LICENSE PLATE NUMBER LOCALIZATION AND RECOGNITION BASED ON IMAGE PROCESSING

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LICENSE PLATE NUMBER LOCALIZATION AND RECOGNITION BASED ON IMAGE PROCESSING

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A thesis submitted in fulfilment of the
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DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have been that which is learned for its own sake also teach me of the whole general knowledge of everything. It is also dedicated to my mother, who taught me that even the largest task can be accomplished first with help of GOD ‘Allah’ and if it is done one step at a time.

ACKNOWLEDGEMENT

In preparing this thesis, I was in contact with many people, researchers, academicians, and practitioners. They have contributed towards my understanding and thoughts. In particular, I wish to express my sincere appreciation to my main thesis supervisor, Mr. Mohammed Qadir for encouragement, guidance, critics and friendship. Without his continued support and interest, this thesis would not have been the same as presented here.

My sincere appreciation also extends to all my colleagues and others who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to all my family member.

ABSTRACT

License plate recognition is a web-based system that specifically will be provided for police officers so they can check and track car every time they want time just by taking a picture of the car plate and then sending it to the police station after a while it will do a background check about the car and the driver on its own. It describes design algorism and the future of implementation. The system has color image inputs of a car and the output has the registration number of that car. It will be helpful in many fields for its people's community. The proposed system can process images at high speed and with high accuracy. This system was developed to meet the performance, computational speed, and customization requirements of vehicle monitoring applications such as stolen vehicle detection systems. Those are plate localization, character segmentation, and character recognition. First, the number of plates is extracted from the original image, then the characters from it are isolated, and finally, each character is recognized. The final program can extract the required information with a high percentage of the test images. Lastly, this project aims to make things easier in many aspects of driving and specifically the community. also helping police officers by reducing the possibility of car accidents.

ABSTRAK

Pengecaman plat lesen adalah sistem berasaskan web yang khusus akan disediakan untuk pegawai polis supaya mereka boleh menyemak dan mengesan kereta setiap kali mereka mahu masa hanya dengan mengambil gambar plat kereta dan kemudian menghantarnya ke balai polis selepas beberapa ketika. akan melakukan pemeriksaan latar belakang tentang kereta dan pemandu sendiri. Ia menerangkan algoritma reka bentuk dan masa depan pelaksanaan. Sistem ini mempunyai input imej berwarna kereta dan output mempunyai nombor pendaftaran kereta itu. Ia akan membantu dalam banyak bidang untuk komuniti rakyatnya. Sistem yang dicadangkan boleh memproses imej pada kelajuan tinggi dan dengan ketepatan yang tinggi. Sistem ini dibangunkan untuk memenuhi prestasi, kelajuan pengiraan dan keperluan penyesuaian aplikasi pemantauan kenderaan seperti sistem pengesanan kenderaan yang dicuri. Itu ialah penyetempatan plat, pembahagian aksara dan pengecaman aksara. Pertama, bilangan plat diekstrak daripada imej asal, kemudian aksara daripadanya diasingkan, dan akhirnya, setiap aksara diiktiraf. Program akhir boleh mengekstrak maklumat yang diperlukan dengan peratusan tinggi imej ujian. Akhir sekali, projek ini bertujuan untuk memudahkan dalam banyak aspek pemanduan dan khususnya masyarakat. juga membantu pegawai polis dengan mengurangkan kemungkinan kemalangan kereta.

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LIST OF ABBREVIATIONS

LPN	LICENSE PLATE NUMBER
LPR	LICENSE PLATE RECOGNITION
TH	THONNY IDE
GPS	GLOBAL POSITIONING SYSTEM

Chapter 1

INTRODUCTION

1.1. Introduction

License plate recognition (LPR) is an image processing system that recognizes a vehicle by identifying the license plate [1]. A license plate recognition system is a camera that converts a vehicle license plate image into computer-readable data that can be compared to a database list. According to [1][2], LPR is a type of Intelligent Transport Systems (ITS) technology that not only recognizes and counts vehicles but also identifies each vehicle as unique. The LPR system has so many advantages, for example, it can be used for traffic control management to detect vehicles committing traffic violations. Moreover, enter the restricted area without permission. It occupies the lane of public transportation, crosses the red light, and exceeds the speed limit [2]. In other cases, such as commercial vehicle operation or secure access control general security system wherever you are you need to identify vehicles., the vehicle license plate can be compared to a database of acceptable numbers so that the truck can bypass the weighing station or the vehicle can enter a housing complex or parking lot. Judge whether it can be done. As reported by [3], LPR is a new tool for automated vehicle and traffic monitoring using digital image processing. The system will work step by step like this first the camera on the phone will take a picture of the license plate, then it will send it to the police station through texts messages. Lastly, again as a text message from the police station there will be a reply within all the background information of the driver, the location of the vehicle.

1.2. Problem background

Unfortunately, nowadays there is a high possibility of getting into an accident especially when we are parking. Sometimes you just park your car and another car comes and will hit your car without knowing the actual background of the driver or the actual car specifically. It is really important while we drive a car suddenly, we see the car accident to notify the police we just take a cosplay we can notify the police it would make it easier for the community and also for those two people who made the accident so they can figure out for themselves later and do you know who is fairer about the accident. This is a great success and a small favor for the police to make things easier and also for its community. It is a big problem for the drivers and it is confusing since there are teenagers who are driving their parents' car sometimes without their permission. While getting in an accident the driver will not know who is the owner of the car. The proposed solution is making a reliable system which can recognize the plate of all the cars and it will check the background of the car.

1.3. Project aim

The actual aim of this project is to reduce the possibility of having an accident by underage people, these approaches are limited by several factors. Also, this system is specifically used for law enforcement purposes, including to check if a vehicle is registered or licensed.

1.4. Objectives

The proposed system will provide the following objectives:

1. To analyze and create an image processing LPR system algorithm considering car plate numbers from Iraq.

2. To develop and design all the functionality while making a mobile web-based system.
3. To develop a system more secure for the community and help the police officer.
4. To analyze how the check background works at any place and analyzing the GPS depends on the place the picture is going to be taken.
5. To test it, the system will go through various Iraqi plate numbers with different states (day and night) and different conditions.

1.5. Scope

The license plate number recognition is the system that focuses on image processing using Python and OpenCV. Also, the system is specifically for people to have the ability to read only Iraq plate formats (The system will be specifically for the Iraq area). This system will need GPS to track the location of the car so the data will be sent within the location as text messages and sending data again from the police officers from the police station. The system's reliability is quite strong so it will have the ability to do a background check as soon as the license plate got taken as a picture by the police officers or ordinary people. For the testing part, the system will recognize 5-10 license plates so it shows how it works.

1.6. Importance of the Project

The reason that this topic got chosen is because of the low-security dirty drivers have in the streets especially during happening an accident expectedly. The motivation behind choosing this project is how futuristic the system is and how helpful it can be for the drivers especially for the younger ones because the last thing they want is to get involved in some trouble or some situations in the street. Everyone can get benefits from this system because it is so suitable and helpful to check the background of the driver while driving in or even when an accident possibly can happen in some places.

1.7.Report Organization

This chapter was organized to go through many aspects of the project like introduction, objectives and aim, problem background, and lastly importance of the project. The main focus of this chapter was breaking down the importance of the first step of the project. In the next chapter which is chapter 2 (Literature Review), the report is discussed several existing systems, and provides the characteristics of each system and why they have been proposed.

Chapter 2

LITERATURE REVIEW

2.1. Introduction

In the previous chapter the general introduction, aims and objectives, and problem statement of the proposed system are discussed. This chapter is a literature review based on all papers that have been chosen, they will be reviewed in details. Moreover, in this chapter, several existing systems are discussed in terms of software and tools, technologies, and advantages/disadvantages of these systems are will be discussed. Nowadays occurring an accident is most common in some places and it is quite hard for a police officer to know about their background and it is necessary to do background checks while an accident happens within a text message which can be sent to the police officers, and do a background-checked on a specific driver so the possibility of occurring an accident will be decreased hopefully.

2.2. Current System Analysis

This section will go through the approaches and techniques that are now in use in using license plate number localization and recognition using image processing how are the United States most car doesn't have a database of Wi-Fi and Internet browser to expose their location. The majority of the system are you using the standard camera on that please there is no such a system that the user can only use their phone to cabbage the license plate number and sending it to the police station so they can get their information back. The majority of the systems well only track the speed of the specific car or their location mostly there's no such a system to be in service for the police stations or the users so it will come in handy and convenient for them. Plenty of systems that can be in servers for police stations but there is no such system that could

be specific for the user so it will decrease the number of accidents or the crowd noise during an accident that will happen anytime anywhere.

2.2.1. Car Plate Recognition Based on CNN Using Embedded System with GPU

The built-in system is more implemented using GPU to recognize license plates without detection lines. The deep learning network for license plate recognition uses AlexNet, which is relatively simple. Testing has confirmed that license plate numbers can be effectively recognized by the Jetson TX1 onboard system [4]. This system is more limited because the embedded system with the GPU will only be using cameras that are standard

2.2.2. Current system analysis

This idea can be done in various designs and font styles of car license plates [5].It uses a graphical user interface with MATLAB programming to recognize license plates that deny or allow access to the car. The proposed interface serves as the first phase of the project to transform the facility's main entrance into a fully automated car entrance control system by reducing the number of parents at the main entrance. This phase involves building a license plate database, creating a main processing interface, and simulating the controller as a human assistance system that processes and controls the car entrance using a graphical user interface. The project was planned to take place in a university building with access to car entrances managed, controlled, and monitored by security guards which is quite suitable for our case. The gate provides access/exit to faculty, visitors, and student vehicles that move an average of 300 vehicles per day, managed by three guards. According to the security procedures and guidelines of the present system, and the vehicle entry/exit protocol, vehicle entry into the building is a very important issue. This work is manually managed and executed

by the security guard in charge of the main door, such as managing the entry and exit of the car, registering the license plate of the car, and registering the names of the staff and faculty members who belong to the car [3].

2.2.3. License plate identification and recognition using neural pattern matching

The idea purposely recognizes vehicle nameplate details through cameras installed at various locations on the road. It also plays an important role in ITS, which has several practical uses such as vehicle tracking, parking fee payments, Overspeed vehicle detection, road accident control, and illegal/counterfeit vehicle identification/tracking. The task of license plate recognition changes as the characters used in different languages change, and different approaches are presented accordingly. The author shows an effective recognition system for Malaysian license plates. License plate recognition can be performed on one and two lines using a smearing algorithm [4]

2.2.4. Automatic Number Plate Recognition using high-quality image

They used a camera to capture a license plate image from the desired scene. Either a still image or a photographic video was captured and processed by an image processing-based recognition algorithm to achieve alphanumerical conversion of the captured image into a text entry. After a high-quality image of the scene/ vehicle was acquired, the central dependency of the ANPR system is the robustness of its algorithm. These algorithms required very careful scrutiny and require thousands of lines of software coding to achieve the desired results and cover the complexity of all systems [6]. Based on the results on methods and algorithms, and software and tools all previous systems have used different methods and algorithms, and also implemented their system using different software and tools. Most of the systems have

used image preprocessing techniques to enhance the high-quality of images, which is are great methods and algorithms to make the implementations way easier since the system is more focused on the implementation part.

2.3. Technology Used

For the majority of the systems which are recent ones, they have used incredible techniques and algorithms. the specific algorithms and tools that are suitable for the implementation part is Sobel Edge Algorithm and Image Enhancement or recognition which are both possible also Character Segmentation will be suitable for the segmentation part while recognizing every character in the car plate number.

Languages: for developing the codebase the majority of the systems have used python IDE more specifically Thonny IDE which is easier with using pyterssect, OpenCV library which is more focused on the deep core interaction rather than designing

2.4.Chapter Summary

This chapter is all about literature review based on the chapters that have been chosen. The whole paper has used different methods and technologies for its advantages also the comparison between them has been mentioned within the tools and algorithms. For an effective license plate recognition system to be trustworthy and secure enough, the system should use strong methods and algorithms according to the comparison that has been mentioned above.

Chapter 3

SYSTEM DEVELOPMENT METHODOLOGY

3.1. Introduction

The project's overall concept was covered in the preceding chapters, and several current systems were reviewed in the second chapter. As a consequence of that review, we were able to determine which methodologies, software, and hardware would benefit the proposed system that had been used in current systems. Moreover, in this chapter, the methodology of the system and the one that has been chosen within its justification also the user requirements, system design, system development, and testing will be discussed. Most importantly the hardware and software requirements will be illustrated in this chapter.

3.2. License Plate Recognition Methodology and Justification

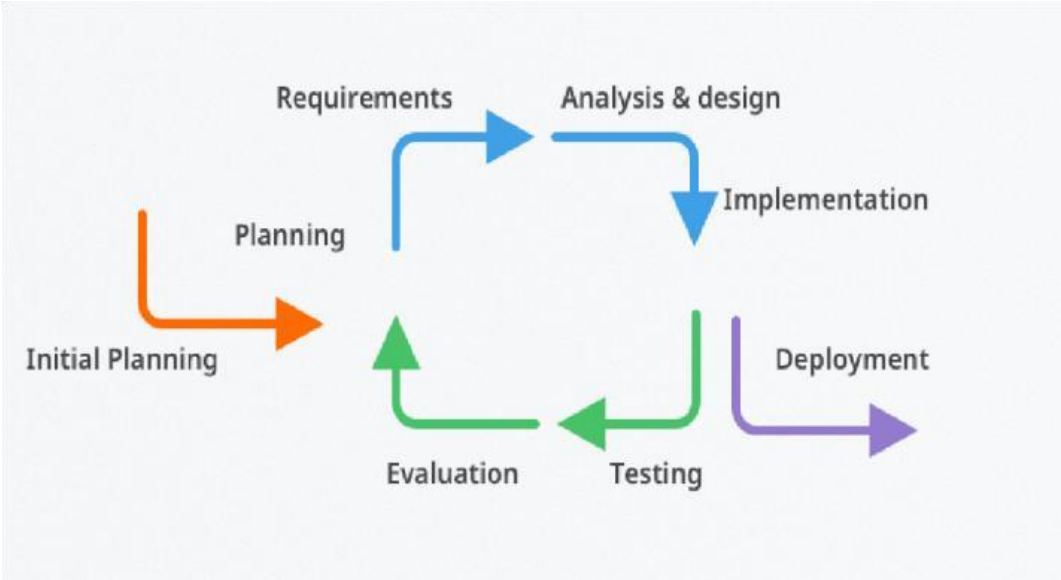

Figure 3-1 Project Life Cycle

Many methodologies can be used while developing a system, such as waterfalls, prototyping, scrum, rational unified process (RUP), rapid application development (RAD), iterative development, Agile, and so on for this project. After doing a deep search, iterative development has been selected to model the license plate recognition system. The iterative model is most often thought of as a cyclic process. After the initial planning phase, a small number of phrases are repeated many times, with the software being gradually improved and repeated as the cycle completes. Improvements can be quickly identified and implemented during each iteration so that the next iteration is at least slightly better than the last iteration [4]. License plate recognition is a system that should focus more on the implementation part despite focusing on the design and how it is going to look. The agile iterative approach allows software development teams to plan, design, review, and adapt iterations.

This software development model is a comprehensive and accessible methodology that can greatly benefit agile organizations. Compared to other approaches, the agile iterative approach is more flexible, innovative, faster, and more modifiable. This approach leaves room for customer involvement in the development process and eliminates the need for retroactive changes after the deliverable is released.

3.3. The Phases within Iterative Development

Agile software system methodology is divided into six phases that lead the software to success. Those phases are requirement gathering, design, development, testing, deployment, and review.

