

VEHICLE NUMBER PLATE RECOGNITION SYSTEM

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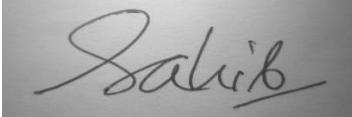
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DEDICATION

This thesis is dedicated to my family, who supported me through the ups and downs of life. Who has always blessed me with their purest intentions. Who motivated me to pierce through the tough time faced by me while staying here, thousands of miles away from them.

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ABSTRACT

Vehicle number plate recognition system is intelligent system which recognizes the characters on a vehicle plate number and store the vehicles info in the database. While storing the license plate number the system also stores where the vehicle entered from and in what time and date the vehicle entered the campus area. Beside the vehicle details and the vehicle entry details the user can also enter the owner details of the vehicle. The application also allows the user to change the details of the owner as an owner of a certain vehicle might change but the vehicle details will not change as it is going to stay same forever. Some of the unique features included in this system is the user can also ban vehicles from entering, meaning if a vehicle is selected to be banned, then it shows for the next time the security guard will be able to see that this vehicle is banned from entering so something must be wrong with it. So, the guard can stop the vehicle and make the campus area much safer. The optimum reliability is shown by the combination of the hardware and the software integration. The current system of the UTM security does not involve the automated system where it will be easy for the guards and also the drivers to pass through the security check. The challenges faced while implementing the system are the algorithm on smartphone for higher coding efficiency and lower computational complexity with higher scalability. The main objective of this report is to design and implement such recognition system on smartphone so that the complexity and the time length of the security check at the gates can be reduces and make is more time efficient. The application is based on the FLUTTER framework of the DART programming language. The system uses firebase real-time database as the database where the data will be stored, Google ML kit for the Optical Character Recognition as it supports wide range of SDKs and also supports null safety for development.

ABSTRAK

Sistem pengecaman plat nombor kenderaan adalah sistem pintar yang mengiktiraf aksara pada nombor plat kenderaan dan menyimpan maklumat kenderaan dalam pangkalan data.Sambil menyimpan nombor plat lesen sistem ini juga menyimpan di mana kenderaan itu masuk dari dan dalam masa dan tarikh kenderaan memasuki kawasan kampus.Selain butiran kenderaan dan butiran kemasukan kenderaan, pengguna juga boleh memasukkan butiran pemilik kenderaan.Aplikasi ini juga membolehkan pengguna menukar butiran pemilik sebagai pemilik kenderaan tertentu mungkin berubah tetapi butiran kenderaan tidak akan berubah kerana ia akan kekal sama selama-lamanya.Beberapa ciri unik yang dimasukkan dalam sistem ini adalah pengguna juga boleh mengharamkan kenderaan daripada memasuki, yang bermaksud jika kenderaan dipilih untuk diharamkan, maka ia menunjukkan untuk kali seterusnya pengawal keselamatan akan dapat melihat bahawa kenderaan ini dilarang daripada memasuki jadi sesuatu mesti salah dengannya.Jadi, pengawal boleh menghentikan kenderaan dan menjadikan kawasan kampus lebih selamat.Kebolehpercayaan optimum ditunjukkan oleh gabungan perkakasan dan integrasi perisian. Sistem keselamatan UTM semasa tidak melibatkan sistem automatik di mana ia akan mudah bagi pengawal dan juga pemandu untuk melalui pemeriksaan keselamatan.Cabaran yang dihadapi semasa melaksanakan sistem adalah algoritma pada telefon pintar untuk kecekapan pengekodan yang lebih tinggi dan kerumitan pengiraan yang lebih rendah dengan kebolehskaalan yang lebih tinggi.Objektif utama lapor ini adalah untuk mereka bentuk dan melaksanakan sistem pengiktirafan tersebut pada telefon pintar supaya kerumitan dan tempoh masa pemeriksaan keselamatan di pintu pagar dapat dikurangkan dan dibuat adalah lebih cekap masa.Permohonan ini adalah berdasarkan rangka kerja FLUTTER bahasa pengaturcaraan DART.Sistem ini menggunakan pangkalan data masa nyata firebase sebagai pangkalan data di mana data akan disimpan, kit Google ML untuk Pengiktirafan Aksara Optik kerana ia menyokong pelbagai SDK dan juga menyokong keselamatan batal untuk pembangunan.

TABLE OF CONTENTS

	TITLE	PAGE
DECLARATION		ii
DEDICATION		iii
ACKNOWLEDGEMENT		iv
ABSTRACT		v
ABSTRAK		vi
TABLE OF CONTENTS		vii
LIST OF TABLES		xi
LIST OF FIGURES		xii
LIST OF ABBREVIATIONS		xiii
LIST OF APPENDICES		xiv
 CHAPTER 1 INTRODUCTION		 1
1.1 Introduction		1
1.2 Problem Background		1
1.3 Project Goal		2
1.4 Project Objectives		2
1.5 Project Scope		3
1.6 Project Importance		3
 CHAPTER 2 LITERATURE REVIEW		 5
2.1 Introduction		5
2.2 Current Mobile License Plate Recognition System		5
2.3 Current System Analysis		6
2.3.1 Mobile System		6
2.3.2 Automatic License Plate Recognition Feature		8
2.4 Comparison Between Systems		9
2.5 System Development Related Technologies		11
2.5.1 Android		11

2.5.2	iOS	12
2.5.3	Dart	13
2.5.4	Flutter	13
2.5.5	Python	13
2.5.6	Firebase ML KIT	14
2.5.7	Google (Cloud FireStore)	14
2.6	Chapter Summary	14
CHAPTER 3 SYSTEM DEVELOPMENT METHODOLOGY		17
3.1	Introduction	17
3.2	Methodology Choice and Justification	17
3.3	Agile Development Phase	18
3.3.1	Requirements	18
3.3.2	Design	19
3.3.3	Development	19
3.3.4	Testing	20
3.3.5	Deployment	20
3.3.6	Review	21
3.4	Analysis of Hardware and Software Requirements	21
3.5	Justification of Hardware and Software Used	21
3.6	Hardware Requirements for System Development	22
3.7	Software Requirements	22
3.8	Chapter Summary	23
CHAPTER 4 REQUIREMENT ANALYSIS AND DESIGN		24
4.1	Introduction	24
4.2	Requirement Analysis	24
4.2.1	Functional Requirement	24
4.2.1.1	Vehicle Number Plate Recognition System Use Case Diagram	25
4.2.1.2	Actor Description	25
4.2.1.3	Vehicle Number Plate Recognition Use Case Description	26

4.2.1.4	Scan Vehicles Activity Diagram	27
4.2.1.5	Scan Vehicle Sequence Diagram	29
4.2.2	Non-functional requirement	30
4.2.2.1	Performance	30
4.2.2.2	Reliability	30
4.2.2.3	Usability	30
4.2.2.4	Maintainability	30
4.2.2.5	Security	30
4.3	System Architecture Design	31
4.4	System Class Diagram	32
4.5	System Database Design	32
4.6	System Interface Design	33
4.7	Test Case Design	39
4.8	Chapter Summary	41
CHAPTER 5 SYSTEM IMPLEMENTATION AND TESTING		43
5.1	Introduction	43
5.2	System Implementation	43
5.2.1	Development Environment	43
5.2.1.1	Visual Studio Code	44
5.2.2	System Development	45
5.2.2.1	Database Development	45
5.2.2.2	User Interface Development	46
5.3	System Testing	47
5.3.1	Black Box Testing	47
5.3.2	User Acceptance Testing	48
5.4	Chapter Summary	48
CHAPTER 6 CONCLUSION		49
6.1	Introduction	49
6.2	Review of PSM 2 Achievement	49
6.3	Summary of PSM 2 planning and implementation	50

6.4	Conclusion	50
REFERENCES		52

LIST OF TABLES

TABLE NO.	TITLE	PAGE
Table 2.1	Comparison of Mobile LPR and Automatic License Plate Recognition Feature with Proposed Application VNPRS	10
Table 4.1	Use case description	27
Table 4.2	Test Cases	39

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
Figure 2.1	Home page and History Page of Mobile LRP)	7
Figure 2.2	Home screen and Input Image from Gallery Screen	9
Figure 3.1	Agile Model	18
Figure 4.1	Use case diagram of Vehicle Number Plate Recognition System	25
Figure 4.2	Scan Vehicle activity diagram	28
Figure 4.3	Scan Vehicle sequence diagram	30
Figure 4.4	An overview of MVC architecture	32
Figure 4.5	Class diagram of Vehicle Number Plate Recognition System	33
Figure 4.6	Collection of key value for Firebase used in VNPRS	34
Figure 4.7	Login Screen	34
Figure 4.8	SignUp Screen	35
Figure 4.9	Guard Home Screen	35
Figure 4.10	Admin Home Screen	36
Figure 4.11	Register Vehicle Screen	36
Figure 4.12	Register Owner Screen	37
Figure 4.13	Ban Vehicle Screen	37
Figure 4.14	View Vehicle Details Screen	38
Figure 4.15	View Owner Details Screen	38
Figure 5.1	Interface of Visual Studio Code	44
Figure 5.2	Interface of Firebase Realtime Database	46
Figure 5.3	Flutter code for User Interface	47

LIST OF ABBREVIATIONS

UTM	-	Universiti Teknologi Malaysia
VPNRS	-	Vehicle Number Plate Recognition
ALPRF	-	Automated License Plate Recognition Feature
LPR	-	License Plate Recognition
OS	-	Operating System
UI	-	User Interface
XML	-	Extensible Markup Language
MVC	-	Model View Controller
UML	-	Unified Modelling Language
UAT	-	User Acceptance Testing
BBT	-	Black Box Testing
FR	-	Functional Requirement
NFR	-	Non-Functional Requirement
TC	-	Test Cases
ML	-	Machine Learning

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix A	GanttChart	47
Appendix B	Interview Question	48
Appendix C	System Requirement Specification	49
Appendix D	System Design Document	110
Appendix E	System Testing Document	126
Appendix F	Questionnaire of User Acceptance Testing	143

CHAPTER 1

INTRODUCTION

1.1 Introduction

In today's era security is one of the biggest issues. Specially for a university campus as big as Universiti Teknologi Malaysia. This university has the second largest campus in Malaysia with over 2700 acres of land with its campus. So, most of the people come and go out of the campus by using cars. No one knows who is getting in or out of the campus or what kind of people is going through the campus. Though the security guards check the vehicles on the gate but they are lazy and they don't check the vehicles properly. This system followed by the UTM authority has its advantages and disadvantages. Most of them are disadvantages as they do not know who is the driver or the person inside the vehicle.

So, to make it easy, flexible and secured a mobile application for recognizing the number plate of vehicle called Vehicle Number Plate Recognition System is the best way. The guards can see who is going in and who is going out with what vehicle, the system will also show the date, time and the gate number by which the vehicle entered and by which gate the vehicle went out.

1.2 Problem Background

The problem of the current system is that the guard need to manually check who is getting in and going out. The system is very lengthy and the guards do not perform their job properly. When it's time for classes, a long queue is created while getting into the campus. This makes a lot of students and lecturers late for their classes. The security of the vehicles is also compromised as the guards do not know if the driver has the same car while going out that he came inside in. One of Bangladeshi student lost his car from inside the campus.

This project emphasizes on solving these problems. Through this project, a much more convenient management system will be developed. This system will help the users to contribute on the security and the integrity of the campus area.

1.3 Project Goal

The aim of this project is to develop a mobile application to recognize the vehicle license plate number and store the relevant information in the database. The guard should have vehicle and owner relevant information and should be able to scan the license plate number of the vehicle. The admin should be able to ban vehicles from entering also the admin should be able to display all the relevant information in the application.

1.4 Project Objectives

The objectives of the project are:

- (a) To analyse and elicit the requirements of the Security Measures for Universiti Teknologi Malaysia campus area.
- (b) To design Vehicle Number Plate Recognition System and the database according to the needs of the Security Department of the Universiti Teknologi Malaysia.
- (c) To build a mobile application that can provide higher security aspect upon entering the university campus.
- (d) To test Vehicle Number Plate Recognition System based on the requirements outlined.

1.5 Project Scope

Listed below are the scopes of the Vehicle Number Plate Recognition application

- (e) This application is used for scanning the license plate number of the vehicles coming inside the university campus.
- (f) The application will record the date, time and the specific gate number the vehicle coming in and going out of the campus.
- (g) The application will save the vehicle number in the database with the information of the driver and owner of the vehicle

1.6 Project Importance

This project is very much important for UTM. The users will have access to the records of the vehicle entering into the campus. It will help the students and lecturer and also staffs of UTM to save time and energy. This project will be helpful for UTM authority in achieving a secured campus and time efficient security system.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter describes the literature review that is related to this project. The literature review is an important chapter as all the relevant knowledge that helps in better understanding in implementing the project is explained in this chapter. Furthermore, two existing system, related to this project is also discussed in the later parts of this chapter. Comparison between the two-existing mobile vehicle number plate recognition system are conducted to have a clear idea of the characteristics of the systems and generate some useful ideas in designing the system. Lastly, the technologies and tools that are used to develop this system such as flutter, firebase, Android, IOS and others are reviewed and explain under System Development Technologies.

2.2 Current Mobile License Plate Recognition System

Universiti Teknologi Malaysia (UTM) is an innovation led and graduate focused Research University. Currently, Universiti Teknologi Malaysia has two campuses, one is situated in the capital city, Kuala Lumpur, while another campus, which is the main campus of UTM located in Johor Bahru, Malaysia. The UTM Johor Bahru main campus consists of total 11 residential colleges which can supply accommodation for more than 15958 students. Currently, UTM does have any number plate recognition system in Johor Bahru campus but that is not online or digitalized. The aim of this project is to digitalize and improve this system to make it more convenient for the users to use. Currently, the system is manually processed and no one is allowed to enter into the campus after 10 pm. Due to this recent Corona pandemic the rules of the rules for entering and exiting the university campus has changed.

For this situation the students and the lecturers faced a lot of problems as the allocated time for entering and exiting from the campus is narrowed down to few hours. This project aims to make this service more convenient for the users.

2.3 Current System Analysis

This section introduces two existing systems which have similar features with the Vehicle Number Plate Recognition System (SCANU). They are Mobile LPR and Automatic License Plate Recognition Feature. The following subsections describe these two systems in details and furnish a comparison table between these two systems and Vehicle Number Plate Recognition System (SCANU).

2.3.1 Mobile System

Mobile LPR is a mobile software created by MAXSOFT. The rating on google app store for this product is 3.6 stars and it has over ten thousand downloads. This application is also available on App Store created by Apple which means this application is available for both android and IOS devices. This application was founded on February 2020.

MAXSOFT is an America based software company which has branches in Singapore and UK. MAXSOFT offers a range of services which uses the latest software solutions residing in the technological world. Their mission is to help the consumers achieve their dreams products at the lowest cost possible.

The main functions of the product Mobile LPR are scanning the number plate of the vehicle and viewing the history of records. This application also shows the position of the vehicle at a given point of time only if the vehicle has been integrated with GPS system produced by the company MAXSOFT. This product can only scan number plates those are based on America, Canada and Australia.



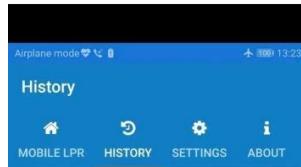
MAXSOFT

Selected license plate country format is:
United States
If you want to change the format, please go to Settings and choose different option from the list.



Start Scanning External Camera Scanning

Unlock All Paid Features



Q Type to search

DOFI1414, 1/5/2019 11:22:48 AM

B1574KH, 1/5/2019 10:20:24 AM

CA4399AB, 1/5/2019 10:20:18 AM

CA4399AB, 1/5/2019 10:19:17 AM

B1574KH, 1/5/2019 10:19:14 AM

CA4399AB, 1/5/2019 9:54:28 AM



Figure 2.1: Home page and History Page of Mobile LRP

2.3.2 Automatic License Plate Recognition Feature

Automatic License Plate Recognition Feature application is created by GLiApps. The rating on the Google App Store of this product is 3.7. This product has over hundred thousand downloads. This application is not available for IOS devices. Automatic License Plate Recognition System was founded in July 24 2019.

GLiApp is a Romania Based company, they offer software products for mobile and web services. Their moto is “We love Coding and We are good at it”. They have in total of 7 products running in the market and 6 of them are only for android users.

The applications functionalities are scanning the license plate and storing it in database. This system can only scan number plates in the region of Europe and United States of America. This application can also read the license plate number from an image from the gallery and from the input by the camera.





Figure 2.2: Home screen and Input Image from Gallery Screen.

2.4 Comparison Between Systems

This section compares the two systems previously introduced, Mobile LPR and Automatic License Plate Recognition Feature (ALPRF). Basically, these systems have a similar core function that is scanning number plate. Yet, they too induce some special feature that distinct themselves from each other. The following table shows the features that are provided by each of the two systems.

Table 2.1 Comparison of Mobile LPR and Automatic License Plate Recognition Feature with Proposed Application VNPRS.

Features	Mobile LPR	ALPRF	VNPRS
Application Platform	Cross-Platform	Android	Android
Automated Method	Yes	No	Yes
Have Computerized Database	Yes	No	Yes
Ban Vehicle	No	No	Yes
Feedback	Yes	No	No
Latest information Update	Yes	Yes	Yes
Show Records	Yes	No	Yes
User Accessibility	Limited	Very Limited	Moderate
Integration with External Database	No	No	Yes
Vehicle Owner Information	No	No	Yes

In the comparison table, it is shown that, among these other systems, Mobile LPR is the only cross-platform license plate scanning app. The other is only based on Android platform. All of these systems share one key characteristic, this is the scanning process. None of the application provide feature to ban vehicles or put the vehicle in blacklist. Only Mobile LPR can view previous records. None of them shows the information about the vehicle owner. User accessibility is poor on both the applications. Not much functionalities can be carried out by the users. None of the application can integrate with external database and among them only Mobile LPR has computerized database. As only Mobile LPR has a digital database, so only Mobile LPR has automated method for scanning.

Vehicle Number Plate Recognition system aims to provide both the services that these systems are currently providing along with the services that they are not

providing such as integration with external database, Vehicle owner info and Ban vehicles.

2.5 System Development Related Technologies

The world is evolving every single day. New technologies are being created by us every now and then. It is best for us to keep ourselves update with the pace that the generation soaring through. Therefore, technology study has been made to choose the best choice of technologies needed for this project to keep pace with the development of time and technology.

The following section are discussing about the technologies that are used to develop the Vehicle Number Plate Scanning System. They are being detailed out in the following parts.

2.5.1 Android

Android is an operating system based on the Linux kernel and the Android Open-Source Project (AOSP) which is led by Google is responsible for developing the Android OS. Android is the most popular mobile OS in the world as it is used by more than a billion phones and tablets all around the world. Android work perfectly with all Google apps such as Gmail, Google Drive and YouTube because it is made by Google. The Android system supports background processing and provides a rich user interface library that supports 2D and 3D graphics using short OpenGL standard and grants access to the file system. The Android system is made from a full software stack and it is divided into four different levels which are Applications, Application framework, Libraries & Runtimes and Linux Kernel.

In Application level, the AOSP contains several default applications such as Browser, Music, Phone and others. An API that allows high-level interactions with the

Android system for an Android application is contained in Application Framework level. While for the Libraries & Runtime, they are on the same level and it provides the libraries for many common functions of the Application Framework and the Dalvik runtime, as well as the core Java libraries for running Android application. The Linux kernel is the last level and it serve as communication layer for the hardware. The developers are working with the libraries and the runtime level most of the time in the process of developing android application.

The latest Android Operating System, the Android 10 version has provided the most stable operating system to power up most of the Smartphone an offering more feature at the same time to provide better user and android 10 was released on 3rd September 2019. This time android did not come up with a dessert name to continue the legacy.

2.5.2 iOS

The iOS is a mobile operating system produced, developed and programmed exclusively by Apple Inc. This operating system only operates in the company-made computers, such as iPad, iPhone and iPod. In reality, the iOS user interface is based on multi-touch gestures (uses more than 1 finger touch) and direct manipulation. Interface control elements are composed of all the elements we find in other devices. OS interaction involves gestures like click, press, pinch, and reverse pinch, all of which have different meanings in the iOS operating system sense and its multi-touch interface. Many applications use internal accelerometers to respond to system shaking (one common result is the undo command) Or rotate it in three dimensions (switching between portrait and landscape mode is one common result). Apple has been widely praised for integrating robust accessibility features into the iOS, allowing people with visual and hearing disabilities to use their devices properly. Major versions of iOS are released annually. The current version, iOS 13, was released on June 3, 2019. It is available for all iOS devices with 64-bit processors; the iPhone 8 and later iPhone models, the iPad (2019), the iPad Air and later iPad Air models, all iPad Pro models, the iPad Mini 2 and later iPad Mini models, and the seventh-generation iPod Touch.

2.5.3 Dart

Dart is a client-optimized programming language for multiplatform applications. Google creates it and it is used to create smartphone, desktop, server, and web applications. Dart is a class based, object-oriented, garbage-collected language with C-style syntax. Dart can compile to either JavaScript or Native Code. It supports interfaces, mixes in, abstract classes, generics reified and category inference. Dart language is required to use Flutter to construct the Vehicle Number Plate Recognition Mobile application.

2.5.4 Flutter

Flutter is an open-source, Google built software development kit for UI. It is used for Android, iOS, Windows, Mac, Linux, Google Fuchsia and the web application development. Flutter applications are written in Dart language and take advantage of many of the more advanced features of the language. Flutter is required to build a mobile cross-platform framework, as it can easily combine mobile apps and databases for Vehicle Number Plate Recognition.

2.5.5 Python

Python is an interpreted, high-level, general-purpose programming language. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects. Python is dynamically typed and garbage-collected. It supports multiple programming paradigms, including structured (particularly, procedural), object-oriented, and functional programming.

2.5.6 Firebase ML KIT

ML Kit is a mobile machine learning system for developers launched on May 8, 2018, in beta during the Google I/O 2018. ML Kit APIs feature a variety of features including optical character recognition, detecting faces, scanning barcodes, labelling images and recognizing landmarks. ML Kit is needed for Vehicle Number Plate Recognition system to make the camera to recognize and differentiate every license plate.

2.5.7 Google (Cloud FireStore)

For storing data through an API, Cloud Firestore is used. It succeeded in the original database system created by Firebase itself. It also allows real-time database and also allows to store nested documents.

For storing data and linking to Vehicle Number Plate Recognition mobile application Cloud FireStore is needed.

2.6 Chapter Summary

In this chapter, the current process for checking the personnel coming in and going out of the UTM campus is explained and analysed to have a clearer vision of the playing standard and services currently provided. Likewise, two existing applications were also chosen that offering the similar feature as Vehicle Number Plate Recognition application to discuss and compare the similarities and differences of them. This can help in solving the problems that may arise from the Vehicle Number Plate Recognition application such as lacking of important features and characteristics. Furthermore, the technologies that are going to be used in the project and the importance of having them applied in the project are being explained.

In the following chapter, the Methodology chapter, the method employed to design, develop and testing the Vehicle Number Plate Recognition application is discussed and explained.

CHAPTER 3

SYSTEM DEVELOPMENT METHODOLOGY

3.1 Introduction

Methodology is a set of rules where unique procedures are extracted to explain or solve different problems. In this phase, agile method is used for expanding the new system. Phases in agile model are:

- Requirements
- Design
- Develop
- Test
- Deploy
- Review

3.2 Methodology Choice and Justification

Agile methodology is a form of project management system. Agile method able the client or stakeholder to make slight changes without creating a massive change for the system development. Its process involve division of tasks as the main purpose and its implementation can be repeated in the event of an error. Agile methodology is based on highest priority which has been provided for user participation from the beginning of the development cycle.

3.3 Agile Development Phase

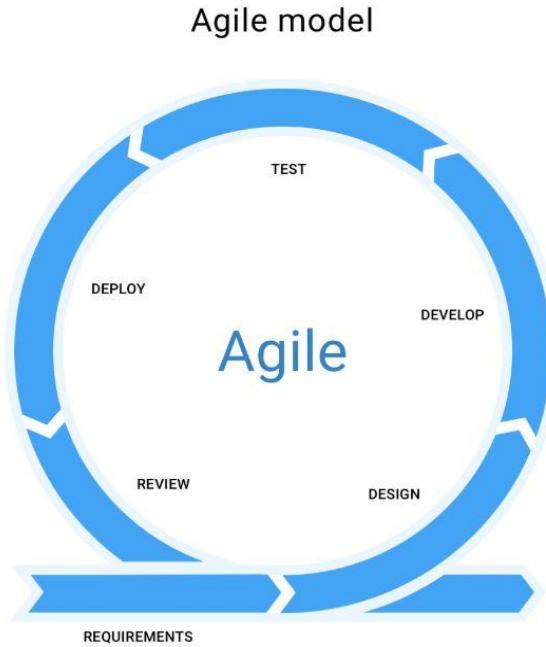


Figure 3.1: Agile Model

3.3.1 Requirements

In this phase, some researches regarding system that will be developed is merely important. Before start building, one thing that matter the most is planning and find a project title with the help of supervisor. After deciding the project title, elicitation of user requirements is needed. For system scope, developer need to decide user roles for using the system once the system has been developed. The importance of user requirements for Vehicle Number Plate Recognition System and how this system issued are described during this phase:

- a) Identify existing systems
- b) Identify project issues and solutions.
- c) Technologies that will be used to develop the system.

