Summer Project Report

On

“Automatic Number Plate Recognition”

By

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Under the guidance of

Internal Supervisor

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Sardar Patel Institute of Technology

Autonomous Institute Affiliated to Mumbai University

2024-25

CERTIFICATE OF APPROVAL

This is to certify that the following students

Kalyani Bharsat [2023510005]

Sanika Bopate [2023510007]

Have satisfactorily carried out work on the project entitled

"Automatic Number Plate Recognition"

Towards the fulfillment of the summer project during Year 2024-25.

_____

Project Guide

(Prof. Sakina Shaikh)

PROJECT APPROVAL CERTIFICATE

This is to certify that the following students

Kalyani Bharsat [2023510005]

Sanika Bopate [2023510007]

Have successfully completed the Project report on **" Automatic Number Plate Recognition"**, which is found to be satisfactory and is approved

At

Sardar Patel Institute of Technology,
Autonomous Institute Affiliated to Mumbai University
Andheri(w), Mumbai

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External Examiner

Head of Department

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(Dr. Bhalchandra Chaudhari)

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Abstract

This project is an Automatic Number Plate Recognition (ANPR) system that enables efficient vehicle number plate identification and management. It allows administrators and state transport departments to upload vehicle images, which are processed to extract and validate number plates. If a number plate is deemed incorrect, the system automatically sends an email notification to the vehicle owner about the incomplete plate number, with a link to pay any associated fines online. The system also includes an administrative dashboard for managing and reviewing data, enhancing vehicle monitoring and compliance processes.

Objectives

The objective of the "Automatic Number Plate Recognition (ANPR) System" is to develop a sophisticated platform that automates vehicle number plate identification and management, enhancing regulatory compliance and operational efficiency. The key goals are:

1. **Implementing Core ANPR Features**
   Develop and integrate essential functionalities for processing vehicle images to extract and validate number plates. Enable administrators and state transport departments to upload images, with the system accurately recognizing and verifying plate numbers. Implement mechanisms for recording and managing detected data, including case numbers, dates, and locations.

2. **Ensuring Robust Data Management and Security**
   Design a secure and scalable backend to support data storage and processing needs. Implement comprehensive authentication, authorization, and data protection measures to ensure the security and privacy of user information. Utilize encryption and secure practices to protect both image data and personal details.

3. **Facilitating Automated Communication and Fine Management**
   Create automated workflows for notifying vehicle owners of incomplete or incorrect number plates via email, including instructions for fine payment. Implement a user-friendly payment portal where owners can view fines and complete transactions seamlessly.

4. **Enhancing User Interaction and Experience**
   Develop a user-friendly interface for both administrators and state transport departments, providing intuitive navigation and interaction. Incorporate real-time updates, notifications, and comprehensive reporting tools to facilitate effective management and user engagement.

5. **Supporting Ongoing Improvement and Adaptability**
   Establish feedback mechanisms to gather user insights and continuously improve the system. Ensure the platform can adapt to evolving needs and technological advancements, maintaining relevance and efficiency in vehicle number plate recognition and management.

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1. Introduction

1.1 Problem Definition

In today's digital landscape, the absence of efficient and automated vehicle number plate verification processes results in delays, inaccuracies, and administrative burdens. Our project, the "Automatic Number Plate Recognition (ANPR) System," seeks to resolve these issues by offering a streamlined solution that automates number plate detection, simplifies fine management, and ensures timely notifications to vehicle owners. By integrating advanced image recognition technology, our system enhances operational efficiency and accuracy for both administrative and transport departments, fostering a more reliable and user-centric approach to vehicle regulation.

1.2 Objectives and Scope

1.2.1 Objectives

The objective of the "Automatic Number Plate Recognition (ANPR) System" is to develop a robust solution that automates vehicle number plate detection and management. By leveraging advanced image recognition technologies and integrating efficient fine management processes, the system aims to enhance accuracy, streamline administrative tasks, and provide a seamless experience for both administrators and vehicle owners.

Key Goals:

- **Implementing Core ANPR Features**: Develop and integrate functionalities to process and validate vehicle number plates, enabling accurate recognition and data management for administrators and state departments.
- **Ensuring Robust Data Management and Security**: Design a secure, scalable backend with authentication and encryption to protect user data and image information.
- **Facilitating Automated Communication and Fine Management**: Automate notifications for incomplete number plates via email and provide a seamless payment portal for fines.
- **Enhancing User Interaction and Experience**: Create an intuitive interface with real-time updates and reporting tools for effective management and user engagement.
- **Supporting Ongoing Improvement and Adaptability**: Implement feedback mechanisms for continuous system improvement and adaptability to technological advancements.

1.2.2 Scope

The scope of "Vehicle Safety and Compliance System" encompasses:

- **Core ANPR Feature Implementation**: Developing and integrating key functionalities for vehicle image processing, number plate recognition, and data management for administrators and state departments.
- **Data Management and Security**: Designing a secure, scalable backend to handle and protect sensitive data, including image and personal information.
- **Automated Communication and Fine Management**: Creating systems for automated notifications of incorrect number plates and a user-friendly payment portal for fines.
- **User Interface and Experience**: Developing an intuitive interface with real-time updates and comprehensive reporting tools for effective user interaction and management.

1.3 Existing System

Existing vehicle safety and compliance systems frequently face challenges such as inadequate number plate recognition accuracy, fragmented data management, and insufficient automation for fine management. Many systems lack comprehensive integration for secure communication and user-friendly interfaces for handling fines and notifications. "Vehicle Safety and Compliance System" aims to address these issues by offering a more accurate, secure, and streamlined solution for vehicle number plate recognition and compliance management.

1.4 Proposed System

The "Vehicle Safety and Compliance System" proposes a robust solution that enhances vehicle number plate recognition and compliance management. The system integrates:

- Advanced ANPR Technology: Accurate number plate recognition with seamless image processing and validation for effective vehicle identification.
- Secure Data Management: Robust backend architecture with encryption and authentication to protect user and vehicle data.
- Automated Fine Management: Automated workflows for issuing fines, notifying vehicle owners, and facilitating online payments.
- User-Friendly Interface: Intuitive interfaces for administrators and state transport departments to manage and interact with data efficiently.