3.3.1. Planning Phase

The first step in an iterative life cycle is a plan for developers and customers to work together to identify software needs, business needs, and stakeholder needs. At this stage, you do not have to identify the risks associated with the project or worry about quality assurance requirements. The next iteration repeats this step to overcome the risks and ensure quality. Once all requirements are identified, analysis is performed to streamline the development process.

3.3.2. Requirements

This phase is iteratively repeated when the complete software specification is developed in smaller requirements blocks [1]. This iteration request is collected and carefully examined to continue working on each iteration. This requirement can be a new requirement or an extension of an already created requirement. Firstly, For the system license plate recognition, the developer first should gather all the requirements of the system and examine the requirement or an extension.

3.3.3. Design Phase

Once the system has the iterative requirements, then it needs to implement the design phase. Effective design is determined to implement the requirements from many choices [1]. This is one of the key steps, as proper design can provide optimal results and keep client funding pressure low. This design can be a new design or an extension of an already created requirement.

3.3.4. Implementation Phase

The specified design is implemented by the developer using the specified coding and metric standards. Developers need to implement unit tests at each stage of development during code development The implementation phase is quite delicate the developer should think about every aspect of the system and all the small details that are needed for it to work its best.

3.3.5. Testing Phase

Once the code is implemented, this testing phase must be implemented to identify any bugs that exist in the code and report any bugs to the developer. Testers can create new test cases or use existing test cases created in previous builds, but thorough testing is prioritized as all bugs affect the software specifications. increase.

3.3.6. Review Test

In this phase, the developed requirements are checked to meet all the criteria according to the currently determined requirements. Based on this further planning, demand planning is designed and implemented as part of the next iteration cycle.

3.4. System Design

The iterative design is a highly suitable way of designing such a big task more focusing on the implementation section. Moreover, this allows you to quickly resolve misunderstandings within your project team and clarify them early in the development life cycle. Also, this approach will generate user feedback to ensure that system

requirements match user requirements. In relation to the client, it will be useful to show the development of the design rather than "throw" the finished product. This ensures that the development team is focused on creating value for the user. Can provide regular testing and provide a highly desirable performance framework for acceptance testing. You can easily integrate “lessons learned” into your final product. This gives stakeholders a better picture of progress at each iteration.

3.5. PSM 1,2 Yearly Gantt Chart

The Gantt chart below illustrates the yearly schedule of the License plate recognition system. The whole PSM1 will be done from Nov 2021 till the end of the year 2022. Lastly, the implementation part will be held in the first two months of the year 2023.

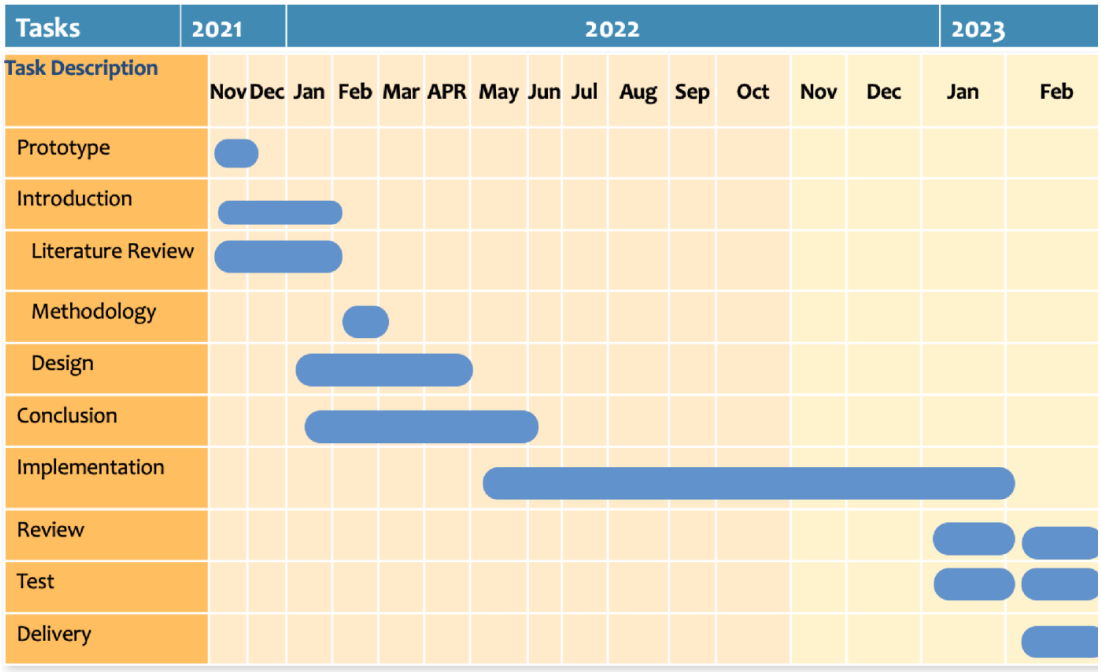

Figure 3-2 The proposed system’s Gantt chart

3.6.Tools and Technology used for the proposed system

Several software and tools are required to build a smart house, including Arduino IDE, an application for writing Arduino code, and Fritzing, which is an application for designing the Arduino with its wires. Finally, there is UiZard, which is used for prototyping.

Table 3-1 shows chosen tools and Technologies the proposed system

Tools	Technologies
Python Computer Language Python OpenCV Library OCR Python Library Thonny IDE	Personal Computer (or Laptop o Mobile Phone Mobile Camo GPS)

3.7.System Requirement Analysis

3.7.1. Hardware Justification

While developing a system hardware requirement is important in software development to ensure optimal execution in a particular user context. The hardware specifications required to build this system are:

Table 3-2 shows the hardware and its specifications

No.	Hardware	Specification
1	Personal Computer	OS: Microsoft Windows version 11 CPU: AMD Ryzen 9 5900X. RAM: 8GB Graphics Card: **AMD Radeon** RX580

2	Smart Phone	Model: IOS, android RAM: 6GB • SD Card: SUNTRSI Cam: 108 MP
3	GPS	• Navmii app for both ios and andriod
4	Internet Connection	128kbps

3.7.2. Software Justification

For the software, Python will be used to create license plate detection and recognition programs because it has many libraries that are suitable for this system that can be done easily. Also, The Python language is one of the most accessible programming languages available because it has a simplified syntax, is not complex, and focuses on natural language. Python code is easy to learn and use, so it can be written and executed much faster than other programming languages [2]. Despite the fact that the program can respond quickly to any kind of input. This will be achieved using three libraries, including pytesseract, imutils, and OpenCV.

3.8. Summary

This chapter is all about the methodologies that have been chosen. In this chapter, a specific method has been chosen and been followed for the implementation part. Also, the workflow and block diagram has been illustrated so it will give the vision of how the actual system will work and what the system needs to be more suitable and efficient.

Chapter 4

REQUIREMENTS ANALYSIS AND DESIGN

4.1. Introduction

In the preceding chapter, the technique has been stated withinside the iterative technique for the system. The system carries five degrees to undergo it together with the evaluation, the layout, and the implementation. Also, all of the software program and equipment which might be wished for the task had been stated withinside the preceding bankruptcy. This bankruptcy is the requirement evaluation and layout of the FRS. Some UML (Unified Modelling Language) diagrams, together with use case, sequence, activity, and class, and additionally interface diagrams can be presented. Chapter 4 makes use of UML modeling to investigate and create the proposed device`s necessities. The device layout depicts the device`s necessities in addition to the task's device behavior.

4.2. Requirement analysis

The technique of figuring out consumer expectancies for a brand new or modified product is known as necessities evaluation so it suggests the illustrations of the preferred layout now and again called necessities engineering. These traits are associated and specific. In this section, the file offers the necessities evaluation the usage of numerous diagrams together with the use case model, sequence model, activity diagram, and class diagram.

4.2.1. Unified Modeling Language (UML)

Use case diagrams are a precursor to apply case specifications, representing a fixed of high-stage gadget capability the usage of symbols for actors, use instances, and interactions. of them. Use case diagrams are regularly used as a precis of all use instances for a gadget, displaying which use instances were documented and documented in addition withinside the complete use case specification.[2] A use case diagram has 4 parts: the use case, the gadget wherein the use case is developed, the actors, and relationships among all of those are included.

4.2.1.1. Use Case Modeling

The proposed capability of a brand-new system is defined in a Use Case Model. A Use Case is a discrete unit of the interplay among a machine and a user (human or computer). This interplay, together with Create Account or View Account Details, is an unmarried unit of significant work. Each Use Case outlines the capability so as to be constructed into the proposed machine, which can also additionally combine capability from different Use Cases or amplify any other Use Case`s behavior.

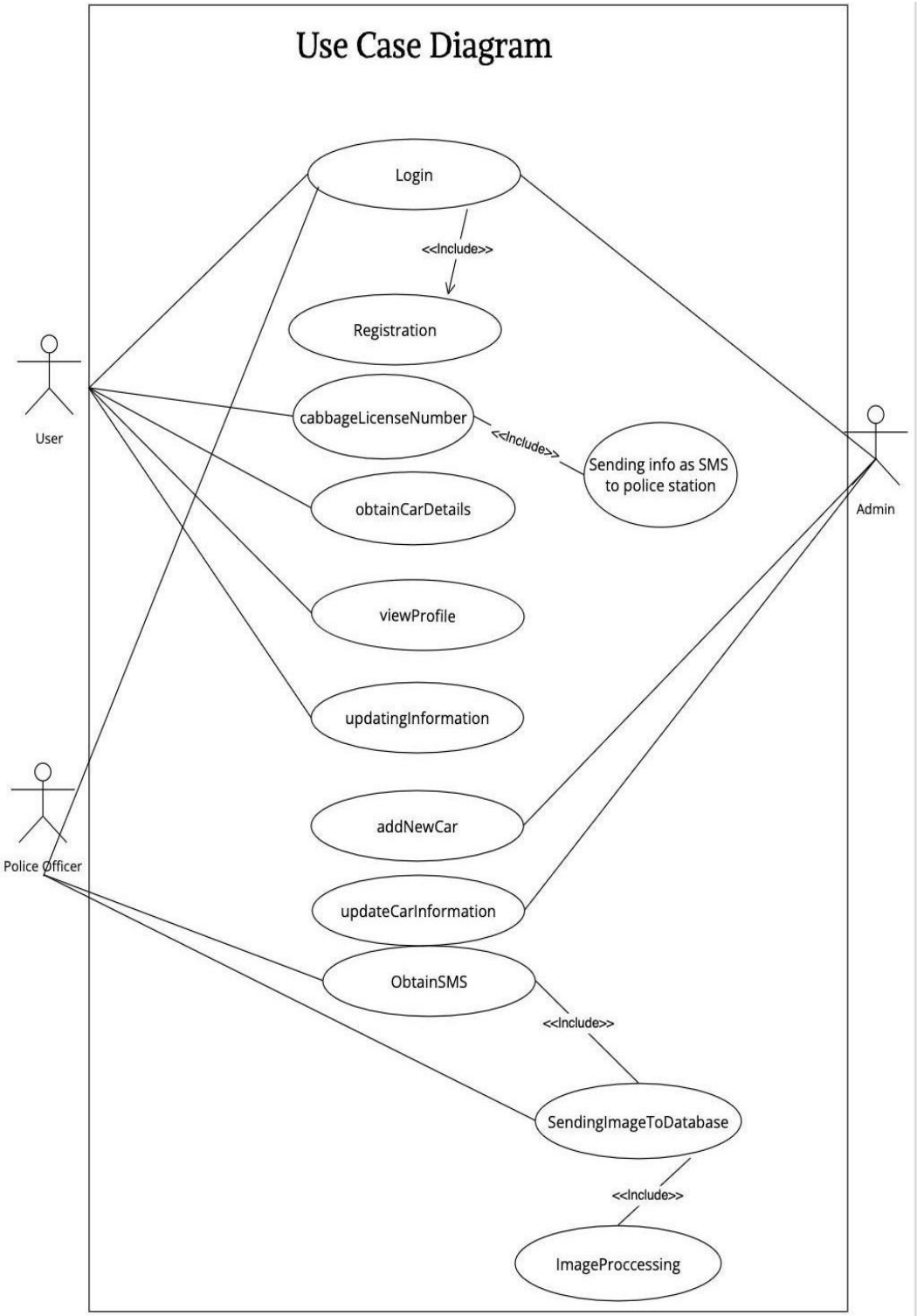

Figure 4-1 use case diagram of the license plate number recognition

4.2.1.2. Sequence Modelling

Sequence diagrams depict interactions among training as a chain of messages exchanged over time. Event diagrams are some other calls for them. A collection diagram is a powerful device for visualizing and validating extraordinary runtime scenarios. These can resource in predicting how a device will behave and figuring out obligations that a category might also additionally require at some stage in the modeling phase.

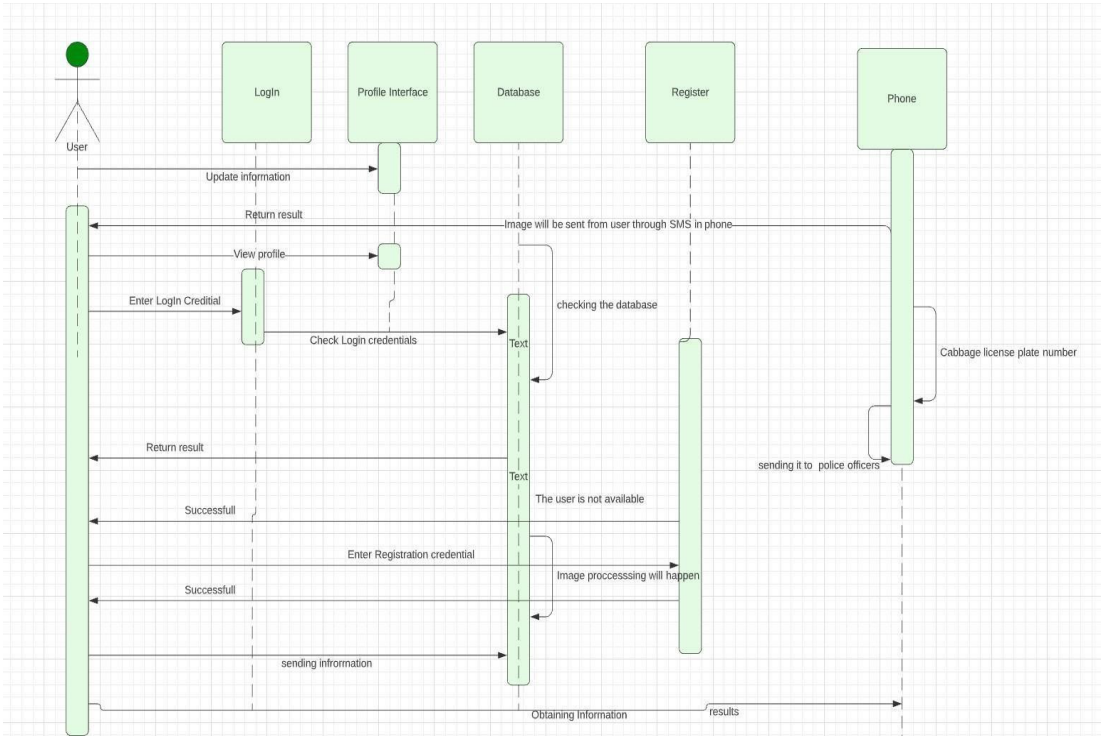

Figure 4-2 sequence diagram of the license plate number recognition (User Stakeholder)