3.3.2 Design

After the requirement phase, Vehicle Number Plate Recognition System will be built with criteria based on problem to be faced. This system will be developed for management of security purposes. User interface design is built to show the system's functionality which is user friendly. Besides that, guards will use the mobile application of this system to manage the vehicles while they are entering or getting out of the campus. Next, to develop this system, developer need to design the UML diagrams to ensure Vehicle Number Plate Recognition System can be of use all the time and in an organized manner. Sequence diagram will show the sequence for each state of the system while activity diagram will display message for each state. Some of the functions in between starts of this system are:

- a) Guards can scan the license plate number of the vehicles.
- b) Guards and admin can add vehicle details and owner details.
- c) Guards and admin can save details in the database and system will validate the details referring to JPJ database.
- d) Admin can view and manage database.
- e) Admin can ban vehicles from entering.

3.3.3 Development

After design phase, developer need to develop the product of system in development phase. In this phase, it is about building code and creating the prototype. This phase will be done during Final Year Project 2.

Flutter will be used to build programming code and create the interface of the mobile application of Vehicle Number Plate Recognition System. Besides that, Cloud Firestore will be used to store data in the cloud as a database for this project. This database will link mobile application (Flutter). These actions will be taken in the process of development:

- a) Dart is used to develop mobile application of the system.
- b) Develop the functions of the mobile application.
- c) Connect Firebase with Flutter.
- d) Build the gate prototype with to link with camera from the mobile phone.
- e) Connect Firebase with System.
- f) Implement machine learning.

3.3.4 Testing

The aim of this phase is to ensure all requirements and objectives are fulfilled. If Vehicle Number Plate Recognition System have issues regarding the code, the steps can be repeated and do correction until it is functioning well. When using agile method, it is able to go back to problematic phase without going back to the earliest phase. Prototype will be used to ensure the system is developed well. Every error will be recorded and later, developer will ensure the program is in a stable state and functioning well. This matter will be taken into account to make sure the system is a quality system.

These are the outcome of this phase:

- a) Guard and admin can register vehicles using mobile application.
- b) The system validates the registered details.
- c) Vehicle(s) license plate number can be recognized by the gate prototype.
- d) Admin can change their vehicle status in the mobile application from approved to banned.
- e) Admin can view vehicle entry records using mobile application.
- g) Admin can change the details or the owner of the vehicle.
- h) Gate prototype can open and close responsively.

3.3.5 Deployment

The aim of this phase is to ensure all requirements and objectives are fulfilled and the product is deployed or it is given to the clients. If any of the requirement is left un-noticed then this phase can help fulfil the criteria.

These are the outcome of this phase:

- a) System is almost to the final stage.
- b) Clients can see the final product by running it.

3.3.6 Review

The aim of this phase is to ensure all requirements and objectives are fulfilled completely. The client can gather all the developers and reviewers in one place and let everybody check the system with different perspective from different reviewers.

3.4 Analysis of Hardware and Software Requirements

To ensure the continuity of system development process went smoothly and development goals achieved, analysis of hardware and software requirements is chosen after identify its specifications for the development of Vehicle Number Plate Recognition System.

3.5 Justification of Hardware and Software Used

Laptop will be used in the development process of Vehicle Number Plate Recognition System. Meanwhile, this system has a specific Android version and iOS version for the mobile application. Therefore, there are minimum specifications Android smartphone which is compatible to use the mobile application of the system. Detailed specifications for hardware and software used in this system are stated in part 3.6.

3.6 Hardware Requirements for System Development

Some hardware are required for the Development of this project. Below is a list of those required hardware:

i. Personal computer

Will be deliberately used for processing and testing of the system for the project development.

- **Operating System:** Windows 7 or above.
- **Processor:** 3.2 GHZ or above.
- **Ram:** 4 Gigabytes or above

ii. Android Smartphone

Will be used for testing the System on Google's android platform during project development.

- **Operating System:** Android 5 and above.
- **Processor:** 2.2 GHZ and above.
- **Ram:** 2 Gigabytes or above

3.7 Software Requirements

There three types of software used to develop Vehicle number plate recognition mobile application.

- a. Proto.io/Just in mind: Used for developing a prototype of the mobile application.
- b. Microsoft Visual Studio Code: Main and most important software used for developing the mobile application.
- c. Enterprise Architect: Used for designing models and documentation.

3.8 Chapter Summary

To summarize, Choosing the best methodology is a very crucial part in developing any project. It helps the developers to build a clear plan of the phases they will be going through. This chapter gave a brief description of the methodology that will be used for this project development and also the phases that the developers will be following. This chapter also gives a proper overview of the tool, software and hardware that will be used for the development of this project. In conclusion, Chapter 3, makes the process of this project development easy to understand and follow.

CHAPTER 4

REQUIREMENT ANALYSIS AND DESIGN

4.1 Introduction

Chapter 4 provides an overview of the design and architecture of the proposed Vehicle number plate recognition system. A commonly used modelling language, UML (Unified Modelling Language) is used for providing a thorough design illustration. In addition to that, for detailed explanation some diagrams will also be encompassed in this chapter. These diagrams will be comprised of Activity, Use case and Sequence diagrams.

A significant role is played by Requirement analysis and design for assuring that the proposed system is being developed following the requirements of the clients or stakeholders. The requirements from them are elicited and archived in detail to ensure that nothing is ignored. These means are vital, keeping in mind that the end goal is to develop a system that fulfils the client's needs.

4.2 Requirement Analysis

Requirement analysis is the procedure in which the requirements are resolved and validated, that are expressed and concurred by the stakeholders. Two types of requirements are available, functional requirements and non-functional requirements.

4.2.1 Functional Requirement

Interactive requirements of the system are considered as the Functional requirements. It portrays the functions provided by the system.

4.2.1.1 Vehicle Number Plate Recognition System Use Case Diagram

Use case diagram shows the interaction between the proposed system and the users. Figure 4.1 illustrates the use case diagram of Vehicle number plate recognition system.

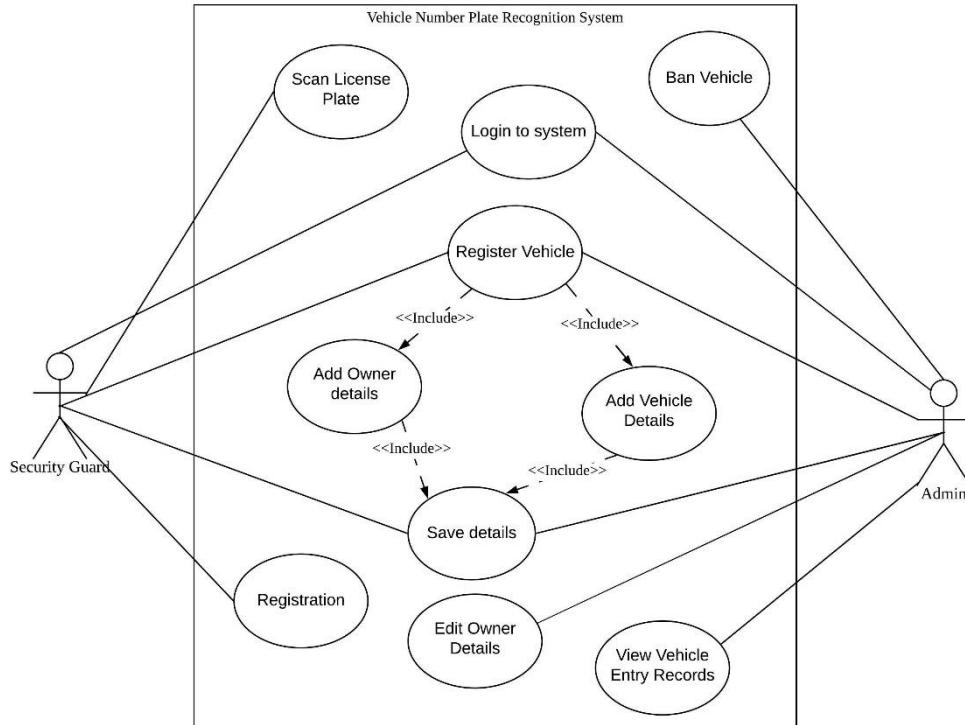


Figure 4.1: Use case diagram of Vehicle Number Plate Recognition System

4.2.1.2 Actor Description

There are 2 types of user or actors for Vehicle Number Plate Recognition System, which are Security Guard and admin. Both users can register and log into his profile. The guard can select Scan Vehicle and start scanning. Both actors can register vehicles and save vehicle and owner details into the database. The system validates the details entered. The admin can view Vehicle entry records, he can also ban vehicles from entering. The admin can also edit the vehicle owner's information or details in the application.

4.2.1.3 Vehicle Number Plate Recognition Use Case Description

There is total 9 use cases. And features of vehicle number plate recognition system are represented by these. Table 4.1 shows the use case descriptions.

Table 4.1: Use case description

Use case	Short Description
Log In	Allows user to log into their Vehicle number plate recognition account by entering their credentials.
Register	Allows user to register vehicles and owner to the system so that they can come and go whenever they want.
Scan Vehicles	Allows the guard to scan number plate of the vehicle.
Add Vehicle Details	Allows user to add the vehicles details.
Add Owner Details	Allows user to add the owner details.
Edit Owner Details	Allows the admin to edit and update owner details.
Save details	Allows the user to save details in database, which is validated by the system.
View Vehicle entry records	Allows the admin to view Vehicle entry records.
Ban Vehicles	Allows the admin to ban vehicles from entering into the campus.
Register Guard	The guard can register to the system using register button.

4.2.1.4 Scan Vehicles Activity Diagram

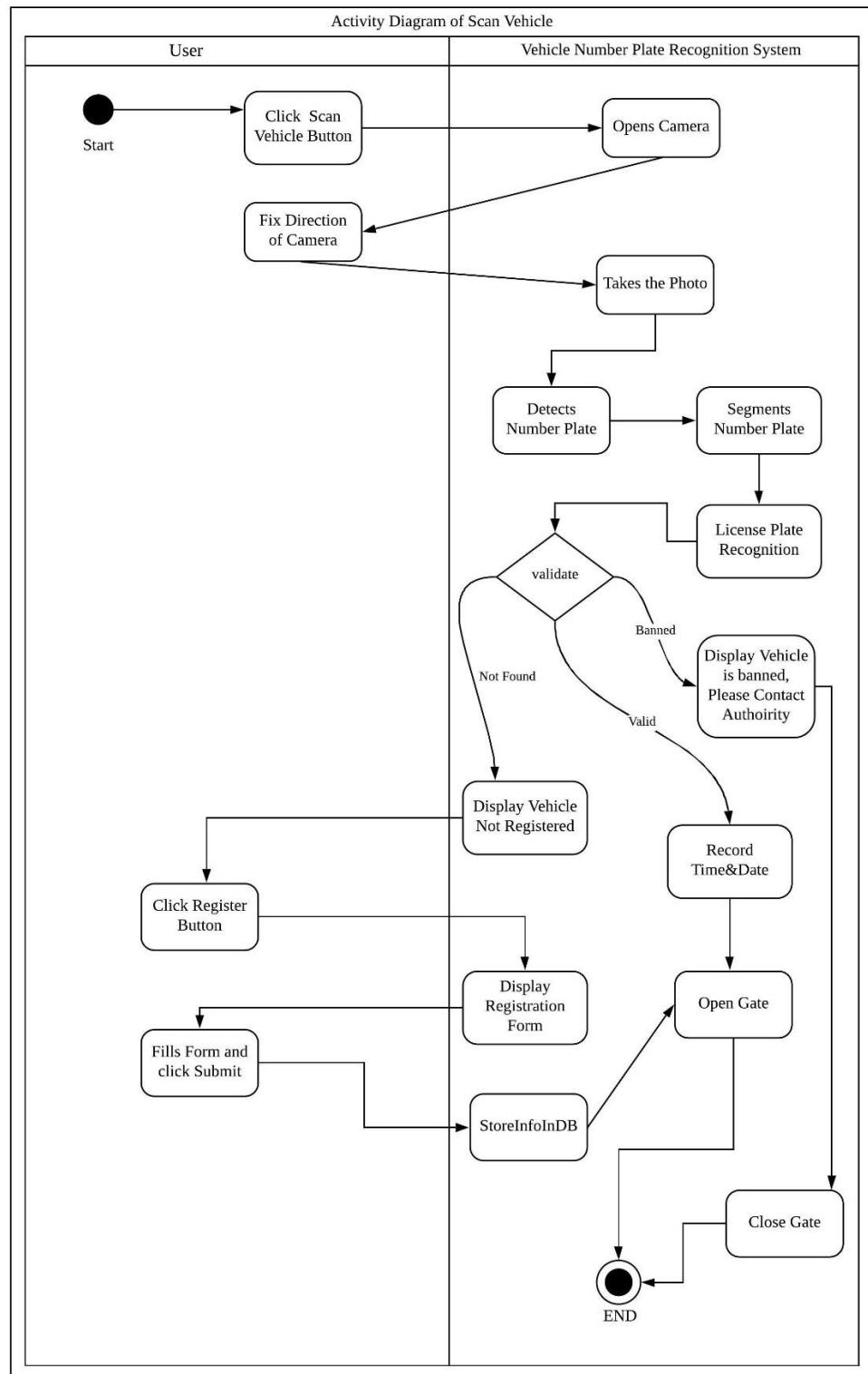


Figure 4.2: Scan Vehicle activity diagram.

The activity starts when the guards click on Scan Vehicle. The system opens the camera. The Guard just need to point the camera on the right direction the system will take picture. After taking the picture the system analyses the picture and localizes the number plate. Then the system segments the number plate into single letters or number. Then the image is converted in grey scale and the numbers are recognized. If the vehicle number is not registered in the system, then the system tells the user to register the vehicle. If the vehicle is registered in the system, then the gate opens. If the vehicle is banned by the admin, then the system tells the user to contact authorities and take necessary actions.

4.2.1.5 Scan Vehicle Sequence Diagram

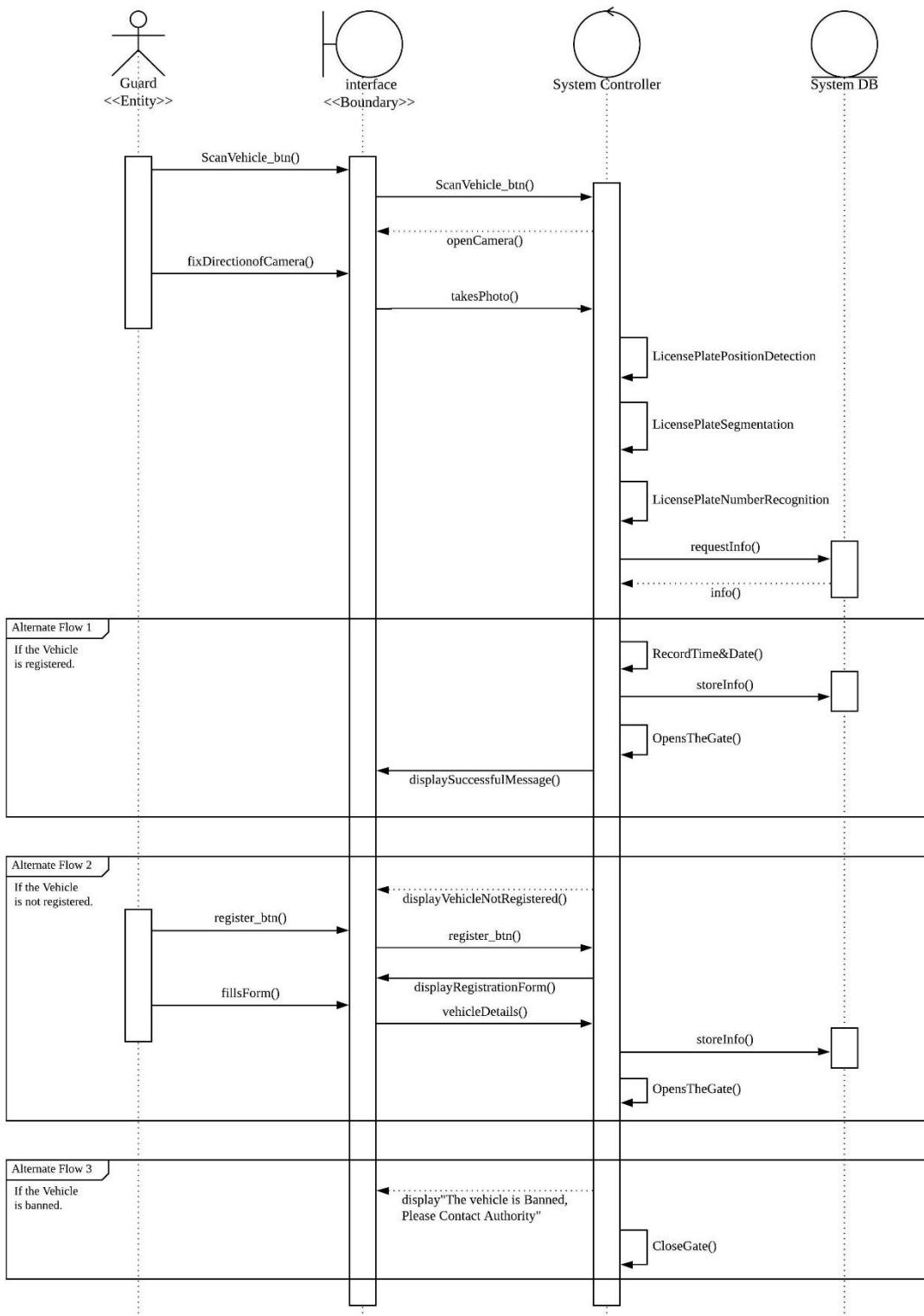


Figure 4.3: Scan Vehicle sequence diagram

4.2.2 Non-functional requirement

Non-functional requirement depicts how the system does the process. The non-functional requirements of Vehicle Number Plate Recognition System are:

4.2.2.1 Performance

Vehicle Number Plate Recognition System needs to have very good performance. To measure performance, the time it takes to complete a command successfully is detected. The lesser the time the better the performance.

4.2.2.2 Reliability

Vehicle Number Plate Recognition System needs to have reliability. The data transfer protocols should be safe so that the data does not leak. The database should be secured as JPJ database information will be stored in system database

4.2.2.3 Usability

End user satisfaction is a very important part. The system should be user friendly and easy to use. It should not be complicated.

4.2.2.4 Maintainability

Vehicle Number Plate Recognition System will have small and frequent update which will be easier to maintain.

4.2.2.5 Security

As this Vehicle Number Plate Recognition System is for security system, the security should be very good. The integrity of the software should be top notch. Guard should not be able to enter as admin.

4.3 System Architecture Design

For the Vehicle Number Plate Recognition System architecture design, MVC architecture is chosen to be the most suitable one.

Model View Controller (MVC) is one of the software architectural patterns, commonly used to implement the screens of the application or the interfaces of the user. A popular choice for developing applications. Normally, it separates the system's logic into three separate parts, which helps increase the reusability of the product. All the parts interact with each other. Differentiating each iteration is easy. The model part defines what the application should have. The view is notified if any changes in state are being made in the model. The model also changes the controller if an updated view is required for different logic. The view describes how the interfaces will be.

The Figure below briefly illustrates MVC architecture.

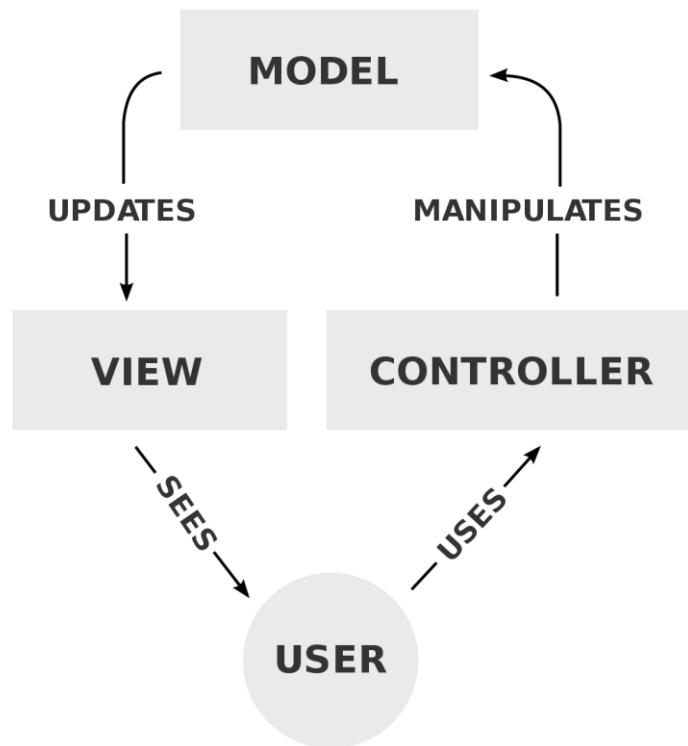


Figure 4.4 : An overview of MVC architecture

4.4 System Class Diagram

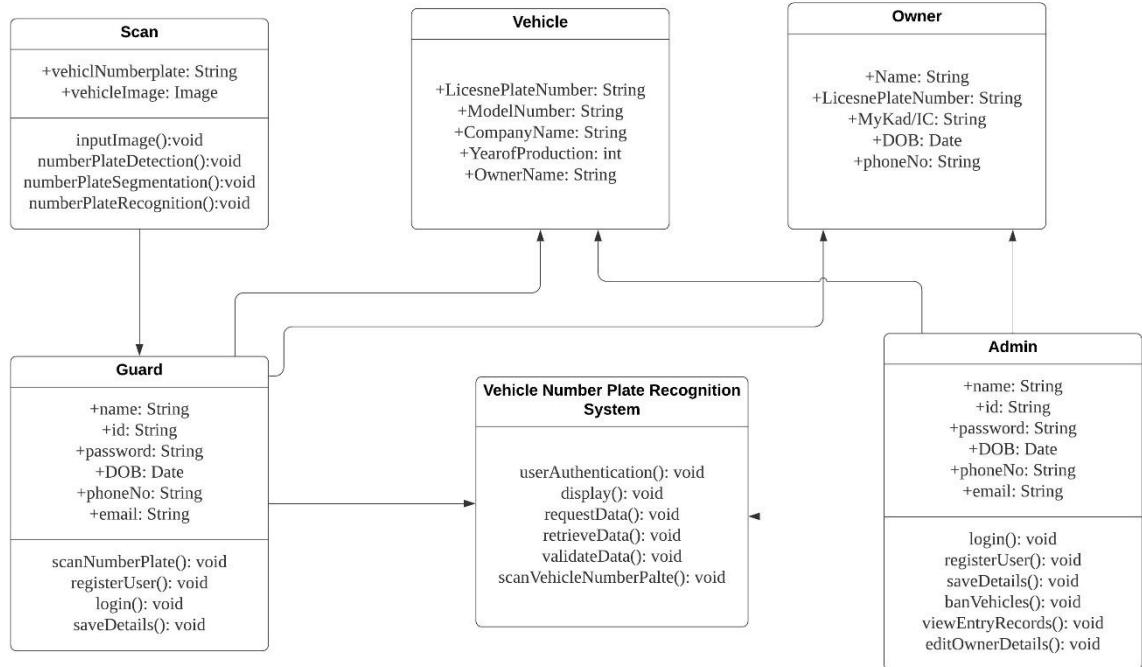


Fig 4.5: Class diagram of Vehicle Number Plate Recognition System

This class diagram shows the how each of the classes are related to each other and what functions or methods they have and what attributes they have.

4.5 System Database Design

Vehicle Number Plate Recognition System used NoSQL database called firebase. This is a google cloud based real-time database and the figure shows the collection of key value pair used for the VNPRS.

Owner		Vehicle	
Key	Value	Key	Value
plateno:	_plateno	ban:	_banned
owner:	_owner	banvalue:	_banval
dob:	_dob	comname:	_comno
icno:	_icno	modelno:	_modelno
phone:	_phone	owner:	_owner

Entry Records		Guards	
Key	Value	Key	Value
entrytime:	time	uid:	id
owner:	owner	name:	name
pass:	entry/exit	email:	email
plateno:	plateno	password:	password
scannedby:	guardname	designation:	designation
		phone:	phone

Admin	
Key	Value
uid:	id
name:	name
email:	email
password:	password

Figure 4.6: Collection of key value for Firebase used in VNPRS

4.6 System Interface Design

A good and simple interface design is very important for system development as the users are going to have interaction with it. A nice and simple interface is all those users want. IF the system is complicated to interact, then user's requirement will not be fulfilled. With a good interface design, users learn the system easily and quickly. The system interface should not be confusing to the users, it will create a bad

impression on user's mind. Figure below shows the interface of Vehicle Number Plate Recognition System.

