**License Plate Recognition System Using Image Processing**

**15-BSCS-P020**



**SESSION 2015-2019**

**BACHELOR OF SCIENCE**

**IN**

**COMPUTER SCIENCE**

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**DECLARATION**

We hereby declare that this project report entitled “License Plate Recognition System” is written by us and is our own effort and that no part has been copied or taken without a mentioning reference of source

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*This project document is submitted to the Department of Computer Science at National Textile University in partial fulfilment of the requirements for the degree of Bachelor of Science in Computer Science. The Project is equivalent to 32 weeks of full time studies. We have read the report and confirm that this report meets the minimum requirements for the degree of Bachelor of Science in Computer Science (BSCS).*

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**ACKNOWLEDGEMENT**

This project required huge amount of work and dedication. The contributions of group members have made it possible. We would like to express our gratitude to our teachers. We are thankful for their aspiring guidance, invaluably constructive criticism and friendly advice during the project work.

Thank God for the wisdom and perseverance that he has been bestowed upon us during this  
project, and indeed, throughout our life: "we can do everything through him who gives us  
strength." My fellow brothers and sisters, for their continual supported and encouragement  
throughout this year.

We would like to thank our respected supervisor **Dr. Rehan Ashraf** for his excellent supervision and management. I am extremely grateful to him and much obliged to respect him. It’s his pure dedication to give us time from his hectic routine which makes this project possible.

We would also like to thank our honorable co-supervisor **Dr. Nadeem Faisal** for his management skills which helps to divide our work much easily and thoroughly. He shows much keen interest in our capabilities and tried to polish it.

**Abstract**

In this era of efficiency and performance machines and systems tends to be better and faster. Everything is getting automated and self aware for making lives easy and less tensed. As population is similarly growing at this rate and vehicles used by people are becoming in large numbers which makes roads and highways much dense. Time is only factor which motivates people to create automated things which performs at much faster rate. Toll plazas are major factor for wasting time on highways as they are getting more crowdy day by day. Security is also a factor to be considered as peoples tends to be more safe and vehicles safety is another aspect. For this purpose we designed an automated system for vehicles which traces their registration plate and automatically checks theirs registration number for security. This system is based on major module of image processing which captures the image and process it to extract the important information which is only registration number and neglect the rest.

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# 1 Introduction

## 1.1 Problem Statement

In this modern world the main problem in every person’s life is security. Security can be of data or property or mobile device and precisely we will talk about vehicle security and there are no useful measures taken for vehicle security in Pakistan, if there are measures they are only eye-catching based. Country’s law states a vehicle running on road must be registered so it can be officially recognized as owned by a person and unregistered or stolen cars are everywhere without out knowledge. There is no authentication software for vehicle’s registered number plate in this region. Even if vehicle is registered there are no systems to detect if this vehicle is cleared or stolen.

## 1.2 Purpose

The main purpose of developing this system is to automate security measure on highway toll plazas to capture vehicle number plates and search motorway police database and police database. A real time-based camera is installed on checkpoints, software captures the video frames from camera and scans for number plate. It automatically alerts authorities if a vehicle has registered/unregistered number. If license plate has registered number, then vehicle is clear to go or if a registered number vehicle is stolen from somewhere if its case is filed. Another purpose of the system is to apply the law which states that a vehicle must use a license plate which is officially issued from excise office.

## 1.3 Project Goals

Our goals are to create a product which is highly responsive, so we can provide authorities an easy and fast way to check vehicles registration and provide facility to track vehicles. We are eager to create a light weight product, so it can be easily installed in any device so in future we can also provide this software to third party organizations for their security as well as in Pakistan we can also provide this software to parking lot renter/tenant as it is trend in this region. Our goal is to create a more interactive software despite it requires less interaction.

## 1.4 Objectives of Project

* Providing user, a friendly automated system.
* User can expand UI for detail view of information.
* Auto alert user if license plate design is not as officially issued.
* Auto alert user if license plate is not registered.
* Auto alert user if vehicle is stolen.
* User can report/alert with major detail of vehicle to nearby police car with single click.
* User can report for major emergency.
* Provides user authorization and authentication.

## 1.5 Project Limitation

* A limited distance between camera and license plate is applied which is about 2-3 meters.
* It cannot resolve distant video/image or with low resolution video/image.
* It can process only single number plate in a video feed.
* It cannot resolve night vision issue otherwise night vision cameras are installed which requires other type of image processing.
* Area of the checkpoint should be properly illuminated.
* It cannot process if camera lens is covered with water droplets in case of rain otherwise camera is installed under a shed.
* It declares other design license number plates as unidentified or unregistered as we are limited to Punjab region for now.
* It cannot process a fast-moving vehicle because we don’t have advanced camera which captures hundreds of frames per second.
* A vehicle should be moving around 20-30km/h.

## 1.6 Project Scope

To create the boundaries of our project first we decided the subdomain in which we are going to apply our idea and we are going to develop this project for toll plaza only. This project is expandable to other domains with minimum change, such domains which require some security and surveillance. The basic feature of this project is universal which is applicable to almost every domain .

## 1.7 Project Scheduling

A project is scheduled according to requirements we gather and how we design and test our system. Project is scheduled w.r.t time and cost. Cost scheduling is more predictable than time scheduling. A good scheduling should be more predictive as it shows progress according to the planning. It should also be flexible so it can be adjusted if there are any ups and downs during development. Table 1-1 shows the tasks that are perform during the working months.

Table 1-1 Project Scheduling

A screenshot of a cell phone

Description automatically generated

## 1.8 Risk Management

Risk management is an important part of the project as it reduces risks which can harm project development in any way. As we are adopted Agile iterative methodology then it is upon us to manage risks on every step of project development. Risks can be of many types which includes cost, performance, schedule and design etc. other risks are unforeseen and unavoidable which may occur. Risk can be different on different work scale as we are developing this project on university scale some other risks may include which might not be present in field of work.

### 1.8.1 Types of Risks

Risks are very important factor in all the projects, that is project related to software or in building architecture. There are many risks involve in this project some of them are mention below.

#### 1.8.1.2 Cost Risk

In project development estimation of cost is undefined it is always approximate. Cost analysis is done before starting of project. To minimize cost risk in future we have to further divide our project in small parts and analyze cost of each part. Categorize the project such that management cost, hardware cost etc. so that we can precisely divide the total cost.

#### 1.8.1.3 Performance Risk

Performance risk is very dangerous type as it found in final result and we have to repeat every step to reduce this risk. It occurs when our final product do not meet our estimated performance. As we are developing a license plate reader through image processing , here performance parts in image processing as processing requires time so less performance means more processing time . If our system takes insufficient time to scan a license plate then our final product is totally useless.

#### 1.8.1.4 Scheduling and Time Risk

Carefully dividing a project development step by step and adding time required to develop modules of whole project , we can acquire a proper schedule. Scheduling risks occurs due to many factors such as team members are nonserious or some avoidable circumstances occurred which postpone small tasks.

#### 1.8.1.5 Change of Requirements

On university scale change of requirement occur when our system do not fit in our required subdomain for which we are developing our project or team members feels we cannot fulfill this requirement in our required time. On market scale change of requirements depends on vendor and how technology is changing w.r.t time.

#### 1.8.1.6 Unforeseen Circumstances

These risks are most undefined as no one knows about future. Unforeseen circumstances include technical difficulties/failures, revolutionary change in technology or any natural disasters. These risks may or may not effect on our project. Most unfortunate possibility is death of all team members in a car crash.

### 1.8.2 Risks in Steps of Development

Developing a project step by step keeps the project from making a mess. Every step requires different specialists who always try to keep project on track. A project manager as a root , keep all the specialists unite and make them better communicate with each other. Risks can occur anywhere and affect on every step of development.

#### 1.8.2.1 Requirement Gathering

Major risk caused during requirement gathering is continuous change of requirements as we are not sure about our final decision other factors include team capabilities. improper scheduling and time estimation may also occurred in our project and cause project to take more time in development.

#### 1.8.2.2 Architecture and Design

Every risk on previous step impacts on next step of development. During architecture and designing the major risk which can occur is cost risk. It is the basic step of how our project is going to work and how much cost is required to build it in working form.

#### 1.8.1.3 Coding and Implementation

During coding and implementation time scheduling is crucial. Poor team management of coders is also affectable during the time of code integration. Such risks extends the time capacity of development.

# 2 Literature Review

## 2.1 Related Work

There are many applications including mobile applications and many desktop applications for the license plate recognition of vehicles this includes Automatic License Plate recognition, Automatic License plate readers, Automatic Vehicle identification, car plate recognition, Mobile License plate reader. But they are all not Video based. ANPR (Automatic Number Plate Reader) was first developed in 1976 for police branch in UK but still it was not perfect at all with many complications. Many of the applications uses different techniques and works on colour images techniques include Neural Networks, Pattern Matching, Segmentation and many.