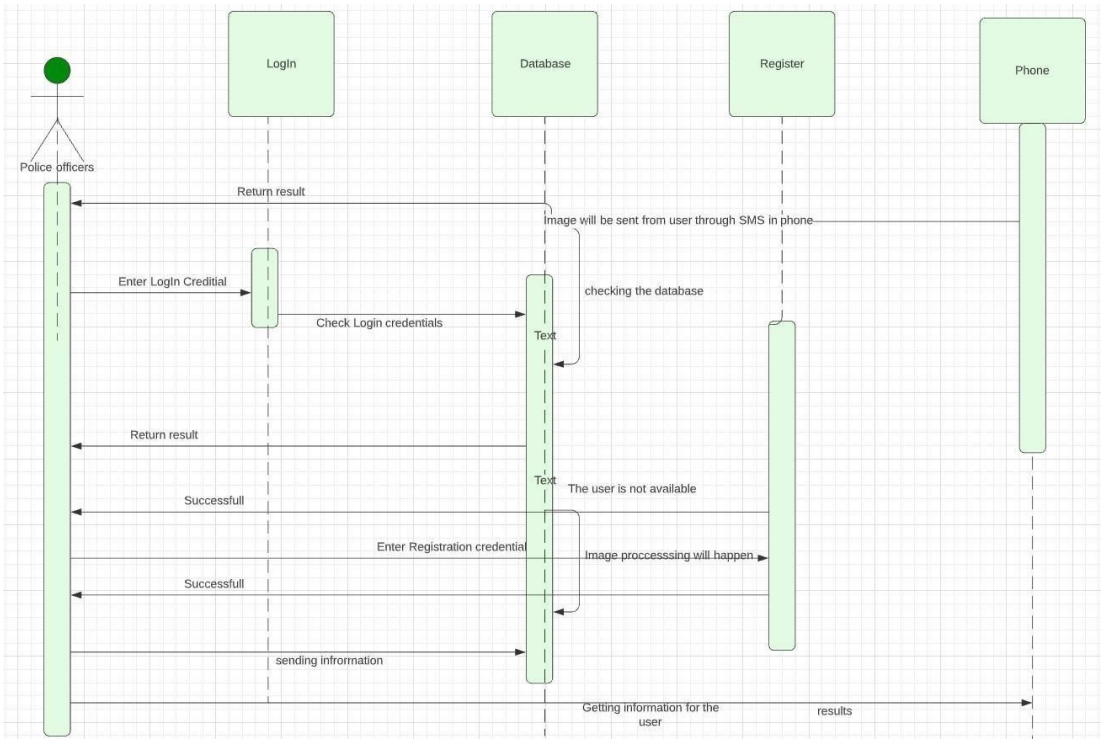

Figure 4-3 sequence diagram of the license plate number recognition (Police Officer Stakeholder)

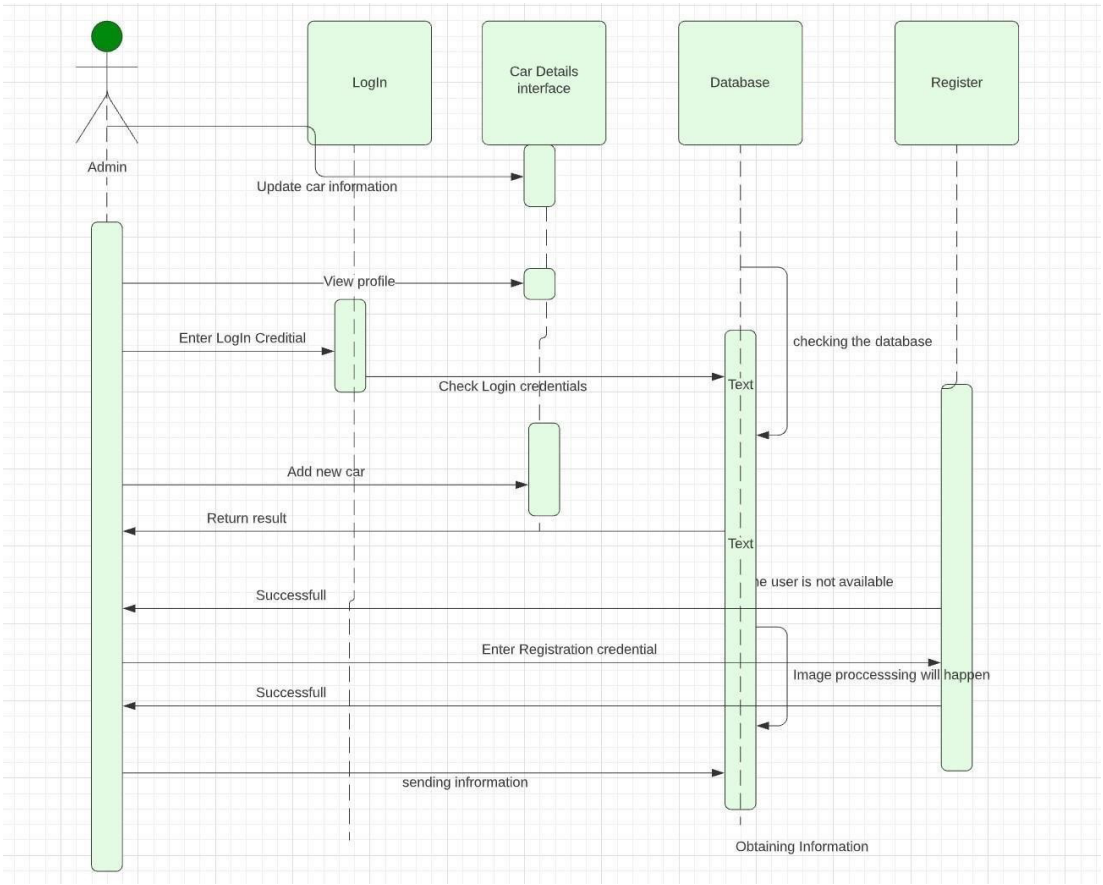

Figure 4-4 sequence diagram of the license plate number recognition (Admin Stakeholder)

4.2.1.3. Activity Diagram

Another essential diagram in UML for describing the dynamic characteristics of the system is the activity diagram. An activity diagram is a flowchart that depicts the movement of information from one action to the next. The activity can be described as an operation of the system. The control flow is drawn from one operation to another. This flow can be sequential, branching, or running at the same time. Activity diagrams use different elements such as forks and joins to handle different types of flow control.

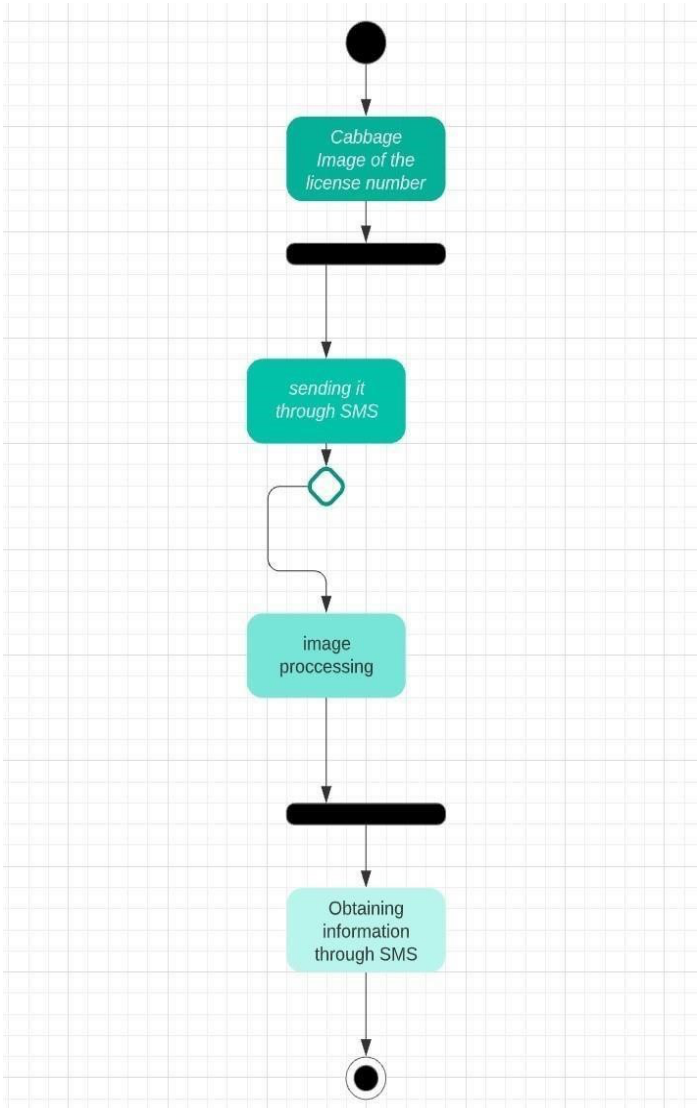

Figure 4-5 shows the diagram of the license plate number recognition

4.2.1.4. Sequence Diagrams for Admin

Class diagrams are important to the object modeling process because they represent the static structure of the system. Class diagrams can be used to represent the components of the system, their relationships, and the features and services they provide. A class diagram of the face recognition system is also included below the diagram.

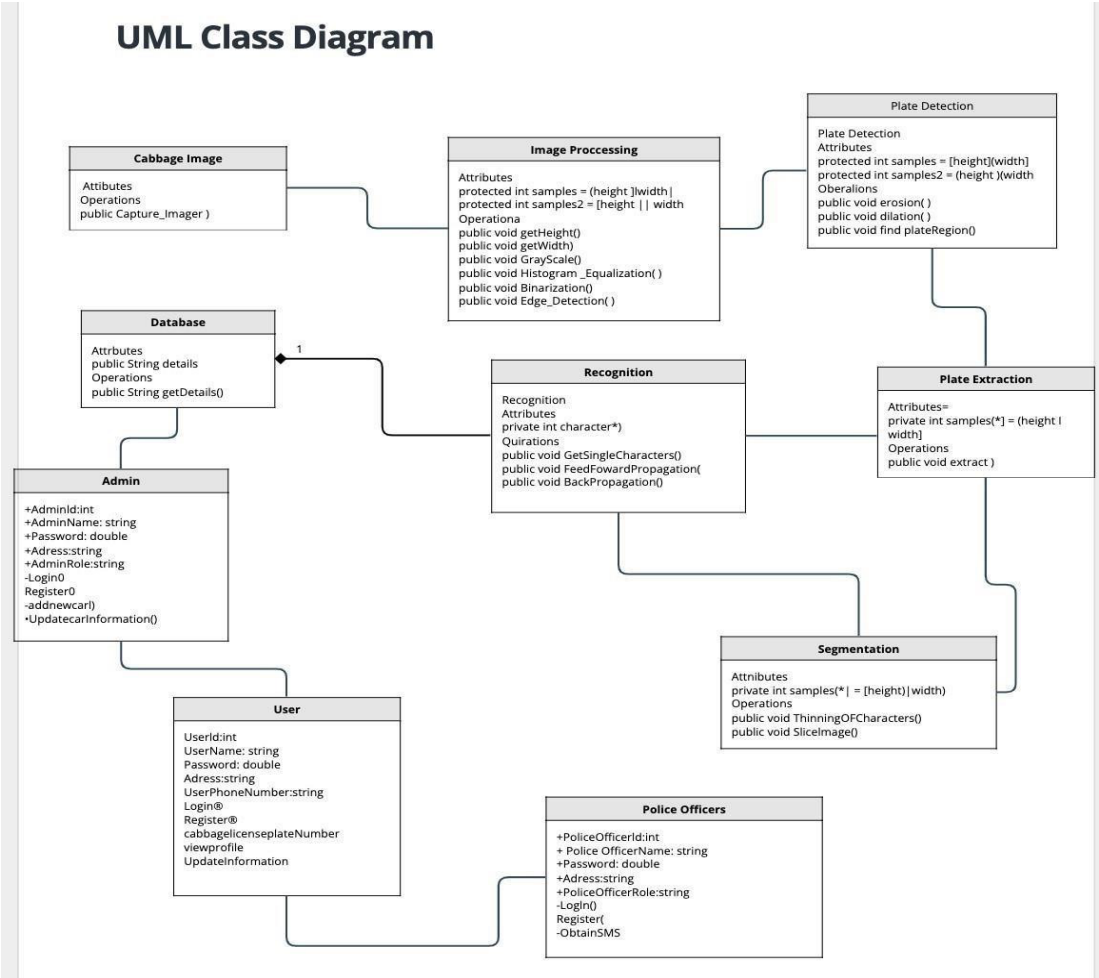

Figure 4-6 shows the class diagram of the license plate number recognition

4.2.1.5. Layered Architecture

System architecture is a conceptual layout that explains the shape and conduct of a device. Among the actors or customers who use this device are a police administrator and an admin a number of the customers. The utility layer, enterprise good judgment layer, and facts get entry to layer are the 3 layers that constitute the tiers. Each layer has its personal set of developments and responsibilities in the device.

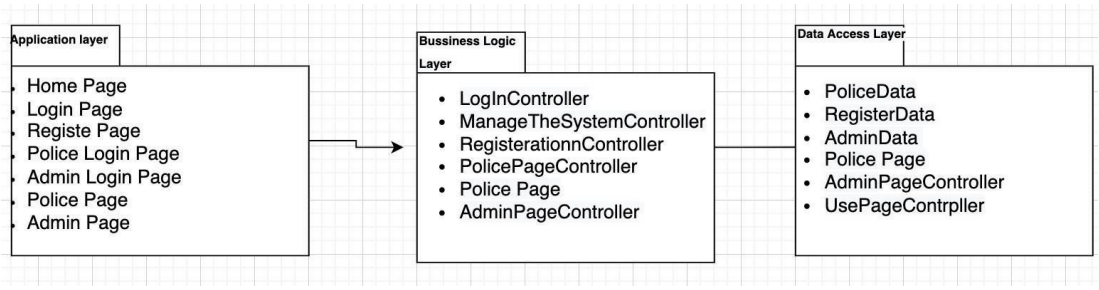

Figure 4-7 shows the system layered architecture

4.3. Interface Design

In design, an interface is in which human customers can offer inputs to computer systems or machines. While that could sound abstract, each day you`re surrounded through examples of this. The contact display screen in your cell phone, the menu device out of your TV faraway and the apps you operate each day all have an interface that relays facts from pc to consumer and vice versa. UI layout pursuits to make that interface intuitive, clean to apply and aesthetically pleasing.

