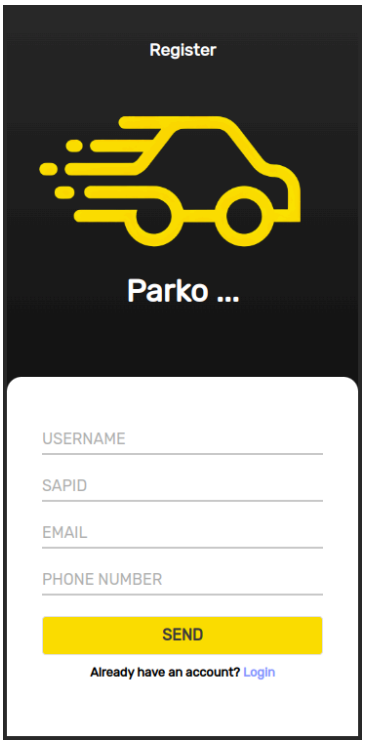
5.3 Software Quality Attributes

Following are the software quality attributes:

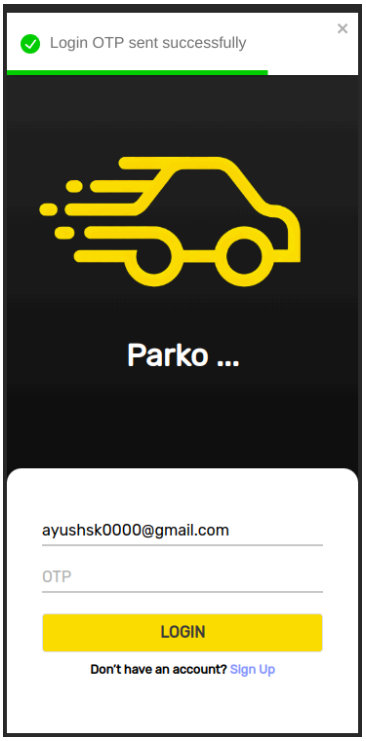
- Availability
- Portability
- Usability
- Testability
- Maintainability
- Reliability
- Scalability

