# AI-based Intelligent Parking Monitoring System

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# Abstract

Efficient parking management is essential for universities to ensure smooth operations. Our project introduces an AI-based parking management system for the University of Engineering and Technology (UET). This system utilizes artificial intelligence to distinguish between registered and non-registered vehicles, streamlining access and enhancing campus security. Vehicle owners can monitor their vehicles' entry and exit times in real-time through a user-friendly interface. By automating parking processes, our solution minimizes human intervention, improves record accuracy, and provides detailed logs for auditing purposes. This innovative approach ensures efficient parking management while promoting convenience and security for all campus users.

# 1. Introduction

Efficient parking management plays a vital role in ensuring smooth operations, minimizing congestion, and improving overall functionality in large institutions. At the University of Engineering and Technology (UET), the increasing volume of vehicle traffic on campus created a pressing need for a modern, automated parking solution. Traditional manual methods were not only time-consuming but also prone to inaccuracies, leading to inefficiencies and security concerns. To address these challenges, we developed an AI-based parking management system aimed at streamlining operations and enhancing user experience.

This innovative system leverages artificial intelligence to differentiate between registered and non-registered vehicles using advanced license plate recognition technology. By automating vehicle identification, the system reduces the need for human intervention and ensures accurate, real-time tracking of vehicle entry and exit activities. Vehicle owners can easily monitor their parking status through a user-friendly interface, which provides detailed logs and notifications to enhance convenience.

Moreover, the system strengthens campus security by maintaining comprehensive records of parking activities, allowing for effective auditing and incident resolution. Designed for scalability, this solution can adapt to future requirements and integrate with other campus management systems. Ultimately, the AI-based parking system offers a robust, efficient, and secure approach to managing parking operations at UET.

# 2. System Overview

Our AI-based parking management system integrates advanced technologies to deliver a seamless and efficient parking experience. The system employs AI-powered Automatic Number Plate Recognition (ANPR) to differentiate between registered and non-registered vehicles, ensuring accurate identification and streamlined access. Vehicle owners can conveniently monitor their vehicles' entry and exit activities in real-time through a user-friendly interface, which enhances transparency and convenience. Additionally, the system allows administrators to perform CRUD (Create, Read, Update, Delete) operations on vehicle records, ensuring accurate and up-to-date data management. This functionality empowers administrators to manage parking operations efficiently while providing vehicle owners with detailed activity logs and notifications to track their vehicles. By combining automation, real-time tracking, and comprehensive administrative controls, the system significantly improves parking management processes, enhancing both security and user satisfaction.

# 3. User Characteristics

The system will primarily be used by two types of users: Administrator and users.

Administrator will include the parking lot management. The administrator is expected to have a moderate technical expertise such as basic computer skills. The admin dashboard should be developed user-friendly so that even if a non-technical person is assigned to be administrator, he/she should be able to perform administration tasks and monitor vehicles.

Users will include students, faculty and staff. These users will have varying technical expertise. The user interface for this user type should be friendly enough so that every person should be able to understand the system and gather its related information from the system.

# 4. Functional Requirements

## 1. Admin Functionalities

- **Authentication:**
  - Admins must be able to **log in** using a secure authentication process (email and password).
- **Vehicle CRUD Operations:**
  - **Create Vehicle**: Admins should be able to add new vehicles to the system by entering vehicle details (e.g., make, model, year, registration number).
  - **Read/View Vehicle**: Admins should be able to **view the list of all vehicles**, including vehicle details such as make, model, and status.
  - **Update Vehicle**: Admins should be able to **update vehicle details** (e.g., update vehicle status, assign to drivers, etc.).
  - **Delete Vehicle**: Admins should be able to **remove vehicles** from the system when no longer needed or when they are decommissioned.

## 2. Vehicle Owner Functionalities

- **Authentication:**
  - Users must be able to **log in** to the system securely using their credentials
- **Track Vehicle:**
  - Users must be able to **track vehicle routes** over time, including historical data such as Vehicle arrival.

# 5. Implementation

In this project, the following technologies and tools are utilized:

1. **Frontend**: Built using **React** to create a dynamic and responsive user interface.
2. **Backend:** Powered by **Node.js** to handle server-side logic and API requests.
3. **Database:** **MongoDB** is used as the database for storing and managing data.

4. **Model Integration:** The backend is integrated with **Flask** to handle machine learning models, which are used for data processing and decision-making tasks.