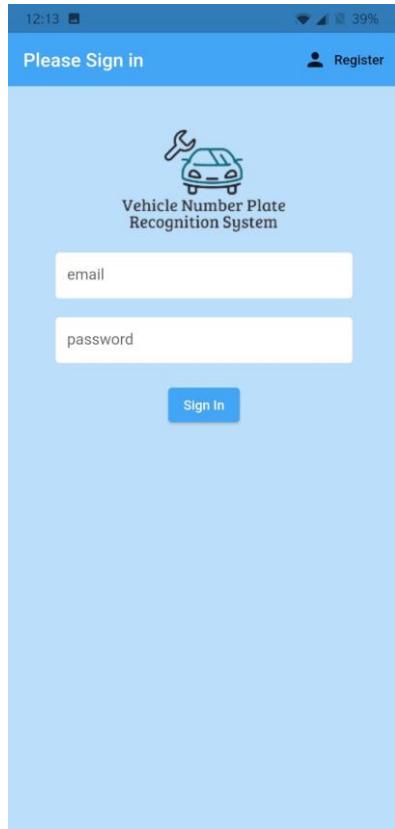


Figure 4.7: Login Screen

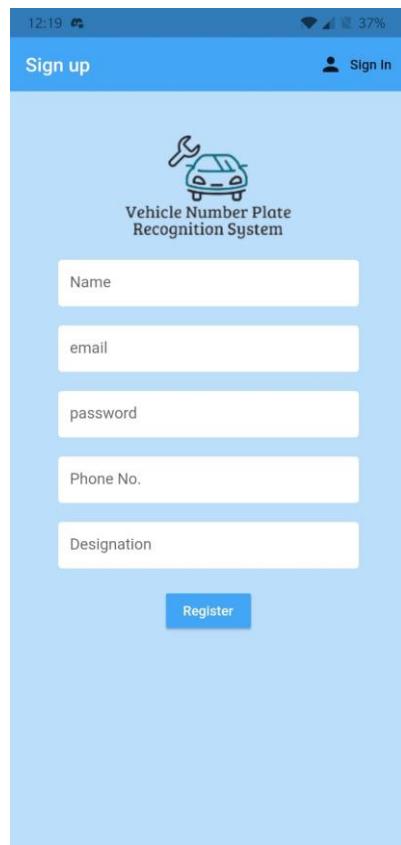


Figure 4.8: Sign-Up Screen

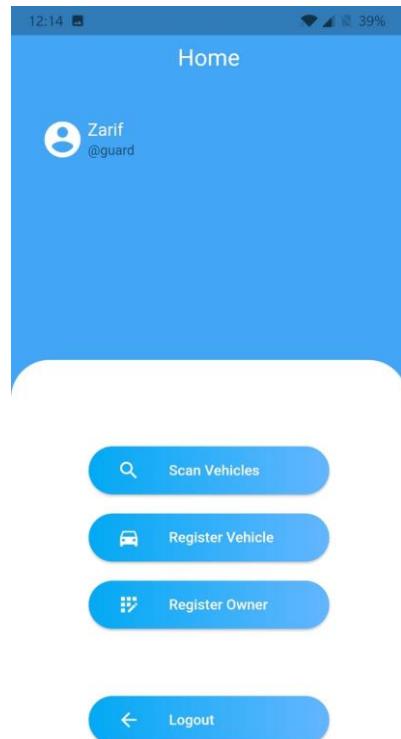


Figure 4.9: Guard Home Screen

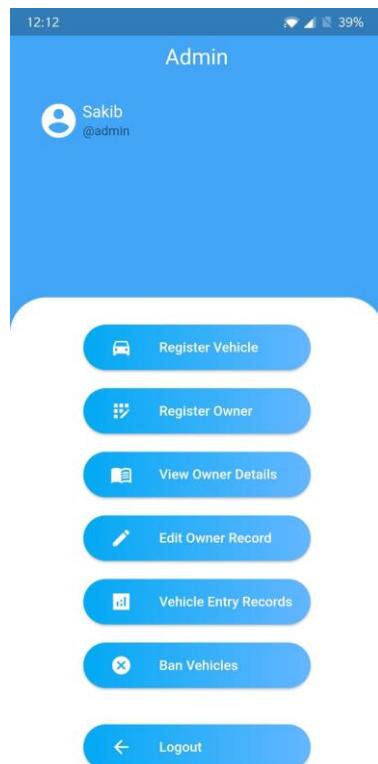


Figure 4.10: Admin Home Screen

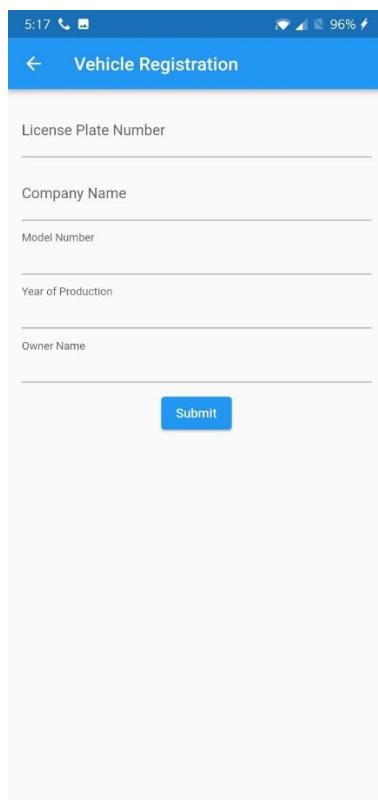


Figure 4.11: Register Vehicle Screen

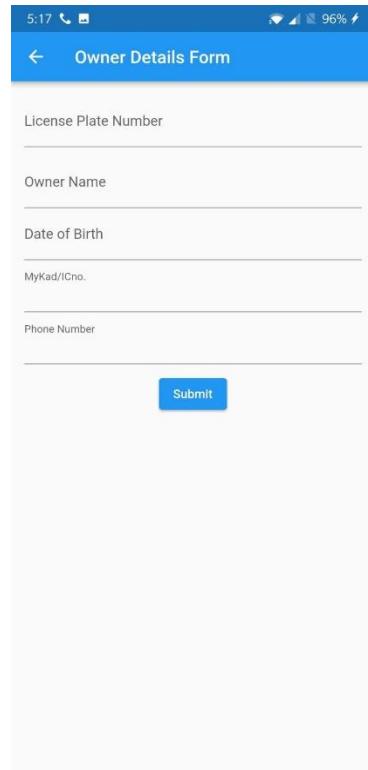


Figure 4.12: Register Owner Screen



Figure 4.13: Ban Vehicle Screen

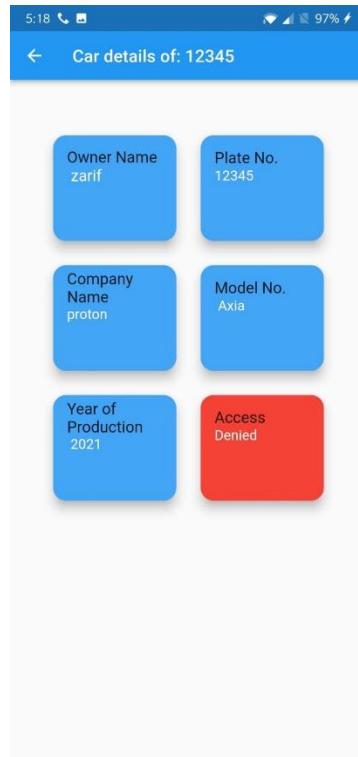


Figure 4.14: View Vehicle Details Screen



Figure 4.15: View Owner Details Screen

4.7 Test Case Design

Table 4.2 Test case

Test Case ID	Test case Scenario	Test Data	Steps	Expected Result	Pass/Fail
TC001	Check user login with valid data	Username: user1 Password: user@123	i) Opens the application. ii) Enter user ID iii) Enter Password iv) Click Login	The user logsins successfully	Pass
TC002	Check user login with invalid data	Username: user1 Password: user@123	i. Opens the application. ii. Enter user ID iii. Enter wrong Password iv. Click Login	The system displays Login is unsuccessful. Incorrect password	Pass
TC003	Check if the user can scan the number plate	License plate number	i) Opens application ii) Click Scan vehicle	The system takes picture of the vehicle and can successfully recognize number plate	Pass
TC004	Check if the correct number plate is detected	License Plate number	i. Opens application ii. Click Scan vehicle	The system takes picture of the vehicle and can successfully recognize the correct number plate	Pass
TC005	Check if the user can register a new vehicle	License Plate number, owner name, model number etc.	i) Click Register Vehicle. ii) Fills up registration form with vehicle data. iii) Click Submit	The system displays Vehicle is successfully registered	Pass
TC006	Check if the user can register a	License Plate number, owner	i. Click Register Vehicle	The system displays Vehicle is	Pass

	vehicle which is already registered	name, model number etc.	ii. Fills up registration form with vehicle data iii. Click Submit	already registered	
TC007	Check if the admin can edit owner details	Vehicle license number, name, phone number etc.	i) Click Edit owner details ii) Fills up the owner details form iii) Click Submit	The system display Owner Details Updated successfully	Pass
TC008	Check if the admin can ban vehicles	License plate number, owner name, owner IC number	i. Click ban vehicles ii. Fill up the form iii. Click Submit	The system displays the Vehicle is Banned Successfully	Pass
TC009	Check if the user can add owner details	Name, IC no, Phone number, vehicle license plate number, DOB	i) Click Add owner Details ii) Fill up the form with owner data. iii) Click Submit	The system display Owner Details Added successfully	Pass
TC010	Check if the admin can view vehicle entry records.		i. Click View Entry Records	The system displays the vehicle entry records	Pass
TC011	Check if the admin can view banned vehicle		i) Click View Banned Vehicles	The system displays the banned vehicle records	Pass

4.8 Chapter Summary

This chapter has thoroughly discussed the requirement analysis and the design phase of Vehicle Number Plate Recognition System. Furthermore, a brief overview of system architecture, database design, system user interface and test cases are also included in Chapter 4.

CHAPTER 5

SYSTEM IMPLEMENTATION AND TESTING

5.1 Introduction

The goal of this chapter is to explain how a vehicle number plate recognition system is implemented and tested. This chapter will also cover the system's development environment as well as the specifics of system development. In addition, black box testing will be conducted to evaluate the system's functioning without peeping into the internal design of the Vehicle number plate recognition system. User acceptance testing (UAT) is another type of testing that is done to assess the system's usability from the perspective of the user.

5.2 System Implementation

The process of defining how the proposed system should be created is known as system implementation. The process of system realization utilizing programming codes has been completed in this phase. Vehicle Number Plate Recognition System is created with the use of proper tools, logical frameworks, and technology. Following that, the verification and validation procedure was carried out to guarantee that the developed system satisfied the specific criteria.

5.2.1 Development Environment

Development environment is referring to a set of processes and programming tools used to develop, test and debug a system.

5.2.1.1 Visual Studio Code

Microsoft Visual Code is chosen as a viable programming environment for the Vehicle Number Plate Recognition System. Microsoft Visual Code is a small yet effective source code editor from the company Microsoft. Code snippets, integrated version control (Built-in Git), IntelliSense, source code refactoring, and syntax highlighting are all supported. Developers can use Visual Studio Code to modify code in a variety of programming languages, including Typescript, HTML, CSS, C#, Python, and others.

In general, Visual Studio Code allows developers to practice and learn basic commands fast and efficiently. However, if complex programming is required, there are other expertise features available. As a result, Visual Studio Code is the best tool for creating a Vehicle Number Plate Recognition System. The interface visual studio code for the Vehicle Number Plate Recognition System is shown in Figure 5.1.

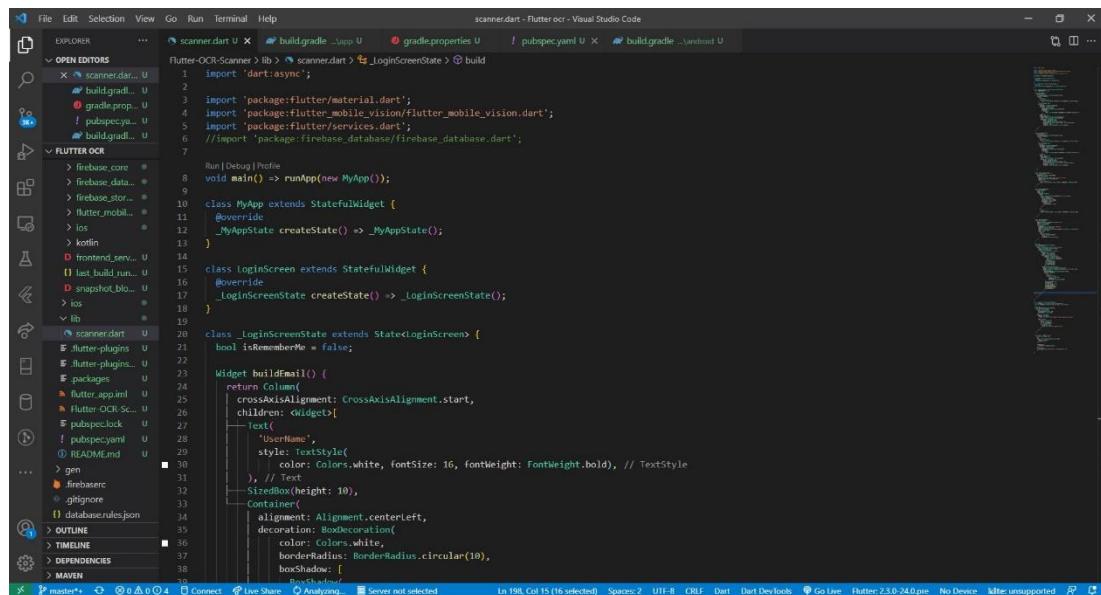


Figure 5.1: Interface of Visual Studio Code

5.2.2 System Development

Database development, user interface development, and system architecture development (Model-View-Controller) are all part of the Vehicle Number Plate Recognition System's architecture and requirement design (MVC).

5.2.2.1 Database Development

The database used to store data in the Vehicle Number Plate Recognition System is Google's Firebase Service, a cloud database service. The Firebase Realtime Database and Firebase Cloud Storage services are used in the Vehicle Number Plate Recognition System. Developers can use Firebase Realtime Database to store and sync system data with a NoSQL cloud database. Data is stored and synchronized in real time so that all connected users can access it. Firebase Cloud Storage is a feature that allows developers to store user-generated information such as photographs and videos. Users can execute CRUD (Create, Read, Update, and Delete) operations using the Firebase service, which has been integrated into the Vehicle Number Plate Recognition System. The interface of the Firebase Realtime Database utilized in the Vehicle Number Plate Recognition System is shown in Figure 5.2.

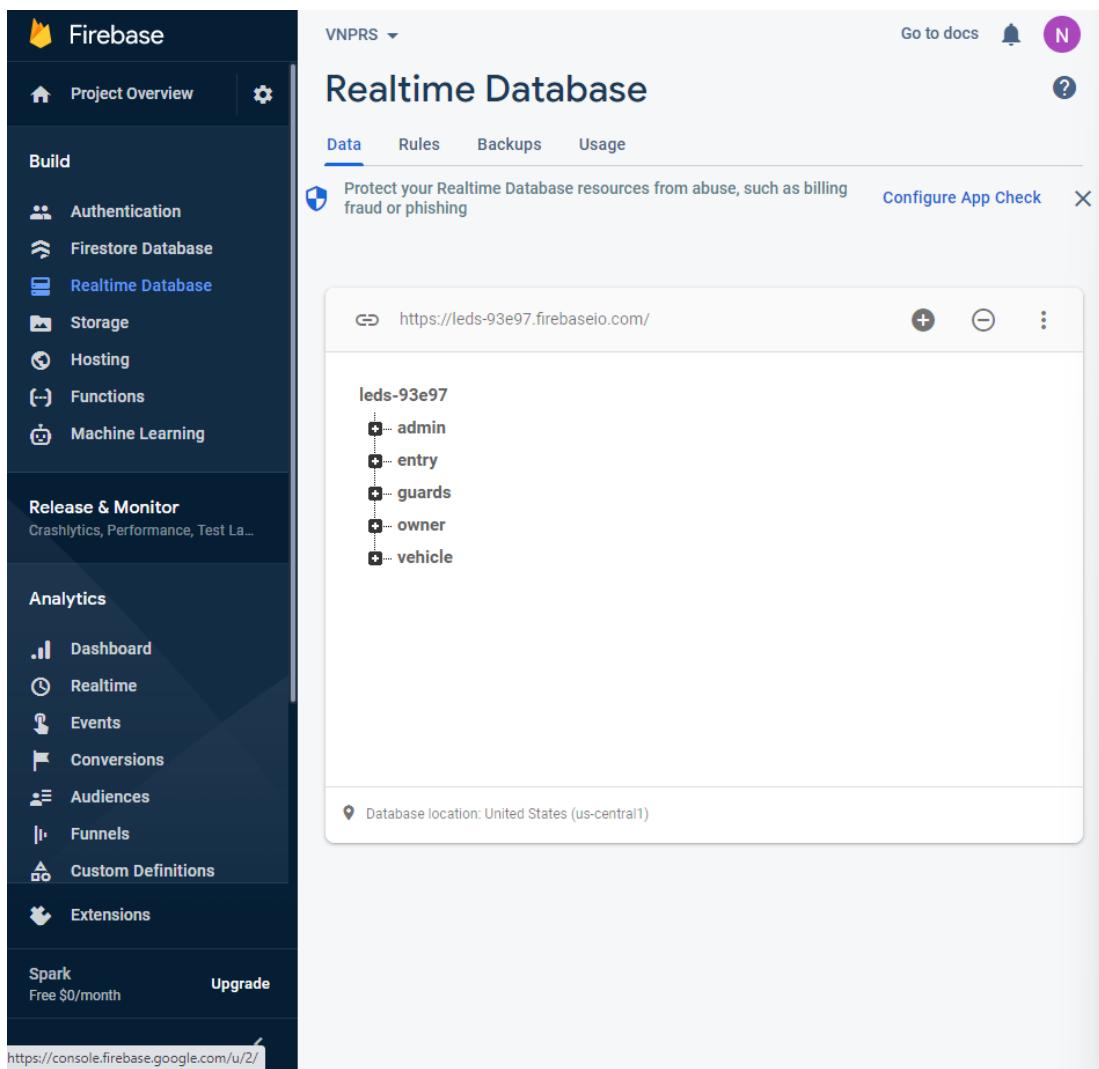


Figure 5.2: Interface of Firebase Realtime Database

5.2.2.2 User Interface Development

The visual arrangement that allows users to engage with the system application is referred to as user interface design. As a result, in order to maximize user engagement with the proposed system, the user interface must be designed in an interactive manner. Furthermore, the usefulness of the user interface elements should not be overlooked. As a result, user interface design is critical since it affects the system's usability and user experience. Flutter Framework is used to create user interfaces for the Vehicle Number Plate Recognition System. The designed user interfaces are multiplatform, including Android. The Flutter code for designing user interfaces is shown in Figure 5.3.

```

155  @override
156  Widget build(BuildContext context) {
157    return Scaffold(
158      body: AnnotatedRegion<SystemUiOverlayStyle>(
159        value: SystemUiOverlayStyle.light,
160        child: GestureDetector(
161          child: Stack(children: <Widget>[
162            Container(
163              height: double.infinity,
164              width: double.infinity,
165              decoration: BoxDecoration(
166                gradient: LinearGradient(
167                  begin: Alignment.topCenter,
168                  end: Alignment.bottomCenter,
169                  colors: [
170                    Color(0x665ac18e),
171                    Color(0x995ac18e),
172                    Color(0xcc5ac18e),
173                    Color(0xffff5ac18e),
174                  ]), // LinearGradient // BoxDecoration
175              child: SingleChildScrollView(
176                physics: AlwaysScrollableScrollPhysics(),
177                padding: EdgeInsets.symmetric(horizontal: 25, vertical: 120),
178                child: Column(
179                  mainAxisAlignment: MainAxisAlignment.center,
180                  children: <Widget>[
181                    Text(
182                      'Sign In',
183                      style: TextStyle(
184                        color: Colors.white,
185                        fontSize: 40,
186                        fontWeight: FontWeight.bold), // TextStyle
187                    ), // Text
188                    SizedBox(height: 50),
189                    buildEmail(),
190                    SizedBox(height: 20),
191                    buildPassword(),
192                    buildForgotPassBtn(),
193                    buildRememberCb(),
194                    buildLoginBtn()
195                  ],
196                ),
197              ),
198            ],
199          ),
200        ),
201      ),
202    );
203  }

```

Figure 5.3: Flutter code for User Interface

5.3 System Testing

Testing is essential to ensure that the system offered is of high quality and that potential users are satisfied. Testing is a required step prior to deployment in order to correct and debug any flaws or errors discovered during testing. As a result, two types of testing are carried out during the development of the Vehicle Number Plate Recognition System: black box testing and user acceptance testing.

5.3.1 Black Box Testing

Black box testing, also known as behavioral testing, is used to guarantee that each behavior input is translated into an accurate output by the system. Only inputs and outputs must be targeted during Black Box Testing, with no regard for the internal design of the Vehicle Number Plate Recognition System. Black box testing not only allows for a seamless system implementation, but it also aids the developer in identifying any inconsistencies or flaws in functional specifications.

To begin, use cases are used to create test scenarios that include valid or incorrect input, an execution path, and expected output. Following the execution of

test cases, the actual and expected outputs are compared in order to find errors. Refer to STD in Appendix E for more information on the Vehicle Number Plate Recognition System test case design.

5.3.2 User Acceptance Testing

The final stage of the software testing process is User Acceptance Testing (UAT). This approach allows possible end users to test the system in real-world circumstances to confirm that it performs as expected. UAT is used in the Vehicle Number Plate Recognition System to test the system's functionality and usability. Participants with expert knowledge of the system were involved in UAT testing. The participants were given a questionnaire to fill out in order to obtain feedback and thoughts on the usability of the produced system. The questionnaires include a five-point scale for assessing agreement on the usability of use cases as well as open-ended questions. For the sample of questionnaire, refer to Appendix F.

5.4 Chapter Summary

During the development of the Vehicle Number Plate Recognition System, software testing was carried out to guarantee that all functional and non-functional requirements were met. Testing is an important process that verifies system requirements and validates system requirements. Before releasing the Vehicle Number Plate Recognition System to the public, software testing helps to improve its overall quality. As a result, testing for the Vehicle Number Plate Recognition System includes Black Box Testing and User Acceptance Testing (UAT).

CHAPTER 6

CONCLUSION

6.1 Introduction

This chapter discusses about the result and the achievements that has been obtained through out the development and implementation process. The after the implementation of this project the mobile application vehicle Number Plate Recognition System is a success and it is assured that all the requirements have been fulfilled that were described in PSM 1, moreover some new features have been added while the implementation process in PSM 2. The application is stable in android platform and the functional requirements can be carried out flawlessly.

6.2 Review of PSM 2 Achievement

There are four objectives were defined during Project. The result and achievement of Vehicle Number Plate Recognition System are stated as below with the respect of those objectives.

i. To elicit the specific requirements for the proposed Vehicle Number Plate Recognition System.

An elicitation workshop with developers and stakeholders elicits the requirements for the Vehicle Number Plate Recognition System mobile application. The Vehicle Number Plate Recognition System's precise requirements are mentioned in the previous Chapter.

ii. To design the related architectural models for the Vehicle Number Plate Recognition System.

The relevant architectural models for the Vehicle Number Plate Recognition System mobile application include use case diagrams, use case descriptions, sequence diagrams, activity diagrams, system architecture diagram, class diagram,

and entity relationship diagram. Those diagrams can be found in the preceding Chapters.

iii. To develop Vehicle Number Plate Recognition System based on the elicited requirements and designed models.

During Project 2, the development of a Vehicle Number Plate Recognition System is carried out based on the elicited requirements and design models. The Vehicle Number Plate Recognition System is built on real equipment and stores information in a cloud database. The Android-only version of the Vehicle Number Plate Recognition System is now available.

iv. To test the Vehicle Number Plate Recognition System using suitable testing techniques including black box testing and user acceptance testing (UAT).

During Project 2, the Vehicle Number Plate Recognition System is tested, which comprises Black Box Testing and User Acceptance Testing. Testing verifies and validates the system's functional and non-functional requirements. With feedback and suggestions for system development, the overall performance of the Vehicle Number Plate Recognition System is positive.

6.3 Summary of PSM 2 planning and implementation

The development, implementation, and maintenance phases of Final Year Project 2 are all planned. The data from PSM1 will be used to construct a vehicle number plate recognition system. Because the Agile process is being used to construct this system, we will be able to spot the flaws in each sentence and correct them properly in Final Year Project 2.

This phase starts from the Chapter 5 where we describe the system implementation and testing where the development environments are described and the testing environments are given with the techniques that are used. Later in Chapter 6 a brief review of the development and implementation phase are given.

6.4 Conclusion

In summary, the construction of a Vehicle Number Plate Recognition system will be beneficial to students and society at UTM because there is now no effective technique for UTM security to keep track of vehicles within UTM. Using manual records takes a long time, and the records may become lost or obsolete as time passes. This method will aid in the tightening of security measures on campus. Overall, this method is an excellent way for UTM security to show off their strength while also keeping the vehicles that enter and exit the campus safe. As a result, Vehicle Number Plate Recognition has been a big success.