6. Output screens

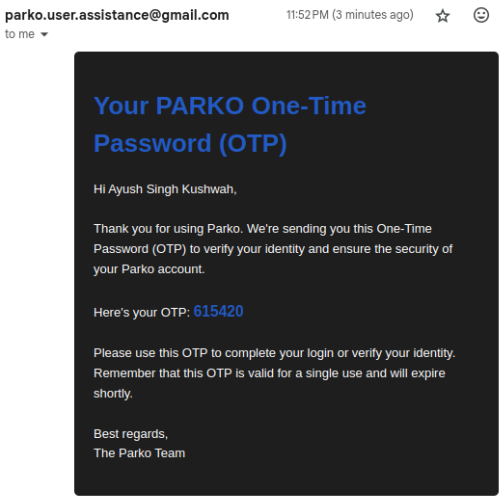
6.1 Registration Page



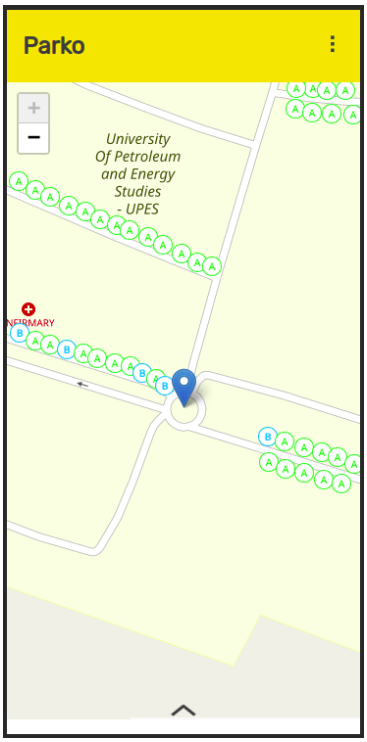
6.2 Login Page



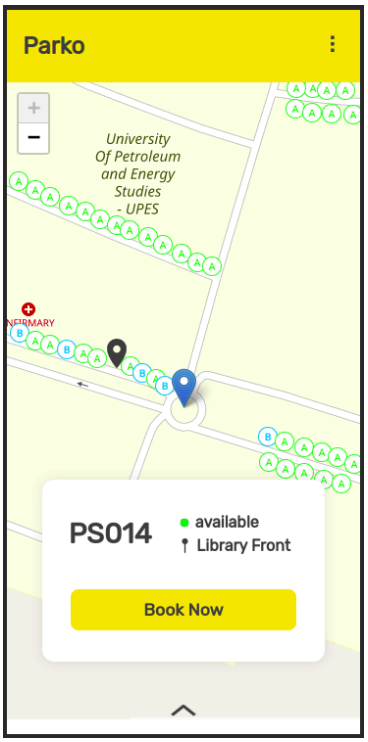
6.3 OTP on Mail



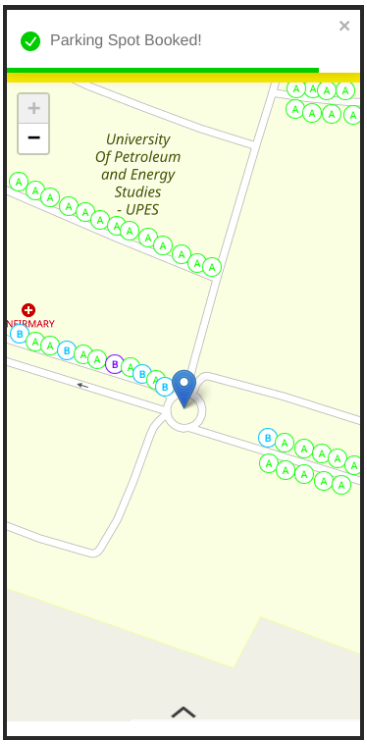
6.4 Home Page



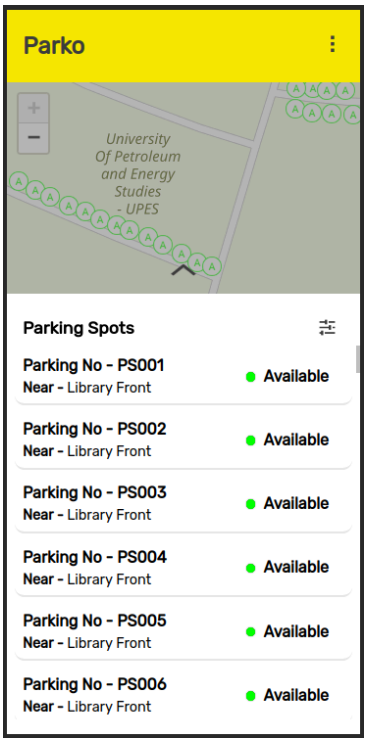
6.5 Booking Spot



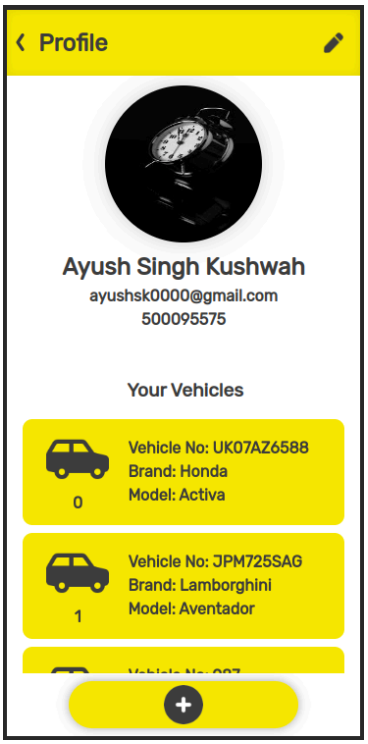
6.6 Booking Confirmed



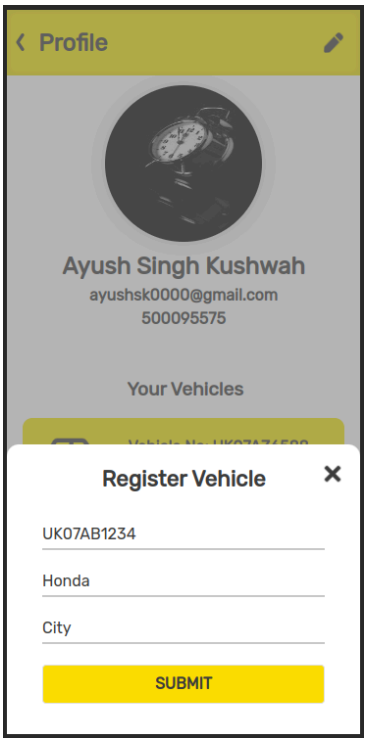
6.7 Parking Spot List



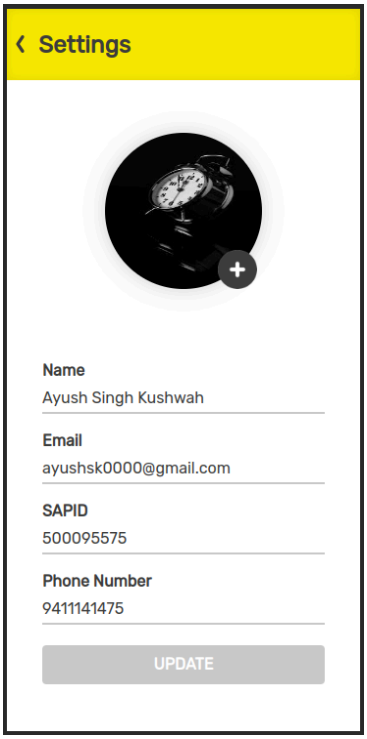
6.8 Profile Page



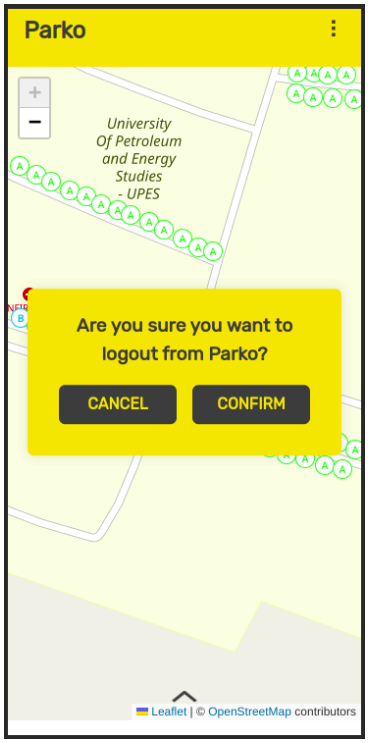
6.9 Register Vehicle



6.10 Settings Page



6.11 Logout

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7. Limitations and Future Enhancements

- A lot of enhancements & features will be integrated in future such to locate your vehicle, extend your parking time, report any issues, check your vehicle's live image, provide feedback, etc.
- Monitoring, Auto Scaling, Load Balancing & other DevOps solutions will be implemented to make sure the application can handle large traffic easily.
- Interactive and Easy to Use Admin Dashboard to be developed for easier monitoring and administration.
- Shaping the application to meet real time parking needs in different settings such as Malls, Societies and Parking Areas.

Appendix A: Glossary

- HTTP(S) - HTTP is the backbone of data communication on the internet. It's a protocol used for transmitting and receiving web content, such as text, images, and videos. HTTPS is the secure version that encrypts data to protect it from unauthorized access during transmission, commonly used for online transactions and secure web browsing.

- NFC - NFC is a short-range wireless technology that enables contactless data transfer between devices when they are in close proximity (typically a few centimeters). It's commonly used for mobile payments, access control systems, and data sharing between smartphones or other compatible devices.

- RFID - RFID is a technology that uses radio waves to identify and track objects, animals, or people. Each RFID tag or card contains a unique identifier that can be read wirelessly. It's widely employed in supply chain management, inventory tracking, access control, and even pet identification.

- IEEE 802.11 (WIFI) - IEEE 802.11, more commonly known as Wi-Fi, is a set of wireless networking standards that allows electronic devices to connect to the internet and local area networks without the need for physical cables. It's widely used in homes, businesses, and public places for wireless internet access.

- IEEE 802.15.1 (BLE) - Bluetooth Low Energy, or BLE, is a wireless communication technology designed for energy-efficient, short-range connections. It's commonly used in devices like fitness trackers, smartwatches, and various Internet of Things (IoT) devices to enable wireless connectivity with smartphones and other devices while conserving battery life

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