## 6. System Architecture

The system architecture of the project is designed to ensure smooth communication between the frontend, backend, database, and model integration. The components are structured as follows:

- **Frontend (React):**

    1. The **React** frontend serves as the user interface, providing an interactive and responsive experience for users.
    2. It communicates with the backend via RESTful API calls (using HTTP requests) to fetch or send data to the server.
    3. React manages the UI components, handles user inputs, and displays dynamic content to users.

- **Backend (Node.js):**

    4. The backend is built with **Node.js**, which handles all server-side logic, API routing, and client requests.
    5. It manages the authentication process, data validation, and handles CRUD operations on the database.
    6. The backend also facilitates communication between the frontend and the **MongoDB** database.

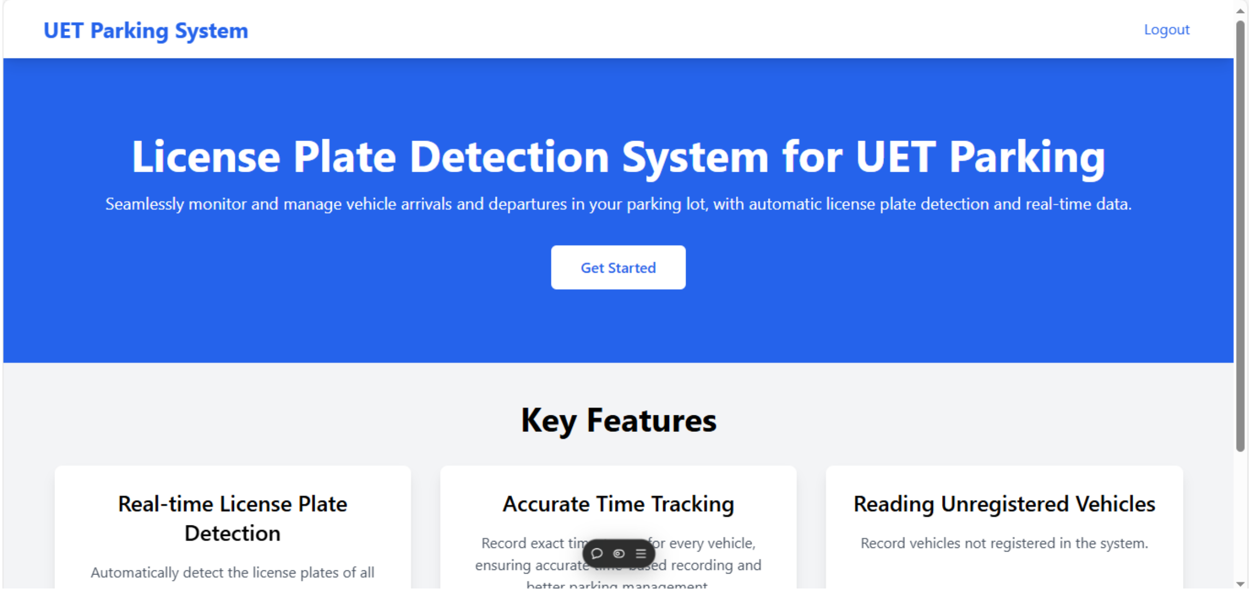
- **Database (MongoDB):**

    7. **MongoDB**, a NoSQL database, is used to store and manage application data in a flexible, schema-less format.
    8. Data such as user profiles, projects, tasks, and other relevant information are stored and queried via MongoDB.
    9. The database interacts with the backend using Mongoose (in Node.js) to manage data efficiently.

- **Model Integration (Flask):**

    10. **Flask**, a micro web framework for Python, is used to integrate machine learning models with the system.
    11. The Flask server handles requests related to the model, such as data processing and predictions, by accepting inputs from the backend or directly from the frontend.
    12. The model (e.g., a machine learning model for classification or prediction tasks) is deployed within Flask and responds with the results to the backend for further processing or display.

# 7. Wireframes



UET Parking System

Logout

License Plate Detection System for UET Parking

Seamlessly monitor and manage vehicle arrivals and departures in your parking lot, with automatic license plate detection and real-time data.