Some of the Project mentioned below was recently developed.

**License plate recognition (LPR) system** is a desktop application that use segmentation of character algorithm for the extraction of license plate. This application is only limited to Saudi Arabia. Inductive learning-based method and SVM method are mainly used for the detection that is they both works together and this one divides classes into smaller groups and other classify these groups these then apply on the plate characters and then for the learning of the plate characters.

In many system Morphological operators are used for image pre-processing and after this a simple template matching algorithm is run for character recognition, in another study plate image is normalized and then apply scaling and cross validation to remove outliers and then finally SVM was applied for the character recognition. Some application used camera-in-motion that is image is capture by webcam for the image character recognition light, background and position of the vehicle is not important then images are to be localized and then afterwards images character are segmented, multiple neural networks are used for character recognition

Sobel colour edge detector is a perfect method for detecting vertical edges and when invalid edge in encountered it will be eliminated and the region of license plate was searched using template matching, Connected Component analysis and Mathematical Morphology is then used for the segmentation and for the character recognition Radial basis function neural networks are used and was for successful in night hours and daytime condition.

**Automatic license plate recognition (ALPR)** but however it works under restricted conditions like fixed illumination, limited vehicle speed, the routes must be designated and still background. The Experiments were conducted, and success rate was satisfactory

Working of this system is unique it uses vector quantization to extract the textual properties of the segmented area due to the contrast colours of the plate will have high contrast and that is plate will be separated by means of mathematical morphology. Many projects work on the image gradient they simply tried to detect the images edges by mean of edge detection and geometric feature of the license plate so if the edges may not be relevant then you apply Gaussian filter to delete them and next step is to just remove the non-vertical edges and determined the plate from high contrast areas.

Main algorithm that was used is Artificial Neural Networks. So for this we need colour information to determined plate and that is we give eight neighbour of pixels to the multi-layer perceptron they processed the image line by line and the plate in determined due to some sequence of pixels features and for the accuracy of the image geometric features are concerned. Some of the methods are used to determined the plate includes the Hough transform for the line detection is very accurate but nonetheless it is very difficult method and high processing and time consuming, on the other hand histogram analysis for noisy image still not helpful, Morphological mainly in real time system are used rarely but still very time consuming, light based method are used but they are still very problematic due to light condition, Sobel operators methods used vertical edges by image improvement and noisy border of background were removed. Genetic Algorithms are also used they have high performance rate and deals with the different light condition images of the plate. In Taiwan vehicles have variety of plates so methods like fuzzy logic do better in these cases.

Complex backgrounds are very difficult to deal so for this Histogram Equalization techniques are used for the plate to be extracted, in this technique the threshold to be set for improving the quality of the image and after this improvement next step is to calculate the pixels differences for per big area and smoothed edges using dilation techniques. Scanning row-column method are also used in which number of changes of colours are to be counted and then detection take place but however this method has its limitation that is plates with angel have different image colours on the corners so it will remove some plate parts.

**A real time vehicle’s license plate recognition system** was simply based on Pattern Matching. Basically, this was a simple project that only collect data for surveying or some application purposes and was done on C++ language.

First in this algorithm for the recognition of the license plate character by processing the captured image and plate detection based on the pattern matching this system simply follows a smart algorithm for the recognition but only limited to Alberta license plates. Figure 2-1 shows a Alberta number plate that contains three numbers and three letters so there many an ambiguity between the characters and digits like O letter and 0 number digit or mang be letter B and number digit 8 but it has been solved. First three letters characters are only needed to compare with letters A-Z and similarly for three digits they needed to compare with patters of digits 0-9.



**Figure 2-1 Alberta License Plate[1]**

The main problem in this is to find the area for the character recognition where the characters are printed and this is usually horizontally and vertically centered, so by taking colours in consideration we get the bottom and top of the character position, when the image character is found next step is to segmentized the number plate as shown in the figure 2-2.

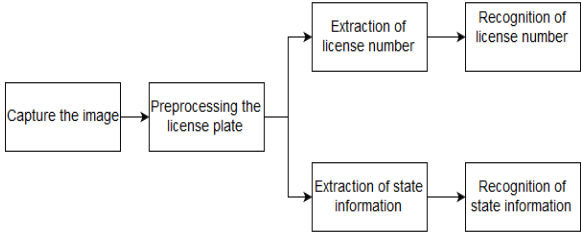


**Figure 2-2 Segmented Plate[2]**

Now finally next step is to recognize the character from the segmented plate by taking horizontal concentration of colours and the pattern matching is done with the alphabets and digits but depending on the font style like in Alberta license plate Ariel font is used. For every letter and digits, A-Z and 0-9 histogram is generated for each characters for building the library.

**Learning-Based approach for license plate recognition** was basically uses neutral networks as filters for analysing the colour and texture of license plate. It was also the Video based projects mainly used in parking lots etc. 1000 videos were tested, and success rate was satisfied

Many of the project related to ALPR concentrated on license plate of countries that have different and unique design standards, but all the past build systems or application concentrate on license plate number that is they mostly are ineffective in recognizing and detecting information on many countries and area plates. A typical Automatic license plate recognition system shown in Figure 2-3 shows that first image is captures and we perform pre-processing after then localization of the license plate number and then finally recognition of the license plate number, but in this system research the main focus is on the information extraction and then recognition from the license plate number.

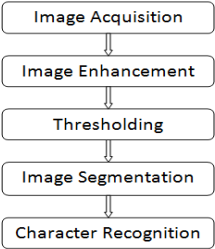


**Figure 2-3 A Simple ALPR System**

In any Automatic license plate recognition system segmentation is most common thing to do which is a process labels connected pixels. Segmentation is main a feature extraction from the number plate image like in segmentation using pixel connectivity we use binary image for segmentation pixel size and aspect ratio are to be consider in this. In segmentation using projection profiles again binary image is used but with considering background and foreground pixels that have opposite values thus helping us to determined starting and ending position of the alphabets characters in the image using vertical projection and for the extract of the information form the license plate number is done by horizontal projection. In segmentation using prior knowledge it simple works on the information like Hight, aspect ratio, width and colour distribution.

**Car license plate recognition with neural networks and fuzzy logics** is another application that use neural networks for minimizing the errors in recognition. The experiments were done on Highways of Netherland.

For the security reasons driver picture can also be taken by camera so it may create the difficulties of the system to recognize the license number plate and may affect the efficiency and accuracy of the system so it is very important to check these efficiency relation problems for the future however we also take care of the non-constant variables. Some of the non-constant variables are vehicle license plate orientation, speed of the vehicle, type of vehicle, weather conditions, distance between the camera and license plate, type of vehicle font and type of license plate. The steps of method is briefly shown on figure 2-4.



**Figure 2-4 Steps used in LPR System[3]**

Now we briefly the steps how they are carried out in this proposed system first is image acquisition for some VLPR it simple capture images by using digital camera or by webcam etc and save the image in JPEG format and them image will be cropped to its edges only license plate characters would be seen, next step is colour image processing that is RGB image is obtain of colour pixels with matric array of MxNx3 and is shown in colour cube with both primary and secondary colours. Next step is conversion of RGB image to binary images that is all pixels value 0-255 will be converted to 0-1 and image would be black and white. Next step is Image Enhancement that is to increase and improve the quality and visibility of the image. Then third last step is thresholding grey level thresholding is used. Second last step is image segmentation that is image is divided into small parts to extract and analyse the character objects. Finally character recognition by normalization that is using neural networks

## 2.2 Area of Studies

We must have to cover the subjects that is related to our projects and that will also help out in the making of this project. Mainly **Digital Image Processing** for the detection, recognition, identification of the license plates. **Database** for matching the number plates for further processing. **Software Engineering** will guide us the flow of data and let us choose the best methodology for this project. **Software Project Management** for best managing the time and schedule this project and finally **Software Architecture and Design** for documenting this project.

## 2.3 Reason of Development

Video based License plate recognition is most widely used around the world but with certain limitations so basic reason behind this project is that it provides you the easiest way to recognize the number plate with very less limitation as the project scopes is within the highways or motorways domains mainly including toll tax plazas. One of the main reason for the development is we are making it cost effective that may be used by ruler areas or countries.

The related studies section shows that most of the working of applications are limited and using the most complex techniques like neutral networks. And in this project, we are using simple techniques like pre-processing of image applying filters and segmentations and in the end template matching. A light weight project that can be easily be installed and portable.

Other reasons include that in my country Pakistan we are always at high risk stakes so security concerns. So, we are eradicating the main security issue by developing this project, it can be used on military outpost or by city traffic police or mainly on toll tax plazas on motorways and highways. We are adding more and more modules in this project to make it scalable like in addition it will also find out if the car is registered or not, if the car is stolen or not, as application would be integrated by City Traffic Police Database that will hold the record of the car in the country.