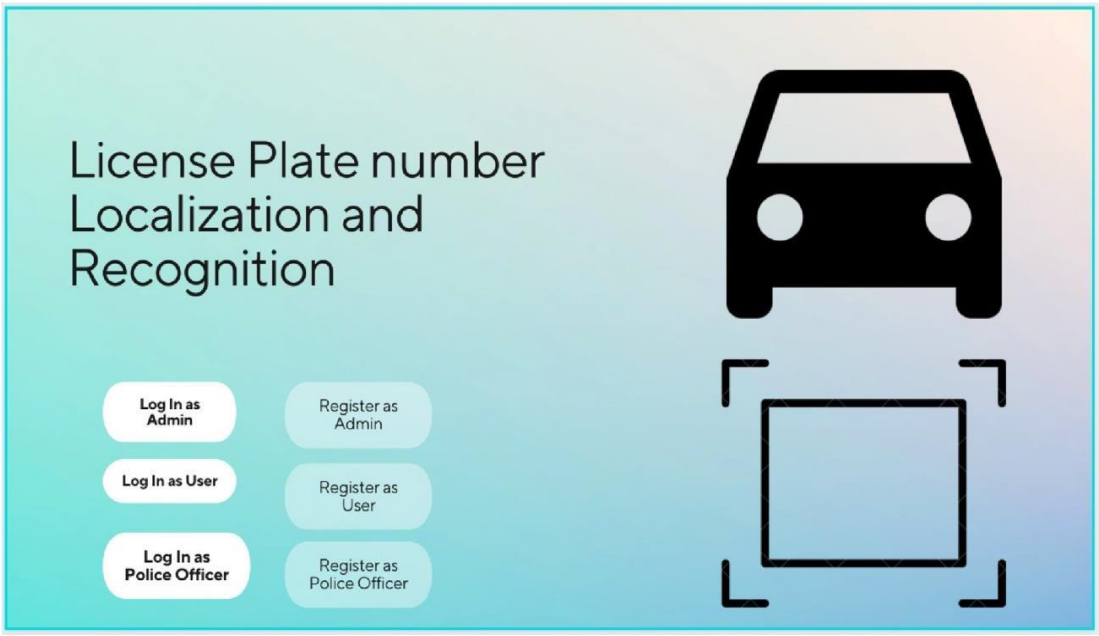

Figure 4-8 shows the home page of the License plate Number Localization and recognition

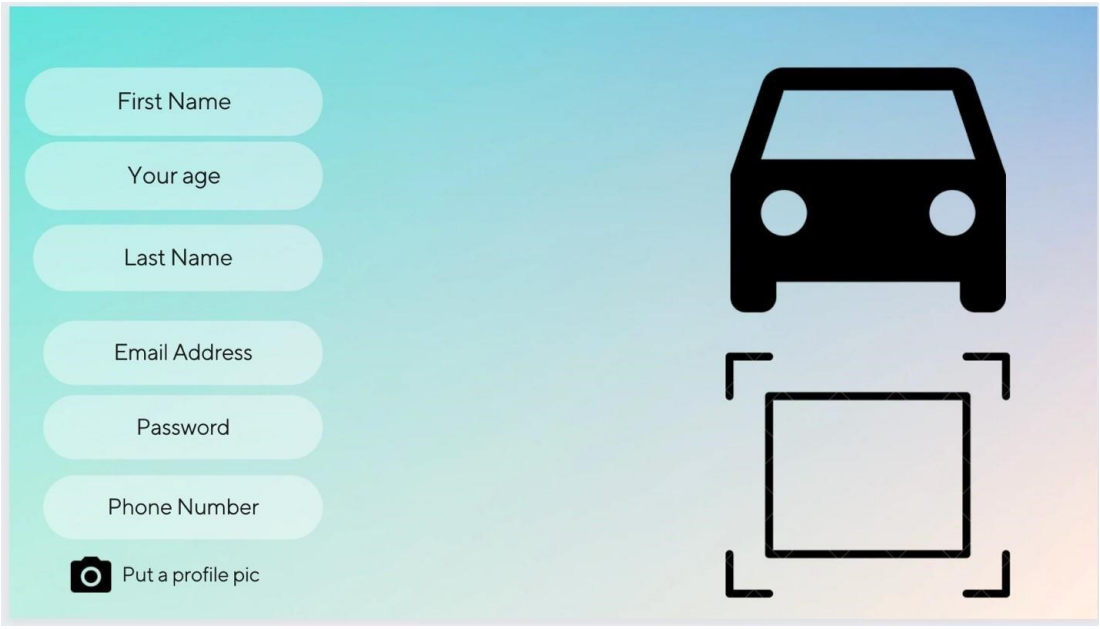

Figure 4-9 shows the register page of the License plate Number Localization and recognition

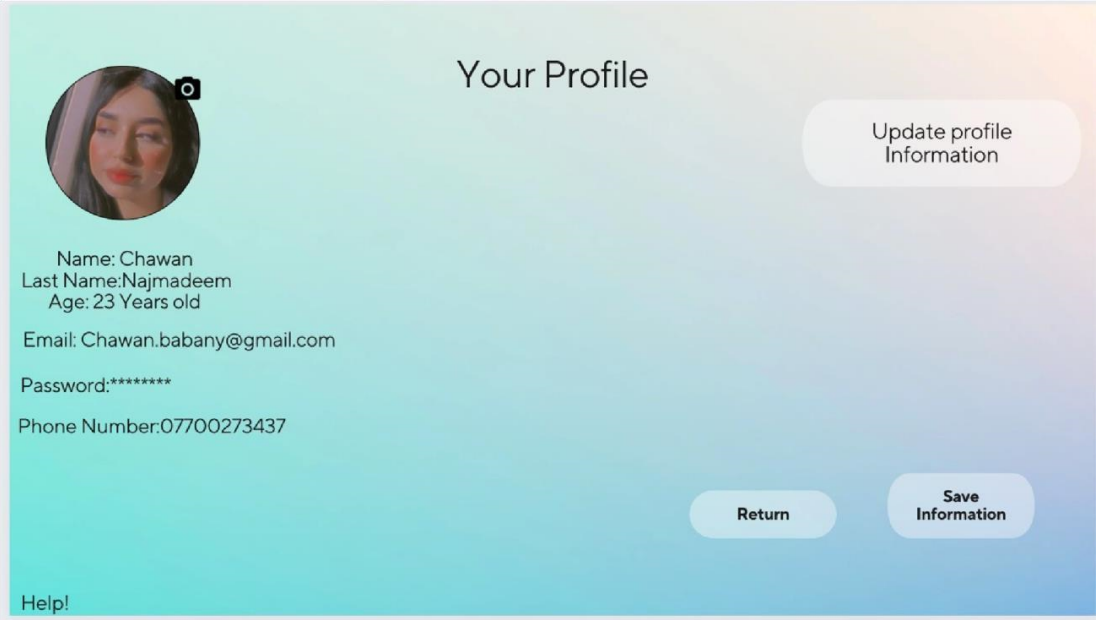

Figure 4-10 shows the Profile page of the user in of the License plate Number Localization and recognition

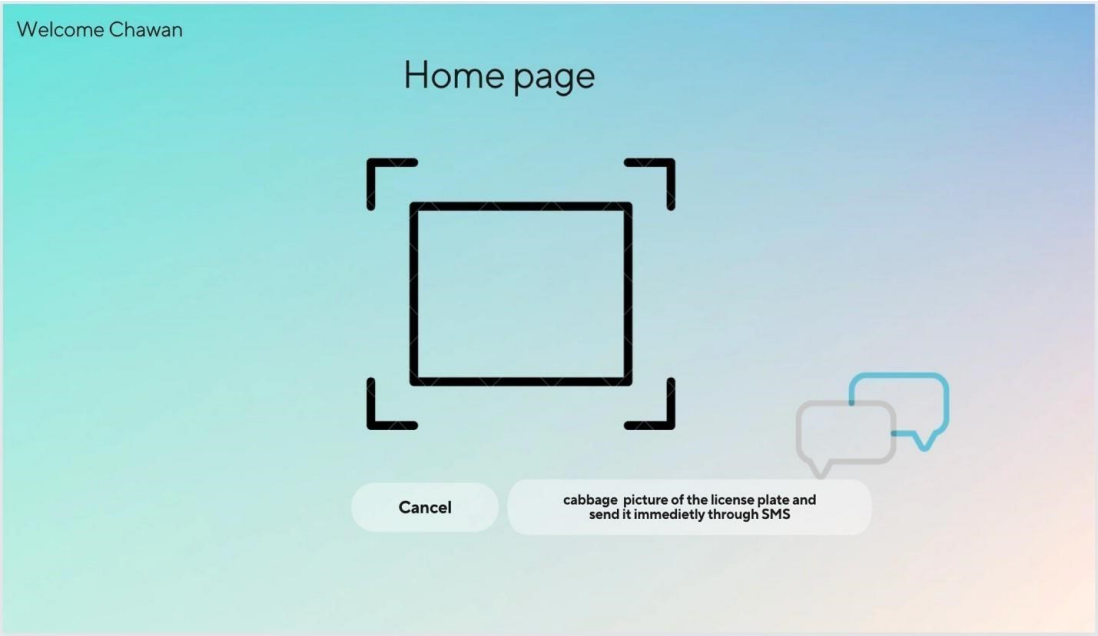

Figure 4-11 shows the home page and cabbaging picture of the License plate Number

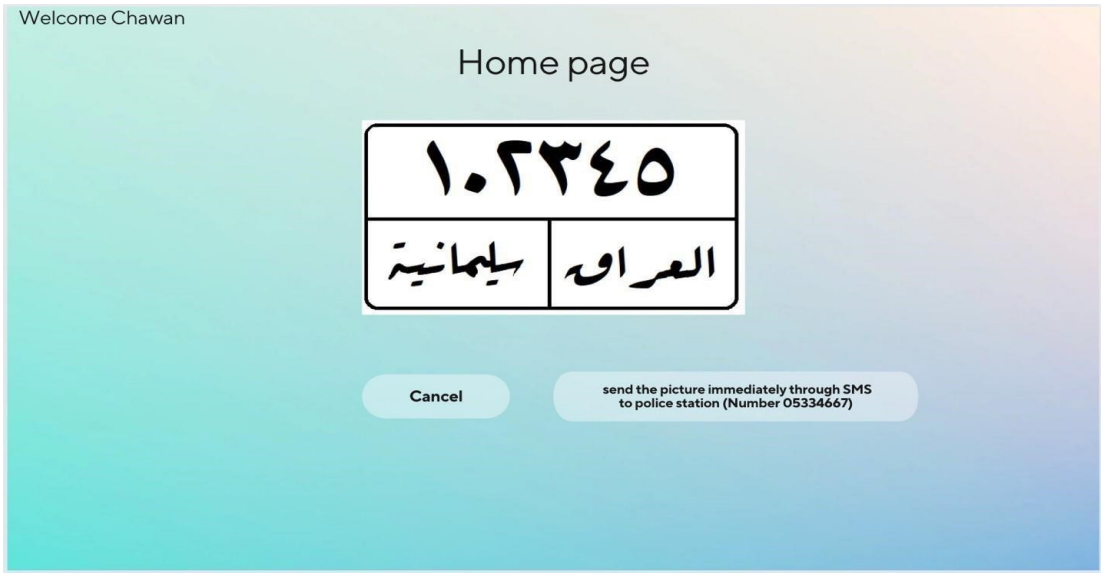

Figure 4-12 shows thereafter cabbaging the license plate number in home page of the License plate Number Localization and recognition

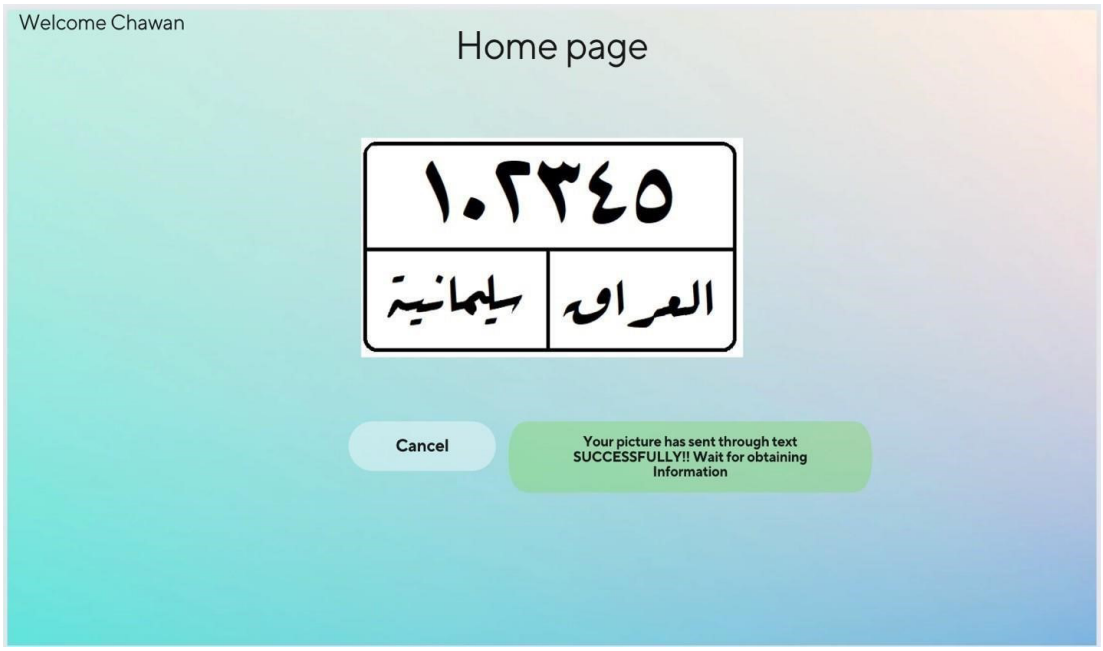

Figure 4-13 shows the home page after cabbaging and sending the plate to the number and waiting for the reply within text messages of the License plate Number Localization and recognition

Chapter 5

IMPLEMENTATION, AND TESTING

5.1. Conclusion

License plate recognition is a web-based system that specifically will be provided for police officers so they can check and track car every time they want time just by taking a picture of the car plate and then sending it to the police station after a while it will do a background check about the car and the driver on its own. It describes design algorism and the future of implementation. The system has color image inputs of a car and the output has the registration number of that car. It will be helpful in many fields for its people's community. The proposed system can process images at high speed and with high accuracy.

This system was developed to meet the performance, computational speed, and customization requirements of vehicle monitoring applications such as stolen vehicle detection systems. Those are plate localization, character segmentation, and character recognition. This system is more useful for police officers because has the ability to make things easier and decrease fewer accidents within cars, also to make people life easier and help its community for the best

5.2. Future Work

In order to improve and to keep enhancing this system, certain additional features and function abilities can be implemented in the future. In the PSM1 also all the Unified Modeling Language (UML) is finished. For PSM2 should be finished all the implementation code for the system.

Chapter 6

CONCLUSION AND RECOMMANDATION

6.1. Implementation

This project has been implemented by python language using PyCharm code editor. Python language is popular programming for implementing systems. And the license plate number recognition needs some libraries that other coordinators and other programming languages didn't have for example the image processing in the OCR which stands for optical character recognition is some libraries like by tesseract and cv2 and most commonly easier. During the quarantine there are many algorithms in methods have been used for the license plate number recognition system by bringing the license plate digital information among other data such as vehicles direction and speed or the name of the driver to the mix license plate recognition allows operators to immediately Catherine associate more data about every vehicle passing the control point.

The license plate number recognition is such a big system and it needs to be tested accordingly for this purpose the Blackbox testing has been designed for this system. Black-box testing tests your system without any prior knowledge of the internal workings of your system. The tester provides the input and observes the output produced by the system under test. This allows you to identify how your system reacts to unexpected and expected user actions, their response times, ease of use issues, and reliability issues. The black box test is a powerful test method for testing the system end-to-end. Just as end users "don't care" about how the system is coded or built and expect a good response to a query, testers simulate user activity to see if the system works as promised. I can do it. Black-box testing evaluates all relevant subsystems such as UI / UX, web or application servers, databases, dependencies, integrated systems, etc.

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Khan, J. A., Shah, M. A., Wahid, A., Khan, M. H., & Shahid, M. B. (2017). Enhanced car number plate recognition (ECNPR) system by improving efficiency in preprocessing steps. 2017 International Conference on Communication Technologies (ComTech).

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Engineering Sciences (ARES). https://doi.org/10.1109/aresx.2018.8723276Shafi, I., Hussain, I., Ahmad, J., Kim, P. W., Choi, G. S., Ashraf, I., & Din, S. (2021).

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Lubna, Mufti, N., & Shah, S. A. (2021). Automatic Number Plate Recognition: A detailed survey of relevant algorithms. Sensors, 21(9), 3028.https://doi.org/10.3390/s21093028.

