Vehicle License Plate Detection and Recognition System

Submitted in Partial fulfillment of the requirements

For the degree of

Bachelor of Engineering

by

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

There are various softwares created for automatic number plate detection and recognition. Out of this most of the systems are based on optical character recognition and few systems are also based on neural networks. Various countries like Dubai and UK have been using ANPR system for controlling traffic, but it's not much implemented in India because the number plates are not standardized. Moreover the numbers on number plates are written in different fonts and styles that make it difficult for the system to recognize the characters. The automatic number plate detection can be used to identify the number plate from the picture of the vehicle. Localization algorithms are used to detect the number plate and later the numbers are segmented. Once the numbers are segmented, they are recognized using neural networks and the obtained number plate is matched with the database to identify the owner of the vehicle to deduct the amount from his account if he is a prepaid user else the bill for the car is generated.

Acknowledgement

We would like to express our gratitude towards our guide Prof. Poonam Bhogale whose guidance, suggestions and encouragement helped us to coordinate this paper. We would also like to thank Prof. Sonali Patel for helping us in our project for solving our doubts and helping us in the implementation. We also thank the department of Computer Engineering of K J Somaiya College of Engineering for providing us the tools and giving us the opportunity to complete this project successfully.

Lastly, we thank the lord almighty, our family and friends for their constant encouragement and support without which this project would not be possible.

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Chapter 1

1. Introduction

A Vehicle License Plate Detection and Recognition System detects the number plate in the image of a vehicle, localizes it, recognizes the characters in the image and stores it in the text format.

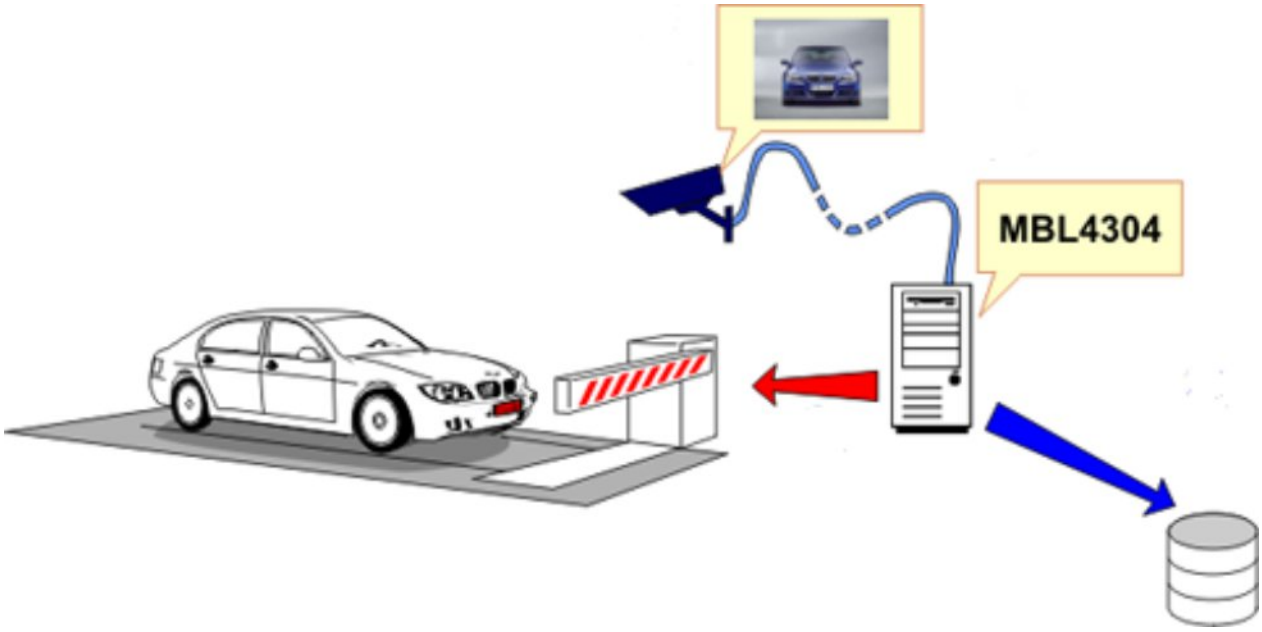

Figure 1.1 Basic Design [8]

1.1 Motivation

We often have to face the problem of standing in long queues at toll plazas or even at parking lots for the payment. Also, the current cameras installed do capture the license plate of vehicles and convert the image into a text format to be stored. Such systems can also be used in case of accidents and to identify stolen vehicles.