Furthermore, this project is design for my country Pakistan as in Europe or in UK these types of projects are already implemented and developed but in Pakistan it may have been developed but not implemented. So, it will be implemented on small scale even on university level and then on large scales like on Motorways or Highways

# 3 Methodology

## 3.1 Methodologies for Software Development

In the development of the software there are many things that must be kept under consideration to make the software, so basically there are several steps in the software development including requirement elicitation, system design, program design, implementation, integration testing, acceptance testing, maintenance.

The choosing of the Methodology for your project must be perfect to handle many problems that could be face during the making. Many of the methodologies involves different factor some are according to risk management some focuses on implementations some involves testing phase iteratively and finally the maintenance part.

So if you chooses the waterfall model or V model you are definitely sacrificing your project risk problem, you can’t handle risk or if any changes made to the requirements if you choose these types of model.

There are many methodologies nowadays some of them includes waterfall model V-model, spiral model, Agile, Scrum.

## 3.2 Existing Methodologies

Following the List of Top Methodologies using nowadays.

* Agile
* Rapid Application Development
* Spiral
* Extreme Programming
* Waterfall
* Scrum

### 3.2.1 Agile

There are many form of Agile Development Method including scrum, future Driven Development, Extreme Programming, Crystal. There is continues change in the business environment, Businesses are operated globally so there is rapid change, and these changes can be new opportunities in the market, economically condition etc.

Actual meaning of this Agile is that it has capability of embrace the change. It can be demonstrated by umbrella. Whole Process is shown in figure 3-1 Agile

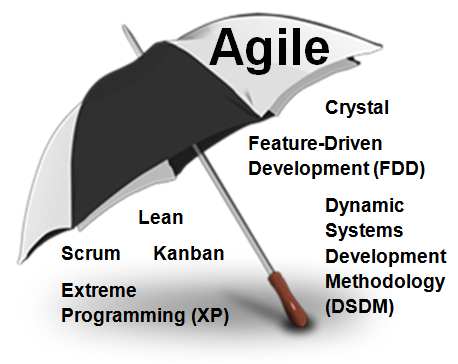


Figure 3-1 Agile Development Model [4]

### 3.2.2 Rapid Application Development

RAD is a condensed Development Process that basically made high cost system with low investment. Helps the Developer to shift the requirements according to the future change. If there any change made on the already build software then RAD helps you out in any manner to made changes.

RAD have four phases

1. Requirements Planning
2. User Design
3. Development
4. Cutover

In the User design and development phase there is iteration over these phases until the user is satisfied that the project is build according to the requirements. RAD is very effective in some cases that where projects objectives are well define but not computationally complex. The RAD is famously use for those software that are short in size and time sensitive. Process is shown in Figure 3-2

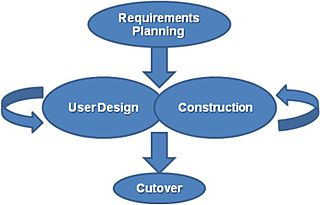


Figure 3-2 RAD [5]

### 3.2.3 Spiral

Spiral Model is one of the oldest Methodology and that is the combination of Water fall Model and Iterative Model. Every phase of the Spiral Model starts with design goal and ends with the prospection of client that viewing the progress. Basically there are some limitations with the spiral model that is its not well defined in the software development as that of scrum.

So reasons is that the spiral model is not cost effective relatively expensive and not suitable for the small scale projects.

Spiral can have 4 phases following show the details.

1. Planning
2. Risk Analysis
3. Engineering
4. Evaluation

Planning includes the estimation of cost, scheduling and the resources required for iterations. Important part includes the understanding the system requirements that can only be achieved if there is strong communication of client and system analyst.

Risk analysis is one of the important phase in the development as it identifies the potential risk and then tries to reduce it.

Engineering includes the basic thing that project need like testing, coding and deploying it on the client side.

Evaluation is done when your software is ready to deploy, and it is done by client, the client simply evaluate the software by monitoring the potential risk. Shown in Figure 3-3

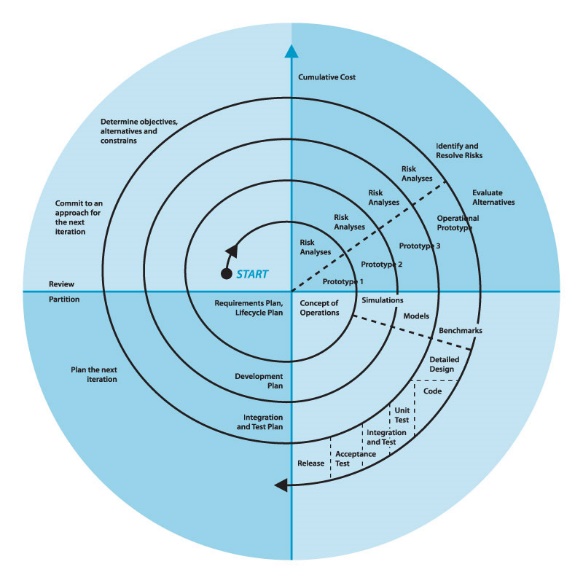


Figure 3-3 Spiral Model [6]

### 3.2.4 Extreme Programming

Extreme Programming is actually the sub branch of the Agile Development. it is actually a kind of design we use to improve the substantial in the software like is quality of service. The most effective use of Xp is that it easily adopts the changing needs of the client.

Xp is used for basically high quality software with very simple and fast development. if you want to reduce the cost of your project then extreme programming would be best to choose. Another function of Xp is that it avoids you not to develop the modules that are not currently needed. Model is shown in Figure 3-4.

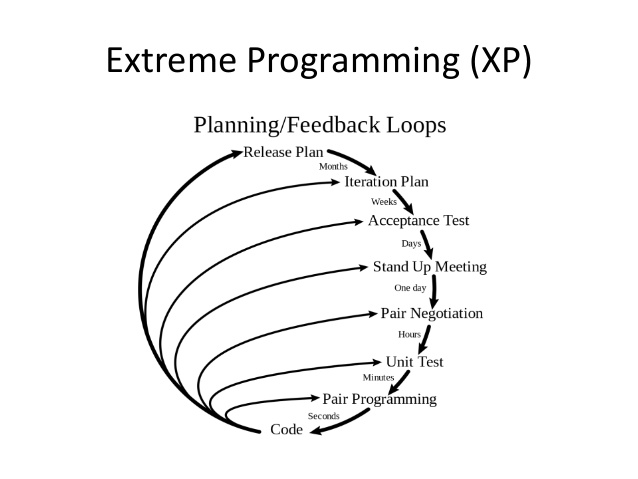


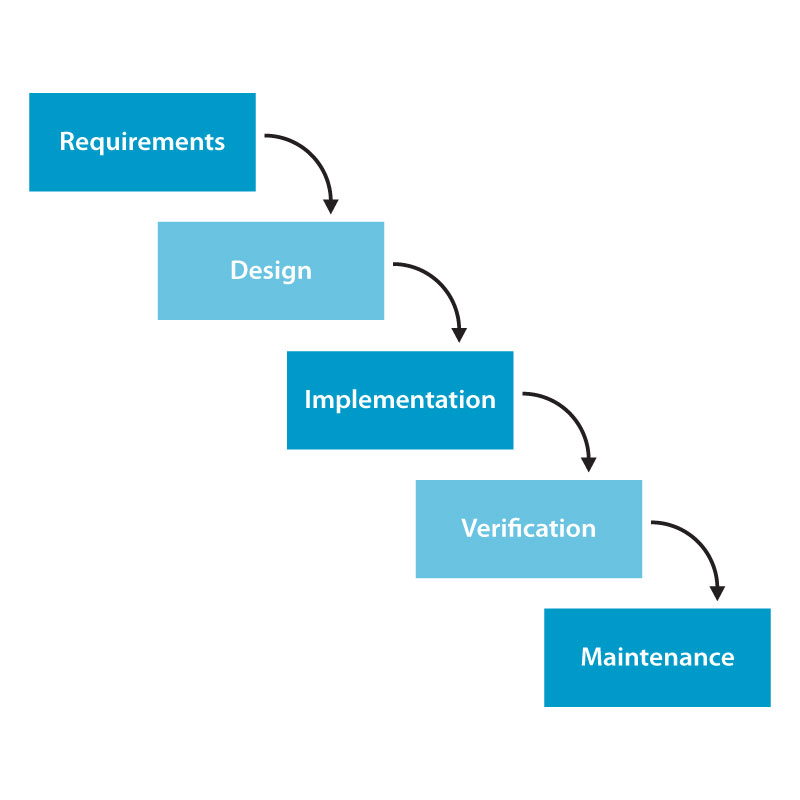
Figure 3-4 Extreme Programming [7]

### 3.2.5 Waterfall Model

This methodology is one the oldest and tradition model for the development of the software and its comes with the several phases that are sequential that flows steadily downwards like a waterfall flowing through the phases, but it is easy to manage and understandable.