Appendix A

Software Testing Documentation

This test contains the following test cases:

UC001_01: e.g. Login (username)

Test Case ID	Input data	Expected result	Actual result	Pass / Fail
TC001_01_01	5	Username is tooshort, try again	unsuccessful	pass
TC001_01_02	6	Goto password field	successful	pass
TC001_01_03	10	Goto password field	successful	pass
TC001_01_04	11	Username is toolong, try again	unsuccessful	fail

UC001_02: e.g. Login (password)

Test Case ID	Input data	Expected result	Actual result	Pass / Fail
TC001_02_01	5	Password is too short, try again	unsuccessful	fail
TC001_02_02	6	Password OK	successful	pass
TC001_02_03	10	Password OK	successful	pass
TC001_02_04	11	Password is too long, try again	unsuccessful	fail
TC001_02_05	ab12!@	Password OK	successful	pass
TC001_02_06	abc123	Password missing symbol	successful	pass
TC001_02_07	abc!@#	Password missing number	unsuccessful	fail
TC001_02_08	123!@#	Password missing character	successful	pass
TC001_02_09	abc123	Password missing symbol	successful	pass
TC001_02_10	abcdef	Password missing numbers and symbol	successful	pass

TC001_02_11	123456	Password missing characters and symbol	successful	pass
TC001_02_12	!@#$%^	Password missing numbers and characters	successful	pass
TC001_02_13	(empty)	Password other than character, number and symbol	successful	pass

8.2 Test TC002 for Module1: <Import images data (UC002)>

9. UC001_01: e.g. Login (username)

Test Case ID	**Input data**	**Expected result**	**Actual result**	**Pass / Fail**
TC002_02_01	5	The user fills out car details	unsuccessful	pass
TC002_02_03	6	The user will mention the car detail	successful	pass
TC002_03_04	10	The user write date	successful	pass
TC002_03_05	11	he user will mention the location	successful	pass

Appendix B

Software Requirements Specifications – SRS

1.0 Introduction

Creating a requirements phase in a software development process is a software requirements specification (SRS) (also known as a requirements document). This report lays the foundation for software engineering activities and is built when complete requirements are collected and analyzed. SRS is a formal report that acts as a software representation that allows customers to confirm that (SRS) meets their requirements. It also contains detailed specifications of system user requirements and system requirements. The SRS is a specification for a particular set of software products, programs, or applications that perform a particular function in a particular environment. It serves multiple purposes, depending on who is writing it. First, the SRS can be created by a client on the system. Second, the SRS can be created by the system developer. The two methods create completely different situations and set different purposes throughout the document. The first case, SRS, is used to define user needs and expectations. The second case, SRS, is created for a variety of purposes and acts as a contract document between the customer and the developer.

1.1Purpose

Properly written SRS can serve the following purposes: Customer feedback Software requirements specifications ensure that project management stakeholders and customers really understand the business requirements documentation. This also ensures that the team develops detailed features. Classify requirements Software requirements specifications are documented to break down deliverables into smaller components. The information is organized to help developers understand what features they need to develop and in what order, as well as the boundaries they have to work on. These two points are especially important in the software development process. If your development team doesn't understand that there are certain restrictions on your work, for example, if you need to write your code exactly so that you can compile and run it quickly, the code will provide the functionality you need later. The problem arises when you can. But it takes so long to load that no one can see it! Understanding

the order in which features are developed means that the developer has a complete picture of development. This allows you to plan ahead and save both project time and cost.

1.2 Scope

The system will need to import a photo from gallery on the phone then shoot their license plate and scanning it to check the background. A picture will and transform the optical data into digital information in real-time. The camera firmware employs specialized OCR procedures to convert he license plate image into digital (machine-readable) characters after it has been captured. Since this is a web-based system the picture will be taken by the camera and there will be a back-and-forth response during the process. Also, there are multiple formats of number plates, but the system will be specifically made for the Iraq area which will be easier while implementing only one format. There will be another function which is providing the GPS so the background information will include the driver's location too. Also, the user of this system will be police officers while they come across some struggles, they can take advantage of using this system. The system will be secure enough so ordinary people will not have access to it since every information and background check will be at the police station.

1.3 Definitions, Acronyms and Abbreviation

Abbreviations	**Definition**
LPR	License Plate Recognition
OCR	Optical Character Recognition
ANP	Automatic Number plate
IP	Image processing

Table 1 shows the list of abbreviations and its definitions

2.0 Overall Description

This section of the SRS describes the general factors that affect the product and its **requirements.**

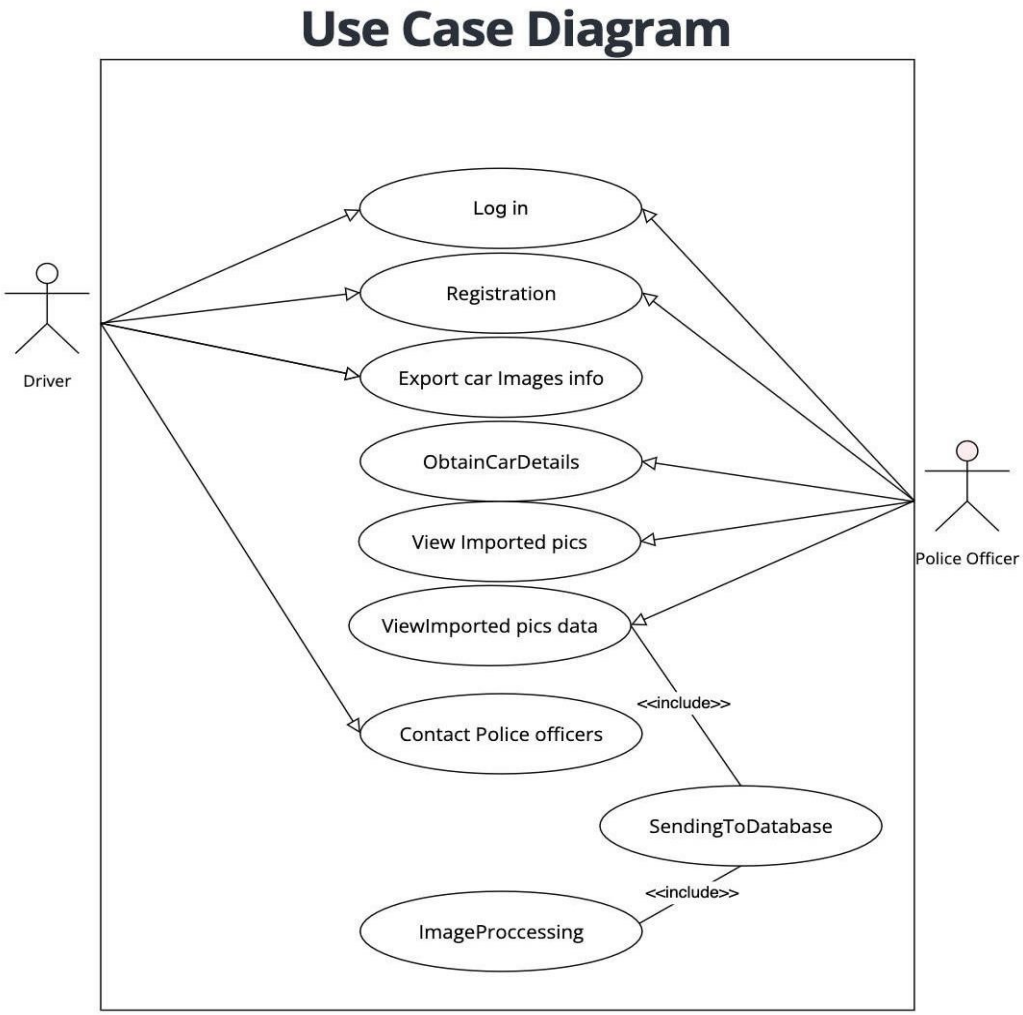

Figure. 2.2 use case diagram of the license plate number recognition

2.1 Product Perspective

The license plate of a recognition system requires a database as long as exporting an image from any type of device into the system so the system can interact with the

database and recognize the license plate number and go through the image processing process. Furthermore, the system needs to somehow interact with the database management software which is (MySQL)

2.1.1 System Interface

Beside running the code and going through the image processing process for the license plate number we have the web base which includes two stakeholders one of them is the polished officer who can also act like an admin and see the important image that has been exported from the drivers into the system and also the police officer also can see the daughter of the image that has been processed by the python. On the other hand, we have the driver which can act like a user and export image into the system so it can recognize it for the driver and also get the data back from the database.