The motivation behind this project is to build a basis for further development in the area of detecting and recognizing license plates which can be modified as per the requirements of the region. The main element of this project concerns the design and implementation of a flexible

and expandable software system that should enable the recognition of different characters of various languages and also the variety of fonts and styles. These features make the system an ideal tool to experiment with and improve it to a large extent.

1.2 Background

1.2.1 Based on Template Matching

This type of system recognizes the characters based on their templates. The system stores the templates of the characters and during the time of recognition the system matches the stored templates with the input and according gives the recognized characters as output. This system has its restrictions as it can implement template matching on a very limited set of fonts and styles of characters, thus, it cannot recognize various styles and fonts if their template is not stored.

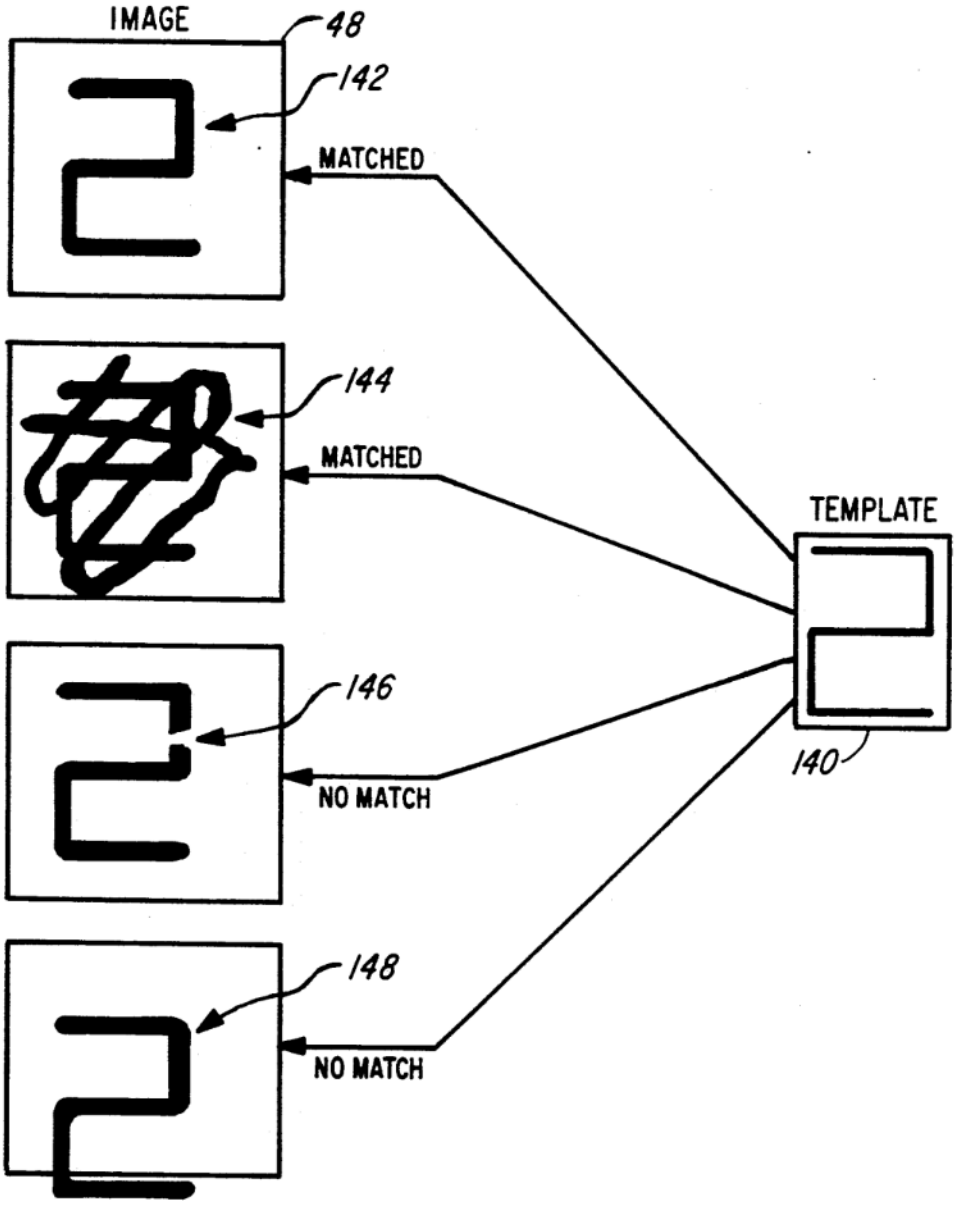

Figure 1.2 Template Matching [9]

1.2.2 Based on Neural Networks

This type of system uses artificial neural networks to recognize the characters. The system uses layers of neurons i.e. input layer, hidden layer and output layer to recognize the extracted features by comparing them to the learned features during training and give the desired output. As the

system uses a learning mechanism, it can be taught to recognize various fonts and styles of characters and hence, is expandable and a very flexible system.