There are certain phases waterfall entails

* Requirement analysis
* System design
* Implementation
* Testing
* Deployment
* Maintenance
* Requirement gathering, and analysis includes all the requirement need to implement the software, that is it simply gathered requirements.
* In System design the gathered requirements are now analyse and design is made according to the requirements and mainly helps to define the system architecture.
* Next phase is implementation all the coding is done in this phase.
* Testing is one of the main phase all the type of testing is done is this phase like white box testing, black box testing.
* Deployment includes installing of the software and application on Desktop or pc.
* Maintenance is most important phase that need to be done throughout the lifetime of this software.

Figure 3-5 Waterfall Model [8]

## 3.3 Selected Methodology

Selecting a methodology is very sensitive to choose as your whole project based on it. The methodology must be selected according to your project like if you are making a software which in future doesn’t need any change you can choose Waterfall model, but in our project case we are using Agile Iterative Model. This model handles many things, one of the thing is Risk, with every iteration we check the risks, development, testing.

Other reason of choosing this methodology is that this project is flexible and can be used in many domains so in that case we can update any module or add any module according to the domain. If the project is being used on the university level less number of module is required but if used on toll plazas or in market parking lot than it have different modules so that’s why we chose Agile Iterative model as shown in Figure 3-6.

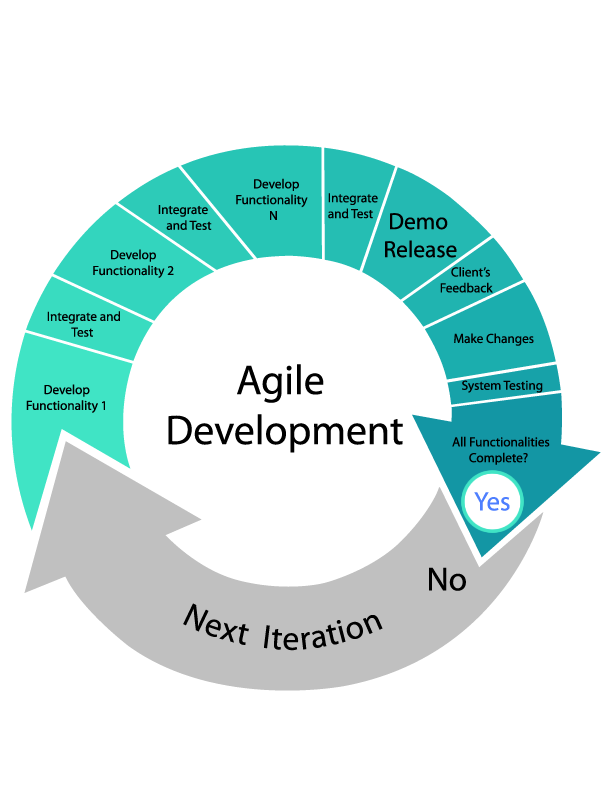


Figure 3-6 Agile Iterative Model[9]

So with every iteration there are phases that we can change, with the changes made we can develop the modules accordingly and we can also add different modules. So agile is basically give us opportunity to embrace the change. So by this improvement are made at each iteration give us best quality of product to the organization.

Error recovery in each iteration is the best feature of this model. Error on testing can be handle on next iteration.

# 4 System Requirement

## 4.1 System Requirements

First thing in developing a system is gathering requirements. On the bases of those requirements we develop that system. Understanding requirements is curial part of requirement gathering phase because requirement is gathered through description of the user desired system and one must understand the exact meaning. System requirement is all about the project that would be run on the machine keeping in view the specification of the machine. These requirements tell about performance of the project. Smooth flow of the project.

## 4.2 Hardware Requirements

Hardware requirements indicate the minimum requirement on which system runs smoothly without any crashing or failure, otherwise recommended required are optional for better requirement. Requirement for our system are as follows.

* High resolution and high-speed camera.
* Processor speed 2.6 GHz
* 1 GB Memory
* Graphics card Asus Strix GTX 1080Ti
* ROM desirable.
* I/O ports
* Monitors.

## 4.3 Software Requirements

Software requirements indicates the platform on which the system is develop and on which the system runs. For the system development MATLAB is required and for the handling the data.

## 4.4 Functional Requirements

Functional requirement concerns with how the system works and how the outsider can interact with the our systems, like if a user or an employee have to use the system his/her have to go through some steps.

The these steps includes.

### 4.4.1 User Sign up by Admin

Due to security reasons not any person can sign up the LPR system. If any user wants to be a part of LPR system his/her must have to contact the admin for an account. User just have to give his Full name, ID ,Username, Password.

### 4.4.2 User Sign in

Now user have its Username and Password which is provided by the Admin, now user just have to open the system and provide its credentials to log in the system.

### 4.4.3 Authentication of User

Authentication of user is very important as this project is attached with the Traffic police database for matching vehicle number plate. So all users must be verified from its national identity card and enter its unique username and password to login.

### 4.4.4 Show All Employee/User

Any User/Employee can see all the employees using the system and admin can also have access to see all the users.

### 4.4.5 Add an Employee/User by Admin

Only Admin have the rights to Add any user to the system with proper authentication. User just have to give his/her credentials like ID, Full Name, Username, Password and Admin can simply add the user.

### 4.4.6 User’s Profile

There are security concerns with the system so user can’t see its profile or manage if he/she wants to update profile must have to concern the admin as all access and rights are own by admin.

### 4.4.7 Recognize License Plate Number

Both Users and Admin can recognize number plate by two methods first is manually that is user can manually browse the picture taken my camera or by the camera on runtime.

### 4.4.8 Deleting User

Admin have the rights to delete any users from the system. User can’t access the database so user need to request the admin if he/she willing to leave the system. User just have to give his/her id to delete from the system.

### 4.4.9 Stolen Vehicle

One of the main functionalities of our system is if the vehicle enters in parking lot or in toll plaza or in any area where our system is deployed it immediately recognize the license plate number and match it with the database named Stolen Vehicles and if the match is found then the vehicle is labelled as stolen, further more system will also fetch the record of that person for which the stolen vehicle is belong. Interface of this module is mention on chapter 7.

### 4.4.10 Registered Vehicles

Further system functionalities include the vehicles license plate number matching with registered vehicles database just for the security purpose and in any case if the license plate doesn’t match in registered vehicles system will give error that your vehicle is unregistered. Interface of this module is mention on chapter 7.

### 4.4.11 Vehicle Info

System also has database name Vehicle Info so if system recognize any license plate it will automatically save its license number and current time and date of when system recognizes. Interface of this module is mention on chapter 7.

### 4.4.12 Database

Our System can interact with various databases like MySQL, Oracle and SQL Server. For our system we use SQL Server Database that works perfectly with MATLAB and for MATLAB use must have to install JDBC/ODBC drivers for databases to interact via Database Explorer in MATLAB.

## 4.5 Non-Functional Requirements

Non-Functional Requirements depicts vague behavior of system. It contrasted with functional requirements but are not functional requirements. It contains additional features which do not affect the basic behavior of our project.

### 4.5.1 Performance

The basic ability of a system to respond in no time in any situation falls in the category of excellent performance. keeping up this ability has major role in developing a good system. Performance also named as response time or as directly proportional to response time.

### 4.5.2 Security

Making a system secure is an essential factor in case you don’t want to get any harm to system. The ability of system to run in safer environment without any outside threat is related to security.

### 4.5.3 Availability

The availability is the numeral factor which can be calculated. It requires the ability of system to be fully committed to its recommended performance for a period of time for example a system can be available for 18 hours in a single day has availability factor of 0.75 otherwise its performance will be affected.

### 4.5.4 Maintainability

All systems require some maintenance in order to run smoothly and also not all systems has 100% fault tolerance. They break down sometimes and maintainability ensures that it will be handled in no time.

### 4.5.5 Reusability

Our system is highly reusable because of single module which can used anywhere where security is needed. The higher the reusability the greater the chances that our product can be demanded in other domains.

### 4.5.6 Extensibility

The secondary aim of this project is to make a spin off which can be handled separately by giving our project enough flexibility and also to create a better version of it. Extensibility means further modules or functional requirements can be added to the system without affecting the existing system.

### 4.5.7 Operability

To make the system more operable , automated as well as manual functional handling is added. In case of any crash of main module a user can manually add details of the subject. This helps in better handling of system and also it increases the factor of availability.

## 4.6 Overall System Requirements

According to the Functional requirements and Non-functional requirements basically tells the features of the project and flow of the data, rights of the users and admin.

There are some feasibility studies that concern with the development of this project and gives you through information about how to deal with the system and what the abilities.

### 4.6.1 Technical Feasibility Study

To check the technical feasibility of this project, have to do study and review some questions like if this project can help you to reduce the crime related to vehicles or if car stolen or not, or if this project is capable of deploying in many fields like toll plazas, parking lots, or even in training institutions.