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- Teddy Surya Gunawan, Abdul Mutholib2, Mira Kartiwi, "Design of Automatic Number Plate Recognition on Android Smartphone Platform", Department of Electrical and Computer Engineering, Kulliyyah of Engineering Department of Information Systems, Kulliyyah of ICT, International Islamic University Malaysia
- <https://play.google.com/store/apps/details?id=com.maxsoft.mobilelpr&hl=en>
- https://play.google.com/store/apps/details?id=ro.gliapps.alpr_feature&hl=en

Appendix A

PSM1 Gantt Chart

Stage	Final Year Project 1 (FYP 1)																									
	Weeks																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
1	FYP1 briefing & Research Methodology	■																								
2	Select supervisors and projects	■	■	■																						
3	Meeting with SV to get advices and feedbacks on the topic & project planning	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
4	Submit project proposal form			■	■																					
5	Proposal Results					■	■	■																		
6	Initial Report Writing Preparation (collecting data)								■	■	■															
5	SRS Report Writing										■															
6	SDD Report Writing											■														
7	STD Report Writing												■													
8	PSM Chapter 1 and 2 Writing													■												
11	PSM Chapter 3 Writing														■											
12	PSM Chapter 4 and 5 Writing															■										
13	Compilation of PSM1																							■		
14	Feedback from Supervisor																							■		
15	Review and submission of report																							■		

Appendix B

Interview Questions

Question	Motivation Actor / task	Answers
i) Approximately how many cars go in and out of campus daily?	FR	Hundreds
ii) Approximately how much time is spent in checking process or verification process per car?	NFR	1.5 to 2 minutes
iii) Does it usually occur that somebody did some bad occurrence and get away with it?	NFR	Sometimes bad things happen inside the campus and the person who did it get away but later we get to know that a car like this was involved in a hit and run
iv) Is it important to keep the vehicle details as well as owner or driver details as records?	FR	As we do the verification process manually, so keeping all those details from every car will take a long time but yes, I think it's important
v) How easy would it be to you if an online automated system is created for the verification process while entering inside the campus?	NFR	It will save a lot of time so I think it will be easy as its not time consuming
vi) How do you keep records of the vehicle entering into the campus?	FR	Usually we just see the student card or if it a staff then they usually have a sticker on the vehicle so let them go. But at night after 12am we tell the passengers to scan the qr code.

Appendix C
System Requirements Specification

TABLE OF CONTENTS

1	Introduction	81
1.1	Purpose	81
1.2	Scope	81
1.3	Definitions, Acronyms and Abbreviations	82
1.4	References	82
1.5	Overview	82
2	Overall Description	83
2.1	Product Perspective	83
2.2	Product Functions	83
2.2.1	Register Vehicle	
2.2.2	Login to System	
2.2.3	Scan License Plate	
2.2.4	Add Owner Details	
2.2.5	Add Vehicle Details	
2.2.6	Save Details	
2.2.7	Edit Owner Details	
2.2.8	Ban Vehicles	
2.2.9	View Vehicle Entry Records	
2.3	User Characteristic	84
2.3.1	The Admin	
2.3.2	The Security Guard	
2.4	Constraints	85
2.5	Assumption and Dependencies	86
2.5.1	Assumptions	
2.5.2	Dependencies	
3	Specific Requirements	87
3.1	External Interface Requirements	87
3.1.1	User Interfaces	87
3.1.2	Hardware Interfaces	87
3.1.3	Software Interfaces	88

3.1.4	Communication Interfaces	88
3.2	System Features	89
3.2.1	Module <Register Vehicle>	89
3.2.1.1	UC001: Use Case <Register Vehicle>	89
3.2.1.2	UC001: Sequence <Register Vehicle>	90
3.2.1.3	UC001: Activity <Register Vehicle>	91
3.2.2	Module <Login to System>	92
3.2.2.1	UC002: Use Case <Login to System>	92
3.2.2.2	UC002: Sequence<Login to System>	93
3.2.2.3	UC002: Activity <Login to System>	94
3.3	Non-Functional Requirements	117
3.3.1	Performance	117
3.3.2	Reliability	117
3.3.3	Usability	117
3.3.4	Maintainability	117
3.3.5	Security	117

1. Introduction

1.1 Purpose

Vehicle Number Plate Recognition system is a cross platform mobile application. Its target is to make the process of checking the vehicle entering into UTM easy. The sole purpose of this Software Requirement Specification (SRS) is to give a brief overview of the system's functional and non-functional requirements.

1.2 Scope

Listed below are the scopes of the Vehicle Number Plate Recognition application:

- This application is used for scanning the license plate number of the vehicles coming inside the university campus.
- The application will record the date, time and the specific gate number the vehicle coming in and going out of the campus.
- The application will save the vehicle number in the database with the information of the driver and owner of the vehicle.

1.3 Definitions, Acronyms and Abbreviation

UTM	Universiti Teknologi Malaysia
User	Security Guard or Admin
Authority	UTM Head OF Security or The Balai Police
ID	Identification number
UC	Use case
SRS	Software Requirement Specification
JPJ	Jabatan Pengangkutan Jalan
IOS	Mobile Devices by Apple Inc.
Android	Mobile Devices supported by google Android operation system.
System DB	Database used for storing information of this application.

1.4 References

"ProjectManagement.com - System Requirements Specification". Retrieved April 2016.

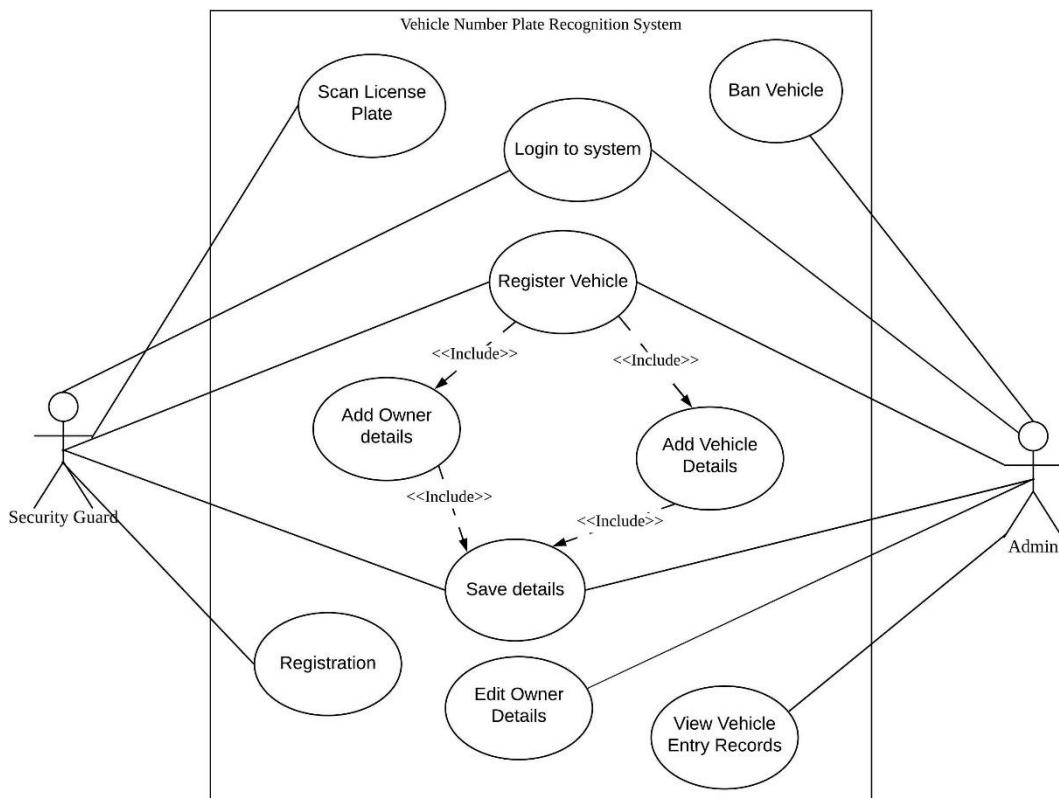
IEEE. IEEE Recommended Practice for Software Requirements Specifications. New York, NY: Institute of Electrical and Electronics Engineers, 1998.

Satzinger, J.W., Jackson, R.B., Burd, S.D.. (2010). *Systems Analysis and Design in a Changing World Fifth Edition*. Boston, MA: Course Technology. p. 238-254

L. Connie, C. Kim On, A. Patricia. (2018). *A Review of Automatic License Plate Recognition System in Mobile-based Platform*. Faculty of Environment, Society and Design, Lincoln University, Christchurch, New Zealand.

1.5 Overview

Figure below displays the use case diagram of Vehicle Number Plate Recognition application. The diagram contains 9 use cases explaining the functional requirements of the application. There are 2 actors involved with this mobile application. They are Security Guard and Admin of the system.



2 OVERALL DESCRIPTION

2.1 Product Perspective

Vehicle number plate recognition system is a mobile application system aimed to make the vehicle checking process faster and safer when entering the University campus. The system scans the vehicle number plate and store the details in the database. If the system finds a new vehicle the system asks the guard to register the driver or the owner into the system giving the details of the vehicle and the driver or the owner. The guard and admin can register new vehicles after login into the system. Only the admin can ban a vehicle from entering the campus.

2.2 Product Functions

The vehicle number plate recognition system has in total of 9 use cases. The description is as follows:

2.2.1 Register Vehicle:

This use case allows the admin or the security guard to register vehicles into the system so that when the vehicle comes into the campus the gate will automatically open.

2.2.2 Login to System:

This use case allows the admin or the security guard to login to the system.

2.2.3 Scan License Plate:

This use case allows the system to scan the vehicle number plate. The system first takes the image input from the camera, then the License plate position is detected, then the License plate is segmented into different letters in the plate and lastly the Licenser plate number is recognised.

2.2.4 Add Owner Details:

This use case allows the security guard or the admin of the system to add the owner information of the vehicle into the system.

2.2.5 Add Vehicle Details:

This use case allows the security guard or the admin of the system to add the vehicle information into the system.

2.2.6 Save Details:

This use case allows the security guard or the admin to save the information of the vehicle and the owner of the vehicle into the database.

2.2.7 Edit Owner Details:

This use case allows the admin to edit or change the owner details of the vehicle if the vehicle has a different owner this time.

2.2.8 Ban Vehicle:

This use case allows the admin to ban or blacklist vehicles into the campus. This measure is taken for security purpose. The admin can take the Blacklisted vehicles from the JPJ database and register them in banned Vehicles so that when any of the vehicles arrives in the campus the system can detect it.

2.2.9 View Vehicle Entry Records:

This use case allows the admin to view all the vehicles that came in and went out of the campus.

2.3 User Characteristics

There are 2 types of user for the Vehicle Number Plate Recognition system. They are the admin of the system and the security guard of the campus. The description of the users are as follows.

2.3.1 The Admin:

1. The admin is the person who is responsible for the operation system.
2. Admin is the person who maintains the system.
3. Has active internet connection.
4. Has an either android or IOS phone.

2.3.2 The security guard:

1. The security guard is the person who is going to check the vehicles while they are coming into the campus.
2. Has active internet connection.
3. Has an either android or IOS phone.

2.4 Constraints

1. The system be accurate at least 95% of the time.
2. If inaccurate the system must be able to notify the authorities.
3. The system must be able to perform reading within 5 seconds.
4. The system must be able to perform reading within 2-meter distance from its point of view.
5. The system must be able to update the information into the database within 30 seconds.

2.5 Assumptions and Dependencies

2.5.1 Assumptions:

1. The system has a high performing camera.
2. The system has high performing processor.
3. The system enough training data to work with before launch.

2.5.2 Dependencies:

1. The system always has a working database.
2. The system needs to be connected to a highspeed internet.

3. Specific Requirements

3.1 External Interface Requirements

There are four external interfaces that are required for developing Vehicle number plate recognition mobile application:

3.1.1 User Interfaces

There are two types of user for the system, they are the Security guard and the admin of the system. The security guard can register a vehicle to the system by providing the details of the vehicle and the owner of the vehicle. The security guard can also save the details into the database. They can also scan the license plate of the vehicle. The admin can register vehicles. Admin can edit the owner details of the vehicle. The admin can also view the entry records of the vehicle. Lastly the admin can ban vehicles from entering into the campus.

3.1.2 Hardware Interfaces

There are 3 types of hardware needed for Vehicle number plate recognition mobile application:

1. Personal Computer:

Used for developing the mobile application and documentation processes.

2. Android Smartphone:

Used to test and run the mobile application.

3. IOS Smartphone:

Used to test and run the mobile application.

3.1.3 Software Interfaces

There three types of software used to develop Vehicle number plate recognition mobile application.

1. Proto.io:

Used for developing a prototype of the mobile application.

2. Microsoft Visual Studio:

Main and most important software used for developing the mobile application.

3. Enterprise Architect:

Used for designing models and documentation.

3.1.4 Communication Interfaces

One communication interface is used for Vehicle number plate recognition mobile application:

Hypertext Transfer Protocol (HTTP)

This protocol is used for getting access to the data stored in the server.

3.2 System Features

3.2.1 Register Vehicle

3.2.1.1 Use case specification of UC001: Use Case <Register Vehicle>

Table 3. 1 Register Use Case Specification

Use Case ID	UC001
Use Case Name	Register Vehicle
Actors	Security Guard and Admin
Pre-Condition	<ol style="list-style-type: none">1. The user is connected to the internet.2. User is logged into the system.
Normal Flow	<ol style="list-style-type: none">1. The user clicks Register Button.2. A registration form is displayed by the system containing fields for vehicles details and owner details.3. User fills form. (References in UC004 and UC005)4. User clicks save button. (References in UC006)5. System validates information.6. System displays registration success message.7. User confirms message.8. If the user wants to cancel the registration then follow alternative flow.9. If the user sees that the vehicle is already registered then follow exception case.
Alternative Flow	<ol style="list-style-type: none">1. User cancels registration by clicking Cancel button.2. A confirmation message is displayed.3. User confirms the message.4. System redirects user to Registration form.
Exception	<ol style="list-style-type: none">1. Follow Use case UC007
Post-Condition	New vehicle added to the database.

Table 3.1: Use Case Description for <Register Vehicle>

3.2.1.2 Sequence Diagram of UC001: use case<Register Vehicle>

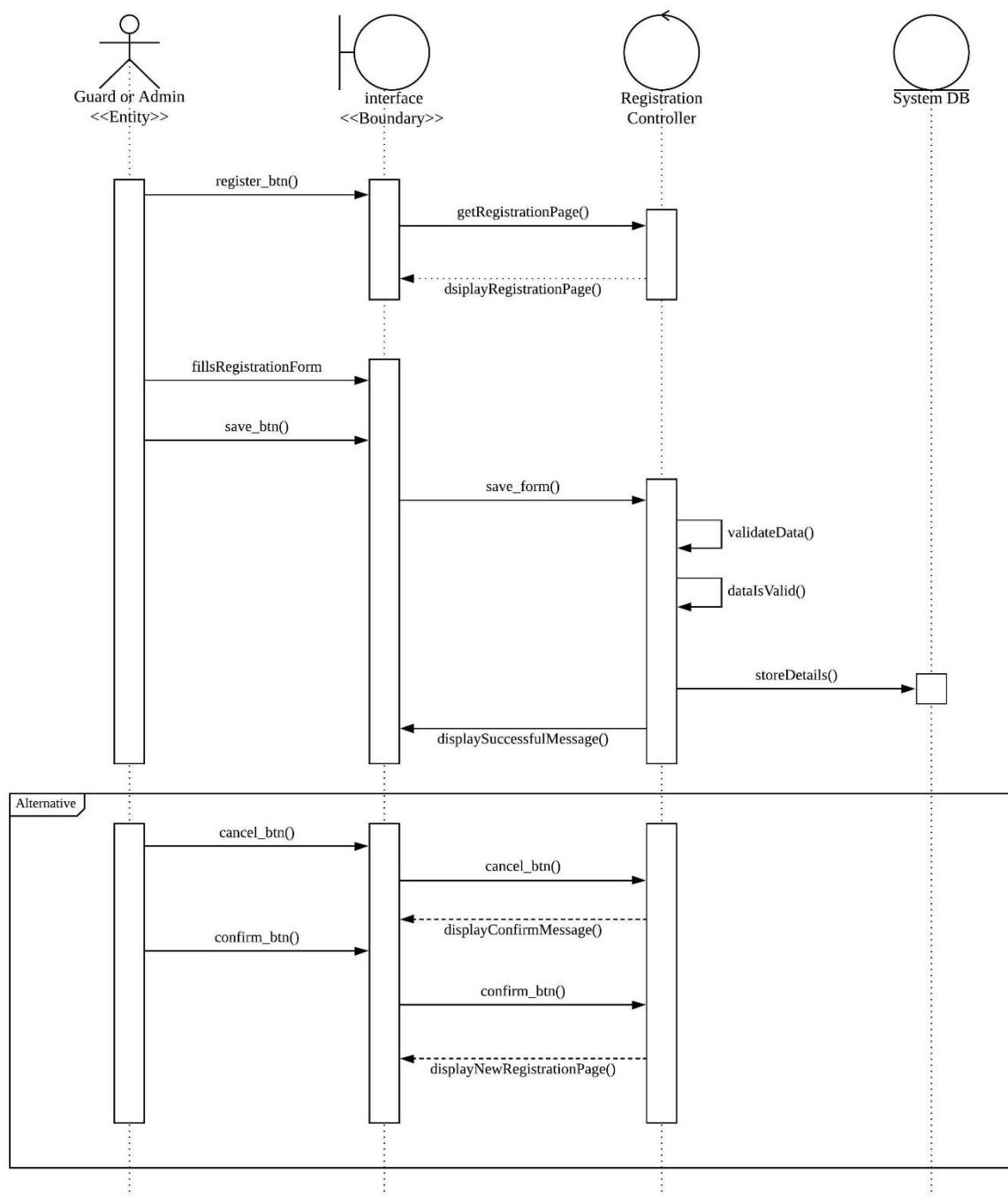


Figure 3.3: System Sequence Diagram of <Register Vehicle>

3.2.1.3 Activity Diagram of UC001: use case<Register Vehicle>

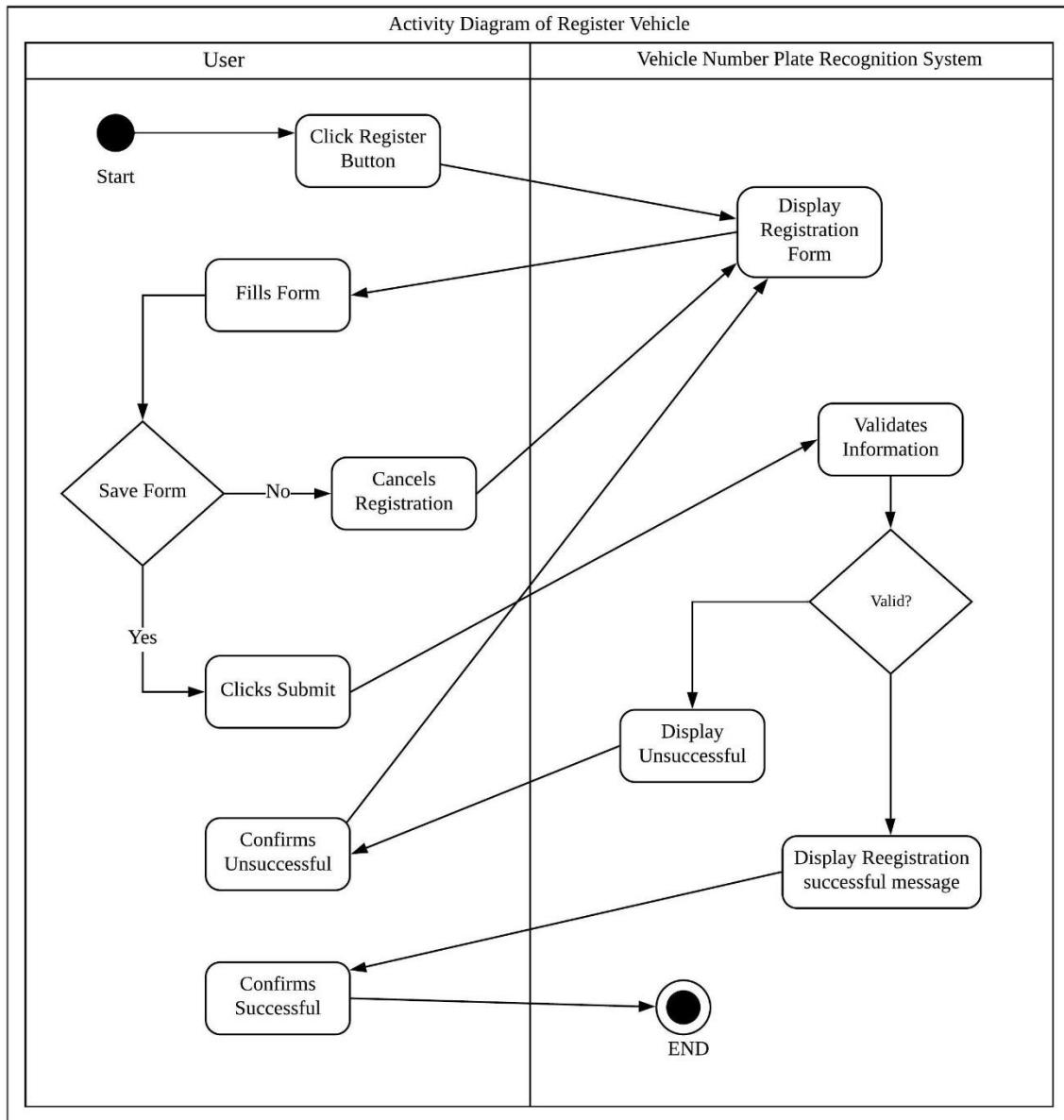


Figure 3.4: Activity Diagram of <Register Vehicle>

3.2.2 UC002: Use Case <Login to System>

3.2.2.1 Use case Specification of UC002: Use Case <Login to system>

Table 3. 2 Login Use Case Specification

Use Case ID	UC002
Use Case Name	Login to System
Actors	Security Guard and Admin
Pre-Condition	(a) The user is connected to the internet. (b)
Normal Flow	1. The user opens the application 2. The user clicks Login Button. 3. The system displays 2 fields with Username and Password. 4. User fills username and password 5. User clicks sign in button. 6. System validates information. 7. System displays home page. 8. If the user puts in wrong password then alternative 1 is followed 9. If the user puts in wrong username then alternative 2 is followed
Alternative Flow	1. The system displays “Password is Wrong. Please try again” message. 2. The system displays “Username is Wrong. Please try again” message
Post-Condition	The user is logged into the system