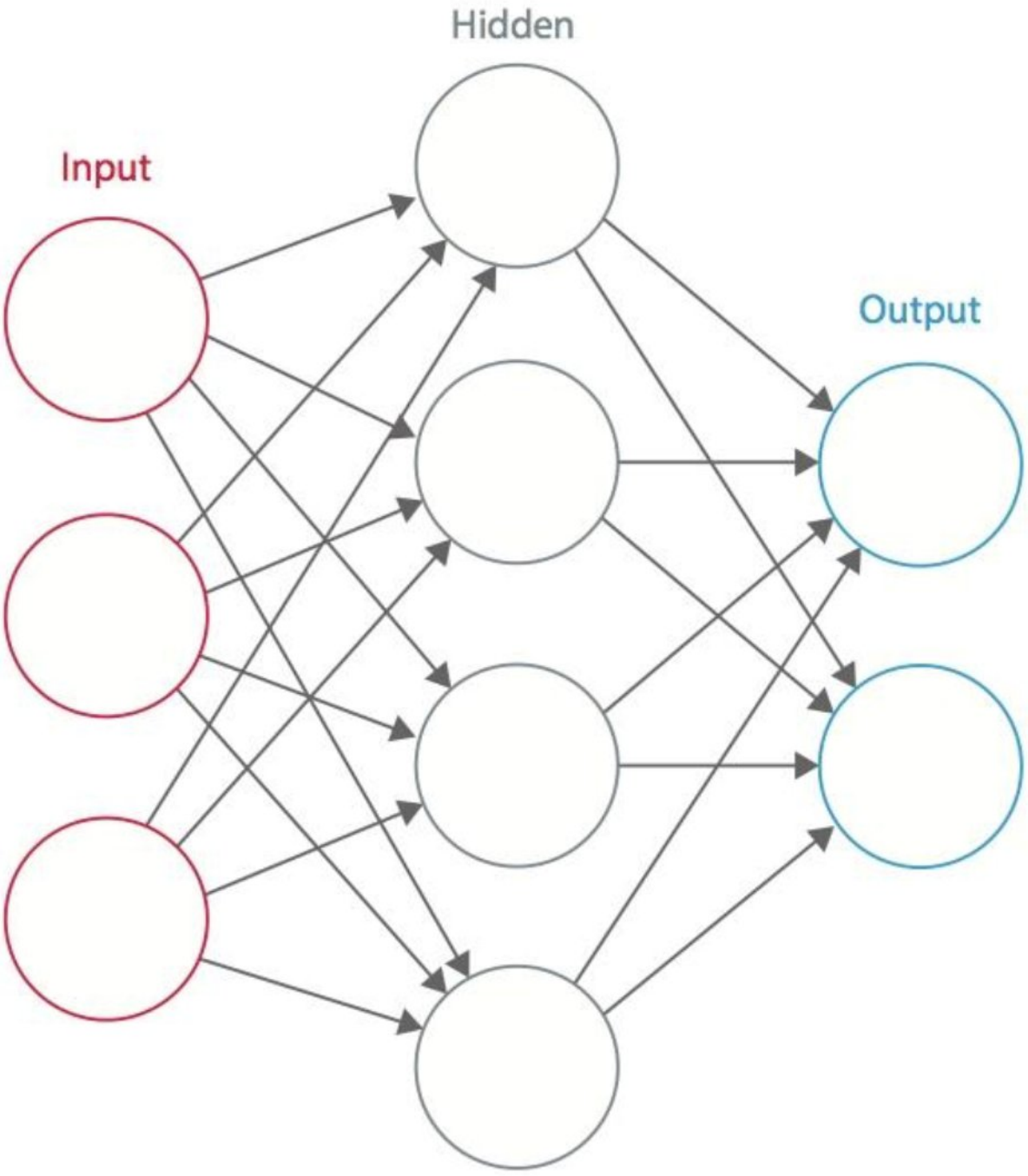

Figure 1.3 Neural Network [10]

Chapter 2

2. Literature Survey

2.1 Approach 1

In the first approach, which is based on template matching, it is used to find small parts of an image by matching them to the image templates. It may require sampling of a large number of points of the image but this can be reduced by reducing the resolution of the template images and the search by the same factor and implementing the procedure on the resultant down sized images. One of the basic methods of template matching is the convolution mask. It is adapted to a particular feature of the search image, which is to be detected. This approach can be easily implemented on grey images or edge images. The output is highest at places where image structure matches the mask structure. The restriction of this approach is its limitation of recognizing the various fonts and styles of characters.

2.2 Approach 2

In the second approach, artificial neural networks are implemented. This approach requires features to be extracted from the input characters which are compared with the features learned during training. The neural network mainly comprises of three layers, the input layer, the output layer and the hidden layer. The input is given in the input layer, the output comes from the output layer and the processing i.e. the comparison of the features takes place in the hidden layer. The neural network needs to be trained, validated and tested using samples. The more the samples, the more the network will learn and give better results. The main feature of this approach is that it is a learning mechanism; hence, it keeps on learning from the input provided. This way it can even learn to recognize various fonts and styles of characters. This approach can also be used to recognize characters of different languages depending on the region.

2.3 Summary

Character recognition using two different techniques can be implemented. The first technique however offers very limited features and can be implemented when there are not many variations in the fonts and styles of characters. The second technique offers a broader view as it covers a large variety of fonts and styles and can also be taught to recognize new variations due to its learning mechanism. Thus, this approach provides a more efficient way to expand the system and implement is on a large commercial scale.