Get Started

Key Features

Real-time License Plate Detection

Automatically detect the license plates of all

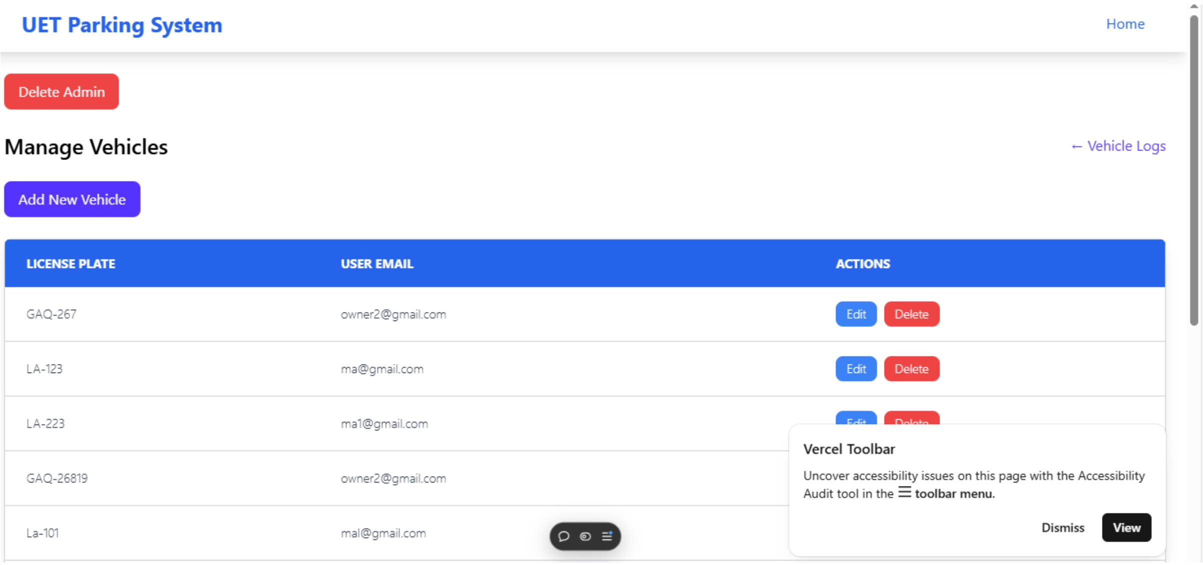
Accurate Time Tracking

Record exact time for every vehicle, ensuring accurate time-based recording and better parking management

Reading Unregistered Vehicles

Record vehicles not registered in the system.

*Figure 1 Landing Page*



UET Parking System

Home

Delete Admin

Manage Vehicles

← Vehicle Logs

Add New Vehicle

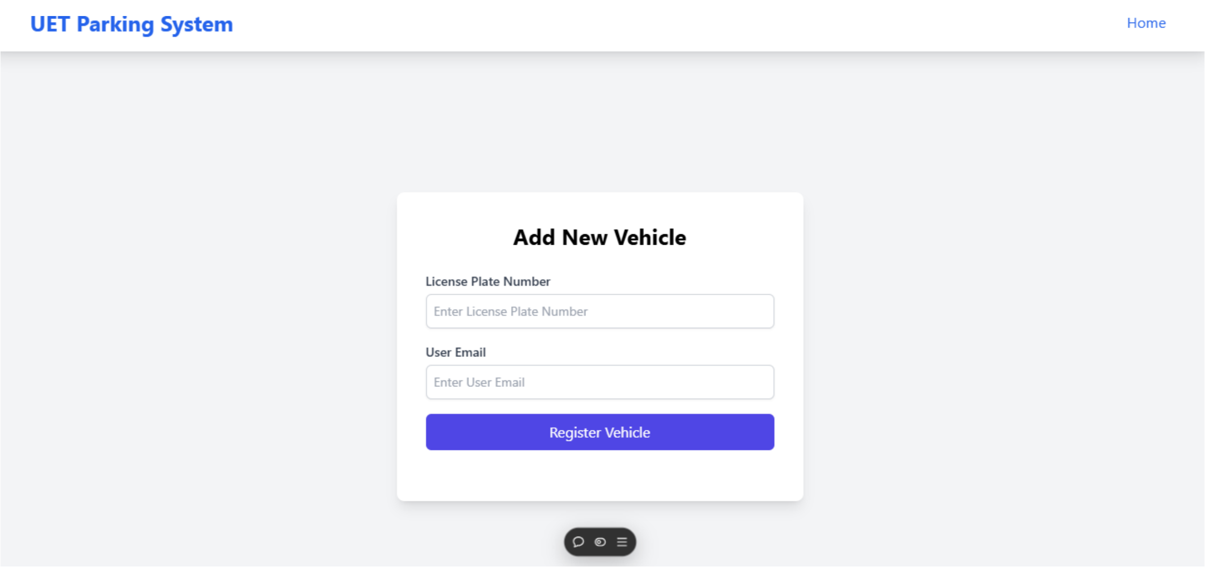
| LICENSE PLATE | USER EMAIL | ACTIONS |
|---|---|---|
| GAQ-267 | owner2@gmail.com | Edit Delete |
| LA-123 | ma@gmail.com | Edit Delete |
| LA-223 | ma1@gmail.com | Edit Delete |
| GAQ-26819 | owner2@gmail.com | |
| La-101 | mal@gmail.com | |