Figure shows the home page of the web base

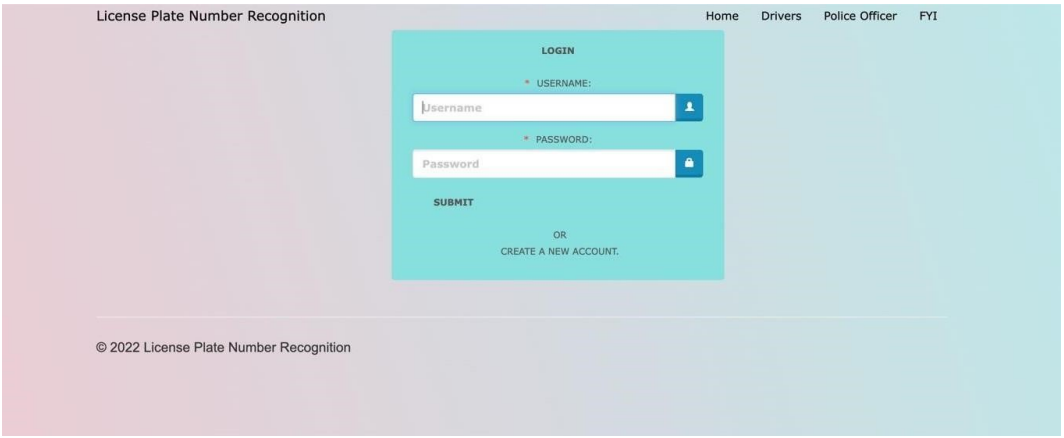

Figure 2.3 shows the log in page

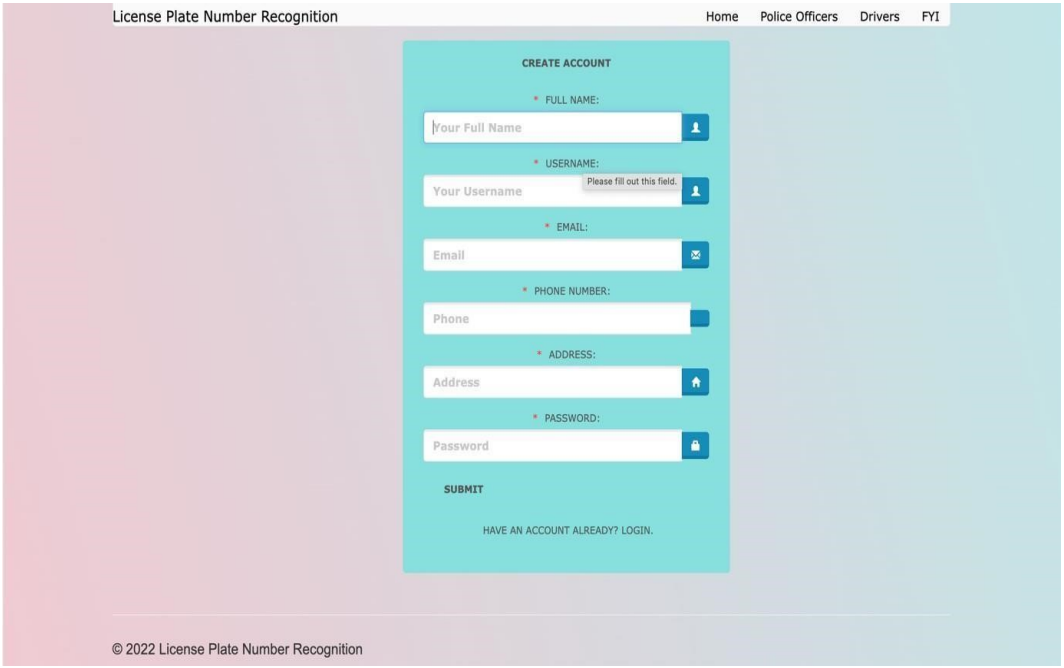

Figure Shows the sign up page for the user

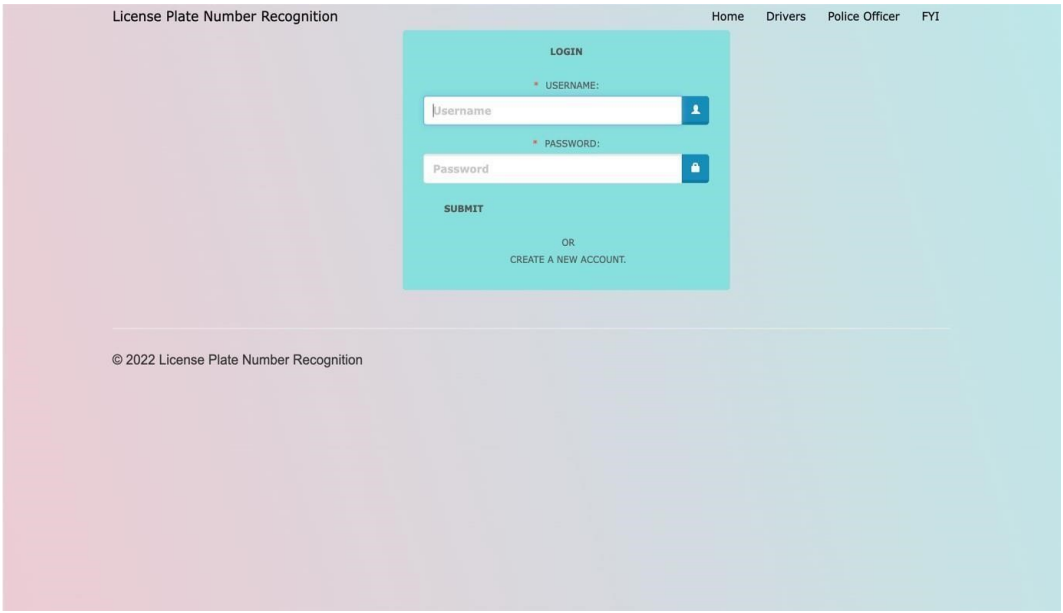

Figure 2.4 shows the sign-up page

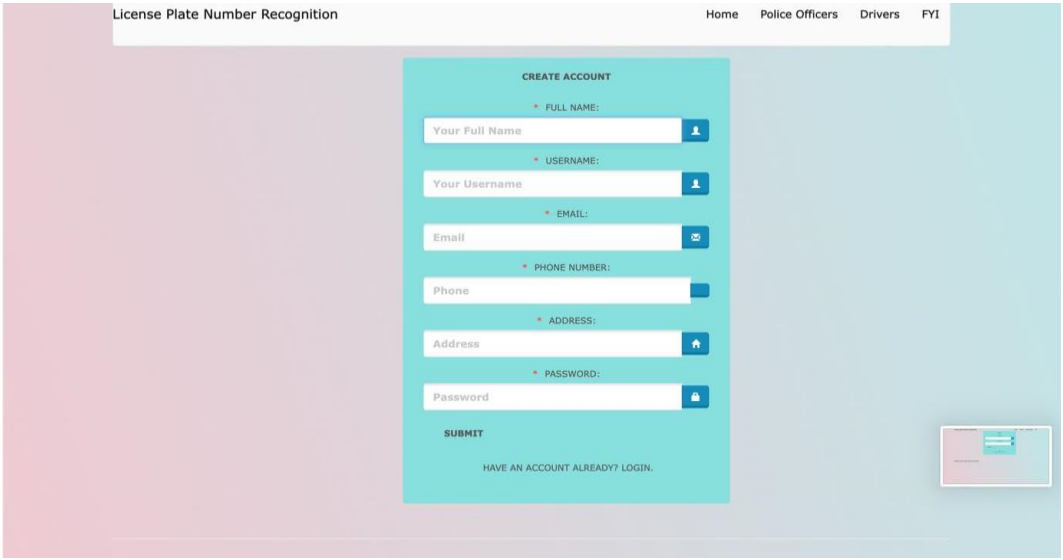

Figure 2.5 shows the sign up page

Figure 2.6 shows the home page

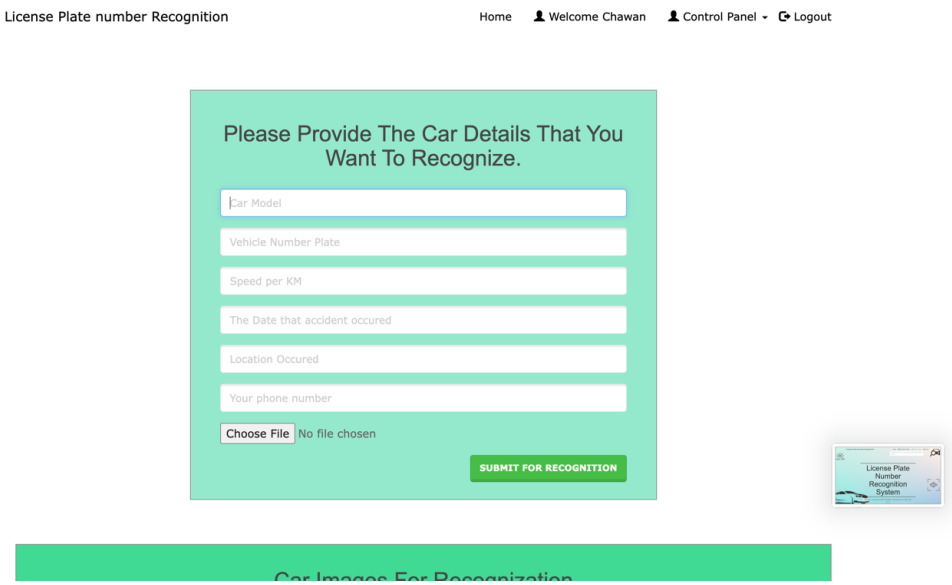

Figure 2.6 shows the car details that user want to recognize

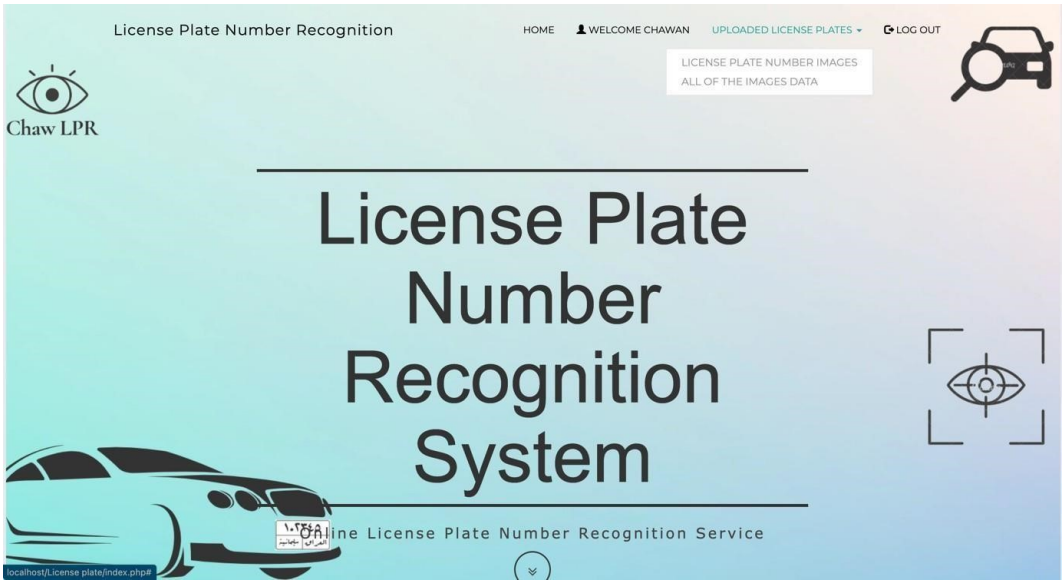

Figure 2.4 shows the sign-up page and the upload license plate image

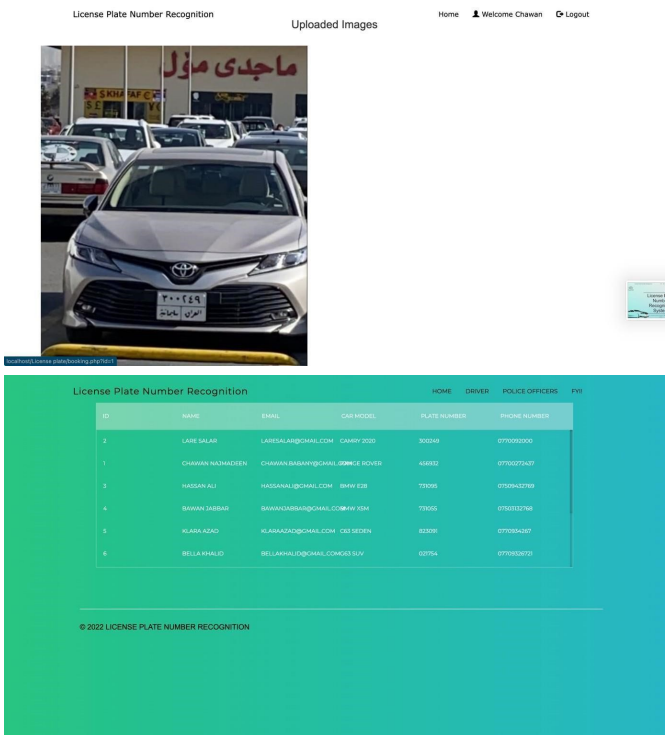

Figure 2.4 shows the uploaded image and its data

Figure 2.5 Shows the contact us after the picture went through image processing

2.1.2 User Interfaces

Says the word base can be used by a different user such as drivers and police officers they can have access into a different operation for example the driver can have the exit into the homepage of the we base and also can export an image into the system and fill out the credential form so the image position can begin. Furthermore, the police officer can see the data as an admin and also see all the images that has been posted into the system while we have contact us in the system and the only user can use the operation is the driver.

2.1.3 Hardware Interfaces

Just like any other system and all the wood bases says the system requires exporting image we need either a laptop that consist of CPU monitor and keyboard and most probably a mouse for somehow any type of input and output and we need also pictures in the system of the device.

2.1.4 Software Interfaces

Says the system is a real time and is a standalone system it does not include any external system into it on the other hand the system requires a database management system like my schedule to somehow manage all the process that been going on in to the whip is like exporting images and feeling all credential about the car that is going to the image processing and also a Web server.

2.1.5 Communication Interfaces

The web-based system communication interface is wholly dependent on the server software to make sure that the correct data will be retrieved from the database so the system can be responsive and work adequately. Specify here.

2.1.6 Operations

The user of the system who is willing to use the system for the house the login so they can have an access into the system for the security purpose/ b) The system will not run and will not image process any type of photo unless it has been sent it from the web face c) The system shall be able to create backup for data daily d) The system shall be able to recognize any type of Kurdish letter alphabet license number.

2.1.7 Site Adaptation Requirements

This system does not include any external data for any type of medication for the side adaptation the system works just fine on a basic computer that's connected to the organization's local area network as long as the management system which is my SQL

2.2 Product Functions

The license plate number recognition and localization based on image processing aims to recognize Dada and send the data back to the driver into the web-based below our major functions of the system.

a) exporting images: the driver through the web base world exports an image into the system so the process can begin and the Car Plate number can be recognized
b) Viewing the imported images: this option can be seen from the police officer user so they can have a nice distance from the all-imported images that the driver's husband posted into the system
c) Getting feedback: the driver can give feedback on the webpage through the web base option and this will be saved into the database management.

NO.	Use Case	Description
1	Register	Users register by filling their information that are required.
2	Login	Users' login into the system by filling out their email and password.
3	Export car images and Info	Main user can search for recipes in the system.
4	Obtain Car details	Main user can set a schedule for their meals when required.
5	View imported pics	The main user can notify a family member or friends using the chat in the system.

6	View imported pics	The notified user will receive messages from the main users.
7	Contact police officers	The main user will be able to add notified users registered in the system.

2.3 User Characteristics

License plate number recognition system is designed to be very user-friendly and easy to use user of the system will not require a special training the system is self-explanatory before the operating system but just a short briefing it will be enough for them regarding the detailed functionalities however all the users must login first so they can have an access into the system and he also has to know how to take pictures and to export images into any type of system so they can access until this is so also. Based on the following table we have three users in this system, each user has a specific role in this system. The three users in the system are:

1- Main user
2- Notified user
3- Admin

NO.	**Actor**	**Role**
1	Driver	This user is able to perform all functions in the system. They can add images so the system can recognize it and image process it.
2	Police officer	This user has the ability to manage information and maintain car information

Table 2.2 shows the actor and its role.

2.4 Constraints

There are the few constraints of the license plate number recognition system horse **for proper functionalities.**

a) This system is designed with some sort of library that can only accept license plate numbers and cannot recognize any other context
b) For getting the information but I am realizing who is that person is the Driver has to wait for a while so they can get in contact with them
c) This System is designed that way that the system can also recognize the new plate number of the cars
d) The plate number and the image that the driver is going to export into the system first have to be in the database and has to be generated.

3 Assumption and Dependencies

The user of the system is assuming to have their own account so they can have an access into the system b) For the security purpose the drivers have to fill out the credentials so they can access into the system and they can use it c) Assuming all the users of the system of basic computer knowledge and knows how to operate this system so mostly so they can get what they want in return

3.1Apportioning of Requirements

For the license plate number localization and recognition based on image processing system several functions are omitted this function might be implemented in the future and upcoming upgrades.

a) First while the system can recognize the plate numbers through an exported image that has been sent from the driver automatically it will be send it to the driver's location phone number.
b) The database will be Smart enough to recognize any type of number plate for immigrants and for the ones who visit the city