1.5 System Requirements

Hardware Requirements on Server Side:

Table 1.5.1 Hardware Requirements on Server Side

Processor	Modern multi-core processor or above
RAM	Minimum 4 GB RAM
Storage	Minimum 10 GB Hard Disk Space

Hardware Requirements on Client Side:

Table 1.5.2 Hardware Requirements on Client Side

Device	Windows, Linux / Computer system / Laptop and good internet connection
Processor	Modern multi-core processor or Above
RAM	Minimum 2 GB RAM
Storage	Minimum 250 MB Storage Space

Software Requirements on Server Side:

Table 1.5.3 Software Requirements on Server Side

Operating System	OS Independent
Technology	Python, Flask, MySQL

Software Requirements on Client Side:

Table 1.5.4 Software Requirements on Client Side

Operating System	Windows, Linux / Computer system / Laptop
Server	Not Required

2. Software Requirement Specification (SRS) and Design

2.1 Purpose

The purpose of the Vehicle Safety and Compliance System is to develop a robust and user-friendly platform that automates number plate recognition, fine management, and communication. By integrating advanced features for image processing and secure interactions, the system aims to provide a streamlined and efficient solution for vehicle registration and compliance.

2.2 Definition

The Vehicle Safety and Compliance System is designed to facilitate the identification and verification of vehicle number plates through advanced image recognition. It includes functionalities for uploading images, processing and validating plates, issuing fines, and communicating with vehicle owners. The system focuses on accuracy, security, and user convenience to ensure effective vehicle management and compliance.

2.3 Overall Description

2.3.1 Product Functions

The product functions include:

1. **Core ANPR Features:** The system provides essential functionalities for processing vehicle images to extract and validate number plates. It supports image uploads from administrators and state transport departments, ensuring accurate recognition and verification of plate numbers.

2. **Automated Communication and Fine Management:** It includes automated workflows for notifying vehicle owners about incomplete or incorrect number plates and managing fines. The system facilitates seamless communication via email and a user-friendly payment portal for fine transactions.

3. **Data Management and Security:** The platform ensures secure data storage and processing, implementing authentication and encryption measures to protect user information and image data.

2.3.2 User Characteristics

- **Administrators:** Administrators can use the system to manage vehicle image uploads, verify number plates, and oversee compliance-related tasks. They benefit from efficient data handling and automated communication features.

- **State Transport Departments:** State transport officials can upload images, verify vehicle number plates, and manage fine issuance. The system provides tools for accurate plate recognition and seamless fine management.

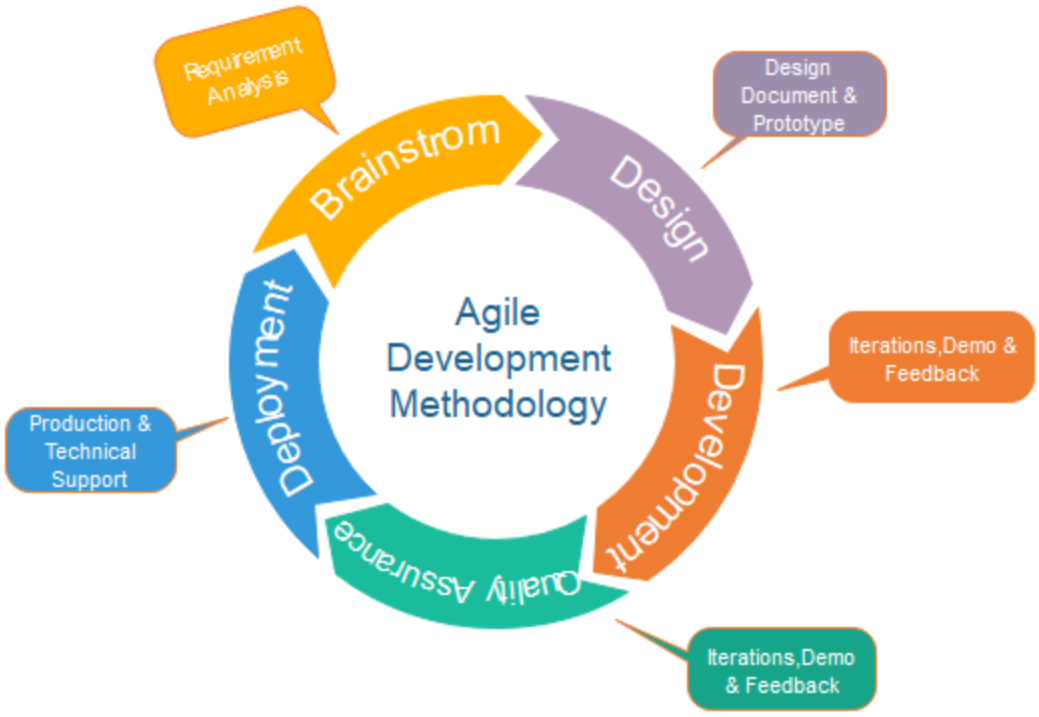
- **Vehicle Owners:** Vehicle owners receive notifications about incomplete or incorrect number plates and can use the platform to view and pay fines. The system offers a straightforward interface for fine payment and communication.

- **Developers and IT Support:** Technical personnel can utilize the system for ongoing maintenance, updates, and improvements, ensuring its continued efficiency and adaptability.