So yes of course our project is technical feasible in many fields as the system we are making can easily be deploy or install in standalone computers or even portable can easily be convert to other applications like android or web.

The project if installed on Desktop doesn’t require any fast internet just accessing online Databases.

### 4.6.2 Economic Feasibility

This feasibility concerns with the cost that is the project is economically affordable or not. Well this project needs some investment it may be costly for small organization as it needs high resolution camera or in dark night vision camera may use.

#### 4.6.2.1 Development Cost

Cost to develop this system is little bit high due to expensive high resolution camera and fast standalone desktop with high processing speed. All its takes

* Hp Laptop with core i7 7th gen
* MATLAB R2017 for the development.

### 4.6.3 Operational Feasibility

This project is solves many real life problems in fast way, as it responses very fast in recognizing the number plate and matching it with database thus giving an alert. It perform many functions includes

* Matching number plate with stolen car number plate
* Matching number plate with unauthorised number plate

## 4.7 Use Case Diagram

Use case diagram are very important for any project or system as it describe and visually tells how the external user or internal user can interact with the system and who have the access or rights to which module of the system.

### 4.7.1 System Use Case Diagram

System includes User/Employee and Admin as an actor who can interact.

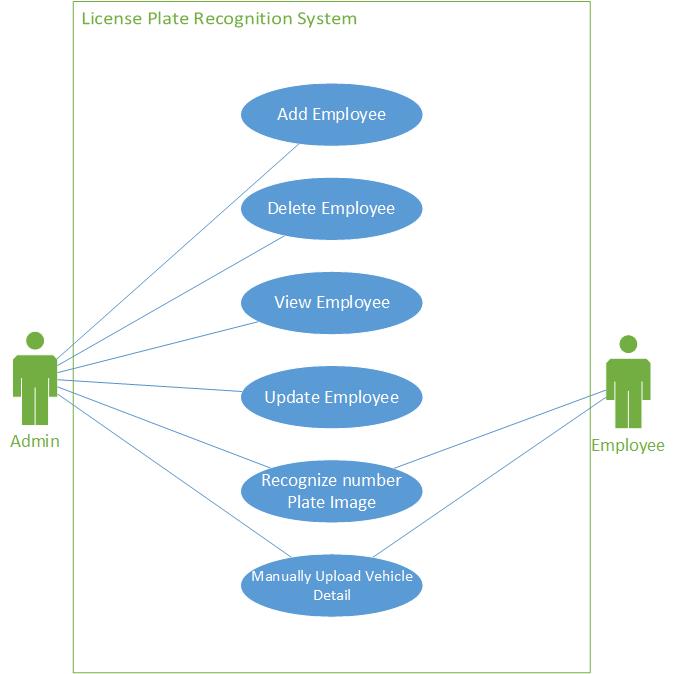


Figure 4-1 Overall System Use Case Diagram

We need to describe our system other use cases like authentications and admin cases separately for clear vision.

**A picture containing text

Description automatically generated**

Figure 4-2 Authentication Use Case Diagram

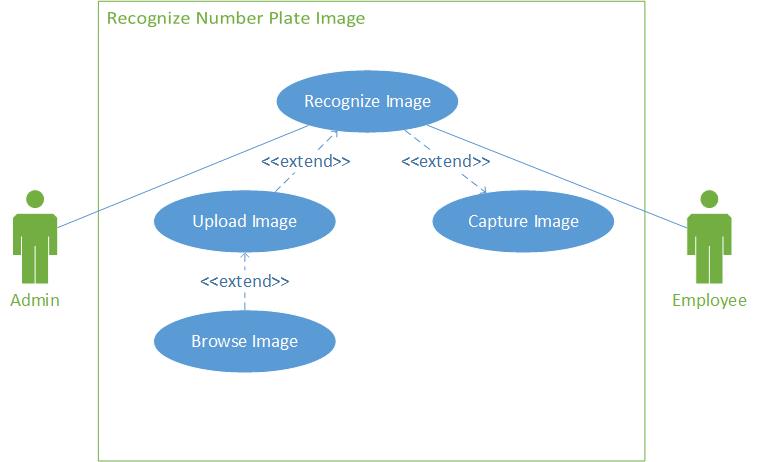
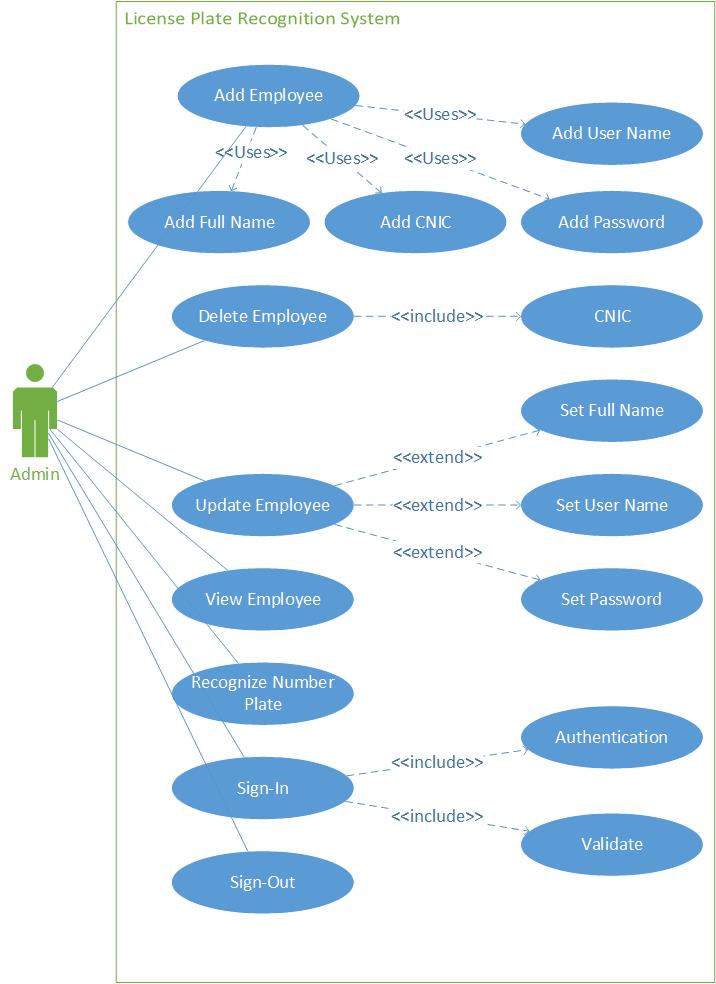
****

Figure 4-3 License Plate Recognition Use Case Diagram

### 4.7.2 Admin Use Case Diagram

Functionality that Admin can perform includes

* Admin can add an user
* Admin can delete any user
* Admin can update any user
* Admin can view all the user
* Admin can set username and password for the users
* Admin can recognize the plate.

****Figure 4-4 Admin Use Case Diagram

### 4.7.2 Employee Use Case Diagram

Employee can perform limited functionalities

* Employee can recognize license plate
* Employee can Add number plate manually

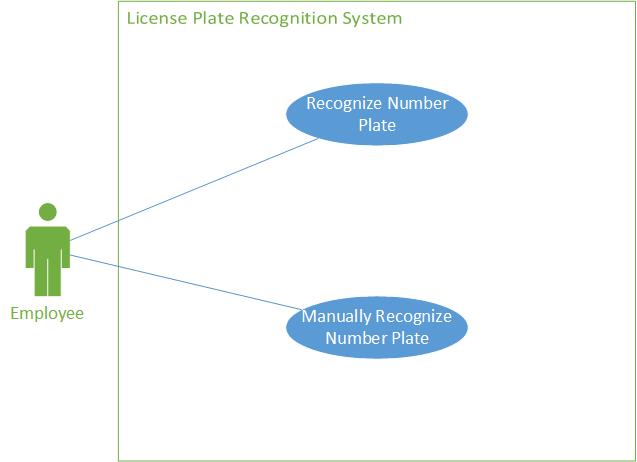


Figure 4-5 Employee Use Case Diagram

## 4.8 Use Case Tables

These tables represents the situation of how to a single activity works with their related paths and further where an activity will bring you.

### 4.8.1 Sign up

This scenario represents how a user can first access this system by making himself as a member by providing his info.

Table 4-1 User Sign Up

|  |  |
| --- | --- |
| Use Case Name | Sign Up |
| Priority | High |
| Use Case Id | 1 |
| Actor | Admin |
| Precondition | None |
| Basic Path | * User opens the app. * Click sign up button. * Sign up page appears. * User fill information. * Click sign up button. |
| Description | User become the employee of the department using the system |
| Post Condition | User is asked to sign in |

### 4.8.2 Sign in

This scenario represents the authorization of a person access to the system

Table 4-2 User Sign In

|  |  |
| --- | --- |
| Use Case Name | Sign In |
| Priority | High |
| Use Case Id | 2 |
| Actor | Admin/Employee |
| Precondition | User must first Sign up |
| Basic Path | * User opens the app * Click sign in button * Sign in page appears * User fill information * Click sign in button to proceed |
| Description |  |
| Post Condition | User access the basic functionality of the system |

### 4.8.3 Add Employee

This scenario represents how a new user is add to the system access so that new employee user can use the functionalities of the system separately. This act can only be done by admin user.