Table 3.1: Use Case Description for <Login>

3.2.2.2 Sequence Diagram of UC002: use case<Login to system>

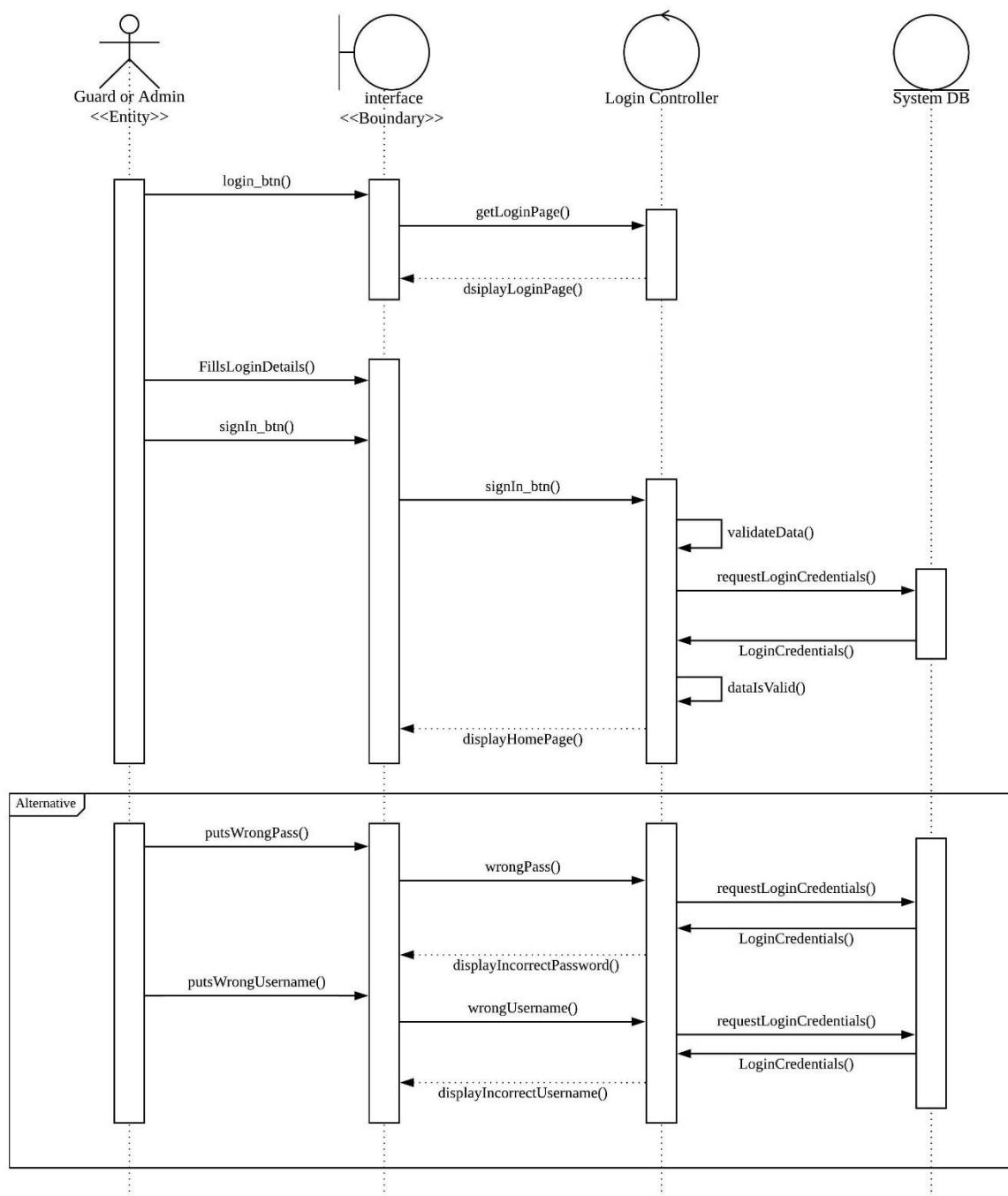


Figure 3.3: System Sequence Diagram of <Login to system>

3.2.2.3 Activity Diagram of UC002: use case<Login to system>

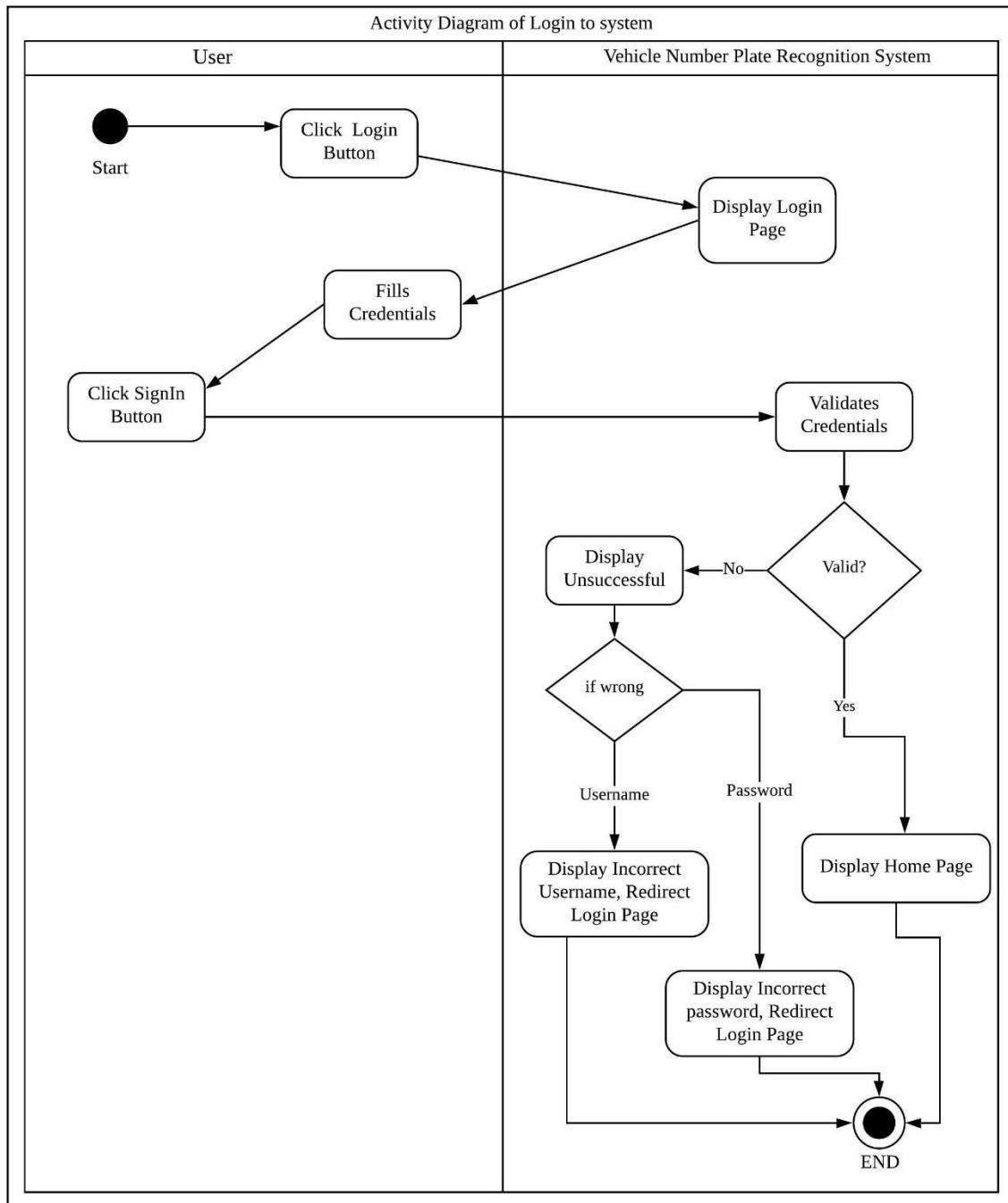


Figure 3.4: Activity Diagram of <Login To system>

3.2.3 UC003: Use Case <Scan License Plate>

3.2.3.1 Use case Specification of UC003: Use Case <Scan License Plate>

Table 3. 3 Scan License Plate Use Case Specification

Use Case ID	UC003
Use Case Name	Scan License Plate
Actors	Guard
Pre-Condition	<ol style="list-style-type: none">1. The user is connected to the internet.2. The user is logged into the system
Normal Flow	<ol style="list-style-type: none">1. The user clicks Scan Vehicle.2. The system opens the camera within the application.3. The user faces the camera on the direction of the vehicle.4. The system takes the picture.5. The system detects the position of the License Plate Number.6. The system divides the License Plate Number into segments that contain only one letter or number.7. The system recognize the letters and puts it together.8. The system validates the number with the database.9. If the number is found, Follow Alternate Flow 1.10. If the number is not found, Follow Alternate Flow 2.11. If the number is in list of banned Vehicles, Follow Alternate Flow 3.
Alternative Flow	<ol style="list-style-type: none">1. The system records the time and date.1.1. The system opens the gate.2. The system displays “Vehicle not registered. Register vehicle to enter”.2.1. The user clicks Register button and follow UC001.3. The system displays Alert Message saying “Vehicle is banned. Contact Authority”

Post-Condition	
-----------------------	--

Table 3.1: Use Case Description for <Scan License Plate>

3.2.3.2 Sequence Diagram of UC003: use case<Scan License Plate>

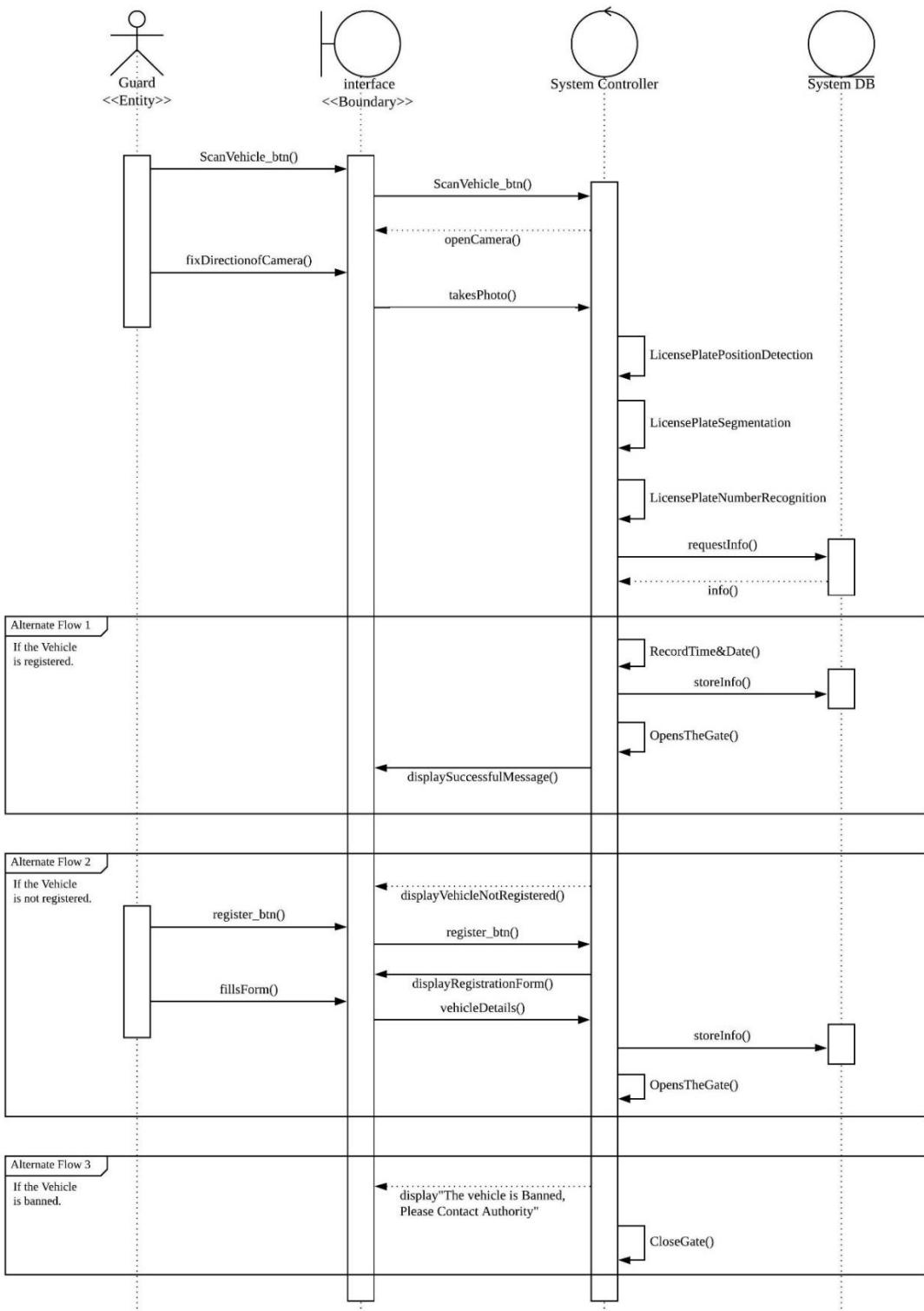


Figure 3.3: System Sequence Diagram of <Scan License Plate>

3.2.3.3 Activity Diagram of UC003: use case<Scan License Plate>

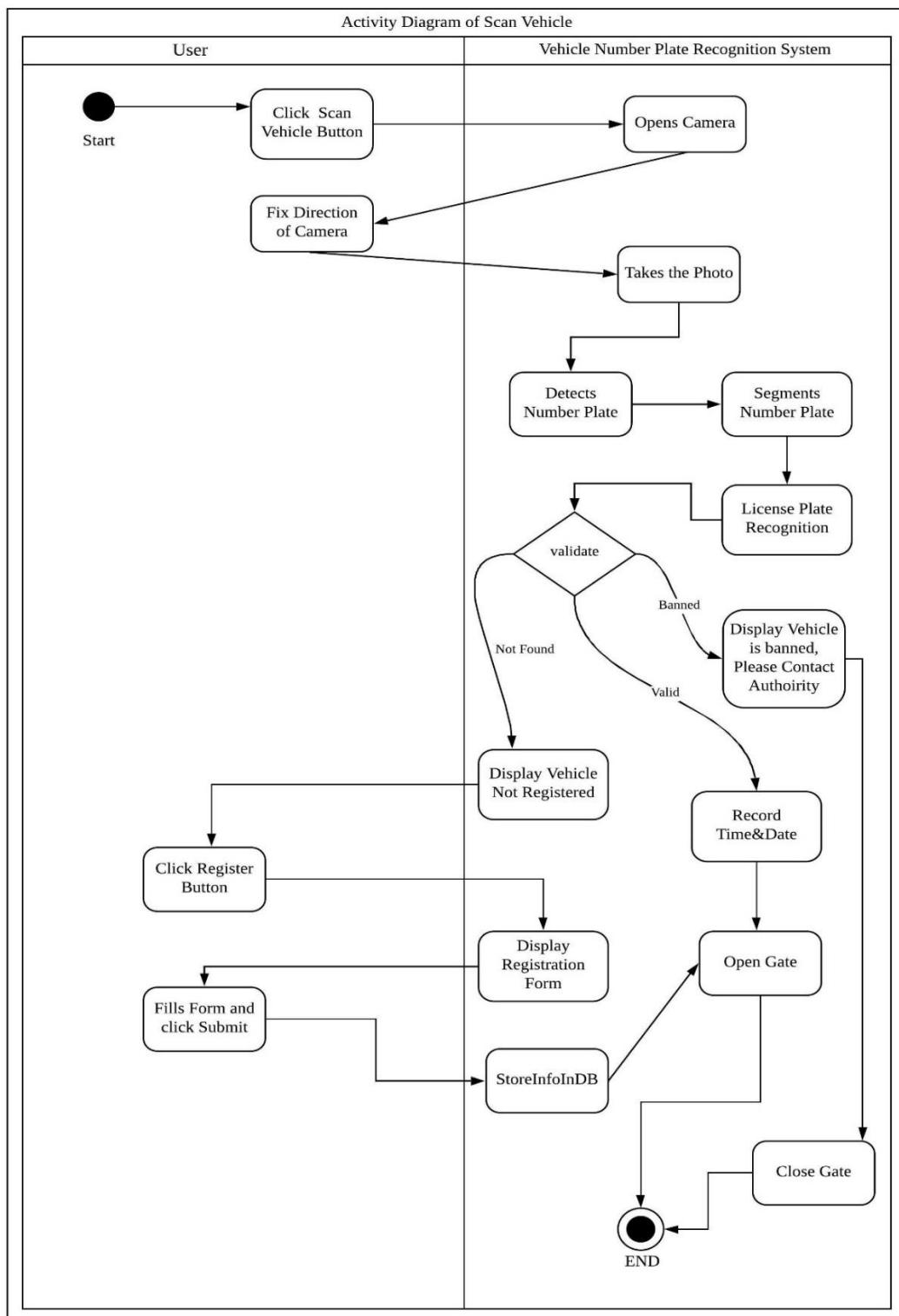


Figure 3.4: Activity Diagram of <Scan License Plate>

3.2.4 UC004: Use Case <Add Owner Details>

3.2.4.1 Use case Specification of UC004: Use Case <Add Owner Details>

Table 3. 4 Add Owner Details Use Case Specification

Use Case ID	UC004
Use Case Name	Add Owner Details
Actors	Security Guard and Admin
Pre-Condition	<ol style="list-style-type: none">1. The user is connected to the internet.2. The user is logged into the system
Normal Flow	<ol style="list-style-type: none">1. The user Clicks Add Owner Details Button2. The system displays a form fields Name, Date of birth, Mykad or IC number, Vehicle number, Phone Number.3. The user fills Name, Date of birth, Mykad or IC number, Vehicle number, Phone Number.4. The user clicks save button. (Reference in UC006)5. The system displays Details are added successfully.6. The user clicks Confirm button.7. The System displays home page.
Alternative Flow	
Post-Condition	The owner details are added to the database.

Table 3.1: Use Case Description for <Add Owner Details>

3.2.4.2 Sequence Diagram of UC004: use case<Add Owner Details>

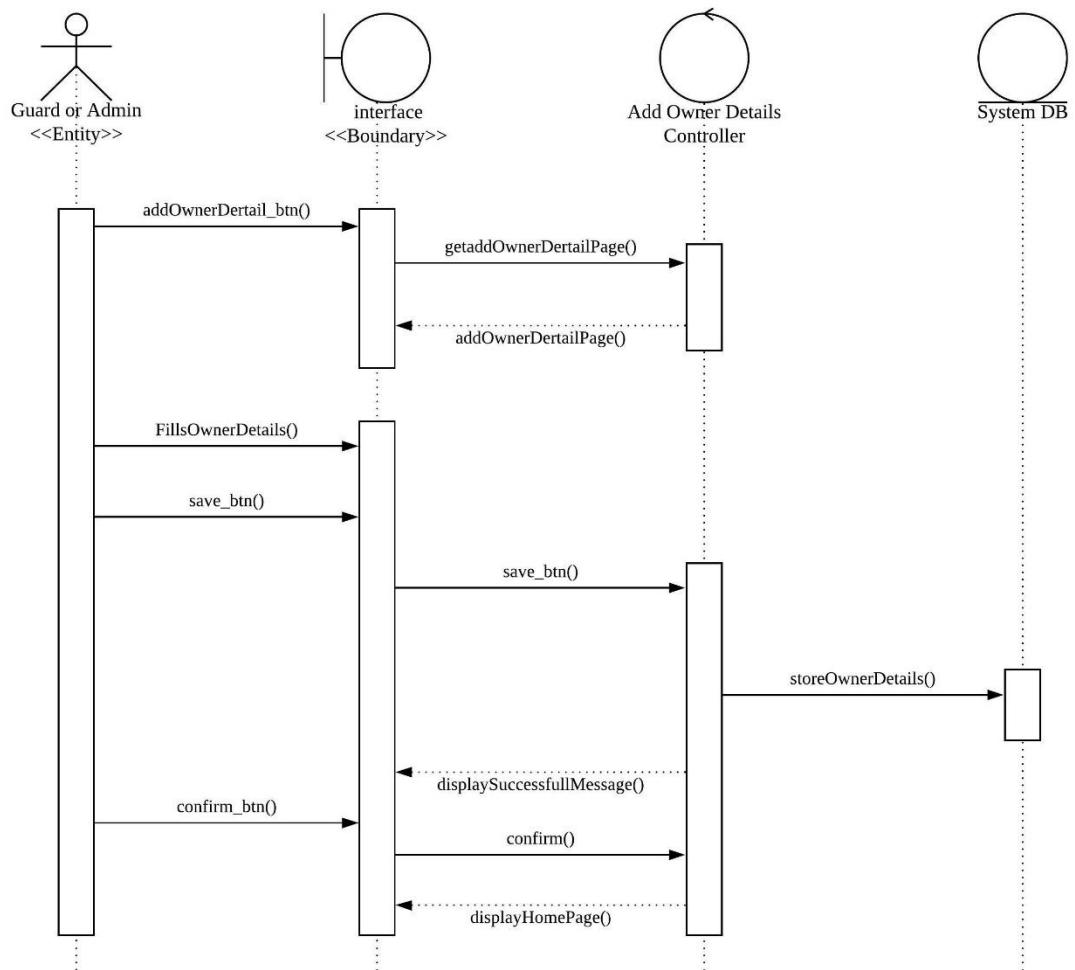


Figure 3.3: System Sequence Diagram of <Add Owner Details>

3.2.4.3 Activity Diagram of UC004: use case<Add Owner Details>

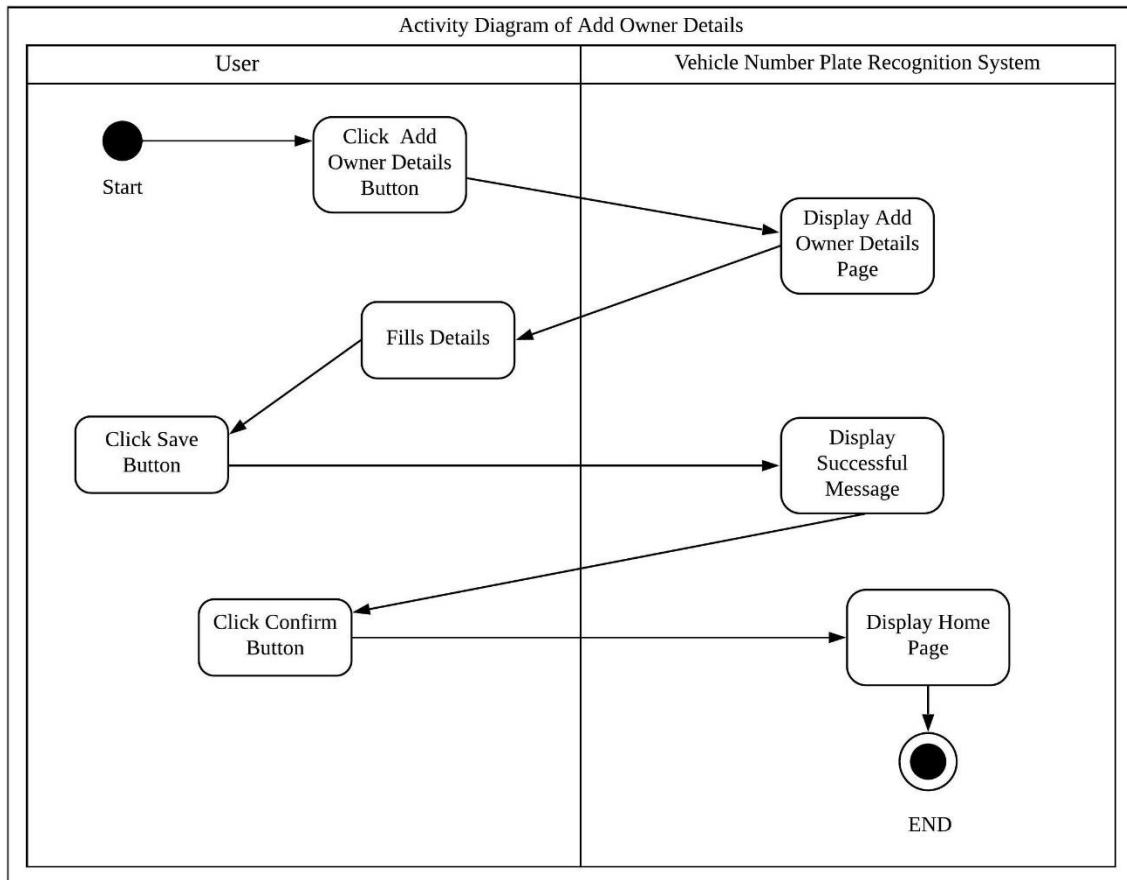


Figure 3.4: Activity Diagram of <Add Owner Details>

3.2.5 UC005: Use Case <Add Vehicle Details>

3.2.5.1 Use case Specification of UC005: Use Case <Add Vehicle Details>

Table 3. 5 Add Vehicle Details Use Case Specification

Use Case ID	UC005
Use Case Name	Add Vehicle Details
Actors	Security Guard and Admin
Pre-Condition	<ol style="list-style-type: none">1. The user is connected to the internet.2. The user is logged into the system
Normal Flow	<ol style="list-style-type: none">1. The user Clicks Add Vehicle Details Button2. The system displays a form fields Model Name, Company Name, Year of production, License plate number, Owner Name.3. The user fills Model Name, Company Name, Year of production, License plate number, Owner Name.4. The user clicks save button. (Reference in UC006)5. The system displays Details are added successfully.6. The user clicks Confirm button.7. The System displays home page.
Alternative Flow	
Post-Condition	The vehicle details are added to the database.