3 Project Analysis and Design

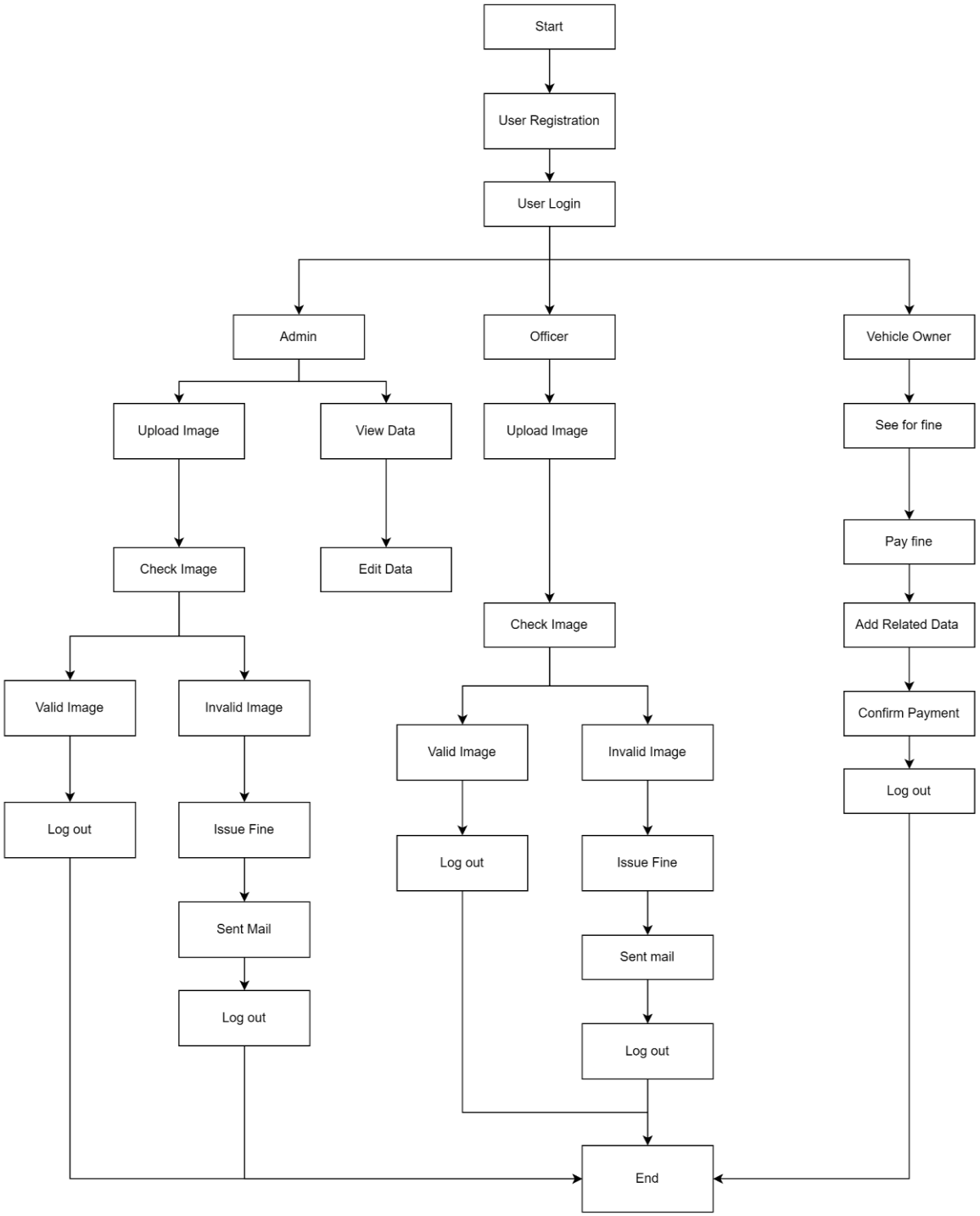
3.1 Methodologies Adapted

The Agile methodology is adopted for the development of the Vehicle Safety and Compliance System. Agile emphasizes iterative progress, frequent feedback, and adaptability, making it suitable for handling the complex and evolving requirements of the system. This approach involves continuous collaboration with stakeholders, regular updates, and incremental improvements to ensure the system remains responsive to user needs and technological advancements. By leveraging Agile practices, the project can efficiently integrate features such as image processing, automated notifications, and secure data management, resulting in a robust and user-centric solution.