Table 4-3 Add Employee

|  |  |
| --- | --- |
| Use Case Name | Add Employee |
| Priority | High |
| Use Case Id | 3 |
| Actor | Admin |
| Precondition | Admin must sign in. |
| Basic Path | * Admin sign in the app * Click on add employee button * Fill information * Click on add button |
| Description | Admin add the employee id in the system |
| Post Condition | Employee can sign in with assigned username |

### 4.8.4 Delete Employee

This scenario represents how to remove an employee user . This act is only done by admin user.

Table 4-4 Delete Employees

|  |  |
| --- | --- |
| Use Case Name | Delete Employee |
| Priority | Medium |
| Use Case Id | 4 |
| Actor | Admin |
| Precondition | Admin must sign in |
| Basic Path | * Admin sign in the app * Click on delete employee button * Fill information * Click on delete button |
| Description | User is restricted to further use the system |
| Post Condition | None |

### 4.8.5 Update Employee

In order to edit info of the employee user this modules helps by updates the new info to the old info.

Table 4-5 Update Employee

|  |  |
| --- | --- |
| Use Case Name | Update Employee |
| Priority | Medium |
| Use Case Id | 5 |
| Actor | Admin |
| Precondition | Admin must sign in |
| Basic Path | * Admin sign in the app * Click on update employee button * Fill information * Click on update button |
| Description | Employee info is updated to the system |
| Post Condition | None |

### 4.8.6 Recognize Plate

The major functionality of the system is represent in following table .

Table 4-6 Recognize Plate

|  |  |
| --- | --- |
| Use Case Name | Recognize Plate |
| Priority | High |
| Use Case Id | 6 |
| Actor | Admin/Employee |
| Precondition | Admin/Employee must sign in |
| Basic Path | * Admin/Employee sign in the app * Click on recognize plate button * Browse image or capture image * Start recognizing |
| Description | License plate is extracted and stored in database for validation |
| Post Condition | Checks status for registration and stolen car. |

# 5 Architecture Design

## 5.1 Architecture

Basically, in all the projects architecture of the software defines the workflow and frameworks of the project model. The Architecture also helps the user or the programmers to study the model and easily use the system.

## 5.2 System Architecture

System Architecture shows the workflow of our system that is how the employee and admin can interact with the system. Employee can simply use the system by entering login details as well as the admin as this system is a desktop application.

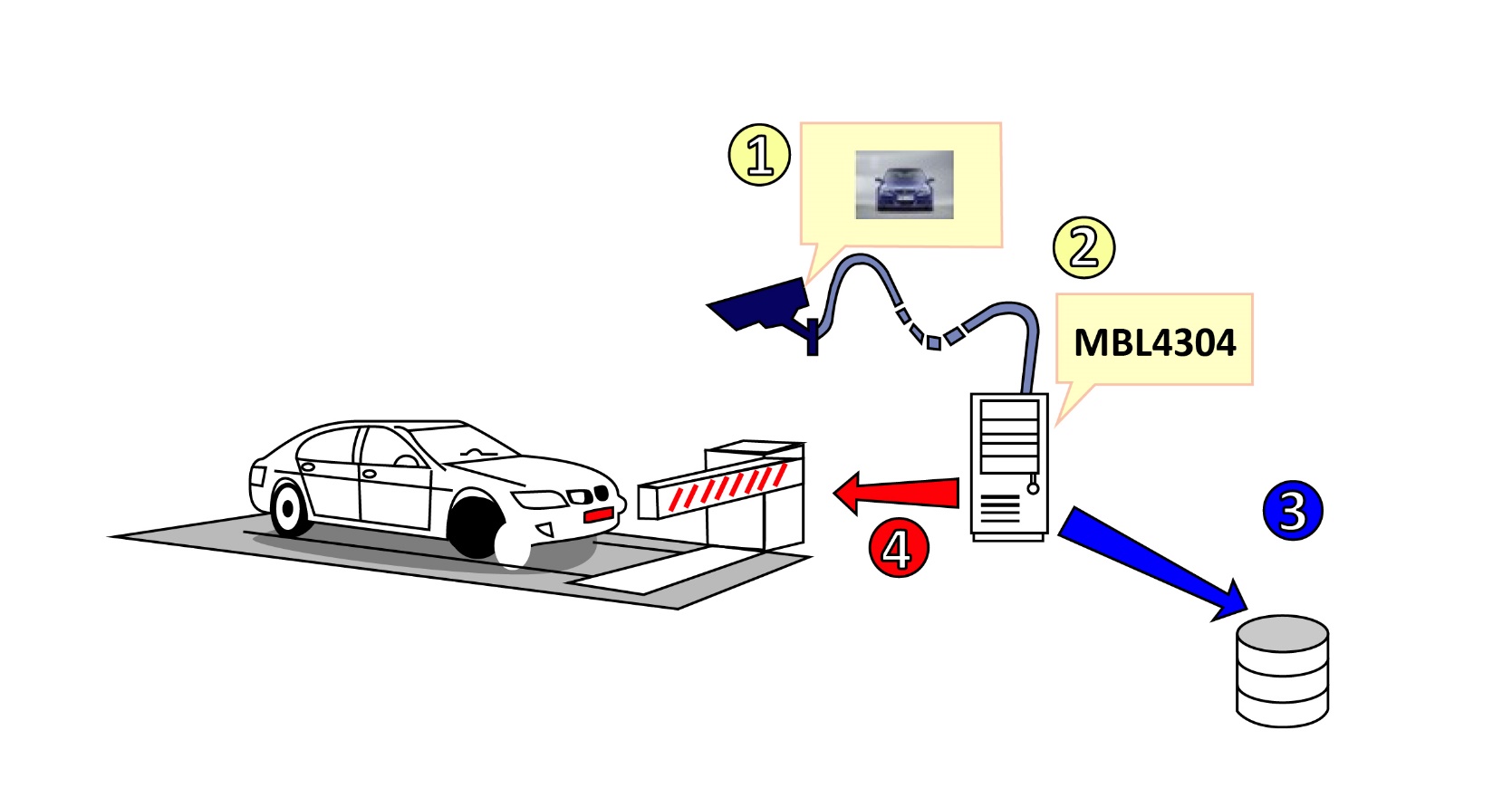


Figure 5-1 System Architecture [10]

## 5.3 Sequence Diagrams

Sequence diagram are one of very important diagrams in the project as the name depicts itself that these diagrams tell the sequence of some events. Diagram includes the messages that passes from one object to other and then other will respond corresponding, every object and actor has a activation time that is it will active for some time and then rest and if need by other object it will active again.

### 5.3.1 Employee Sign- In Sequence Diagram

Figure 5-2 describes the employee sequence that is how employee perform sign in. He/she enters the username and password which then validates further and if match found then the event is successful.

A screenshot of a social media post

Description automatically generated

Figure 5-2 Employee Sign-in Sequence Diagram

### 5.3.2 Employee Sign-up by Admin

Figure 5-3 shows the how the Admin creates the account of an employee. Admin will enter the details of employee like CNIC that will validates and then admin enters employee full name, username and password.

A close up of a map

Description automatically generated

Figure 5-3 Employee Sign-up Sequence Diagram by Admin

### 5.3.3 Admin Sign-in Sequence Diagram

Figure 5-4 describes the admin sequence that is how admin perform sign in. He/she enters the username and password which then validates further and if match found then the event is successful



Figure 5-4 Admin Sign-in Sequence Diagram

### 5.3.4 Delete Employee by Admin Sequence Diagram

Figure 5-5 shows the how the Admin deletes the account of an employee. Admin will enter the details of employee only CNIC that will validates then and if match found it will delete form the databases.

A screenshot of a cell phone

Description automatically generated

Figure 5-5 Delete Employee by Admin Sequence Diagram

### 5.3.5 Update Employee by Admin Sequence Diagram

Figure 5-6 shows the how the Admin updates the account of an employee. Admin will enter the details of employee that will gathered by them which the need to update. Admin will enter CNIC that will validates then and if match found it will update that employee record from the databases.

A screenshot of a social media post

Description automatically generated

Figure 5-6 Update Employee by Admin Sequence Diagram

### 5.3.6 View all Employee by Admin Sequence Diagram

Figure 5-7 shows the how the Admin view the account of All the employee using the system. Admin just have to click the button that will fetch records of employee and show it on the GUI.