Chapter 3

3. Problem Description and Scope

3.1 Problem Definition

- To design and implement a Vehicle License Detection and Recognition System that can recognize the characters in the license plate of a vehicle localized from the image of the vehicle and convert it into text format.
- Once the input of the image is given, the localization of the license plate takes place by applying dynamic threshold on the horizontal and vertical histograms of the image.
- After the localization, the segmentation of the characters in the localized license plate takes place by removing the noise which is done by removing the objects containing less than 30 pixels.
- These segmented characters are recognized using neural networks and displayed in text format.

3.2 Scope

- Even with the most efficient system to detect and recognize license plates, there are always new fonts and styles coming up which may not be recognized by the current system.
- This is where neural networks come into play. Due to its learning mechanism, it can be taught to recognize these fonts.
- Moreover, as the license plate may have characters as per the local language in that region, neural networks can be taught to recognize those characters.
- Thus, the system is a very flexible and expandable providing a broader aspect to its applications.

Chapter 4

4. Software Project Management Plan (SPMP)

4.1 INTRODUCTION

4.1.1 Project Overview

This project is to design a vehicle license plate detection and recognition system to recognize the characters of a license plate which is localized from the image of a vehicle. Expected delivery date of the project will be 21st May, 2016.

4.1.2 Project Deliverables

- Source code
- Executable code
- Database
- Software design document
- Software test document
- User Manual
- Final Product

4.2 PROJECT ORGANIZATION

4.2.1 Software Process Model

The Water Fall Model is being used for the development of the system since the requirements of the system are well known. Moreover each module in the code can be broken into different parts and then can be integrated so that the changes can be done easily in the system. Thus, due to the nature of the system the drawback of the waterfall model i.e. the problem of accommodating changes is resolved.