3.1.1. Diagrammatic Representation of Agile Model

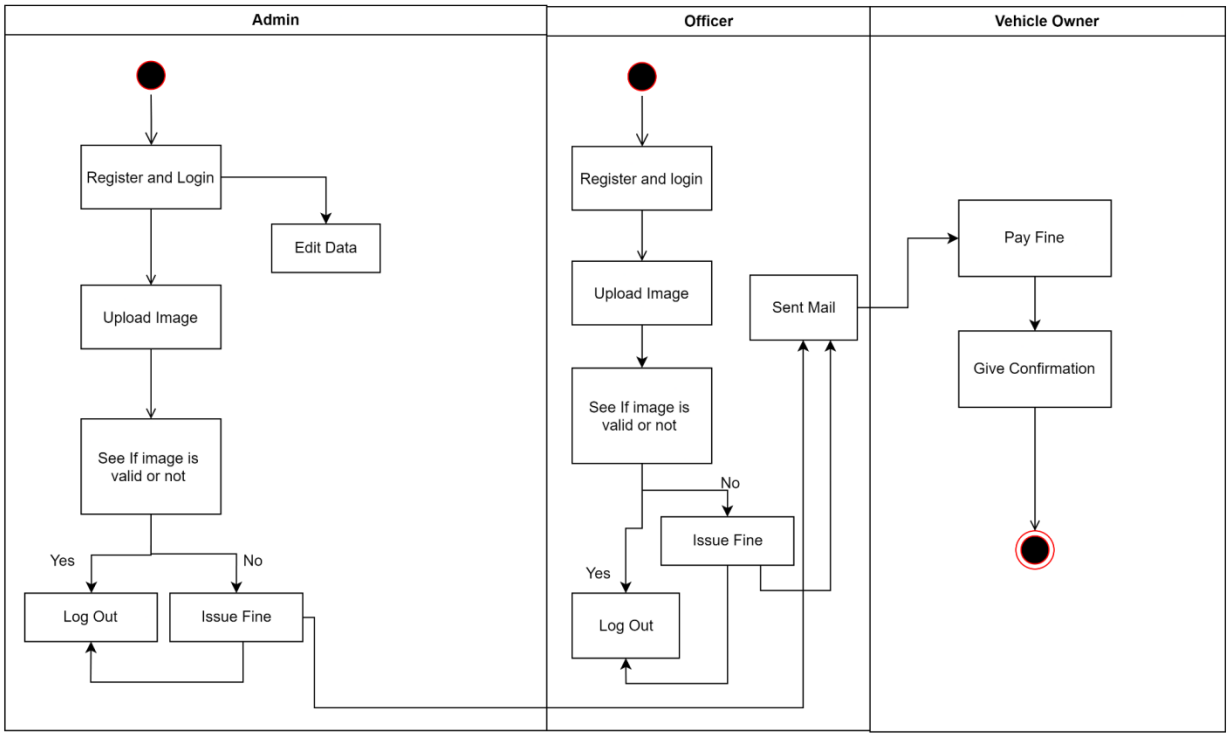
3.1.2 System flowchart



3.1.2 System flowchart

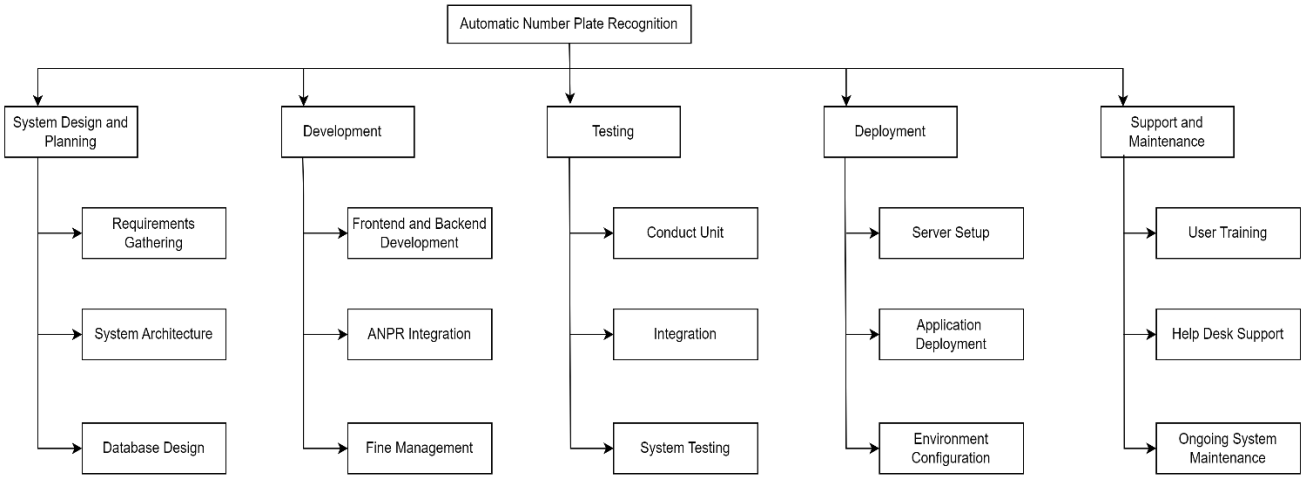
3.2 Modules

3.2.1 Activity Diagram



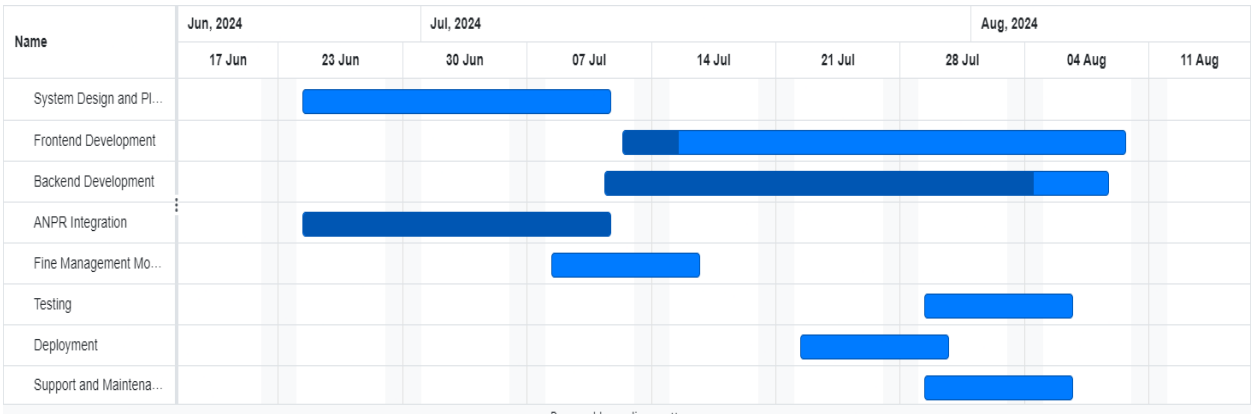