4. Specific Requirements

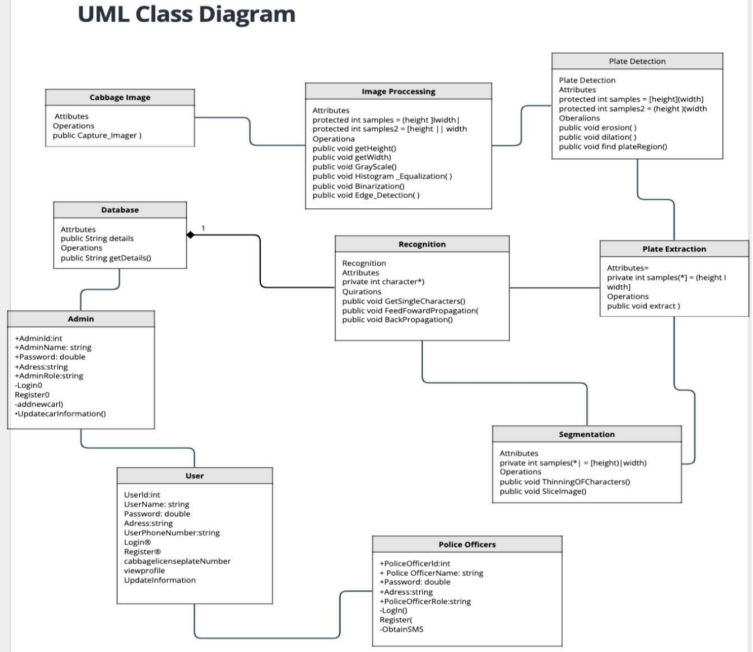

Figure 2.6: Domain Model of < license plate number recognition system>

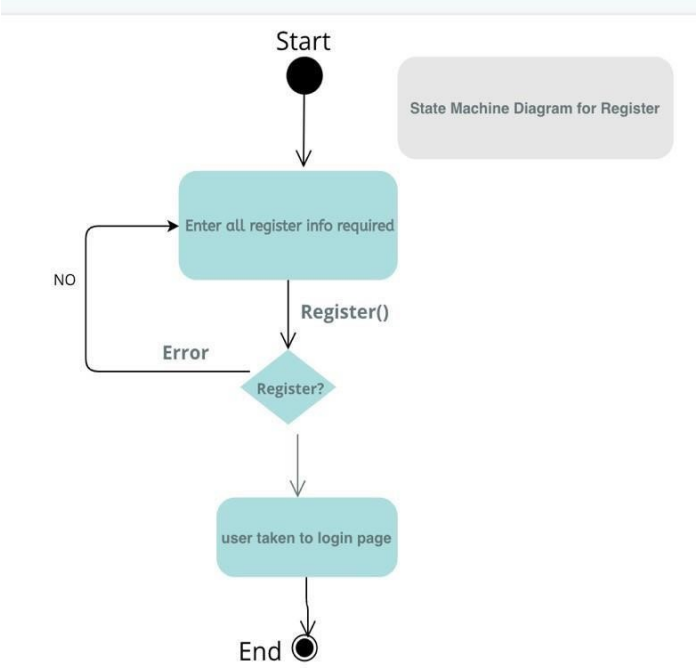

Figure 2.7 shows the state machine diagram for register

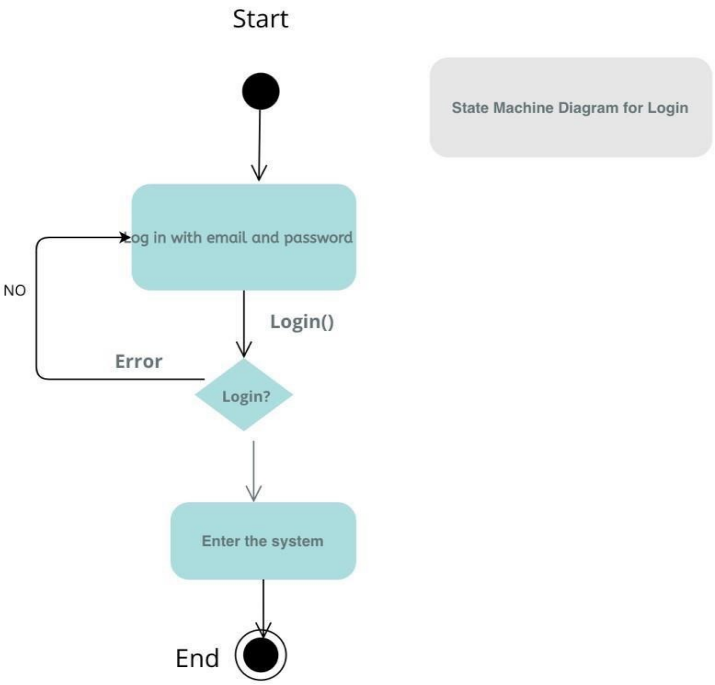

figure 2.8 shows the activity diagram for the users

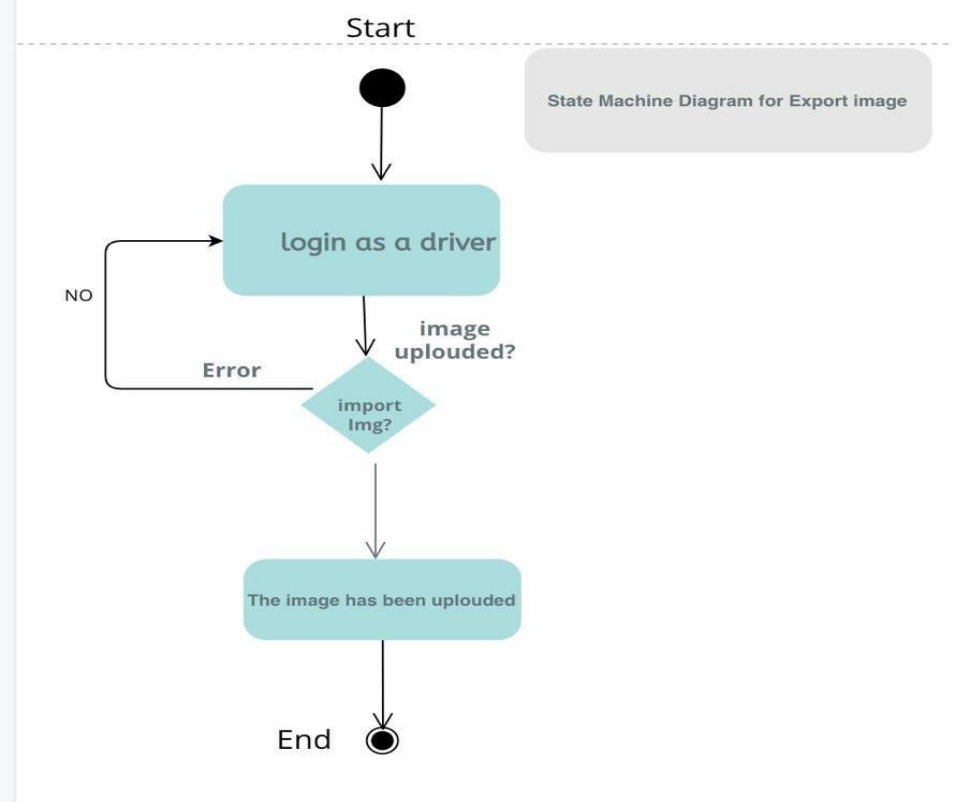

figure 2.8 shows the activity diagram for the users

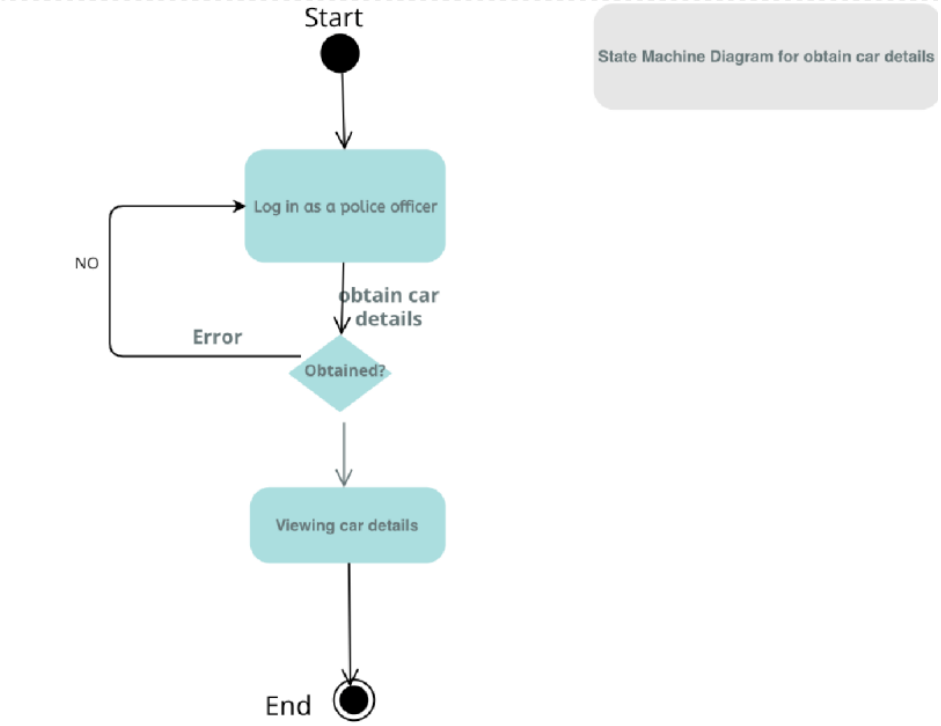

figure 2.9 shows the activity diagram for the car details

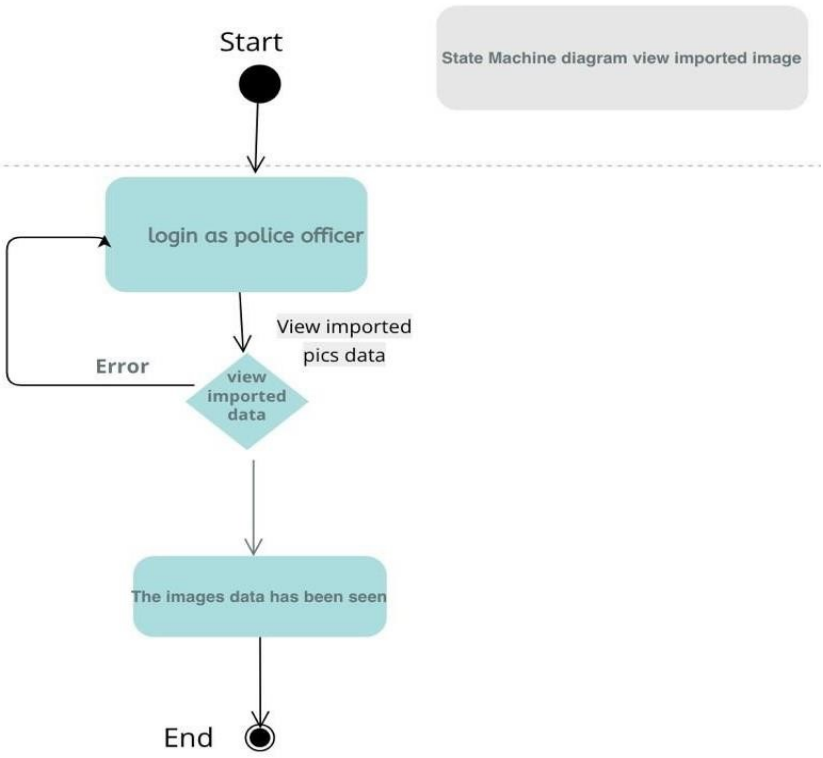

figure 3.0 shows the activity diagram for imported images

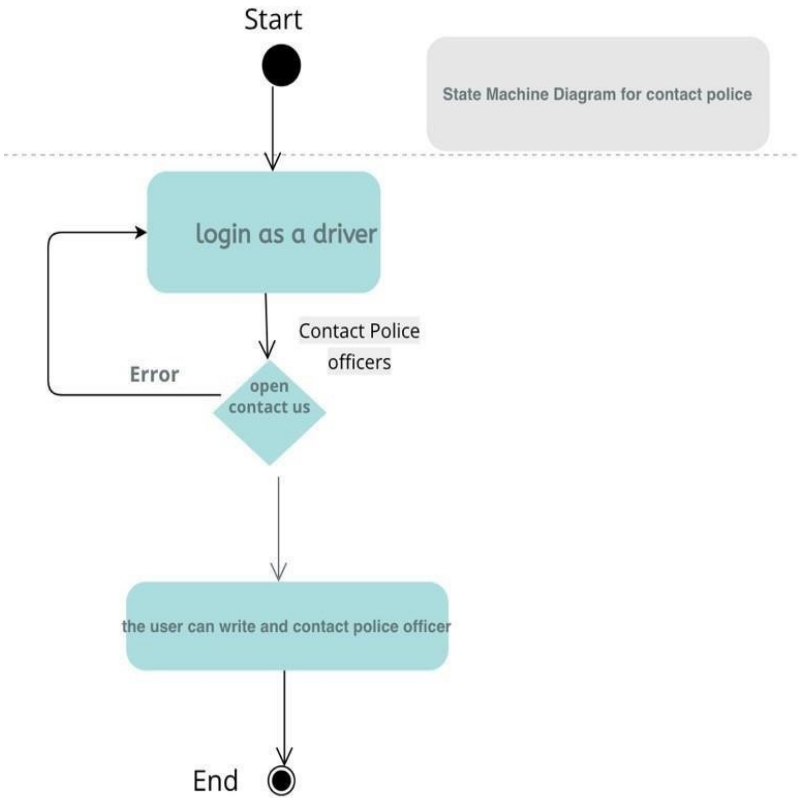

figure 3.1 shows the activity diagram for imported images

4.1 External Interface Requirements

4.1.1 User Interfaces

Says the word base can be used by a different user such as drivers and police officers they can have access to a different operation for example the driver can have the exit into the homepage of the base and also can export an image into the system and fill out the credential form so the image position can begin. Furthermore, the police officer can see the data as an admin and also see all the images that have been posted into the system while we have contact us in the system and the only user who can use the operation is the driver.

4.1.2 Hardware Interfaces

Says the system does not include with an internal interface or any type of hardware the system is still on the lawn is still on does not communicate with any other order interfaces.

4.1.3 Software Interfaces

The system is still for five database management software handles the database for the system and the MySQL is used and down below is the details of the database

4.2.1 Communication Interfaces

The Communication between the different parts of the system a different operation is very important since everything is related to each other and the Weepies is responsive this is the most important step which they did that they stick a bigger place in this

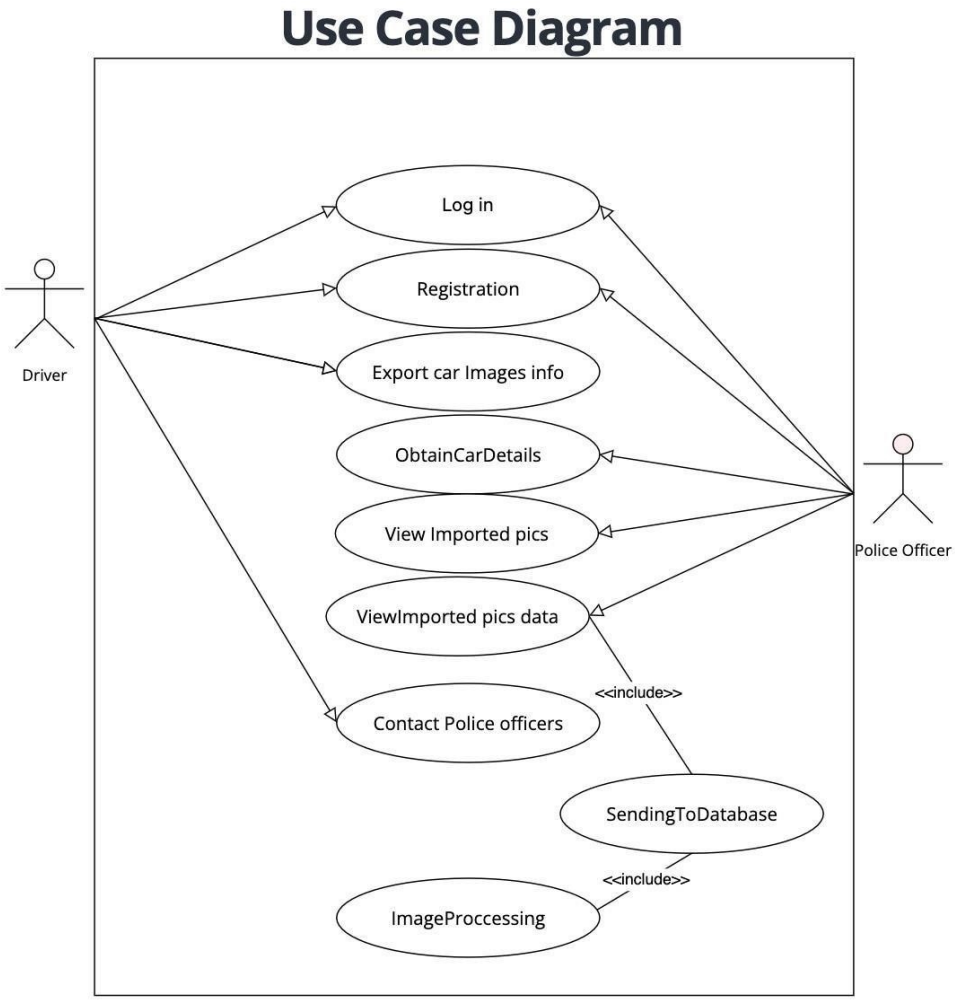

Figure 3.2: shows the use case diagram for all the stakeholders

Appendix C

Software Design Document - SDD

1.0 Introduction

Software design documents are documents that provide documentation that you can use as a guide. Software development by providing details on how to build software. Inside the software, A design document is a descriptive, graphical document of a project's software design. Use case models, sequence diagrams, collaboration models, object behavior models, and other support requirements information.

1.1 Propose

The purpose of the software design document is to provide a description of the system design. Complete enough to understand and proceed with what software development means It is built and how it should be built. Software design documentation provides information You need to provide a detailed description of the software and system you are building.

1.2 Scope

This software design document is for a baseline system that serves as a proof of concept. Use of building systems that provide basic functionality to demonstrate the feasibility of large enterprises Scaled production deployment. This software design focuses on the basic system and important parts From the system. This particular software design document is Documents and document modifications. The system is used in combination with Other existing system, mainly composed of abstracted document interaction façade Document interaction and handling of document objects.

Abbreviations	Definition
LPR	License Plate Recognition
OCR	Optical Character Recognition
ANP	Automatic Number plate
IP	Image processing

This document explains the software design documentation of license plate number recognition, this document explains the software created to facilitate the analysis, planning, implementation, and decision thinking. This documentation is organized as the following: a- System Architectural Design b -Detailed Description of Components c- Data Design d- User Interface Design

2.0 System Architectural Design

In this section, the architecture of the system will be explained briefly stating the architecture chosen and the characteristics and parts of this architecture for the license plate number recognition system

2.1 Architecture Style and Rational

The architecture style selected is the MVC architecture style. MVC stands for "Model-View Controller" and means that an application is divided into three interconnected parts, or screens, which can be called the interface of the application. What the user sees and manipulates. The model is the connection between the view and the controller. A controller is a class that contains the necessary data and logic for your project. Controllers, which are providers in our project that are primarily

connected to the back end of the project, are what you request and what you request. Model View Controller is commonly used for mobile and web applications.

.2 Architecture Model

In the architecture model below, the architecture has two aspects: the front end and the back end. On the front end, you can see the view layer in MVC as mentioned above. View layers are

interface layers that users view and interact with. Therefore, place the application interface at the view level. The user then interacts with the controller by requesting data and information or actions as a sample statement that allows the user to request a recipe from the controller. The controller does this and sends the recipe information back to the user, and the controller interacts with itself. The model is the data collector and is responsible for the logic part. The model connects to the database and sends and receives the required data or information.