Table 3.1: Use Case Description for <Add Vehicle Details>

3.2.5.2 Sequence Diagram of UC005: use case<Add Vehicle Details>

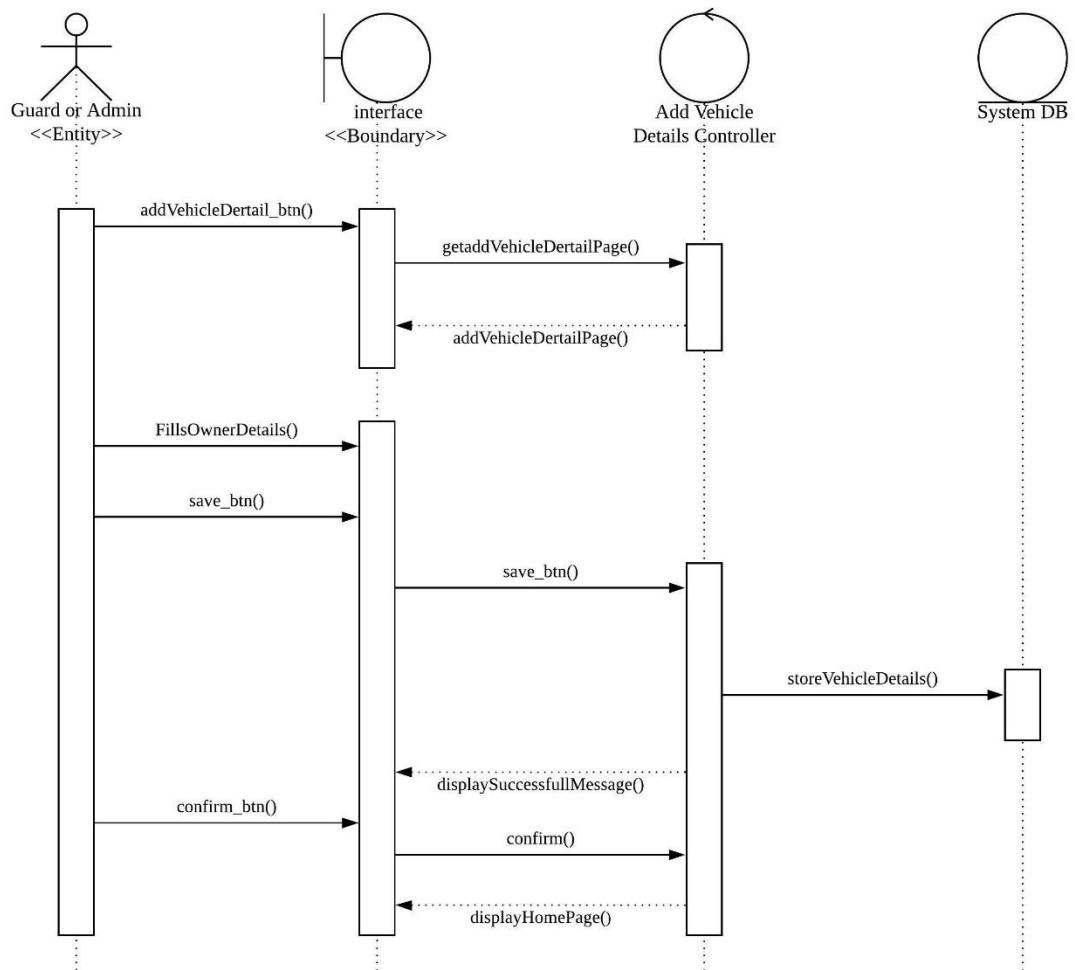


Figure 3.3: System Sequence Diagram of <Add Vehicle Details>

3.2.5.3 Activity Diagram of UC005: use case<Add Vehicle Details>

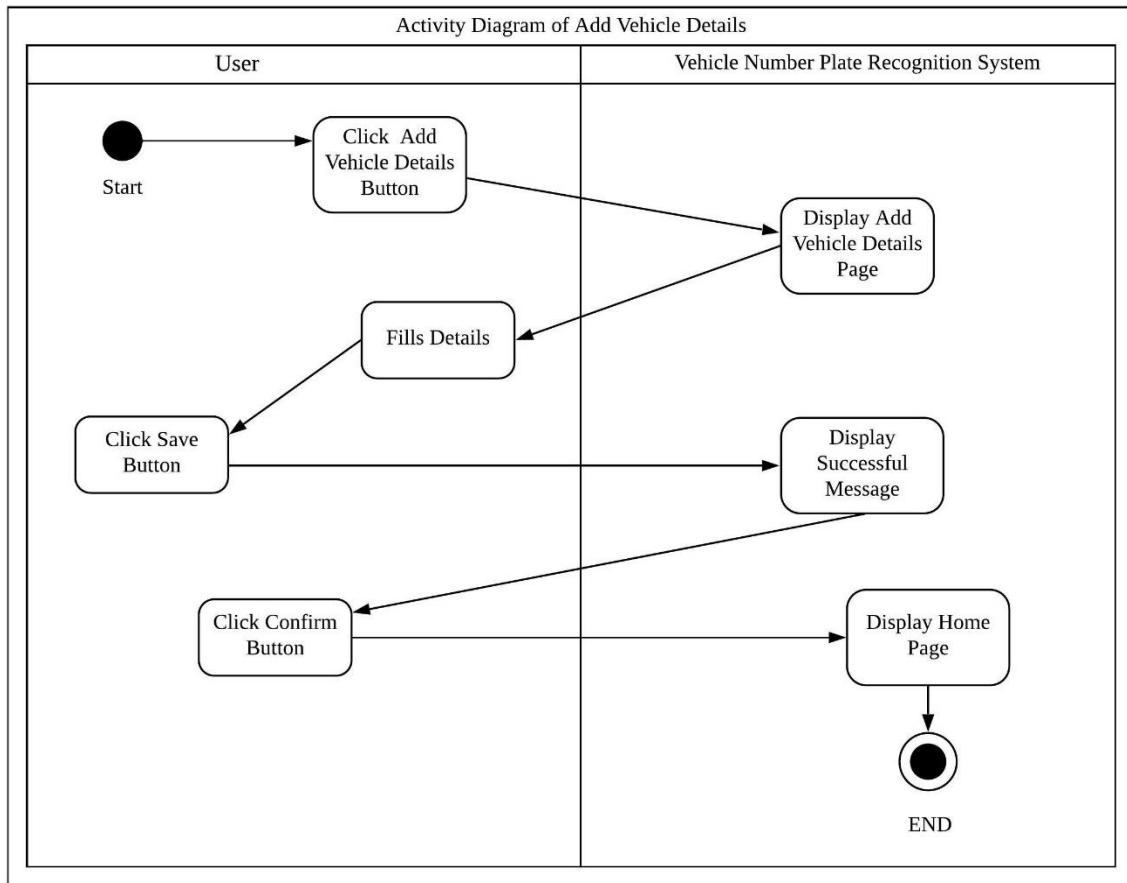


Figure 3.4: Activity Diagram of <Add Vehicle Details>

3.2.6 UC006: Use Case <Save Details>

3.2.6.1 Use case Specification of UC005: Use Case <Save Details>

Table 3. 6 Save Details Use Case Specification

Use Case ID	UC006
Use Case Name	Save Details
Actors	Security Guard and Admin
Pre-Condition	<ol style="list-style-type: none">1. The user is connected to the internet.2. The user is logged into the system
Normal Flow	<ol style="list-style-type: none">1. The user fills the form with vehicle and owner data and clicks save button.2. The system takes the data input into the system Database.3. The system searches by the name of the owner and License plate number in the JPJ Database.4. If the information matches then the system displays Successful message.5. If the system does not find any match then the system displays No records found.6. The user confirms message.7. The System displays home page.
Alternative Flow	
Post-Condition	The details are added to the database.

Table 3.1: Use Case Description for <Save Details>

3.2.6.2 Sequence Diagram of UC006: use case<Save Details>

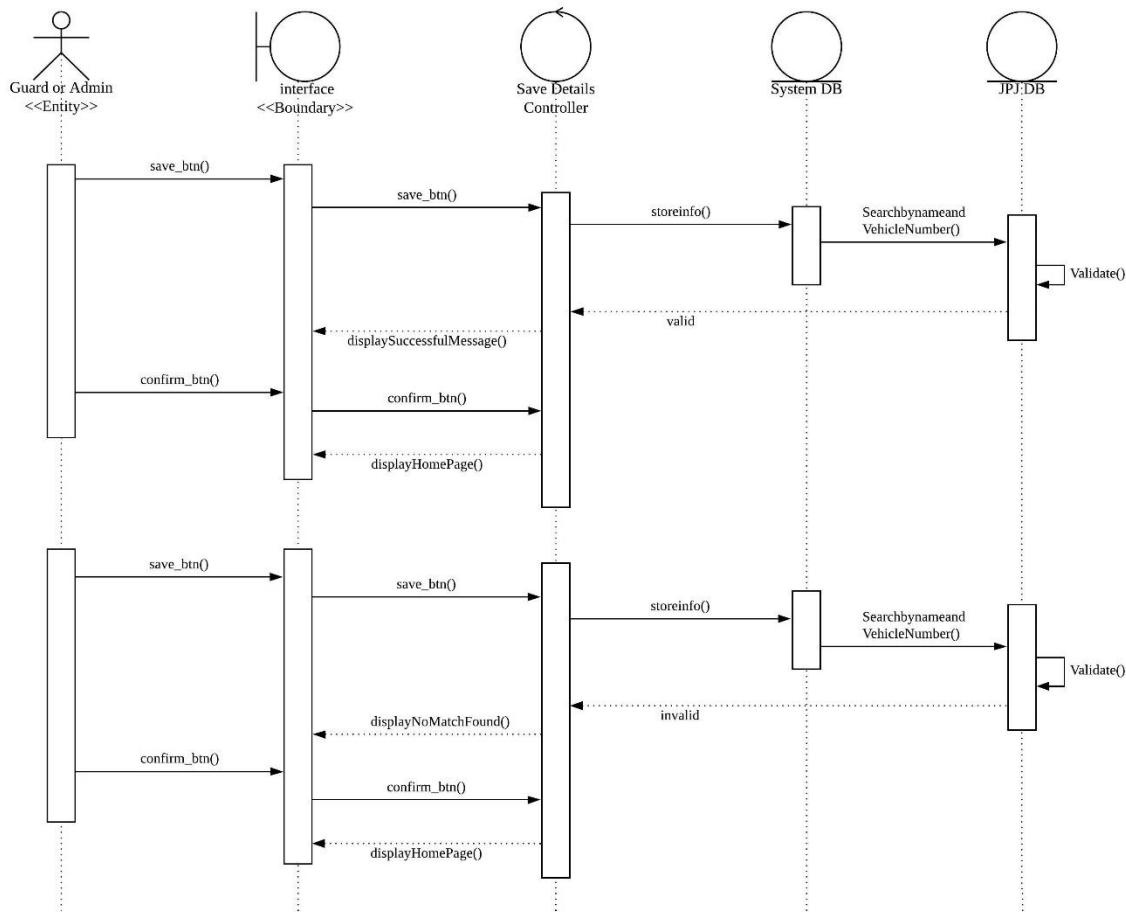


Figure 3.3: System Sequence Diagram of <Save Details>

3.2.6.3 Activity Diagram of UC006: use case<Save Details>

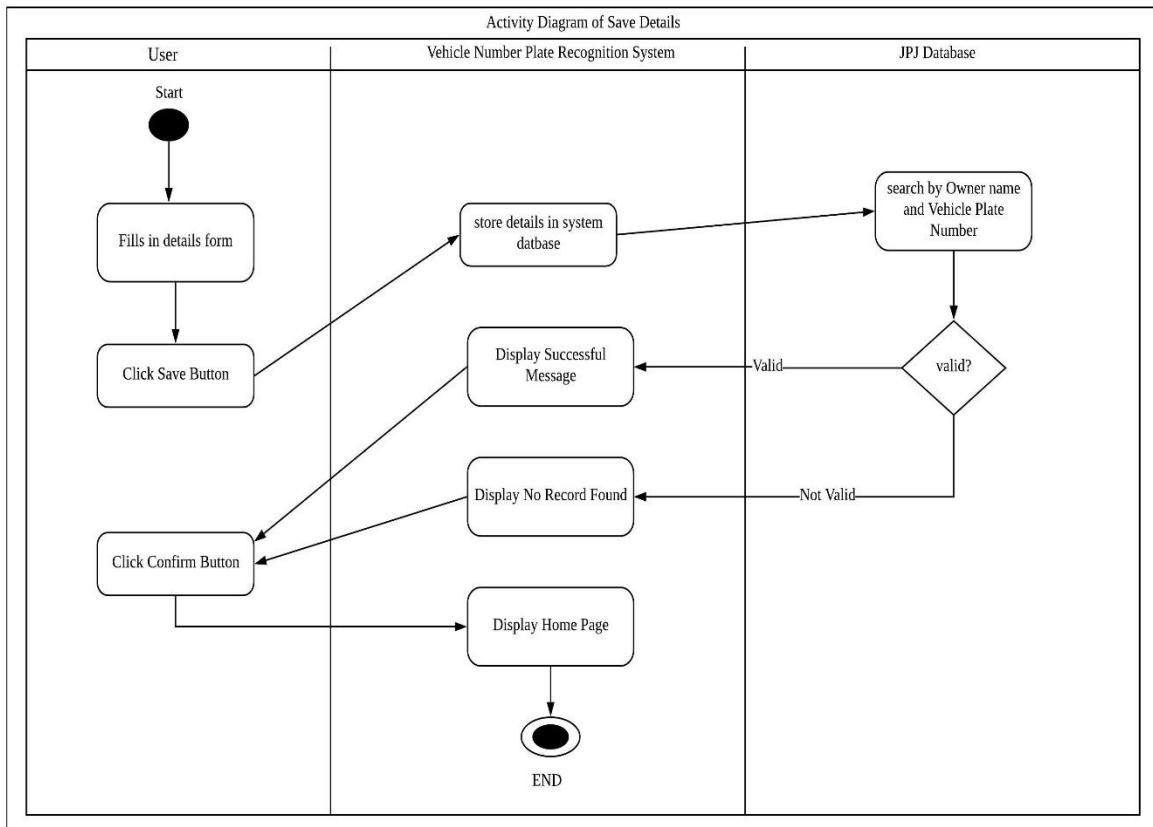


Figure 3.4: Activity Diagram of <Save Details>

3.2.7 UC007: Use Case <Edit Owner Details>

3.2.7.1 Use case Specification of UC007: Use Case <Edit Owner Details>

Table 3. 7 Edit Owner Details Use Case Specification

Use Case ID	UC007
Use Case Name	Edit Owner Details
Actors	Admin
Pre-Condition	<ol style="list-style-type: none">1. The user is connected to the internet.2. The user is logged into the system
Normal Flow	<ol style="list-style-type: none">1. The user clicks Edit Owner Details button.2. The system display field for Vehicle Model and License Plate number of Vehicle.3. The user inputs Model number and License Plate number and clicks submit.4. The system displays the relevant Vehicle details and owner details.5. Th user clicks Edit Details.6. The system displays a new form for owner.7. The user fills the form and press update.8. The system updates the vehicle owner details and displays Successful message.
Alternative Flow	
Post-Condition	The details are added to the database.

Table 3.1: Use Case Description for <Edit Owner Details>

3.2.7.2 Sequence Diagram of UC007: use case<Edit Owner Details>

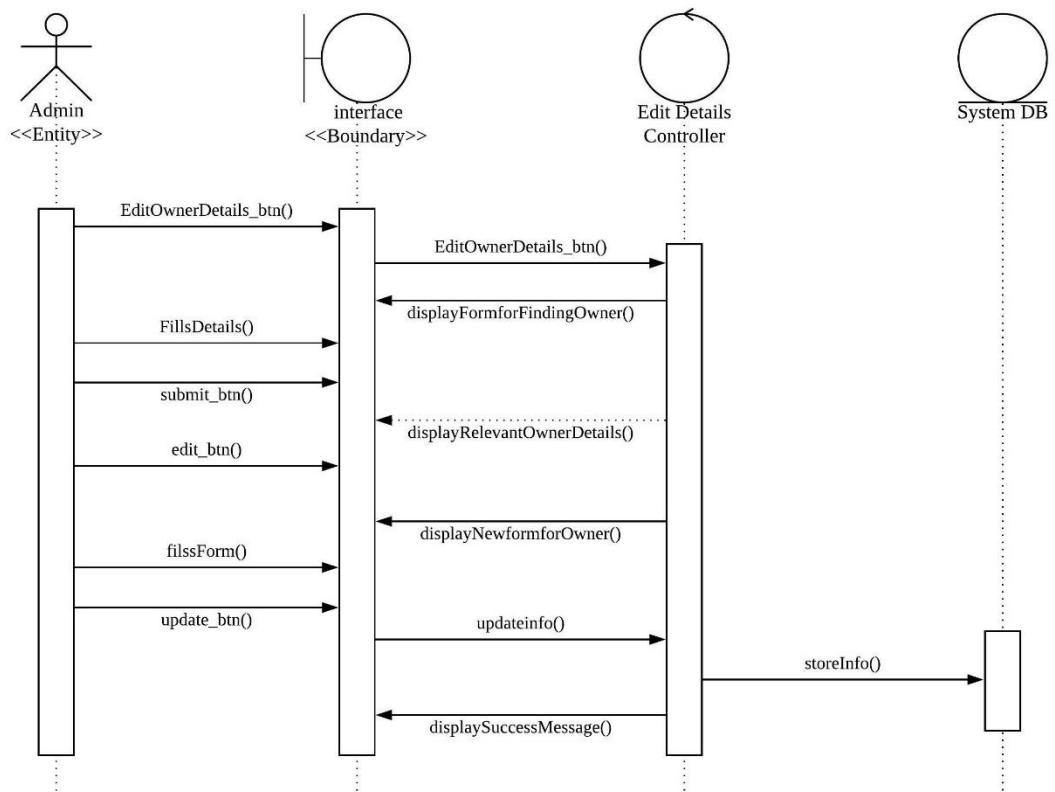


Figure 3.3: System Sequence Diagram of <Edit Owner Details>

3.2.7.3 Activity Diagram of UC007: use case<Edit Owner Details>

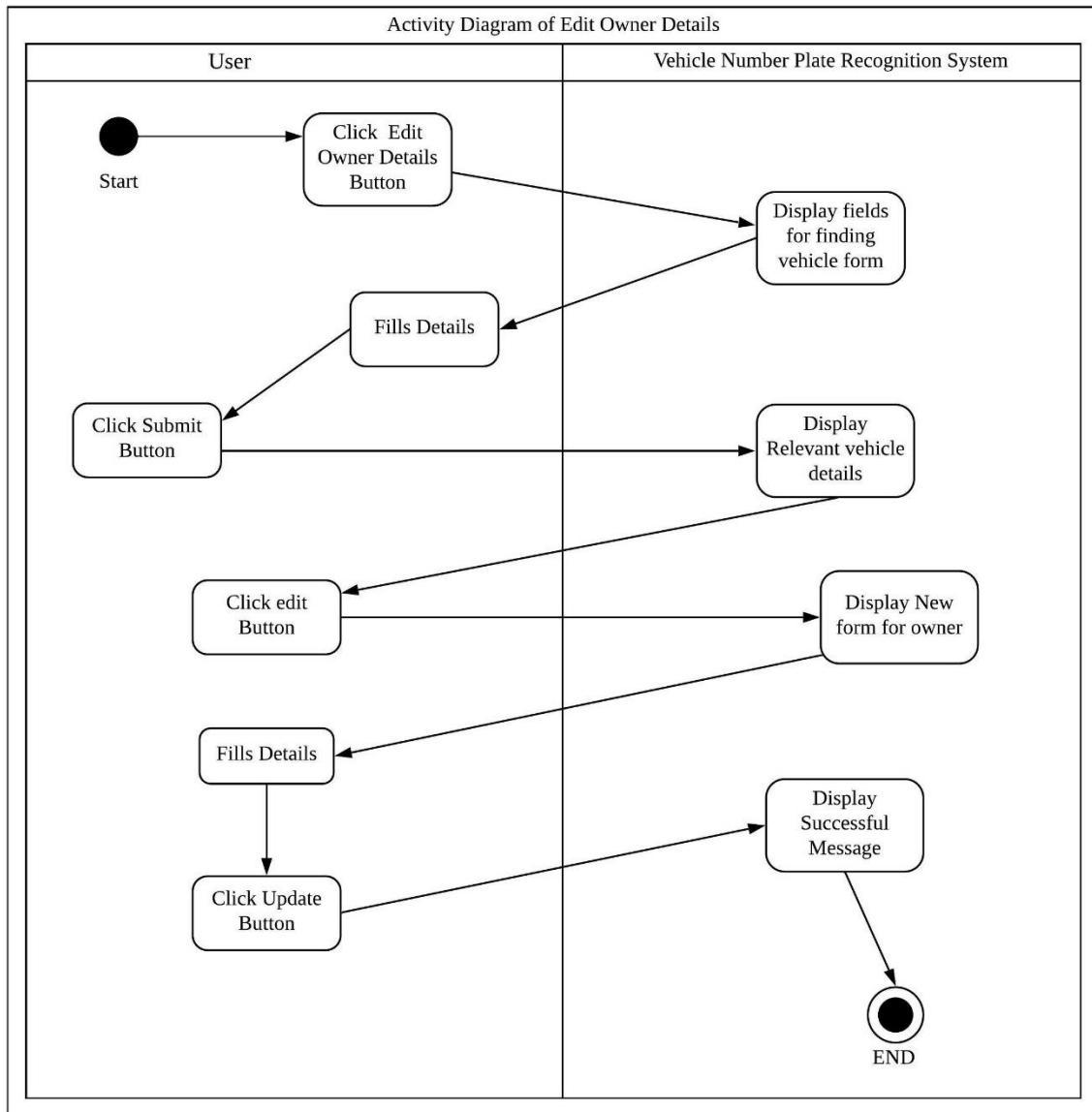


Figure 3.4: Activity Diagram of <Edit Owner Details>

3.2.8 UC008: Use Case <Ban Vehicles>

3.2.8.1 Use case Specification of UC008: Use Case < Ban Vehicles>

Table 3. 8 Ban Vehicles Use Case Specification

Use Case ID	UC008
Use Case Name	Ban Vehicles
Actors	Admin
Pre-Condition	<ol style="list-style-type: none">1. The user is connected to the internet.2. The user is logged into the system
Normal Flow	<ol style="list-style-type: none">1. The user clicks Ban Vehicles button.2. The system display field for Vehicle Model and License Plate number of Vehicle.3. The user inputs Model number and License Plate number and clicks submit.4. The system displays the relevant Vehicle details and owner details.5. Th user clicks Ban This Vehicles.6. The system adds the vehicle and the owner to List of Banned Vehicles.
Alternative Flow	
Post-Condition	The vehicle and the owner is added on the list of banned vehicles.

Table 3.1: Use Case Description for <Ban Vehicles>

3.2.8.2 Sequence Diagram of UC008: use case< Ban Vehicles >

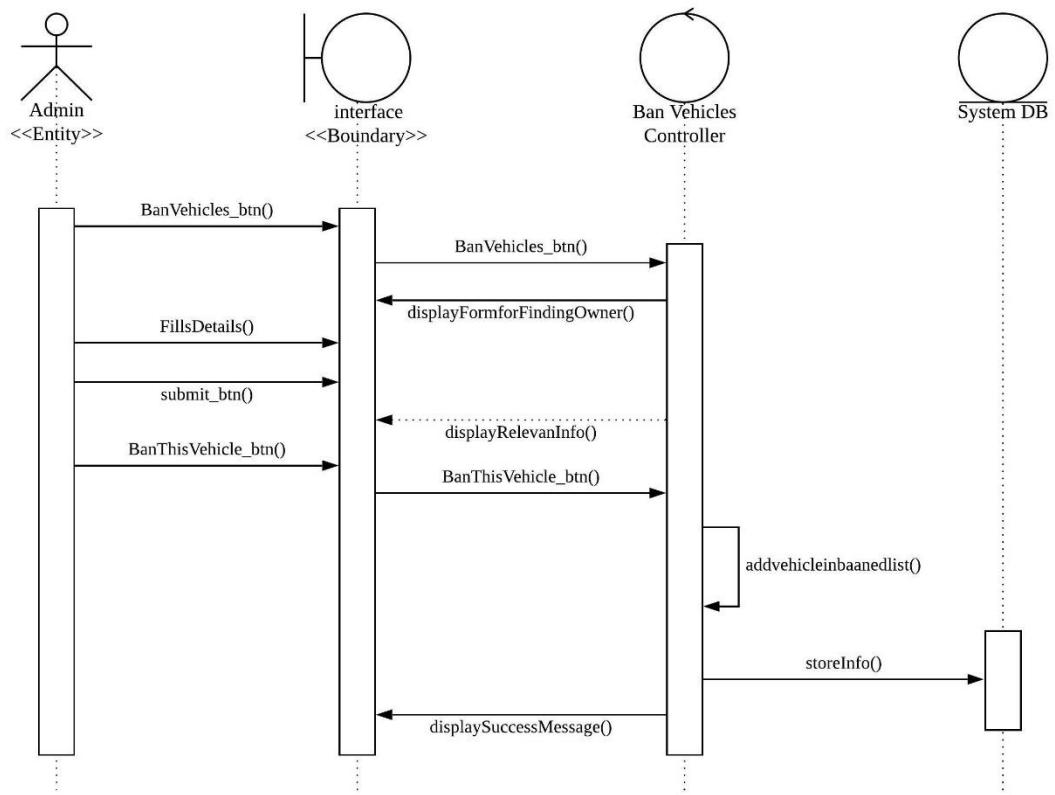


Figure 3.3: System Sequence Diagram of <Ban Vehicles>

3.2.8.3 Activity Diagram of UC008: use case<Ban Vehicles>

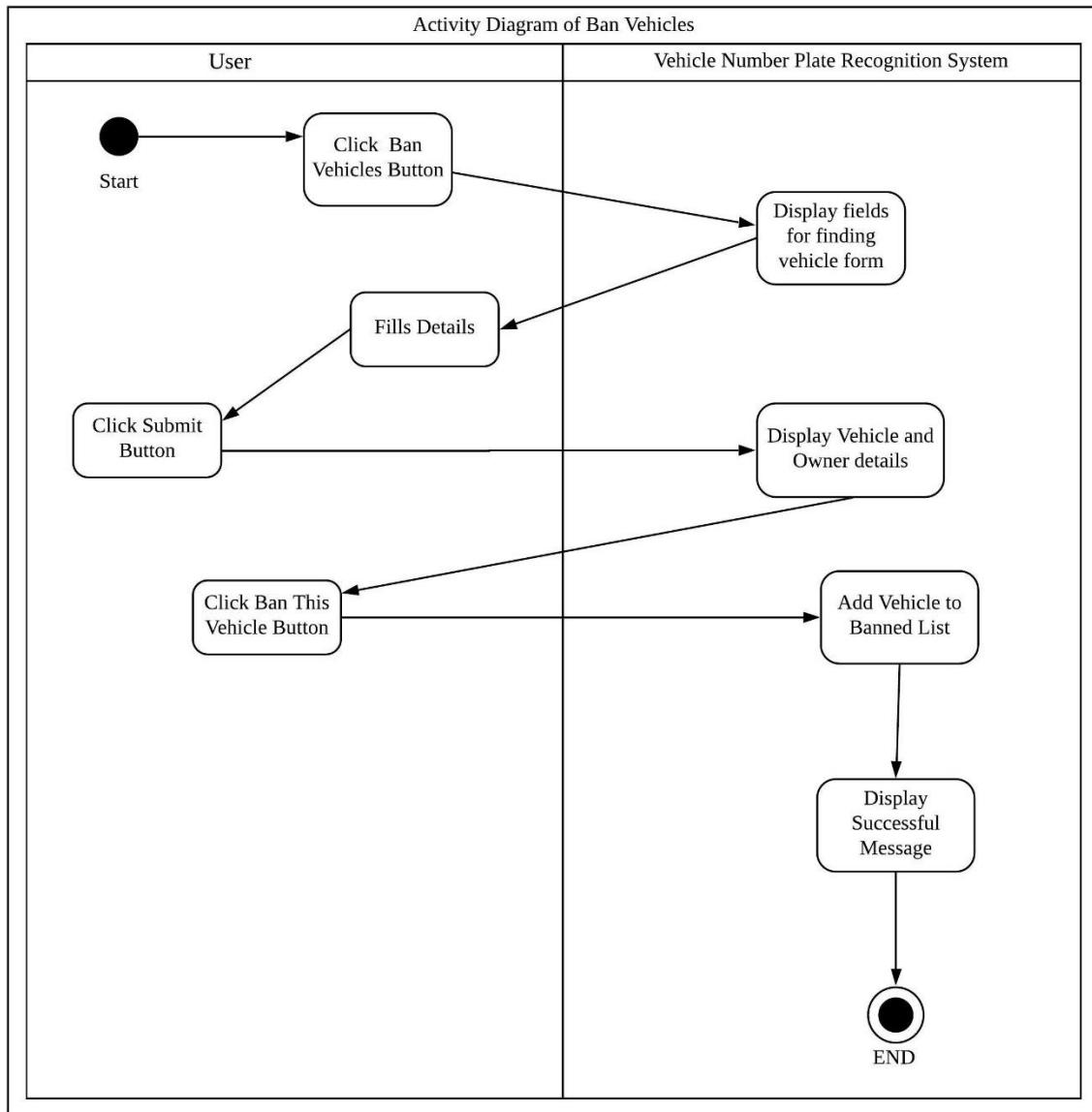


Figure 3.4: Activity Diagram of <Ban Vehicles>

3.2.9 UC009: Use Case <View Vehicle Entry Records>

3.2.9.1 Use case Specification of UC009: Use Case <View Vehicle Entry Records>

Use Case ID	UC009
Use Case Name	View Vehicle Entry Records
Actors	Admin
Pre-Condition	<ul style="list-style-type: none"> 1. The user is connected to the internet. 2. The user is logged into the system
Normal Flow	<ul style="list-style-type: none"> 1. The user clicks View Records. 2. The system displays records for every Vehicle Entry Record. The system stores the info in a table for Vehicle License Plate Number, Entry Time and Date, Entry Gate Number, Exit Time and Date, Exit Gate Number, owner name and Date of birth. 3. The user clicks search icon. 4. The system displays a drop-down list with Vehicle License Plate Number and Date and Time. 5. If the user clicks Vehicle License Plate Number follow alternate flow 1. 6. If the user clicks Date and Time follow alternate flow 2.
Alternative Flow	<ul style="list-style-type: none"> 1. The system displays a form with input Field for License plate Number. <ul style="list-style-type: none"> 1.1 The user input License Plate Number and click submit. 1.2 The system displays All Records for that particular Vehicle. 2. The system displays a form with input Field for Time and Date. <ul style="list-style-type: none"> 2.1 The user input Time and Date and clicks submit. 2.2 The system displays All Records for that particular Time and Date.
Post-Condition	The user sees the records.