Vercel Toolbar

Uncover accessibility issues on this page with the Accessibility Audit tool in the ☰ **toolbar menu.**

Dismiss View

*Figure 2 Admin Page*



UET Parking System

Home

Add New Vehicle

License Plate Number

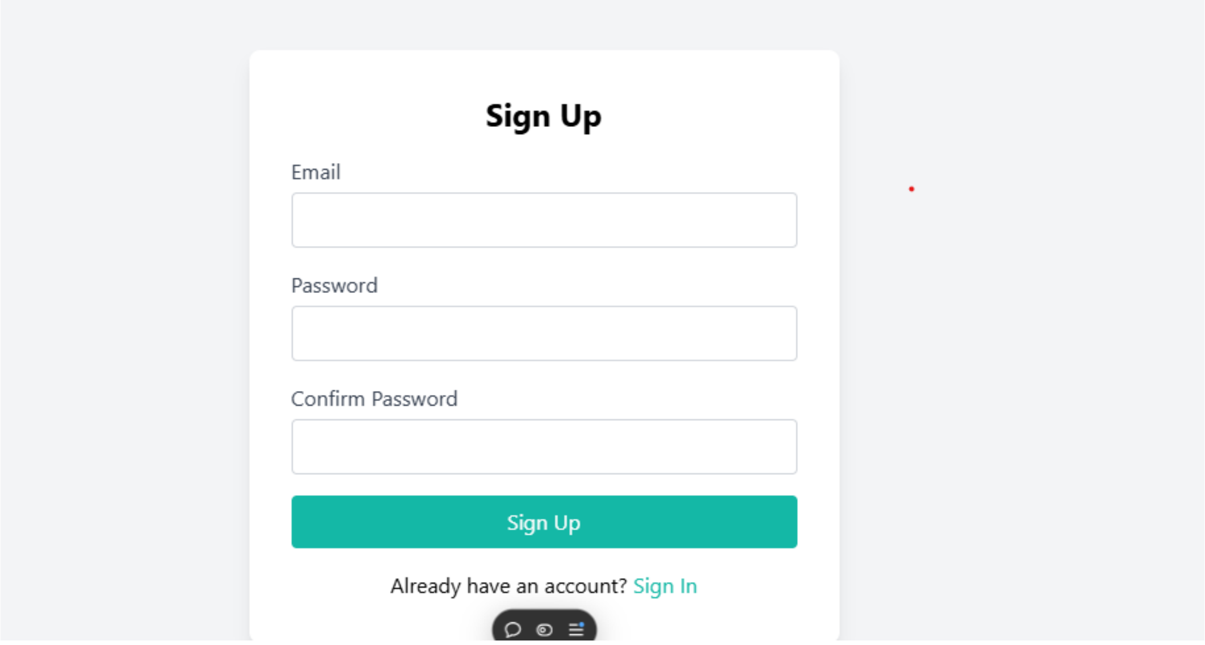
Enter License Plate Number

User Email

Enter User Email

Register Vehicle

*Figure 3 Add Vehicle*



Sign Up

Email

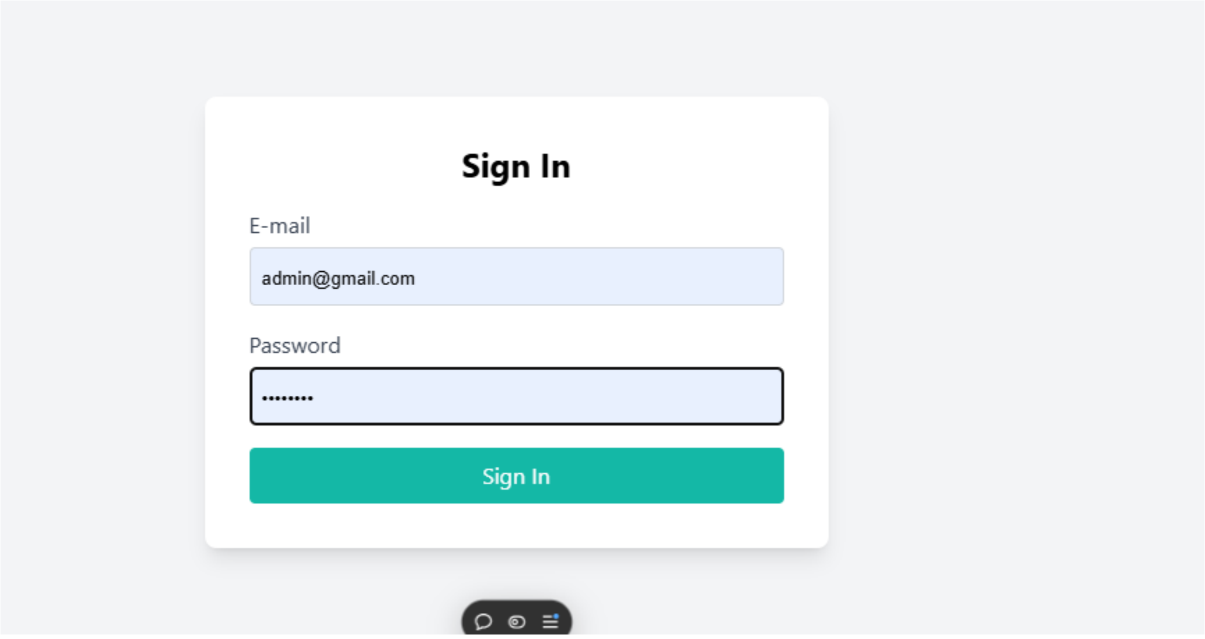
Password

Confirm Password

Sign Up

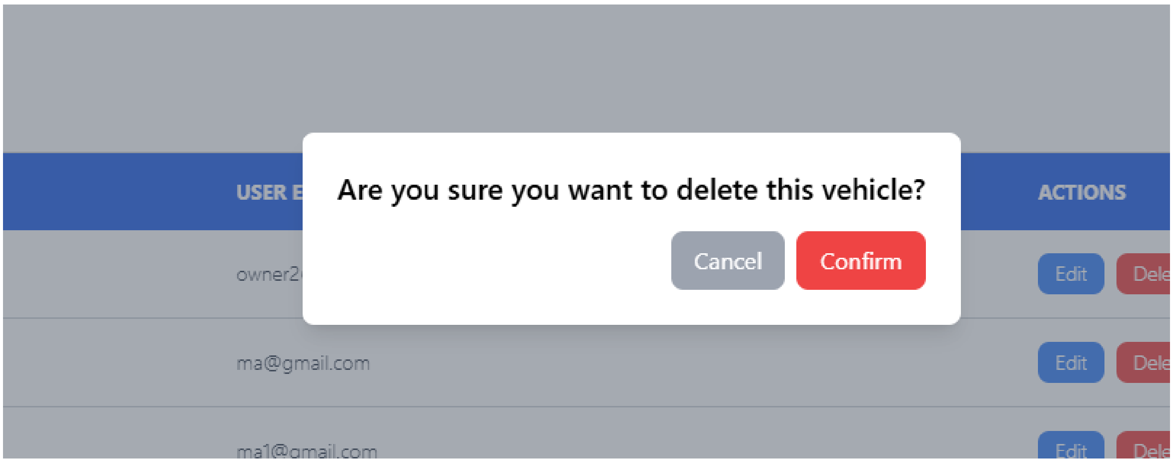
Already have an account? Sign In