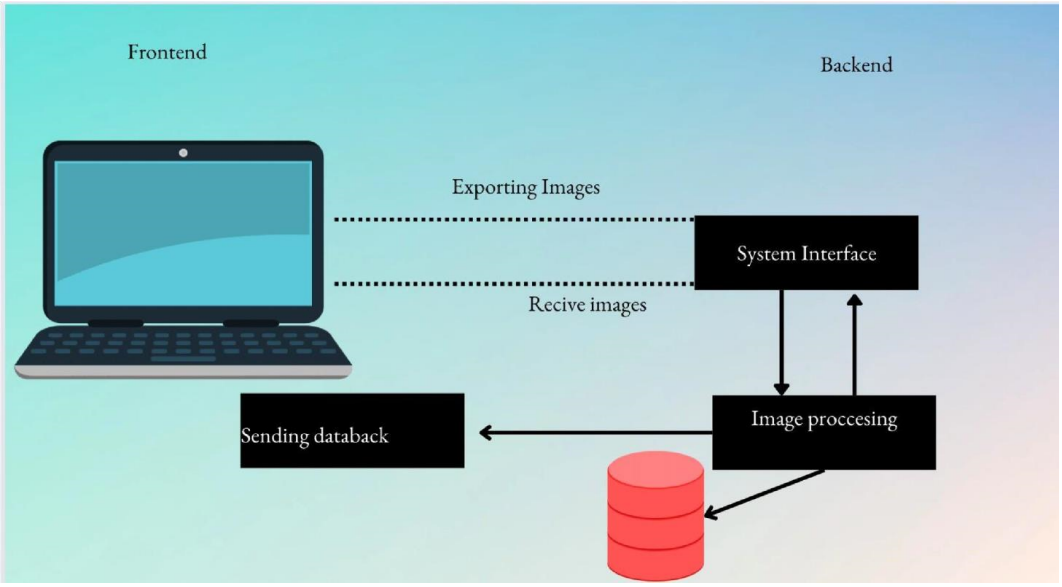

Figure 3.3: Component Model of <License Plate Number Recognition>

2.3 Use Case Diagram

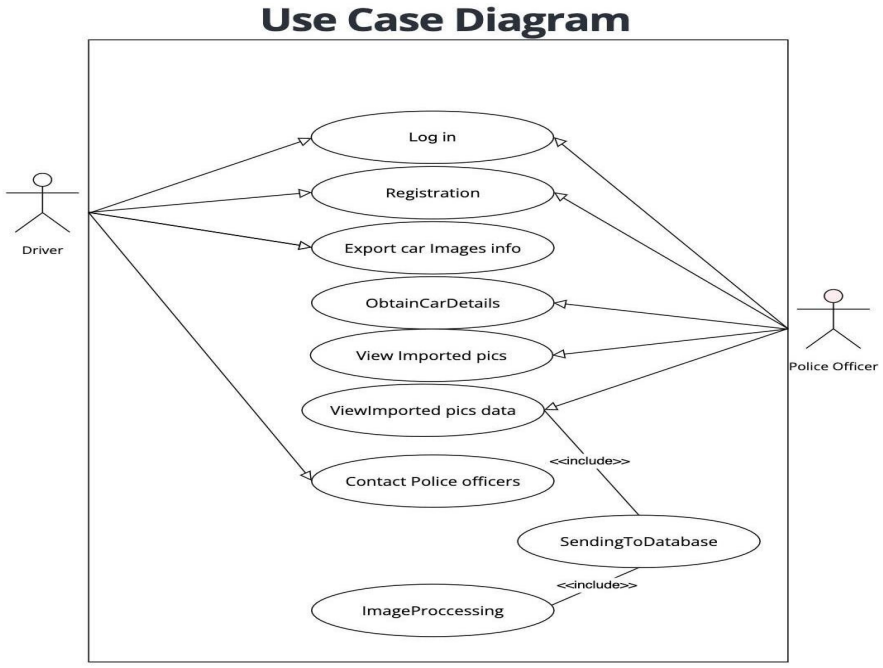

Figure 3.4shows the Use Case Diagram of <Smart Kitchen>

3.Detailed Description of Components

In this section the component of license plate number will be explained, and a package diagram will be created for the system to create a showcase of the system's components

Name	**Type**	**Default**	**Index**
User_name	Varchar	Null	Primary key
age	Int	Null	Not Null
Address	Varchar	Null	Not Null
User type	Varchar	Null	Not Null
Email	Varchar	Null	Unique
Phone no.	Varchar	Null	Not Null

Password	Varchar	Null	Not Null

Table 4.2.1 Database normalization table for UserData

Name	**Type**	**Default**	**Index**
ID	Varchar	Null	Foreign Key
name	Varchar	Null	Not Null
Image	Varchar	Null	Not Null
Car model	int	Null	Not Null
date	Varchar	Null	Unique

Table 4.2.3 Database normalization table for Calendar

Name	**Type**	**Defa ult**	**Index**
Title	Varchar	Null	Primary Key
Schedule_i nfo	Varchar	Null	Not Null
Date	Varchar	Null	Not Null

Table 4.2.4 Database normalization table for Contact Us

Name	**Type**	**Default**	**Index**
Title	Varchar	Null	Primary Key
To	Varchar	Null	Not Null

Table 4.2.5 Database normalization table for system user

Name	**Type**	**Default**	**Index**
User_name	Varchar	Null	Foreign Key
Noti_name	Varchar	Null	Foreign key

4. User Interface Design

4.1 Overview of User Interface

The user interface of this system will be focused on the system which work on mobile since it is a mobile application, the user interface is easy to use and very friendly to any user so that all users no matter the difference will be able to use and understand the interface and know what they should do in every step.

Figure 3. shows home page of the web base design

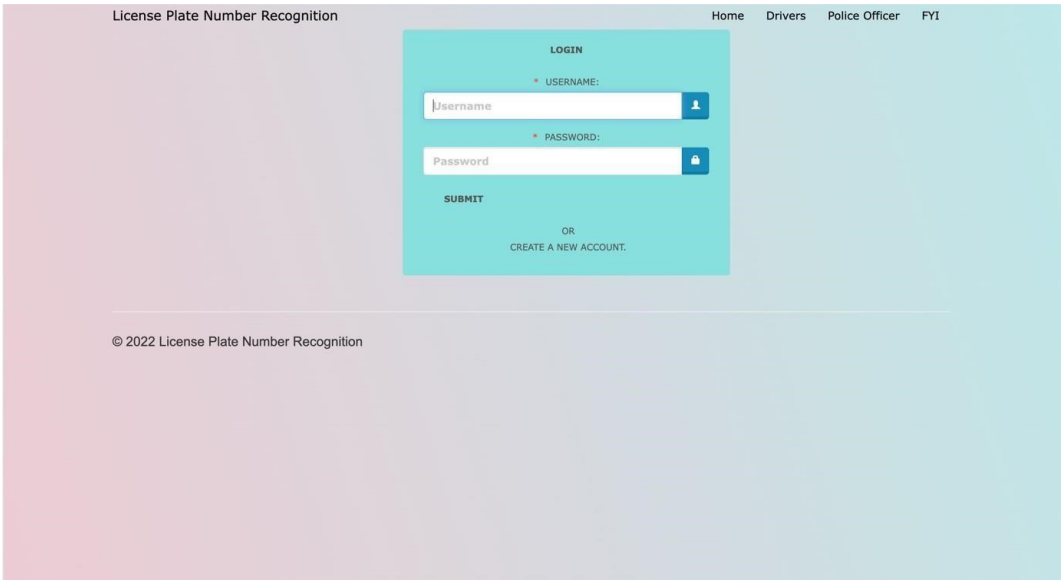

Figure 2.3 shows the log in page

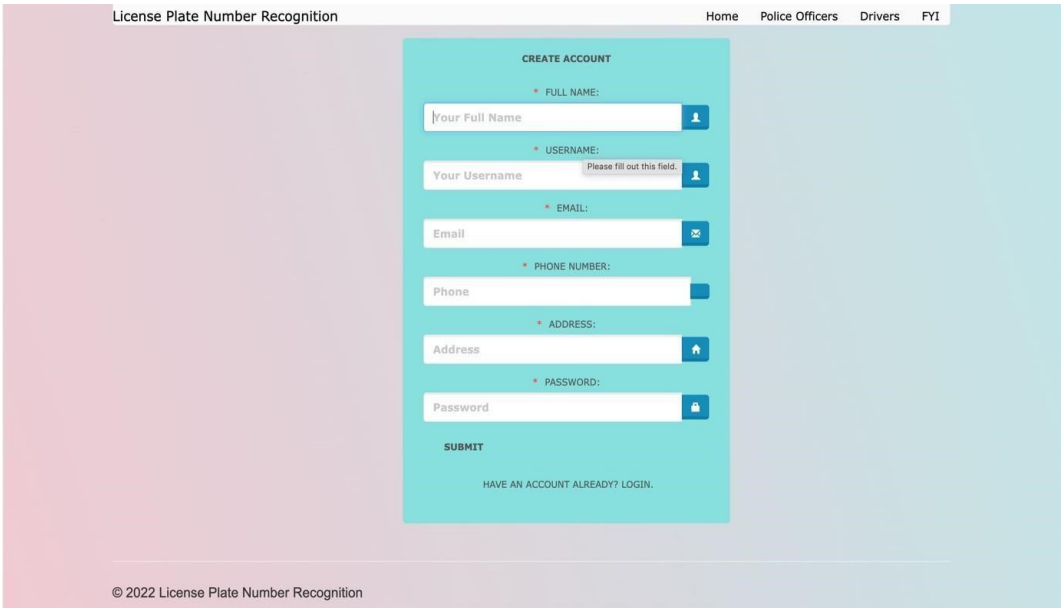

Figure 2.4 shows the sign-up page

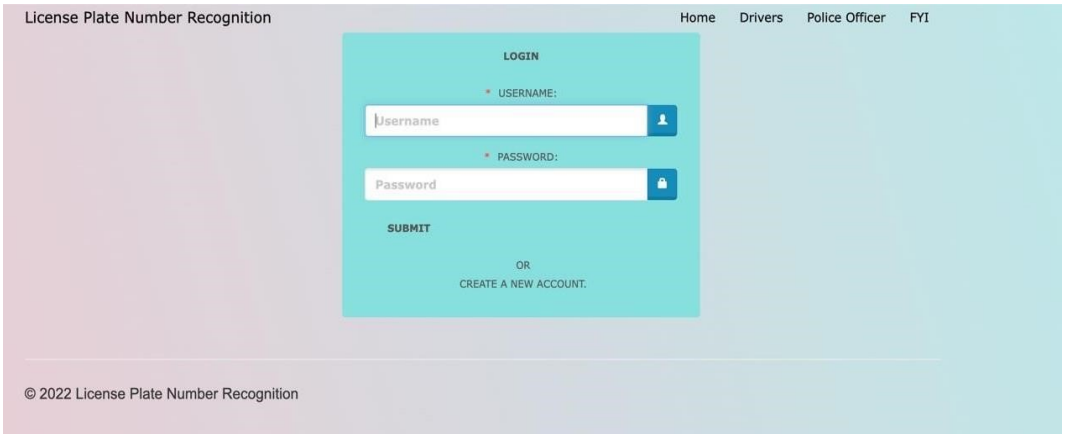

Figure 2.4 shows the log in page for Driver

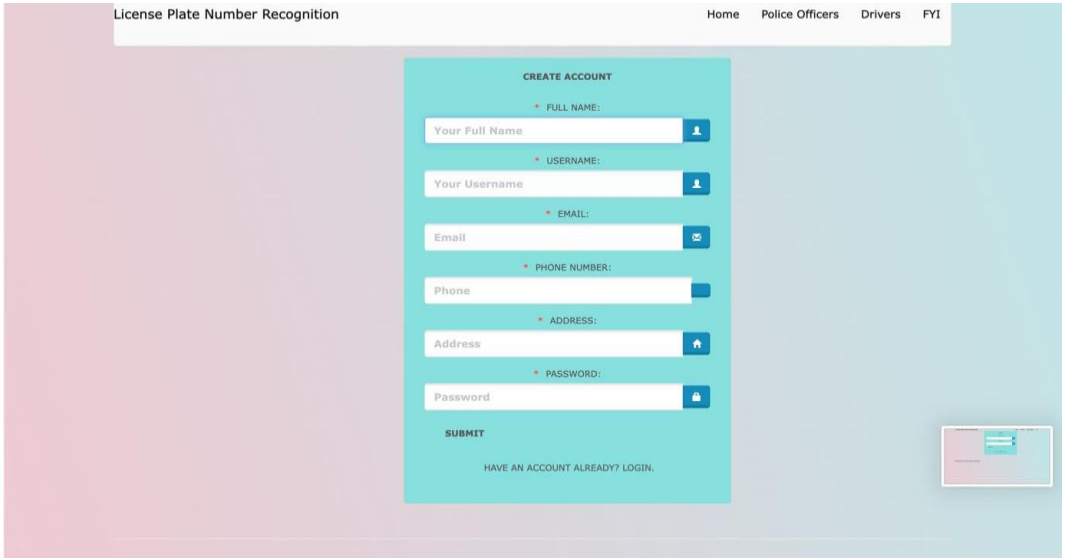

Figure 2.5 shows the sign up page for Police officer

Figure 2.6 shows the home page

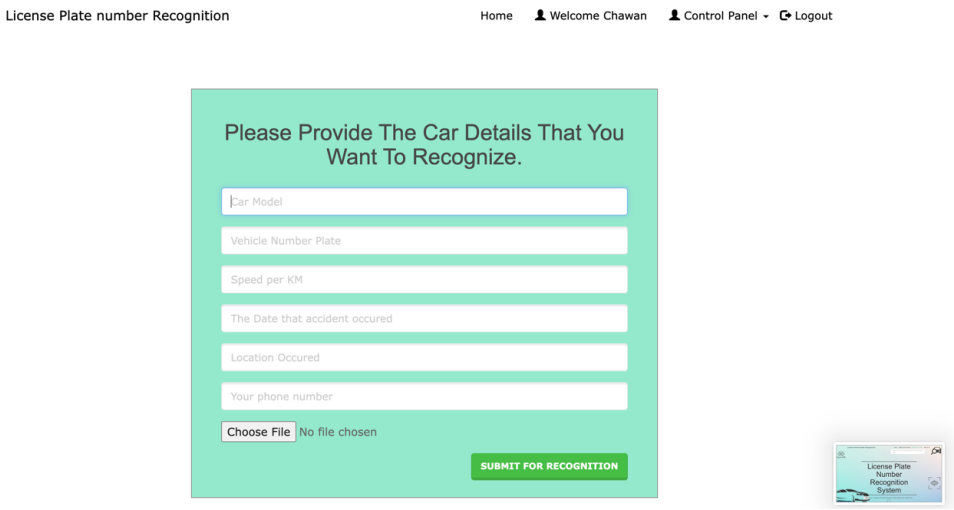

Figure 2.6 shows the car details that user want to recognize

Figure 2.4 shows the sign-up page and the upload license plate image

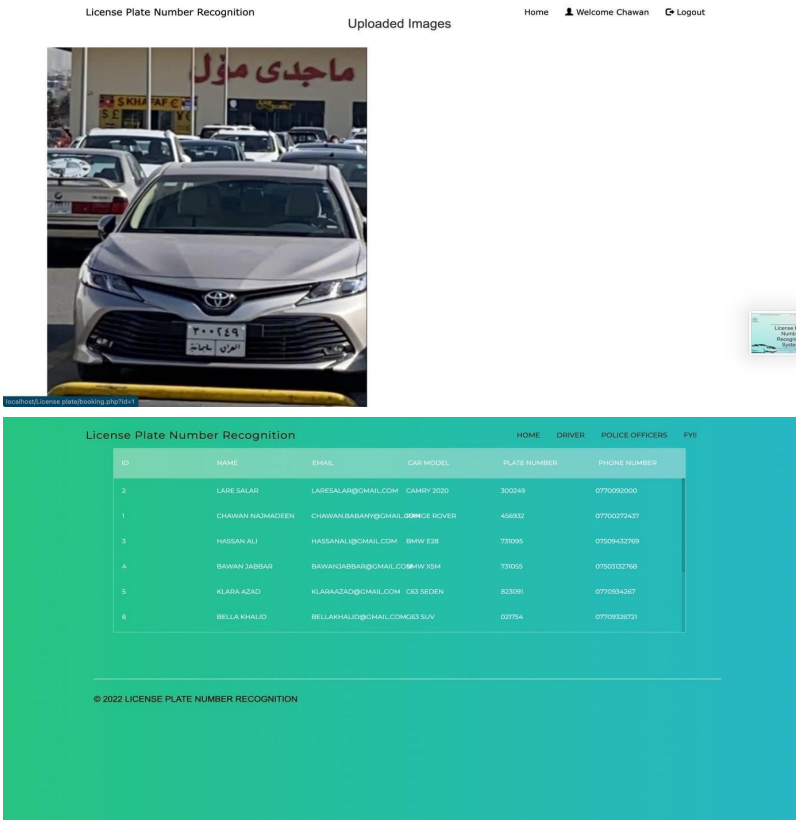

Figure 2.4 shows the uploaded image and its data

Figure 2.5 Shows the contact us after the picture went through image processing