Table 3.1: Use Case Description for <Ban Vehicles>

3.2.9.2 Sequence Diagram of UC009: use case<View Vehicle Entry Records>

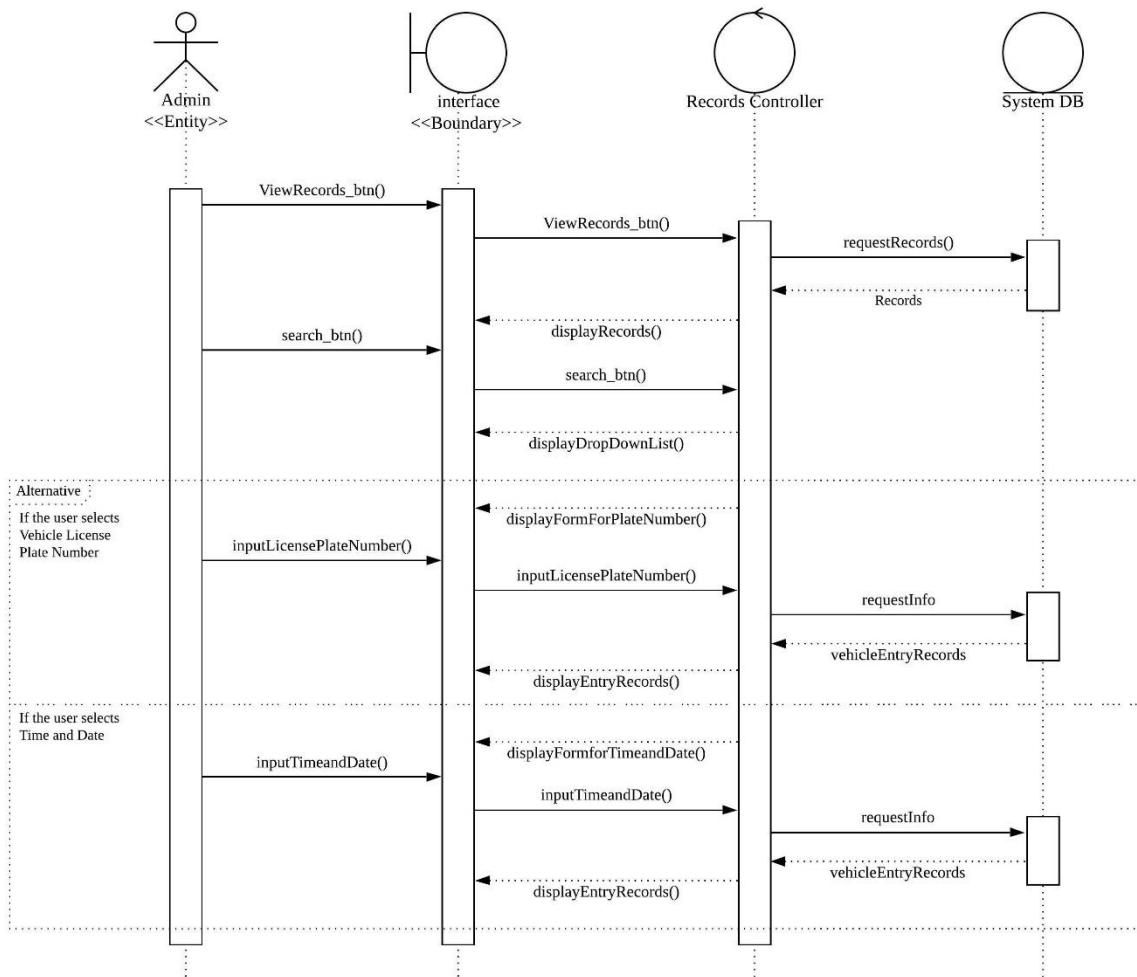


Figure 3.3: System Sequence Diagram of <View Vehicle Entry Records>

3.2.9.3 Activity Diagram of UC009: use case<View Vehicle Entry Records>

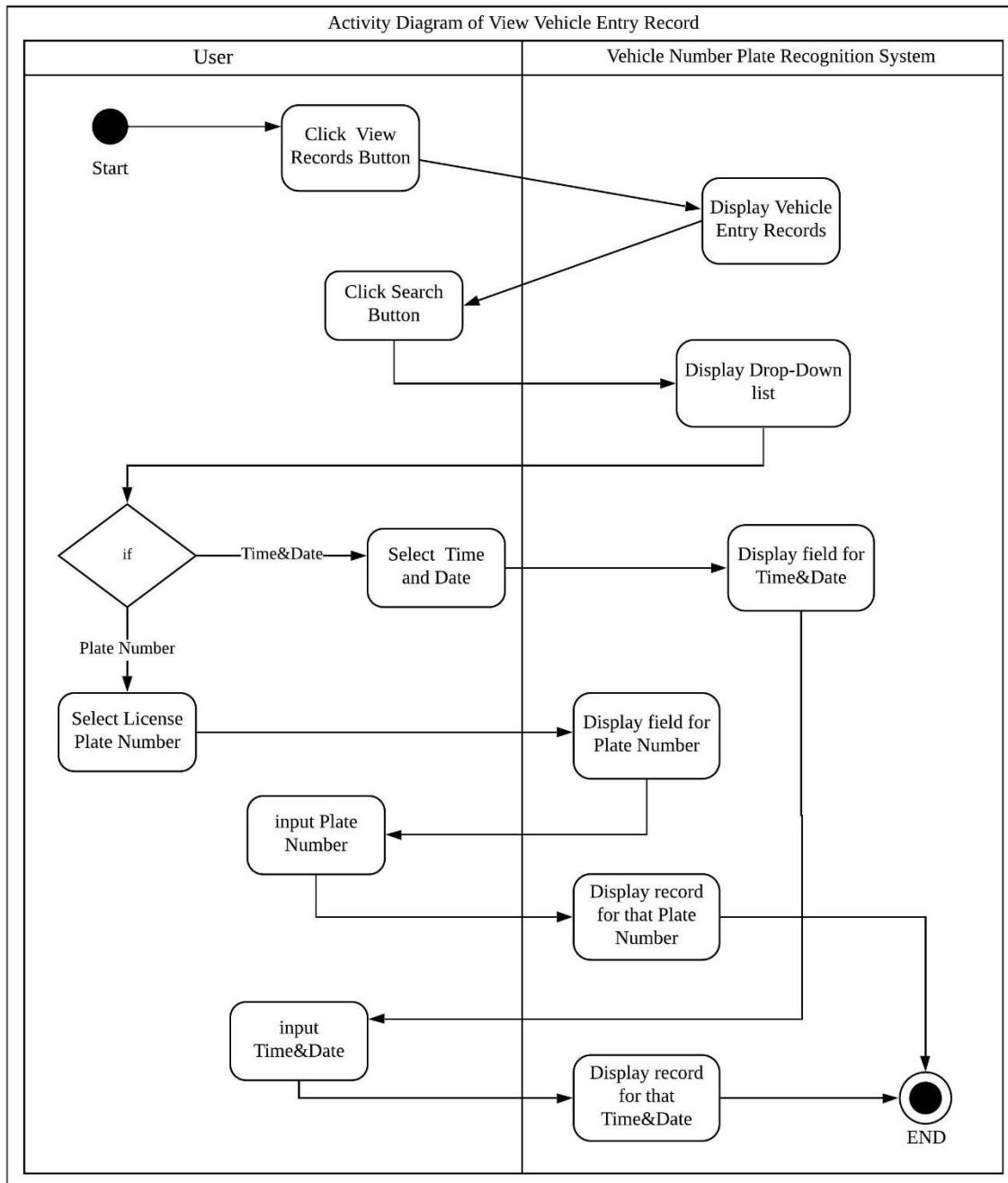


Figure 3.4: Activity Diagram of <View Vehicle Entry Records>

3.3 Non-functional requirements

Non-functional requirement depicts how the system does the process. A number of non-functional requirements of Vehicle Number Plate Recognition System are:

3.3.1 Performance

Vehicle Number Plate Recognition System will have a good performance. The performance of an app is mainly measured by the time it takes to process the commands. The process command time will be made sure to be as minimum as it can get.

3.3.2 Reliability

Vehicle Number Plate Recognition System will be a very reliable system. It will be made sure that the system transactions and processing are ensured and notified properly. Also, the data transferred in a reliable way and using trustful protocols.

3.3.3 Usability

End user satisfaction is a very important part. It will be made sure that the system will be able to satisfy the user requirements.

3.3.4 Maintainability

Vehicle Number Plate Recognition System will have a regular preventive and corrective maintenance. Continuous improvement will be done on this system.

3.3.5 Security

As this Vehicle Number Plate Recognition System is for security system, the security should be very good. The integrity of the software should be top notch. Guard should not be able to enter as admin.

Appendix D
System Detailed Designed Document

TABLE OF CONTENTS

1	Introduction	120
1.1	Purpose	120
1.2	Scope	120
1.3	Definitions, Acronyms and Abbreviations	120
1.4	Reference	121
1.5	Overview	121
2	System Architectural Design	122
2.1	Architectural Style and Rationale	122
2.2	Justification For MVC	123
2.3	Architectural Model	123
3	Detailed Description of Modules	124
3.1	Complete Package Diagram	124
3.2	Complete Class Diagram	125
3.3	Database Design	126
4	Data Design	127
4.1	Data Description	127
4.2	Data Dictionary	128
5	User Interface Design	131
5.1	Overview of User Interface	131
5.2	Screen Images	131

1. INTRODUCTION

1.1 Purpose

Vehicle Number Plate Recognition system is a cross platform mobile application. Its target is to make the process of checking the vehicle entering into UTM easy. The purpose of this Software Design Document (SDD) is to describe the system architecture design and database design of this Number Plate Recognition system.

1.2 Scope

Listed below are the scopes of the Vehicle Number Plate Recognition application:

- This application is used for scanning the license plate number of the vehicles coming inside the university campus.
- The application will record the date, time and the specific gate number the vehicle coming in and going out of the campus.
- The application will save the vehicle number in the database with the information of the driver and owner of the vehicle.

1.3 Definitions, Acronyms and Abbreviation

UTM	Universiti Teknologi Malaysia
User	Security Guard or Admin
Authority	UTM Head OF Security or The Balai Police
ID	Identification number
UC	Use case
SDD	Software Design Documentation
JPJ	Jabatan Pengangkutan Jalan
IOS	Mobile Devices by Apple Inc.
Android	Mobile Devices supported by google Android operation system.
System DB	Database used for storing information of this application.
MVC	Model View Controller
ERD	Entity Relationship Diagram

Table 1.1: Definitions

1.4 References

- "ProjectManagement.com - System Requirements Specification". Retrieved April 2016.
- IEEE. IEEE Recommended Practice for Software Requirements Specifications. New York, NY: Institute of Electrical and Electronics Engineers, 1998.
- Satzinger, J.W., Jackson, R.B., Burd, S.D.. (2010). *Systems Analysis and Design in a Changing World Fifth Edition*. Boston, MA: Course Technology. p. 238-254
- L. Connie, C. Kim On, A. Patricia. (2018). *A Review of Automatic License Plate Recognition System in Mobile-based Platform*. Faculty of Environment, Society and Design, Lincoln University, Christchurch, New Zealand.

1.5 Overview

The Vehicle Number Plate Recognition system is aimed to make the checking process within the campus entry gates safer, faster and easy. This document will describe the entire application by explaining the background of the application and the purpose of the application to be developed. In addition, this document describes the application system architecture of the proposed application by analyzing the system from different perspectives and discussing class diagrams in layers. Next, this document involves application data design that describes the types of data models used in the application including data descriptions, data dictionaries, and data relationships. Finally, this document contains an application user interface design that provides a clearer view of the application.

2. SYSTEM ARCHITECTURAL DESIGN

This chapter will have a discussion about the chosen architecture for Vehicle Number Plate Recognition system, which is Model-View-Controller (MVC).

This architecture was

chosen because this architecture divides the system into three different parts. Model controls the core structure, view controls the display of the system and the controller is for sending, receiving and initializing requests and responses. These parts can be updated or modified without affecting each other.

2.1 Architecture Style and Rationale

MVC Architecture

The software architectural pattern "Model View Controller (MVC)" is commonly used

for implementing user interfaces. It is a popular choice for application development. In

general, the software logic is split into three different sections, which facilitates modularity, collaboration and reuse all the different sections communicate with each other. Applications have become more dynamic and accessible. The portion of the model specifies the data that the device will include. When this data state changes, the design usually notifies the view (in order that the display can be modified) and sometimes the controller (if the changed view needs to be controlled by specific logic). The view component describes how to show the data of the device. The controller provides logic to modify the design and/or display in response to feedback from the app's users.

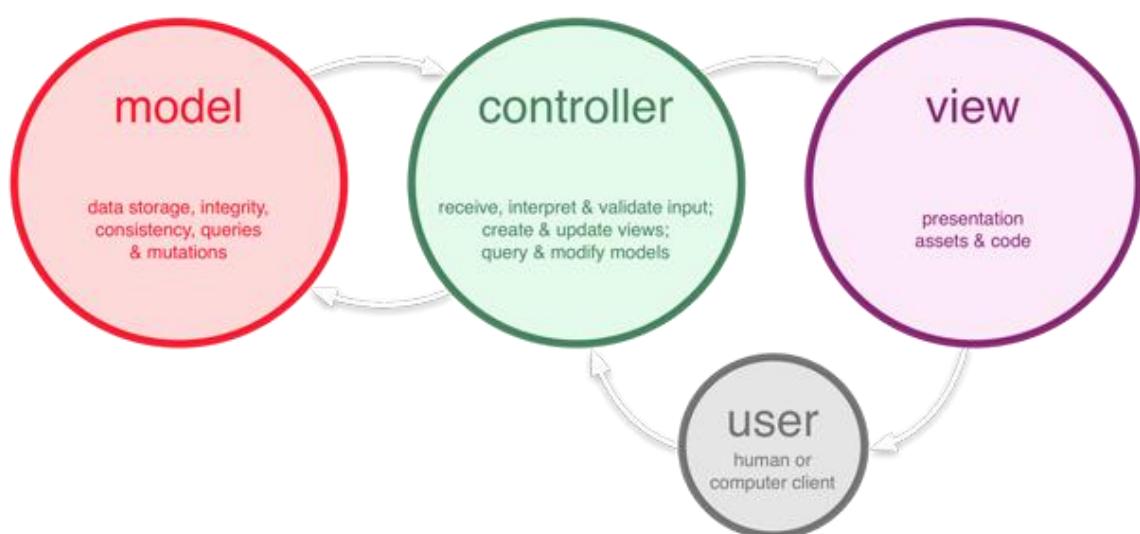


Figure 2.1 :MVC Model Architecture

2.2 Justification of MVC Architecture

The system is split into three MVC components. It can be autonomously updated and modified without impacting the other components. This helps to reduce the ambiguity of system codes by avoiding codes from being combined in one category from other classes. Therefore, MVC permits reuse of codes more often and reduces the coupling between layers. In other terms, there are no dependencies between how the data are actually stored and the representation of the data.