*Figure 4 Signup Page*



admin@gmail.com

*Figure 5 Login Page*



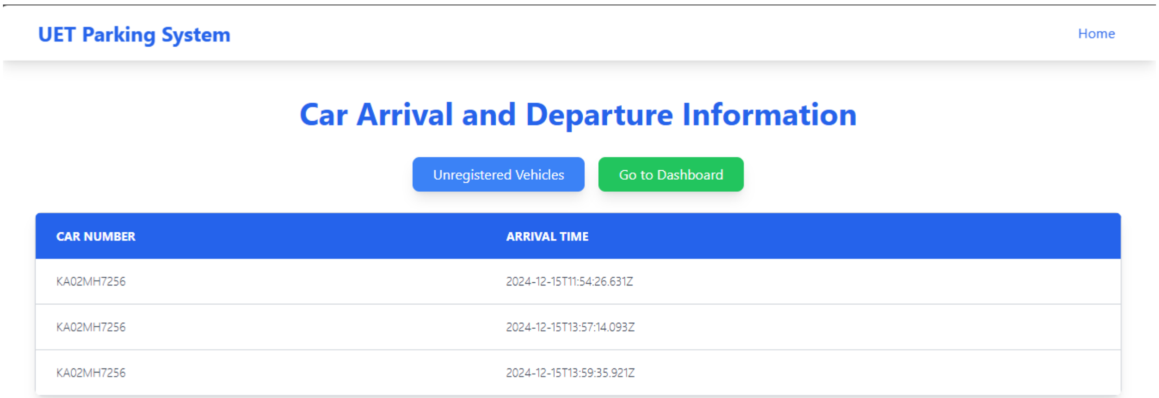
Are you sure you want to delete this vehicle?

owner2

ma@gmail.com

ma1@gmail.com

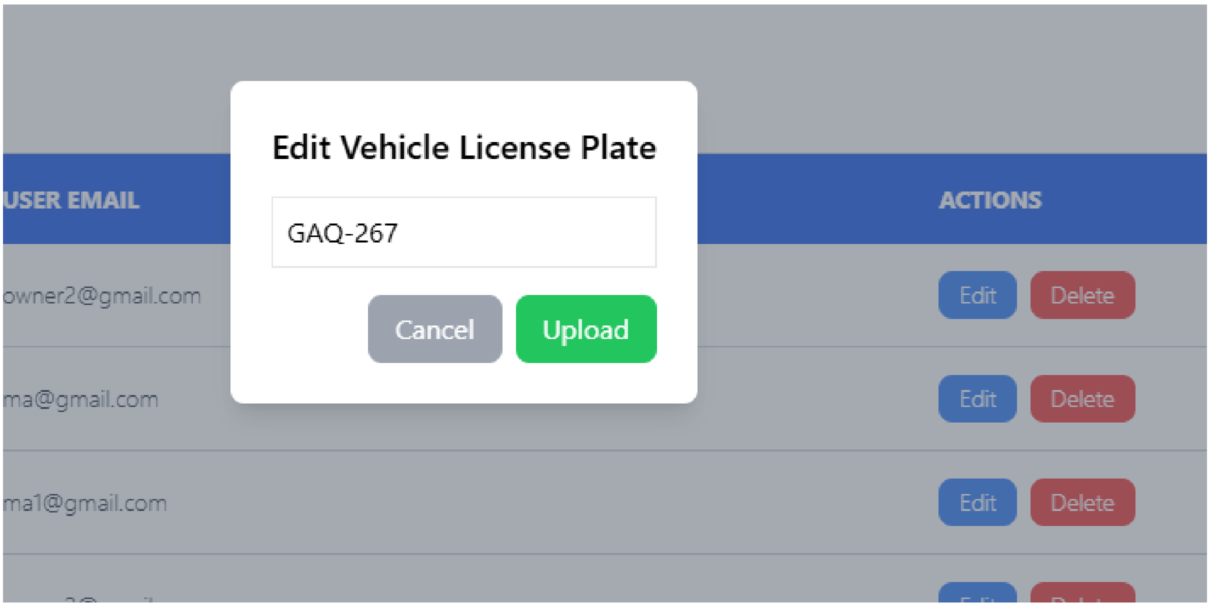
*Figure 6 Delete Vehicle*



Car Arrival and Departure Information

| CAR NUMBER | ARRIVAL TIME |
|---|---|
| KA02MH7256 | 2024-12-15T11:54:26.631Z |
| KA02MH7256 | 2024-12-15T13:57:14.093Z |
| KA02MH7256 | 2024-12-15T13:59:35.921Z |

*Figure 7 Registered Vehicle Logs*



Edit Vehicle License Plate

GAQ-267

| USER EMAIL | ACTIONS |
|---|---|
| owner2@gmail.com | Edit Delete |
| ma@gmail.com | Edit Delete |
| ma1@gmail.com | Edit Delete |

*Figure 8 Edit Vehicle*

# 8. Conclusion

The AI-based parking management system for UET represents a significant step forward in campus automation. By leveraging artificial intelligence, the project delivers enhanced efficiency, security, and user convenience. The system's innovative design and scalability make it a practical solution for modern parking challenges, benefiting the university and its stakeholders.