A close up of a sign

Description automatically generated

Figure 5-7 View all Employee by Admin Sequence Diagram

### 5.3.7 Recognize number plate by Admin Sequence Diagram

This sequence diagram is one the main diagram that describes the whole system how the events will generate and how the objects passes their messages to recognize the plate and save the extracted number to databases. Admin can simply ignite the events by clicking some buttons on the GUI and rest is handled by the system shown in Figure 5-8

A close up of a map

Description automatically generated

Figure 5-8 Recognize number plate by Admin Sequence Diagram

### 5.3.8 Recognize number plate by Employee Sequence Diagram

The sequence diagram would be same for the employee as the backend event are the same all the event will triggered in a same manner as admin diagram as shown in Figure 5-9



Figure 5-9 Recognize number plate by Employee Sequence Diagram

### 5.3.9 Add Manually by Employee Sequence Diagram

Figure 5-10 describes the event sequence when employee add manually the number plate of a vehicle by browsing it form the folder and give it to the system.

A close up of a map

Description automatically generated

Figure 5-10 Add Manually by Employee Sequence Diagram

## 5.4 Activity Diagram

Activity Diagram are also the main part of the architecture diagrams they basically tells the activity of the events how they take place and flow charts of the event occurs. In our system we have two actors the Employees and the Admin they have different activities for controlling the system.

Below sections show the activity diagrams of both the actors.

### 5.4.1 Employee Sign up Activity Diagram

In Figure 5-11 diagram only admin can create the account of the employee admin just have to take the info details like CNIC and other. After the CNIC validation the account will be created.

A screenshot of a cell phone

Description automatically generated

Figure 5-11 Employee Sign up Activity Diagram

### 5.4.2 Admin Sign in Activity Diagram

This Figure 5-12 describes the work flow of sign in by admin. Admin just need to give username and password which later will validate and if yes then admin homepage will open.

A screenshot of a cell phone

Description automatically generated

Figure 5-12 Admin Sign in Activity Diagram

### 5.4.3 Admin Sign in Activity Diagram

This Activity diagram describes the work flow of sign in by Employee. Employee just need to give username and password which later will validate and if yes then Employee homepage will open as shown by Figure 5-13



Figure 5-13 Employee Sign in Activity Diagram

### 5.4.4 Add Employee by Admin Activity Diagram

This activity diagram describes the activity of admin that how he create an account of an employee as shown in Figure 5-14

A screenshot of a cell phone

Description automatically generated

Figure 5-14 Add Employee by Admin Activity Diagram

### 5.4.5 Delete Employee by Admin Activity Diagram

This activity diagram show that how admin delete the employee from the databases successfully as shown in Figure 5-15

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Description automatically generated

Figure 5-15 Delete Employee by Admin Activity Diagram

### 5.4.6 Update Employee by Admin Activity Diagram

Admin can simply update employee using validation of CNIC and employee data.

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Figure 5-16 Update Employee by Admin Activity Diagram

### 5.4.7 View All Employee by Admin Activity Diagram

This Diagram show the activity how the admin can fetch all the employee records from the databases as shown in Figure 5-17

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Figure 5-17 View All Employee by Admin Activity Diagram

### 5.4.8 Recognize plate by Admin Activity Diagram

This is the main activity diagram of the system that tell the workflow of the license plate recognition by Admin as shown in Figure 5-18

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Figure 5-18 Recognize plate by Admin Activity Diagram

### 5.4.9 Recognize plate by Employee Activity Diagram

Employee can also have this right that he can also use this module. This activity show how the employee can perform this activity as shown in Figure 5-19.

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Figure 5-19 Recognize plate by Employee Activity Diagram

5.5 Database Diagram

This Database Diagram as shown in Figure 5-20 describes our whole system diagram that is in our system there is only one Database names LPRS and it has four tables. Three of the tables concerns vehicle that are related associatively.

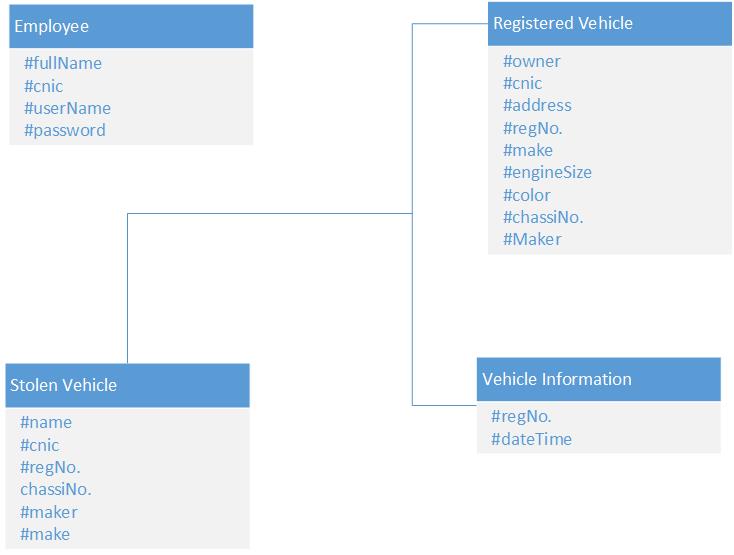
****

Figure 5-20 Database Diagram

## 5.6 Data Flow Diagram

Data Flow Diagram is at number 5th of Software Engineering paradigm one of the most important diagrams that tell the Data Flow of the system that how the data flows from entity to processes and from processes to the database it also shows how the information flows input or output and tells how the data is stored in the different databases of the system. There are mostly three levels of Data Flow Diagram starting from 0-Level to proceeding levels.

### 5.6.1 0-Level Data Flow Diagram

0-Level DFD Diagram is most simple and basic DFD that shows how the stakeholders i.e. Admin and Employee or any actor interact with the system as shown in Figure 5-21.

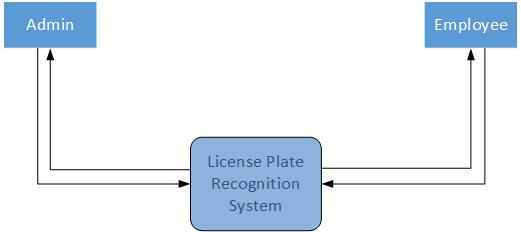
****

Figure 5-21 0-Level Data Flow Diagram

### 5.6.1 1-Level Data Flow Diagram

1-level DFD just add little detail to 0-level DFD that is entities can direct interact with process but cannot directly interact with datastores as shown in Figure 5-22.

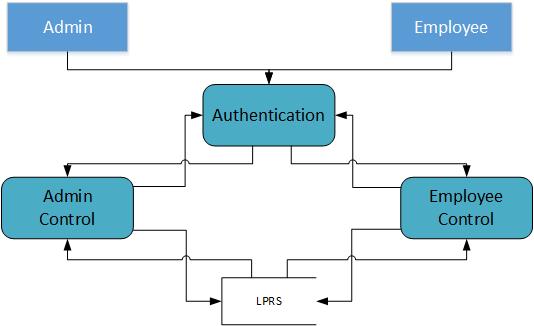


Figure 5-22 1-Level Data Flow Diagram

### 5.6.2 2&3 Level Data Flow Diagram

Further Details add to 1-Level Data Flow Diagram that is it shows the other functionality to the system as shown in Figure 5-23

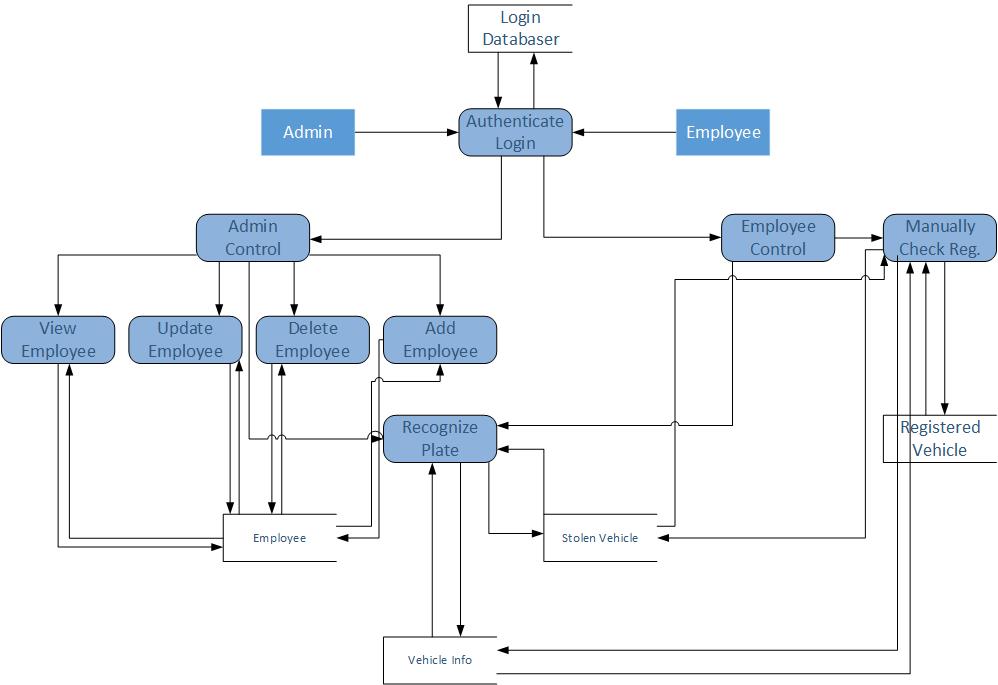
****

Figure 5-23 2&3 Level Data Flow Diagram

# 6 Testing

## **6.1 Test Cases**

Test cases are developed for testing the functionality of your system.Test cases are developed for different features and the output determines whether the system is performing right under specific conditions or not.