2.3 Architecture Model

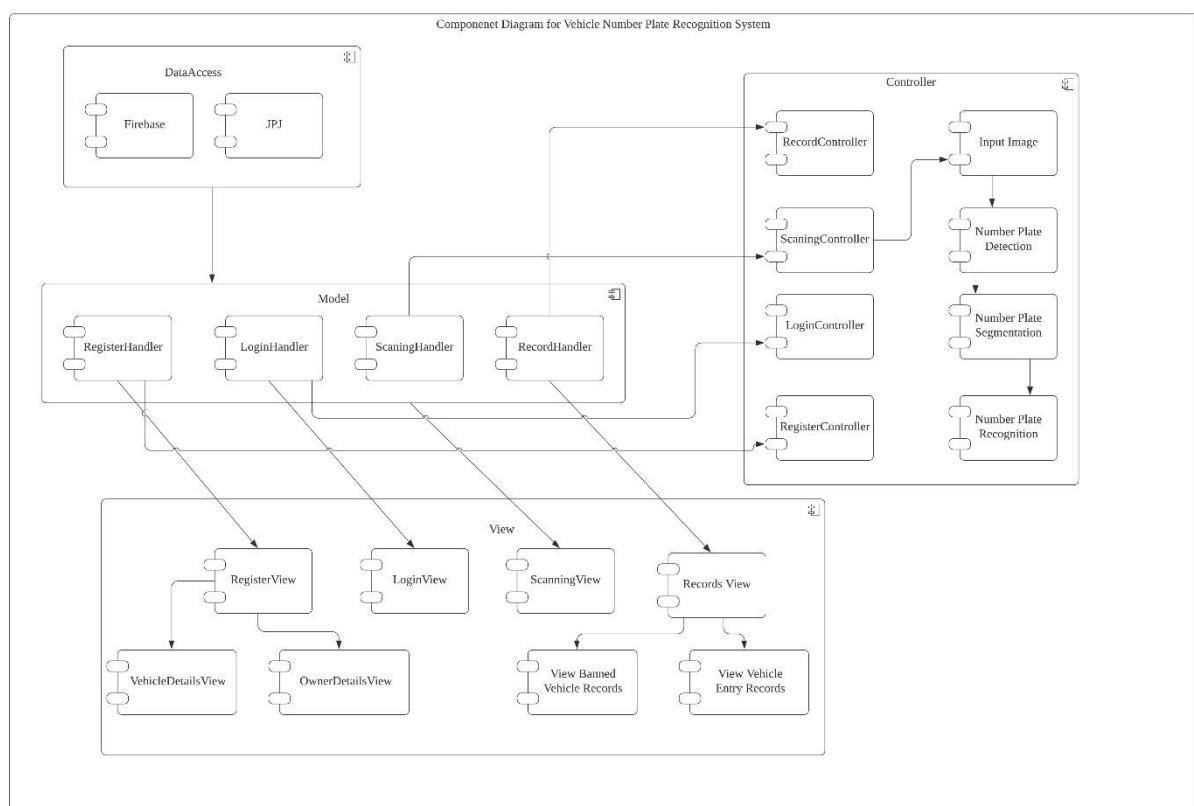


Figure 2.2: Component Model of <Vehicle Number Plate Recognition System>

3. DETAILED DESCRIPTION OF COMPONENTS

3.1 Complete Package Diagram

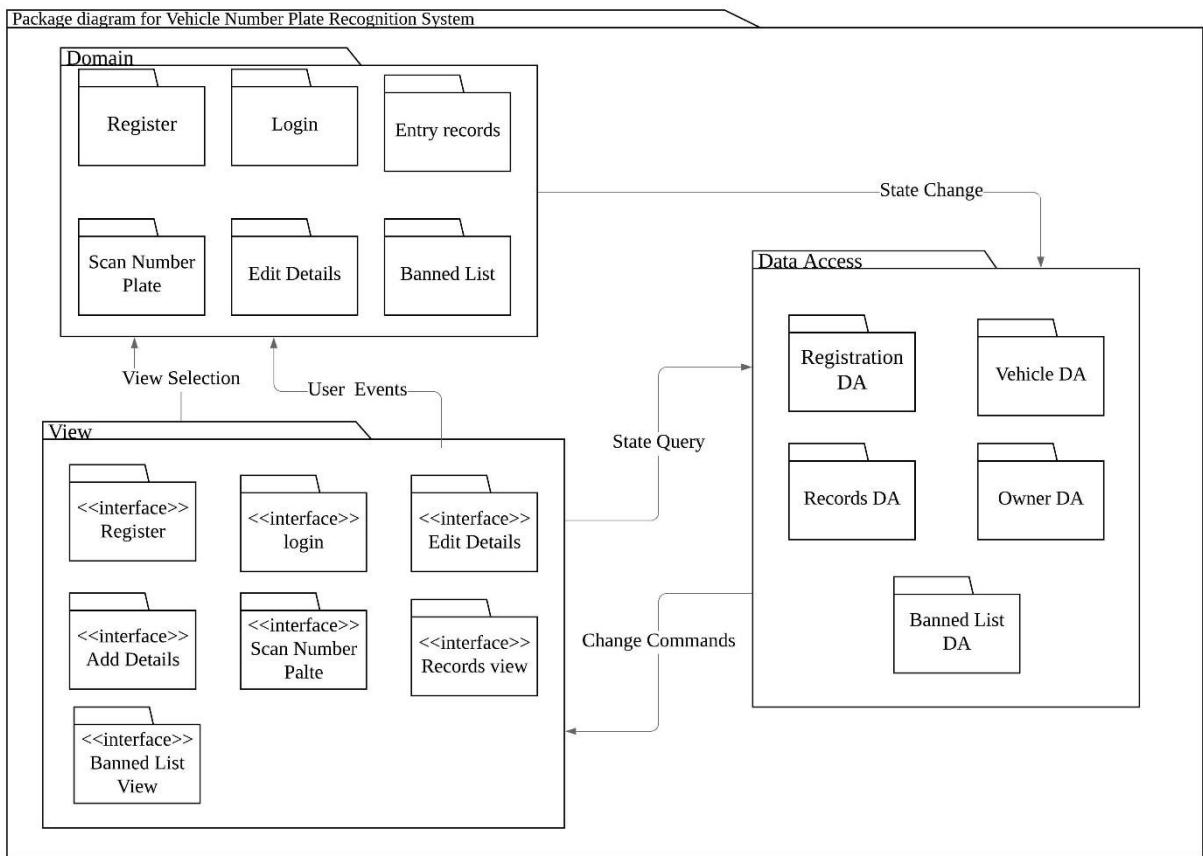


Figure 3.1: Subsystem of <Vehicle Number Plate Recognition System>

3.2 Complete Class Diagram

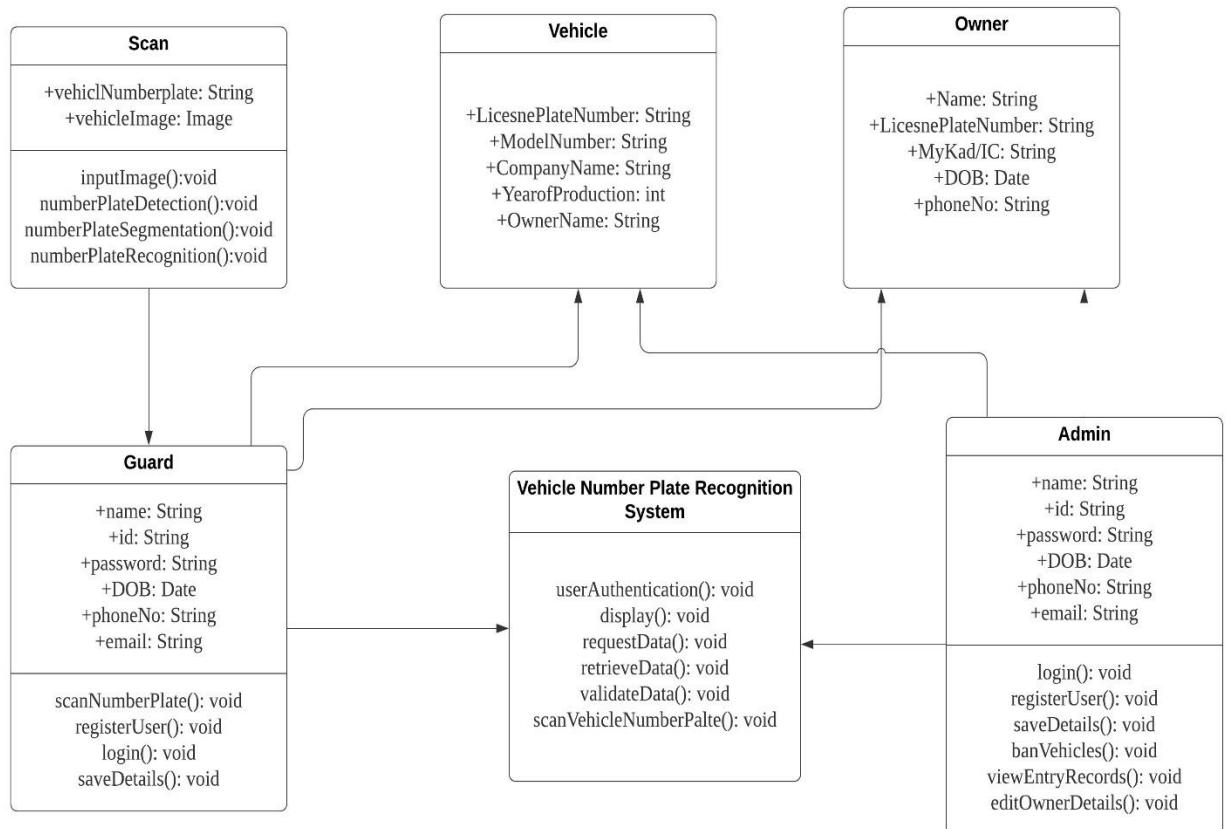
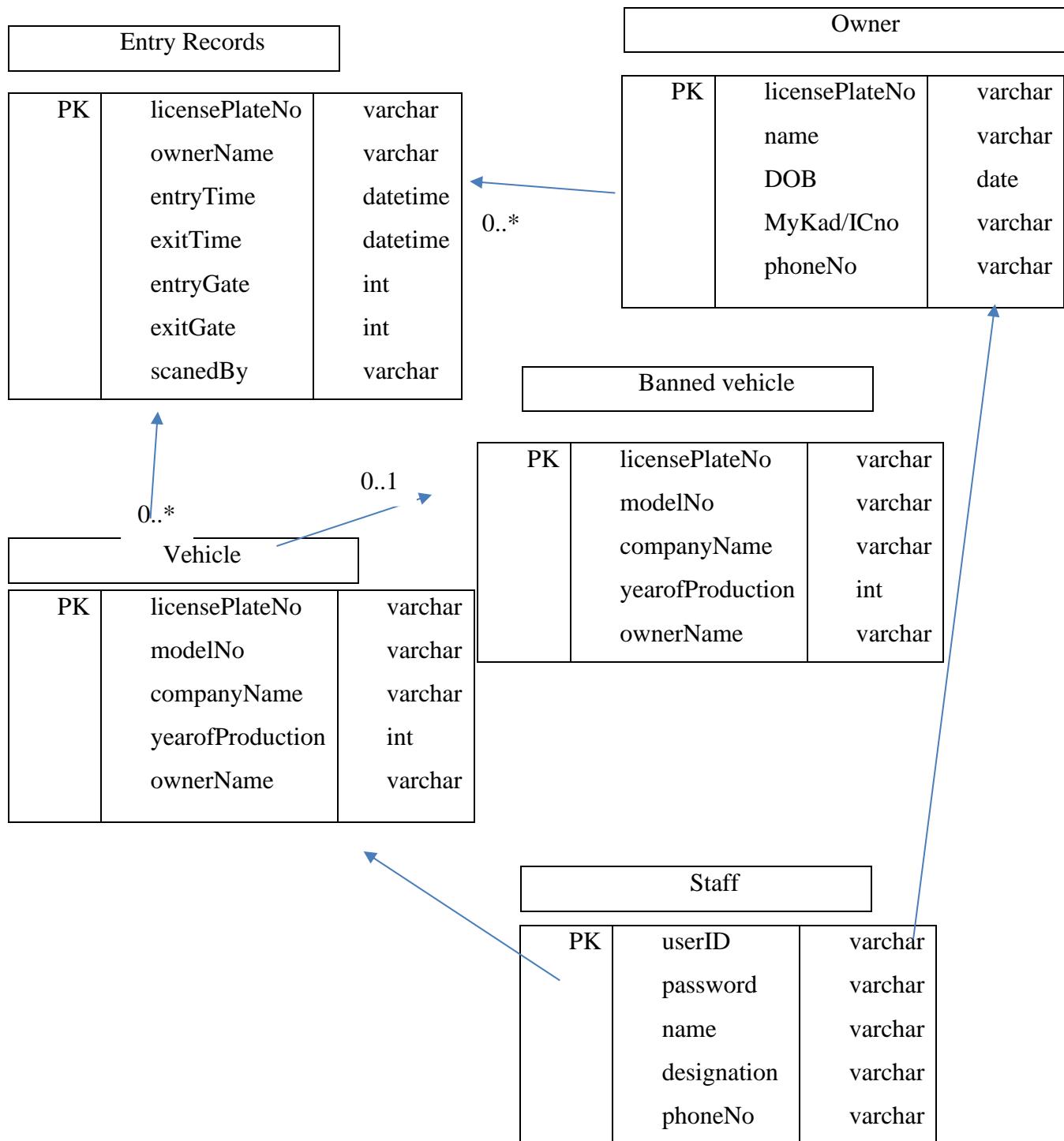


Figure 3.2: Class diagram for <Vehicle Number Plate Recognition System>

3.3 Database Design



4. DATA DESIGN

4.1 Data Description

Table 4. 1 Data description Vehicle Number Plate Recognition database.

TABLE	ATTRIBUTE	DESCRIPTION
Entry Records	licensePlateNo	Vehicle License Plate Number.
	ownerName	Name of the owner of the vehicle
	entryTime	The time that the vehicle entered the campus
	exitTime	The time that the vehicle exit the campus
	entryGate	The Gate through which the vehicle entered the campus
	exitGate	The Gate through which the vehicle exit the campus
	scannedBy	The guard who scanned the vehicle number plate.
Vehicle	licensePlateNo	Vehicle License Plate Number.
	modelNo	The model or version number of the vehicle.
	companyName	The company that produced the vehicle.
	yearofProduction	The year that the vehicle was produced.
	ownerName	The name of the owner of the vehicle
Owner	licensePlateNo	Vehicle License Plate Number.
	name	Name of the owner of the vehicle.
	DOB	Date of birth of the owner of the vehicle.
	MyKad/ICno	National ID number of the owner.
	phoneNo	Hand Phone number of the owner.

Banned Vehicles	licensePlateNo	Vehicle License Plate Number.
	modelNo	The model or version number of the vehicle.
	companyName	The company that produced the vehicle.
	yearofProduction	The year that the vehicle was produced.
	ownerName	The name of the owner of the vehicle
Staff	userID	The username for logging into the system.
	password	The password of the user.
	name	Name of the staff.
	designation	Position of the staff (Admin/Guard)
	phoneNo	Handphone number of staff

4.2 Data Dictionary

Entry Records

Entity Name	Element Name	Type	Length	Key Type
Vehicle Number	licensePlateNo	varchar	15	Primary Key
Name of Owner	ownerName	varchar	20	
Time of entry	entryTime	datetime	4	
Time of exit	exitTime	datetime	4	
Gate of entry	entryGate	int	2	
Gate of exit	exitGate	int	2	
Person scanned	scannedBy	varchar	20	

Table 4. 2: Data dictionary of entry records.

Vehicle

Entity Name	Element Name	Type	Length	Key Type
Vehicle Number	licensePlateNo	varchar	15	Primary Key
Version of Vehicle	modelNo	varchar	20	
Name of company	companyName	varchar	20	
Year of Production	yearofProduction	int	4	
Name of Owner	ownerName	varchar	20	

Table 4. 3: Data dictionary of Vehicle.

Owner

Entity Name	Element Name	Type	Length	Key Type
Vehicle Number	licensePlateNo	varchar	15	Primary Key
Name of Owner	name	varchar	20	
Date of Birth of owner	DOB	date	8	
National ID number	MyKad/ICno	varchar	30	
Hand Phone number	phoneNo	varchar	15	

Table 4. 4: Data dictionary of Owner.

Banned Vehicle

Entity Name	Element Name	Type	Length	Key Type
Vehicle Number	licensePlateNo	varchar	15	Primary Key
Version of Vehicle	modelNo	varchar	20	
Name of company	companyName	varchar	20	
Year of Production	yearofProduction	int	4	
Name of Owner	ownerName	varchar	20	

Table 4.5: Data dictionary of Banned Vehicles.

Staff

Entity Name	Element Name	Type	Length	Key Type
Username of staff	userID	varchar	15	Primary Key
Password of staff	password	varchar	20	
Name of staff	name	varchar	20	
Position of staff	designation	varchar	10	
Name of Owner	phoneNo	varchar	20	

Table 4.5: Data dictionary of Staff.

5. USER INTERFACE DESIGN

5.1 Overview of User Interface

For system development, a good and simple interface design is very important, since users interact with it. All users want a nice and simple interface. If the system is complicated to communicate with then the requirement of the user is not satisfied. Consumers can learn the system quickly and easily with a good interface design. The consumers should not be misled about the interface of the program because it would generate a poor user experience.

Figures in next part shows the interface of Vehicle Number Plate Recognition System

5.2 Screen Images

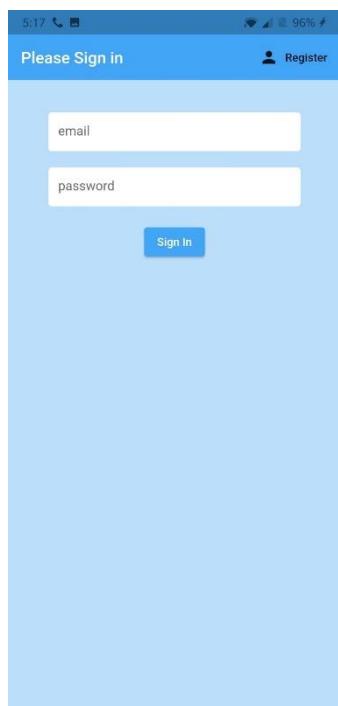


Figure 4.7: Login Screen

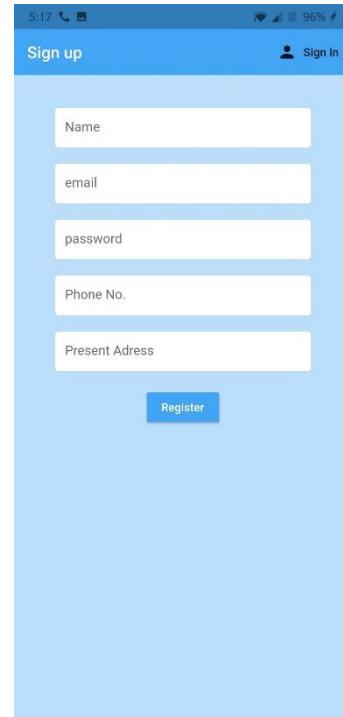


Figure 4.8: Signup Screen

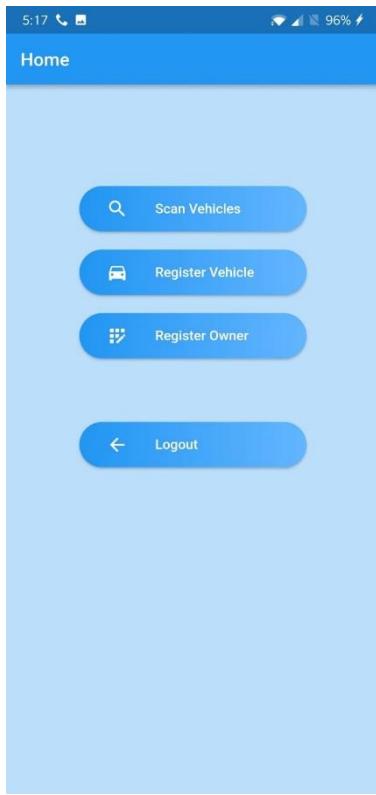


Figure 4.9: Guard Home Screen

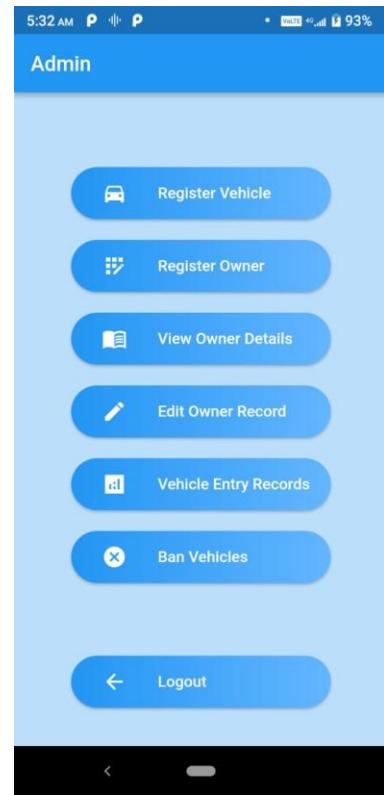


Figure 4.10: Admin Home Screen

The Register Vehicle Screen is a form for vehicle registration. It has a blue header with a back arrow and the text "Vehicle Registration". The form consists of five input fields: "License Plate Number", "Company Name", "Model Number", "Year of Production", and "Owner Name". Below the fields is a blue "Submit" button.

Figure 4.11: Register Vehicle Screen

The Register Owner Screen is a form for owner details. It has a blue header with a back arrow and the text "Owner Details Form". The form consists of five input fields: "License Plate Number", "Owner Name", "Date of Birth", "MyKad/ICno.", and "Phone Number". Below the fields is a blue "Submit" button.

Figure 4.12: Register Owner Screen



Figure 4.13: Ban Vehicle Screen



Figure 4.14: View Owner Records

Appendix E
System Testing Document

TABLE OF CONTENTS

1	INTRODUCTION	136
1.1	Testing	136
2	TESTING PROCESS	136
2.1	Introduction	136
2.2	Black Box Testing	136
2.2.1	Login	136
2.2.2	Scan Number Plate	137
2.2.3	Register New Vehicle	138
2.2.4	Edit Owner Details	139
2.2.5	Ban Vehicle	140
2.2.6	Add Owner Details	140
2.2.7	View Vehicle Entry Records	141
2.2.8	View Banned Vehicle Records	142
3	USER ACCEPTANCE TESTING	142
3.1	Task for User Acceptance Testing	143
3.2	Comments of the User	143
3.3	Improvement onto the system	144

1. INTRODUCTION

1.1 Testing

Testing is the process of assessing the requirements, functions or end users by tracking the results on the expected output after being given input. It is also known as the process of executing a program with the aim of finding "bug" errors. Testing is a part of the Software Development Life Cycle (SDLC).

2. TESTING PROCESS

2.1 Introduction

Vehicle Number Plate Recognition System will be tested with black box testing. Unit testing, Integration testing, System testing, User acceptance testing are combined and performed simultaneously in black box testing activities.

2.2 Black Box Testing

Black box testing is defined as a technique that ignores the internal mechanisms of the system and focuses on the output produced on any system input and implementation. It is also called functional testing.

2.2.1 Login

This function allows the user to login to the system. The test is carried out to check the correctness of the function and the expected result of the Login module of the Vehicle number plate recognition system. The correct username and password is sakib and 12345 respectively.

Test Case ID	TC001-01	TC001-02	TC001-03
Inputs and Actions			
Username	-	sakib	sakib1
Password	-	12345	1234
Result	Expected/Actual		

Login successful	X	√	X
Display Home Page	X	√	X

Test Case ID	TC002-01	TC002-02	TC002-03
Inputs and Actions			
Username	-		sakib
Password	-	12345	
Result	Expected/Actual		
Login successful	X	X	X
Display Home Page	X	X	X

2.2.2 Scan Number Plate

This function allows the user to scan the vehicle number plate. The test is carried out to check the correctness of the function and the expected result of the Scan Number Plate module of the Vehicle number plate recognition system.

Test Case ID	TC003-01	TC003-02	TC003-03
Inputs and Actions			
Username	-	sakib	sakib1
Password	-	12345	1234
Result	Expected/Actual		
Scan Number Plate	X	√	X
Display Number Plate	X	√	X

Test Case ID	TC004-01	TC004-02	TC004-03
Inputs and Actions			
Username	-	sakib	sakib1
Password	-	12345	1234
Result	Expected/Actual		
Scan Correct Number Plate	X	√	X
Display Correct Number Plate	X	√	X

2.2.3 Register New Vehicle

This function allows the user to new vehicle into the system. The test is carried out to check the correctness of the function and the expected result of the Register New Vehicle module of the Vehicle number plate recognition system.

Test Case ID	TC005-01	TC005-02	TC005-03
Inputs and Actions			
Vehicle Information	Fills In	Fills In	Fills In
Button Clicked	Submit Button	Submit Button	Submit Button
Result	Expected/Actual		
Click Register New Vehicle	√	√	√
Display Vehicle Registration Form	√	√	√
Fill In Form	√	√	√
Click Submit	√	√	√
Registration Completion Message	√	√	√

Test Case ID	TC006-01	TC006-02	TC006-03
Inputs and Actions			
Vehicle Information	Fills In used vehicle	Fills In used vehicle	Fills In used vehicle
Button Clicked	Submit Button	Submit Button	Submit Button
Result	Expected/Actual		
Click Register New Vehicle	√	√	√
Display Vehicle Registration Form	√	√	√
Fill In Form	√	√	√
Click Submit	√	√	√
Error Message Displayed	√	√	√
Successful Message Displayed	X	X	X

2.2.4 Edit Owner Details

This function allows the admin to edit owner details. The test is carried out to check the correctness of the function and the expected result of the Edit Owner Details module of the Vehicle number plate recognition system.

Test Case ID	TC007-01	TC007-02	TC007-03
Inputs and Actions			
Owner Information	New Information	Previous Information	No Information
Button Clicked	Submit Button	Submit Button	Submit Button
Result	Expected/Actual		
Click Edit Owner Details	√	√	√
Display Owner Information Form	√	√	√
Fill In Form	√	√	√
Click Submit	√	√	√
Successful Message	√	X	X
Error Message	X	√	√

2.2.5 Ban Vehicle

This function allows the admin to Ban vehicles to enter or rage alarm. The test is carried out to check the correctness of the function and the expected result of the Ban Vehicles module of the Vehicle number plate recognition system.

Test Case ID	TC008-01	TC008-02	TC008-03
Inputs and Actions			
Vehicle Information	New Vehicle Information	Banned Vehicle Information	No Vehicle Information

Button Clicked	Ban Vehicle Button	Ban Vehicle Button	Ban Vehicle Button
Result	Expected/Actual		
Click Ban Vehicle	√	√	√
Select Vehicle	√	√	X
Click Ban Vehicle	√	√	X
Successful Message	√	X	X
Error Message	X	√	√

2.2.6 Add Owner Details

This function allows the admin to add vehicles owner information into the system. The test is carried out to check the correctness of the function and the expected result of the Add Owner Details module of the Vehicle number plate recognition system.

Test Case ID	TC009-01	TC009-02	TC009-03
Inputs and Actions			
Vehicle Information	New Vehicle Information	Banned Vehicle Information	-
Owner Information	New Owner	Old Owner	Owner Info
Button Clicked	Submit Button	Submit Button	Submit Button
Result	Expected/Actual		
Click Vehicle Info	√	√	X
Display Vehicle Info	√	√	X
Click Add Owner Details	√	√	X
Input Information	√	√	X
Click Submit Button	√	√	X
Successful Message	√	√	X
Error Message	X	X	√

2.2.7 View Vehicle Entry Records

This function allows the admin to view the vehicle entry records in the system. The admin can only see the records of the entry and exit information of the vehicles. The test is carried out to check the correctness of the function and the expected result of the View vehicle entry records module of the Vehicle number plate recognition system.

Test Case ID	TC010-01	TC010-02	TC010-03
Inputs and Actions			
Username	sakib	sakib123	-
Password	12345	1234	-
Button Clicked	Login, View Entry Records	Login, View Entry Records	Login, View Entry Records
Result	Expected/Actual		
Input Username and Password	√	√	X
Click Login	√	X	X
View Home Page	√	X	X
Click View Entry Records	√	X	X
Display Entry Records	√	X	X
Display Error Message	X	√	√

2.2.8 View Banned Vehicle Records

This function allows the admin to view the banned vehicle records in the system. The admin can only see the records of the banned vehicles. The test is carried out to check the correctness of the function and the expected result of the View banned vehicle records module of the Vehicle number plate recognition system.

Test Case ID	TC011-01	TC011-02	TC011-03
Inputs and Actions			
Username	sakib	sakib123	-
Password	12345	1234	-

Button Clicked	Login, View Banned Vehicle Records	Login, View Banned Vehicle Records	Login, View Banned Vehicle Records
Result	Expected/Actual		
Input Username and Password	√	√	X
Click Login	√	X	X
View Home Page	√	X	X
Click View Banned Vehicle Records	√	X	X
Display Banned Vehicle Records	√	X	X
Display Error Message	X	√	√

3. USER ACCEPTANCE TESTING

User Acceptance Testing (UAT) is the final but critical beta testing conducted by actual end users to identify whether the requirements of the system are achieved or not. In Vehicle Number Plate Recognition System, UAT are conducted focusing the usability of the system.

3.1 Task for User Acceptance Testing

The table illustrates the list of tasks that were assigned to participants as from different roles of user.

Table UAT 1: List of Task as an admin role

Task	Description
1	Login to system
2	Register Vehicle
3	View Vehicle Entry Records
4	Ban Vehicles
5	Edit Owner Details
6	Add Owner Details

Table UAT 2: List of Task as a Guard role

Task	Description
1	Login to system
2	Register Vehicle
3	Scan License Plate Number
	Add Owner Details

3.2 Comments of the user

The participants involved out of few feedbacks and suggestions of the functional requirements of the developed system. The suggestions are listed below:

- i. The scan number plate will detect if there is any symbol before the licence plate number.
- ii. The scanning will detect the first word that is detected by the camera.
- iii. The plate number detected will not be stored in the database automatically.
- iv. The entry records are congested when displayed in mobile.
- v. The applications takes a bit of time while starting.
- vi. The performance is abit downgraded.

3.3 Improvement onto the System

According to the user feedbacks the overall performance of the Vehicle Number Plate Recognition System is positive but the performance issues are points that need to be noted. If the application is used over time then it might take longer to load. The improvements needed to be noted are:

- i. The tables displayed can be scrollable from left to right.
- ii. The recognition from the image should be clear without the signs detected.
- iii. The information stored should be in different databases to avoid be gathered in one place.

Appendix F
Questionnaire of User Acceptance Testing

**User Acceptance Testing Questionnaire for Vehicle Number Plate Recognition
System**

Part A: Personal Details

1. Name : _____

2. Gender : _____

Part B: In the scale of 1 to 5, please rate according to following questions.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

1. How do you rate the functionality of the use cases (features) in terms of performance?

1	Login	1	2	3	4	5
2	Register	1	2	3	4	5
3	Scan Number Plate	1	2	3	4	5
4	Add Vehicles Information	1	2	3	4	5
5	Add Owner Information	1	2	3	4	5
6	Ban Vehicles	1	2	3	4	5
7	View Vehicle Entry Records	1	2	3	4	5
8	View Banned Vehicle Records	1	2	3	4	5

2. How do you rate the usability of the use cases (features).

1	Login	1	2	3	4	5
2	Register	1	2	3	4	5
3	Scan Number Plate	1	2	3	4	5
4	Add Vehicles Information	1	2	3	4	5
5	Add Owner Information	1	2	3	4	5
6	Ban Vehicles	1	2	3	4	5
7	View Vehicle Entry Records	1	2	3	4	5
8	View Banned Vehicle Records	1	2	3	4	5

3. How do you rate the user interface of the use cases (features).

1	Login	1	2	3	4	5
2	Register	1	2	3	4	5
3	Scan Number Plate	1	2	3	4	5
4	Add Vehicles Information	1	2	3	4	5
5	Add Owner Information	1	2	3	4	5
6	Ban Vehicles	1	2	3	4	5
7	View Vehicle Entry Records	1	2	3	4	5
8	View Banned Vehicle Records	1	2	3	4	5

Part 3: Please answer following questions.

1. Did you understand the concept of the system delivered? If no, please state the reason.

[] Yes.

[] No. Reason: _____

2. Did the system satisfied your requirements for scanning plate number? If no, please state the reason.

[] Yes.

[] No. Reason: _____

3. Do you think the system have improved the current manual workbook system? If no, please state the reason.

[] Yes.

[] No. Reason: _____

4. Did you encounter any difficulty while using this system? If yes, please state the reason.

[] Yes. Reason: _____

[] No.

5. Kindly recommend any improvement(s) for this system (if applicable).