3.2.1 Activity diagram

3.2.2 Work Breakdown Structure

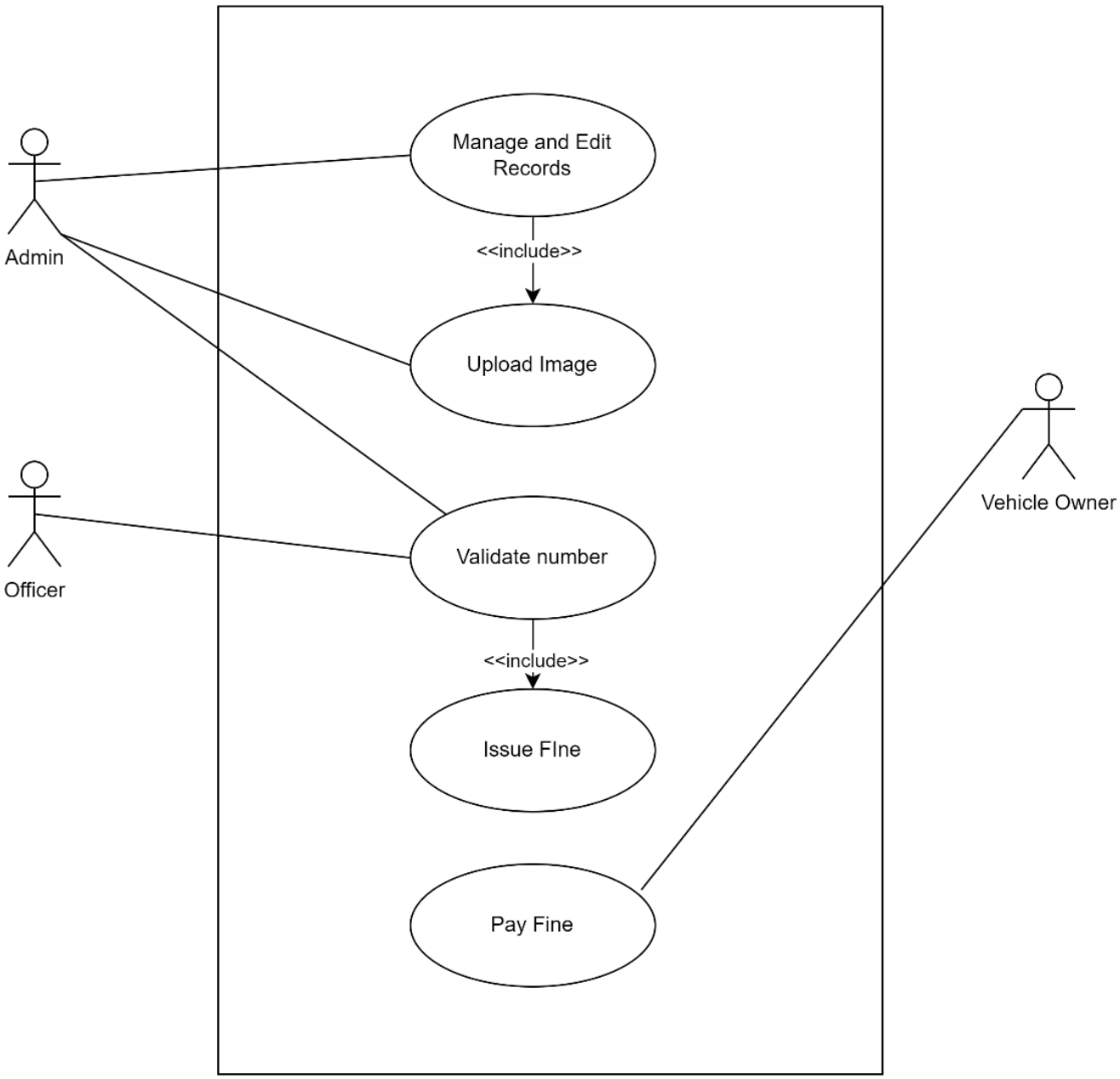


3.2.2 Work Breakdown Structure

3.2.3 Gantt Chart



3.2.4 Use Case Diagram



3.2.4 Use Case Diagram

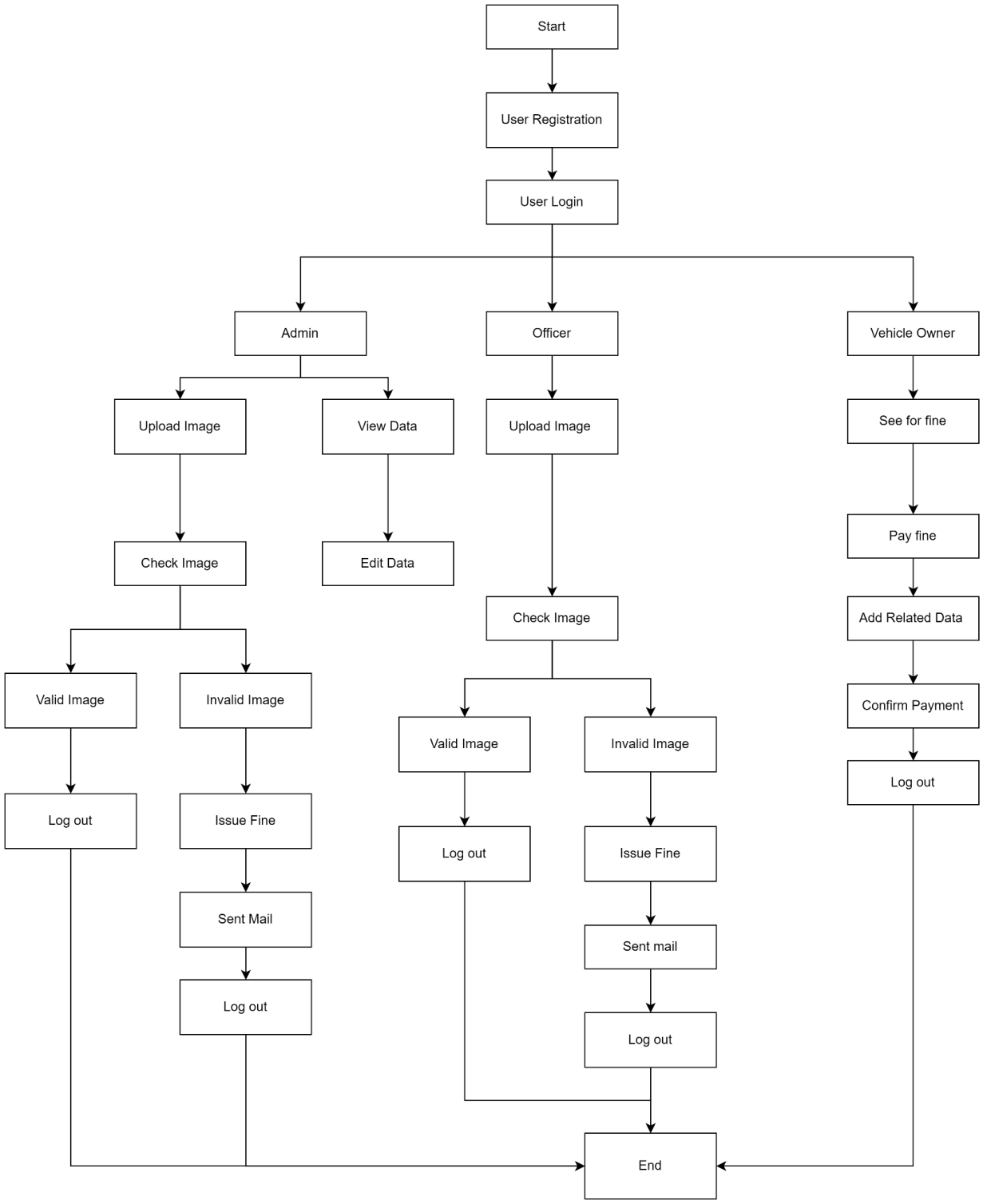
Use Cases:

1. Vehicle Number Plate Detection
2. Data Verification
3. Fine Issuance
4. Image Upload
5. Fine Payment
6. SMS Notification

Use Case ID	Use Case Name	Description	Actors	Preconditions	Steps	Postconditions
UC – 01	Vehicle Number Plate Detection	Detects and reads vehicle number plates using ANPR.	Camera, System	Technologies for ANPR installed	1. Capture image of vehicle. 2. Process image with ANPR. 3. Extract number plate data.	Number plate data stored in the system database.
UC – 02	Data Verification	Verifies the detected number plate against the database.	System, Admin	Number plate data captured	1. Retrieve number plate data. 2. Cross-check with the database.	Verification result logged.
UC – 03	Fine Issuance	Issues fines for vehicles with incorrect or missing number plates.	System, Admin	Number plate verification completed	1. Check for discrepancies. 2. Generate fine details. 3. Issue fine and notify owner.	Fine details saved, notification sent to the owner.
UC – 04	Image Upload	Admin uploads images for vehicle	Admin	Admin logged in	1. Admin selects vehicle image. 2. Uploads image to the system. 3. System processes image.	Image associated with the vehicle record

		compliance checks.				in the database.
UC – 05	Fine Payment	Allows vehicle owners to pay fines online.	Vehicle Owner, Payment Gateway	Fine Issued	1. Owner logs into the system. 2. Views outstanding fines. 3. Completes payment process.	Payment confirmed, receipt sent to the owner.
UC – 06	SMS Notification	Sends SMS notifications to vehicle owners regarding fines and payment deadlines.	System, Vehicle Owner	Fine issued or payment made	1. Generate SMS content. 2. Send SMS via gateway. 3. Log SMS delivery.	SMS sent and delivery status recorded.

3.3 Database Schema/Design



3.3.1 Flowchart Diagram

3.3.3 Database Schema Design

1. Table : Info

Column Name	Data Type	Attributes	Description
Id	INT	AUTO_INCREMENT, PRIMARY KEY	Unique Identifier for each record.
Case_number	VARCHAR(20)		Unique case number for each validation
Date	DATE		Date when the violation was recorded.
City	VARCHAR(20)		City where the violation occurred.
Image	MEDIUMBLOB		Image of the vehicle's number plate.
Vehicle_number	VARCHAR(20)		The vehicle's number plate
State	VARCHAR(20)		State where the vehicle is registered
Fine	VARCHAR(10)		Fine amount or status

2. Table: login

Column Name	Data Type	Attributes	Description
id	INT	AUTO_INCREMENT, PRIMARY KEY	Unique Identifier for each login record.
username	VARCHAR(20)	UNIQUE, NOT NULL	Unique username for login purposes.
password	VARCHAR(255)	NOT NULL	Encrypted password for the user.
role	ENUM	(admin, std, user), NOT NULL	Role of the user in the system.

3. Table: users

Column Name	Data Type	Attributes	Description
id	INT	AUTO_INCREMENT, PRIMARY KEY	Unique Identifier for each record.
Case_number	VARCHAR(20)	UNIQUE, NOT NULL	Unique username for each user.
password	VARCHAR(255)	NOT NULL	Encrypted password for the user.

4. Table: paid_fines

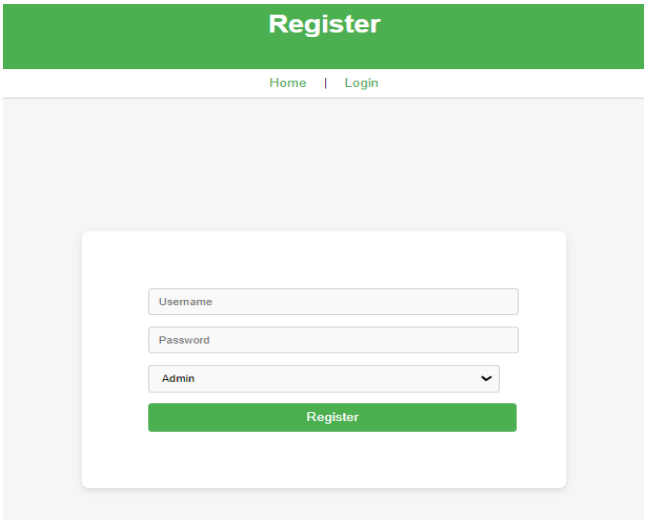
Column Name	Data Type	Attributes	Description
id	INT	AUTO_INCREMENT, PRIMARY KEY	Unique Identifier for each paid fine record.
Case_number	VARCHAR(255)	NOT NULL	Case number associated with the paid fine.
Fine	VARCHAR(10)	NOT NULL	Status or amount of the fine
Date_paid	TIMESTAMP	DEFAULT CURRENT_TIMESTAMP	Date and time when the fine was paid.