## **6.2 Black Box Testing**

A type of testing in which tester does not know about the structure of the system, its design, its code. System is tested by providing different inputs and results of these inputs are matched with supposed outcomes.

### 6.2.1 Register Employee Test Case

Employee can only be added by the Admin, employee just have to give his/her credentials to the admin and expert admin can entered data. Figure 6-1 shows the interface how to add Employee.

**A screenshot of a cell phone

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Figure 6-1: User Registration Form

Table 6-1: Sign Up Test Case

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test Case** | **Test Scenario** | **Test Steps** | **Test Data** | **Result** | **Pass/Fail** |
| 1 | Enter invalid ID | Enter ID, Full Name,  Username  ,Password | ID=186236784654  Full Name=M Usama Butt  Username= usamab8  Password= qwerty123 | ID must be of 14 digits | Pass |
| 2 | Enter invalid ID | Enter ID, Full Name,  Username  ,Password | ID=1A8623678465C  Full Name=M Usama Butt  Username= usamab8  Password= qwerty123 | ID cannot contain any symbols and characters | Pass |
| 3 | Enter invalid Full Name | Enter ID, Full Name,  Username  ,Password | ID=34186236784654  Full Name=M Usama Butt8  Username= usamab8  Password= qwerty123 | Full Name cannot contain any symbols and characters | Pass |
| 4 | Enter valid ID and Full Name | Enter ID, Full Name,  Username  ,Password | ID=34186236784654  Full Name=M Usama Butt  Username= usamab8  Password= qwerty123 | Employee added successfully |  |

Table 6-1 shows the test case of sign-up that what system do if wrong or invalid entries would entered.

### 6.2.2 Login Test Case

Login can be performed by both Admin and Employee to enter into system. Figure 6-2 shows the interface and Table 6-2 tell the test cases if wrong input is given.

**A screenshot of a social media post

Description automatically generated**

Figure 6-2: Login Form

Table 6-2: Login Test Case

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test Case** | **Test Scenario** | **Test Steps** | **Test Data** | **Result** | **Pass/Fail** |
| 1 | Enter invalid Username | Enter Username,  Password | Username= usamab88  Password= qwerty123 | Error: invalid username | Pass |
| 2 | Enter valid Username and password | Enter Username  ,Password | Username= usamab8  Password= qwerty123 | Login successful | Pass |
| 3 | Enter invalid password | Enter  Username  ,Password | Username= usamab8  Password= qwerty1234 | Error: invalid password | Pass |

### 6.2.3 Update Employee Test Case

Only Admin have the rights to update the employee data if employee want to alter his/her data. Figure 6-3 shows the interface how the admin will update employee data.

**A screenshot of a cell phone

Description automatically generated**

Figure 6-3: Update User/Employee Form

Table 6-3 shows the test cases that how the system will react if wrong or invalid and valid data is given to the system

Table 6-3: Update Employee/User Test Case

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test Case** | **Test Scenario** | **Test Steps** | **Test Data** | **Result** | **Pass/Fail** |
| 1 | Enter Valid ID | Enter valid ID,  Full Name,  Username,  Password | ID=03300342345234  Full Name=Hashim Ali  Username=hashim69  Password=9933Wb | Update Successful | Pass |
| 2 | Enter Invalid ID | Enter Invalid ID, Full Name,  Username,  Password | ID=033003423  Full Name=Hashim Ali  Username=hashim69  Password=9933Wb | Invalid ID not match. Enter ID again | Pass |
| 3 | Enter Valid ID but Missing Field | Enter Invalid ID, Full Name,  Username,  Password | ID=03300342345234  Full Name=  Username=  Password=9933Wb | Must fill All the Fields to update | Pass |

### 6.2.3 Delete Employee Test Case

If the Admin wants to remove any employee record, admin can easily delete his/her record from the database by giving CNIC number as shown in figure 6-4

**A screenshot of a cell phone

Description automatically generated**

Figure 6-4: Delete User/Employee Form

Table 6-4 shows the test cases shows the test cases that how the system will react if wrong or invalid and valid data is given to the system.

Table 6-4: Delete Employee/User Test Case

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test Case** | **Test Scenario** | **Test Steps** | **Test Data** | **Result** | **Pass/Fail** |
| 1 | Enter invalid ID | Enter ID | ID=76378746874387 | Error: Employee does not exist | Pass |
| 2 | Enter valid ID | Enter ID | ID=76378746874387 | Employee Removed | Pass |
| 3 | Enter invalid ID | Enter ID | ID=76378746 | Error: incomplete ID | Pass |

# 7 User Manual

## 7.1 Interfaces

Interfaces are the best visual representation that user can easily understand how to use the system. The following section elaborates all the interface of LPRS.

### 7.1.1 Sign Up Interface

Sign up interface for both the employee and Admin. Admin can only create the account for the employee. Interface shown in Figure 7-1.

**A screenshot of a cell phone

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Figure 7-1 Sign-up Interface

### 7.1.2 Sign-In Interface

Same for both the employee and the Admin. Interface shown in Figure 7-2

**A screenshot of a social media post

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Figure 7-2 Sign-in Interface

### 7.1.3 Number Plate Recognition Interface

Main Interface of the system and that is shown in Figure 7-3.

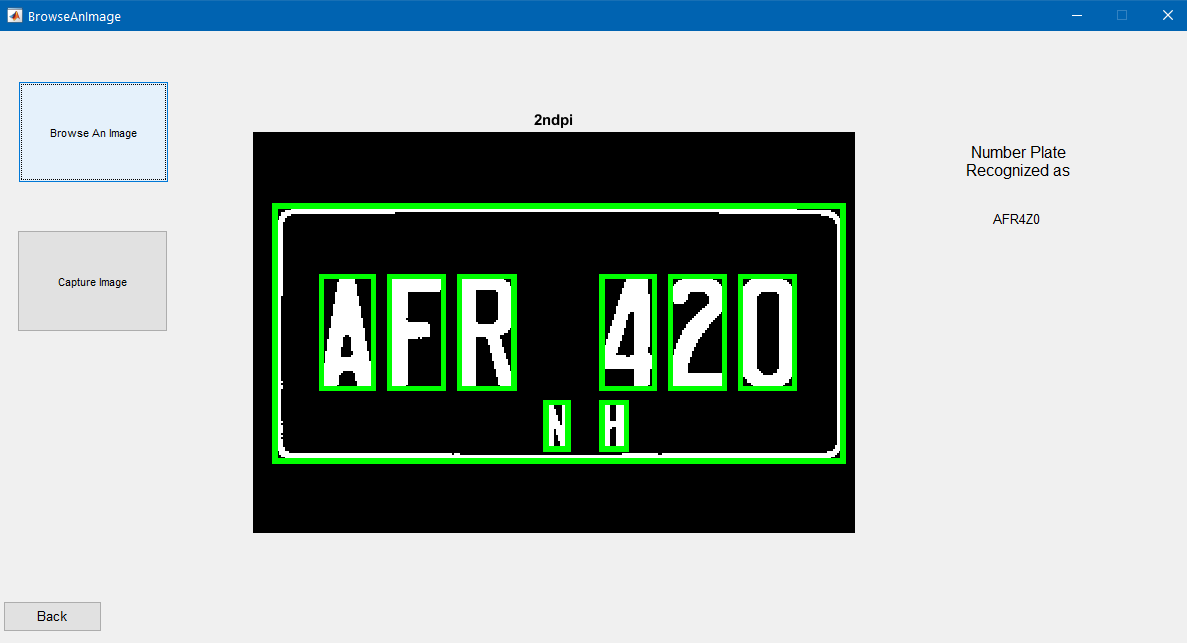


Figure 7-3 Number Plate Recognition Interface

### 7.1.4 Registered Cars Interface

This interface provides the information about the current vehicle status if it is registered or fake by matching with excise database. Interface shown in Figure 7-4.

A screenshot of a cell phone

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Figure 7-4 Registered Cars Interface

### 7.1.5 Stolen Cars Interface

This interface provides the information about the current vehicle status if it is stolen or clear by matching with police database. Interface shown in Figure 7-5.

A screenshot of a social media post

Description automatically generated

Figure 7-5 Stolen Cars Interface

# 8 References

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