4. Project Implementation and Testing

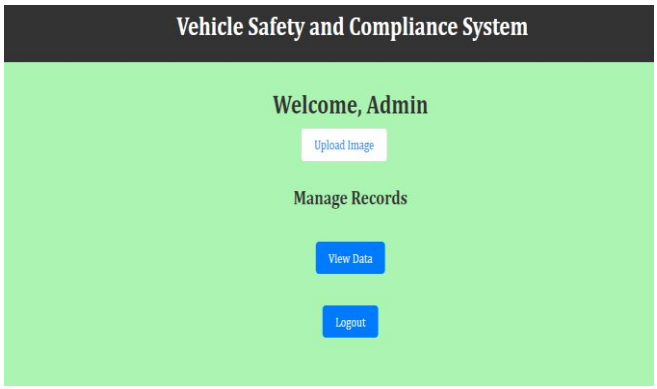
4.1 Snapshot of UI

1. Home Page

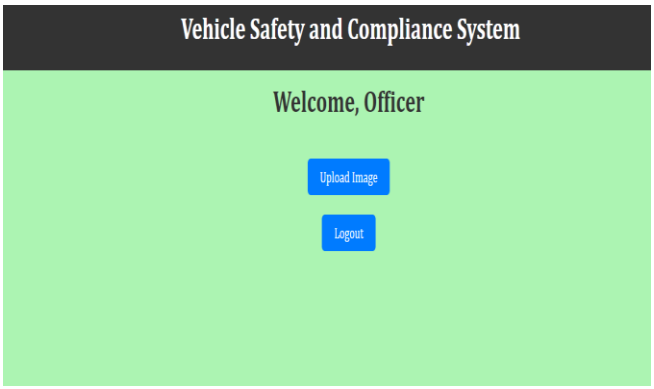
2. Register Page



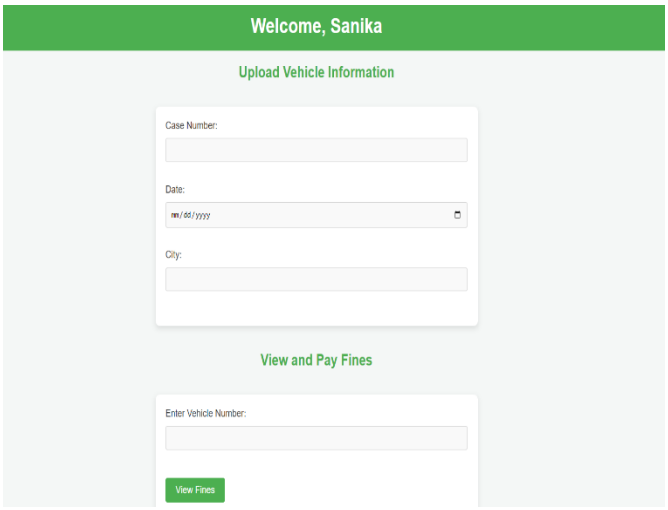
3. Admin Page



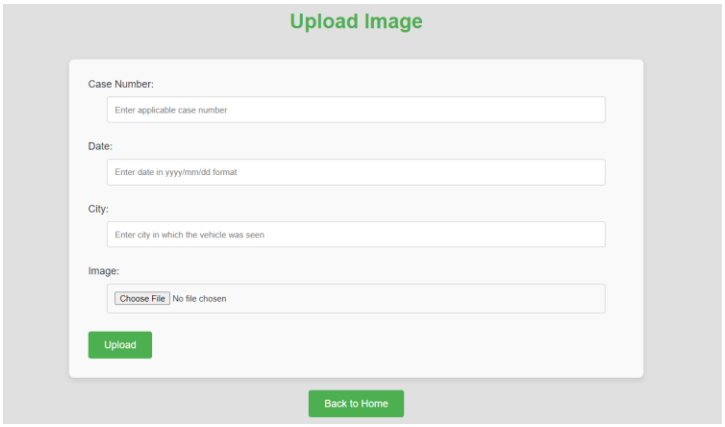
4. Officer Page



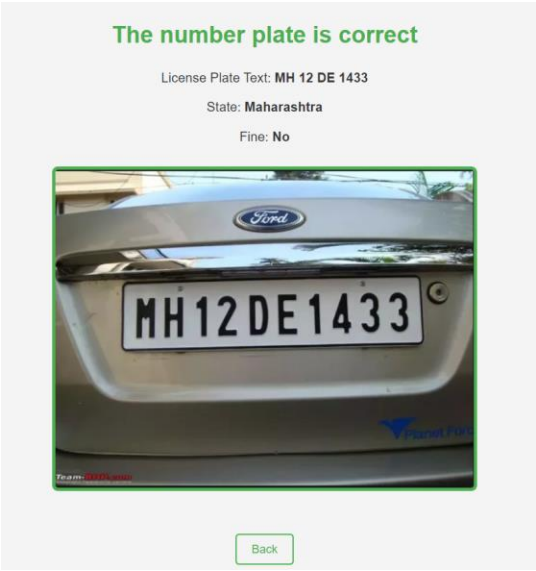
5. Vehicle Owner Page



6. Upload Image Page

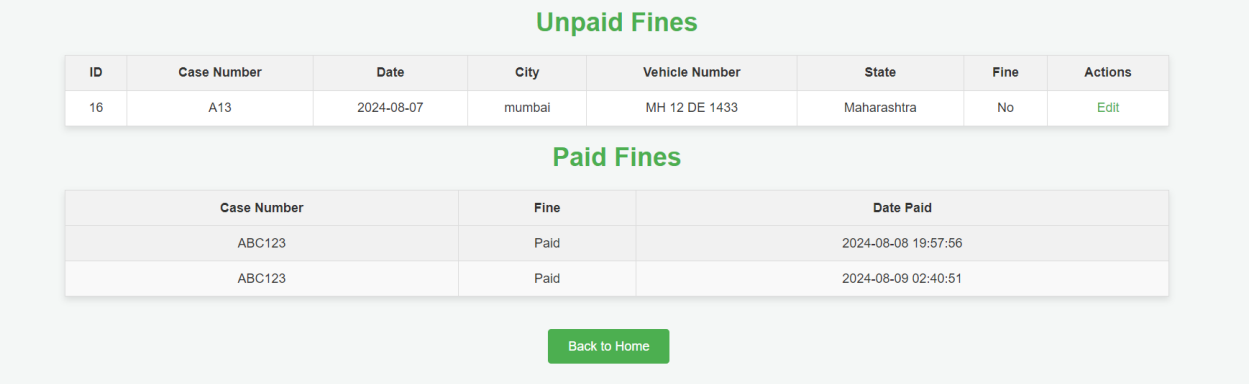


7. Valid Image Format Page



8. Invalid Page Format Page

9. Records Page



5. Test Cases

Test Case ID	Test Case Name	Test Steps	Expected Results	Actual Results	Status
TC-01	ANPR Number Plate Detection	1. Capture an image of a vehicle. 2. Process the image with ANPR. 3. Extract and display the number plate data.	The system accurately detects and displays the correct number plate.	Correct number plate detected	Pass
TC-02	Vehicle Data Verification	1. Retrieve detected number plate data. 2. Compare with existing database entries. 3. Confirm match or mismatch.	The system correctly identifies whether the number plate matches the database entry.	Data matched with database	Pass
TC-03	Fine Issuance for Incorrect Plates	1. Detect an incorrect/missing number plate. 2. Trigger the fine issuance process. 3. Notify the vehicle owner.	The system generates a fine and sends a notification to the vehicle owner.	Fine issued and owner notified	Pass
TC-04	Image Upload by Admin	1. Admin selects an image. 2. Uploads the image. 3. Associate the image with the vehicle record. Image successfully uploaded Pass	The image is uploaded and linked to the correct vehicle record in the system.	Image successfully uploaded	Pass

TC-05	Fine Payment Process	1. Log in as a vehicle owner. 2. View outstanding fines. 3. Complete the payment process.	Payment is processed, and a confirmation is sent to the vehicle owner.	Payment completed and confirmed	Pass
TC-06	SMS Notification for Fine Issuance	1. Generate the SMS content. 2. Send the SMS. 3. Verify SMS delivery.	SMS notification is sent to the vehicle owner with the correct details.	SMS sent and delivered	Pass
TC-07	Vehicle Data Management	1. Add a new vehicle record. 2. Modify an existing record. 3. Delete a vehicle record.	Vehicle data is correctly added, modified, or deleted in the system.	Vehicle data managed successfully	Pass

6. Limitations

1. **Accuracy of ANPR**: The system's accuracy in recognizing and processing number plates can be affected by factors like image quality, lighting conditions, and plate obscuration. This could lead to false positives or missed detections.
2. **Database Performance**: As the database grows with more vehicle data and transaction records, performance might degrade. Efficient indexing and optimization strategies will be crucial.
3. **Scalability**: Handling a high volume of image uploads and user interactions may require scaling strategies. This could involve load balancing, cloud services, or optimizing the application's architecture.
4. **Security**: Ensuring the security of user data and payment information is critical. Implementing strong encryption, secure authentication, and regular security audits will be necessary.
5. **Integration with External Systems**: Integrating with existing state transport department systems and ensuring data consistency could be challenging. Compatibility and data synchronization issues might arise.
6. **User Experience**: The ease of use for administrators and vehicle owners should be tested thoroughly. Poor user experience could impact the system's effectiveness and adoption.
7. **Regulatory Compliance**: Adhering to privacy regulations and data protection laws, such as GDPR or local regulations, will be essential to avoid legal issues.
8. **Maintenance and Updates**: Regular maintenance and updates will be needed to address bugs, adapt to changes in technology, and incorporate user feedback.
9. **Network Reliability**: The system's performance is dependent on network reliability. Connectivity issues could affect real-time data processing and communication.
10. **Cost**: The cost of implementing and maintaining the system, including infrastructure, licensing, and support, should be considered and managed efficiently.

7. Future Enhancements

1. **Advanced ANPR Technology**: Implementing more sophisticated ANPR algorithms and machine learning models could improve accuracy and speed in plate recognition.
2. **Real-Time Alerts**: Adding real-time alerts for both administrators and users when a violation is detected or a payment is due could enhance responsiveness and compliance.
3. **Mobile Application**: Developing a mobile app for users to access their accounts, view violations, make payments, and receive notifications could improve user convenience and engagement.
4. **Enhanced User Authentication**: Implementing multi-factor authentication (MFA) or biometric login options could strengthen security and prevent unauthorized access.
5. **Integration with IoT Devices**: Integrating with IoT devices like vehicle trackers or dash cameras could provide additional data and enhance the system's capabilities.
6. **Machine Learning for Predictive Analysis**: Utilizing machine learning for predictive analysis could help in identifying patterns and trends related to vehicle safety and compliance, potentially preventing violations before they occur.
7. **Automated Report Generation**: Enhancing the reporting features to automatically generate detailed compliance reports, analytics, and insights could help in better decision-making and policy formulation.
8. **Voice Commands**: Adding voice command functionality for hands-free operation, especially for administrators managing the system, could improve usability.
9. **Integration with Other Systems**: Connecting with other governmental or transport systems for seamless data sharing and verification could enhance the system's effectiveness and reduce redundancy.
10. **User Feedback Integration**: Implementing a feedback mechanism where users can provide suggestions or report issues could help in continuously improving the system based on real-world usage.
11. **Enhanced Data Visualization**: Providing advanced data visualization tools for administrators to better analyze trends and patterns in the data could aid in decision-making and reporting.
12. **Dynamic Pricing Models**: Implementing dynamic pricing models for fines based on various factors (e.g., severity, frequency of violations) could make the system more adaptive and fair.
13. **AI-Based Fraud Detection**: Adding AI algorithms to detect fraudulent activities or suspicious patterns in fine payments or plate registrations could enhance security and integrity.
14. **Multilingual Support**: Offering multilingual support in the application could make it more accessible to a wider audience, especially in diverse regions.
15. **Cloud Integration**: Leveraging cloud services for scalability, data storage, and computational power could improve the system's performance and flexibility.

8. User Manual

A. Admin Instructions

1. Log In: Use your admin credentials to access the dashboard.
2. View All Data: Access a comprehensive overview of paid and unpaid fines, along with detailed vehicle and owner information.
3. Upload Images: Select and upload vehicle images for verification purposes.
4. Monitor Officer Activity: Track and review the actions taken by officers, including fines issued and emails sent.

B. Officer Instructions

1. Log In: Enter your officer credentials to access your dashboard.
2. Upload Image: Upload vehicle images for license plate verification.
3. Verify License Plate: Compare the detected plate number with the database and mark as correct or incorrect.
4. Issue Fines: For incorrect plates, issue a fine and send an email to the vehicle owner with instructions on how to pay.

C. Vehicle Owner Instruction

1. Register: Create an account on the registration page.
2. Log In: Access your dashboard using your login details.
3. View and Pay Fines: Check for any unpaid fines, complete the payment process, and upload a screenshot of the transaction.
4. Receive Confirmation: Wait for an email confirmation after the admin verifies your payment.

9. References

9.1 Web References

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[3.] https://jupyter.org/

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9.2 Research Paper Regerences

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