Figure 4.1 Waterfall Model [11]

4.2.2 Roles and Responsibilities

Task	**Responsibility**
Planning	Archit, Vitrag, Saurabh
Design	Archit, Vitrag, Saurabh
Implementation	Vitrag, Saurabh
Testing	Archit, Saurabh
Documentation	Archit, Vitrag

Table 4.1 Roles and Responsibilities

4.2.3 Tools and Techniques

- Number plate localization
    - Tool required: MATLAB
    - Technique: Histograms and Image Filtering
- Segmentation
    - Tool required: MATLAB
    - Technique: Region Growing Algorithm
- Character recognition
    - Tool required: MATLAB (Neural Network Toolbox)
    - Technique: Neural Networks using Supervised Learning
- Storing the license plate in database
    - Tool required: MATLAB (Database Toolbox)
- Documentation
    - Tool required: Microsoft Word

4.3 PROJECT MANAGEMENT PLAN

4.3.1 Tasks

4.3.1.1 Requirement Gathering and Analysis

4.3.1.1.1 Description

Requirements for the project like problem statement, software tool (MATLAB), utility toolboxes, datasets for training neural networks and images for testing are taken into consideration and analysis is made to organize the requirements into modules to help guide the development and figure out what should be tackled first.

4.3.1.1.2 Deliverables

Software requirement specification document (SRS)

4.3.1.1.3 Resources Needed

- Computer
- Microsoft Word 2010
- Paper and pen

4.3.1.1.4 Dependencies and Constraints

The project dependency is

- Availability of subject matter expertise in image processing and neural network systems.

The project constraints are as follows

- Time
- Man hours
- Availability of existing software

4.3.1.1.5 Risks and Contingencies

- Technology risk
- Scope risk
- Structure/process risk

4.3.1.2 Design

4.3.1.2.1 Description

Details on programming languages and environments, packages, application architecture, toolkits, platform, algorithms, data structures, user interface and databases are established

4.3.1.2.2 Deliverable

- Software Design Document (SDD)
- Architecture Document
- Implementation Plan
- Performance Analysis
- Test Plan

4.3.1.2.3 Resources Needed

- Microsoft Word 2010

4.3.1.2.4 Dependencies and Constraints

Platforms with higher RAM and a powerful processor are preferred as MATLAB is a heavy software and takes time to process.

4.3.1.2.5 Risks and Contingencies

In case a powerful processor and a high RAM is not available, the available platform is used but it increases the amount of time required for processing.

4.3.1.3 Implementation

4.3.1.3.1 Description

In this phase, the implementation of the various functions takes place. The input function, the localization function, the segmentation function and the recognition neural networks is implemented.

4.3.1.3.2 Deliverables

- Software code
- Source code
- Executable code
- Critical Error removal

4.3.1.3.3 Resources Needed

- MATLAB with Neural Network and Database toolkit
- Internet Connection.
- Web browser

4.3.1.3.4 Dependencies and Constraints

Availability of certain functionalities and operations may depend on the version of MATLAB used.

4.3.1.3.5 Risks and Contingencies

There is a possibility of algorithm failing to recognize the characters. In this case, variations of the neural network must be implemented on trial and error basis. Also, variations of fonts and styles should be used for training.

4.3.1.4 Testing

4.3.1.4.1 Description

Testing is done by using various types of images taken in different angles, also license plates with different fonts and styles.

4.3.1.4.2 Deliverables

- Software test document
- Internal Testing
- Application Testing

4.3.1.4.3 Resources Needed

- Dataset for training neural network
- Images of vehicles

4.3.1.4.4 Dependencies and Constraints

The results depend on the quality of the images available.

4.3.1.4.5 Risks and Contingencies

- The license plate of the vehicle should be clearly visible in the image.
- Preferably, the image should be of the front-end or back-end of the vehicle.

4.3.1.5 Documentation

4.3.1.5.1 Description

Only delivering the end software is not sufficient, other deliverables also need to be delivered to the customer along with the software. These include user manual, technical manual etc.

4.3.1.5.2 Deliverables

- User manual
- Technical manual

4.3.1.5.3 Resources Needed

- Microsoft word 2010

4.3.1.5.4 Dependencies and Constraints

Test manuals can be prepared when implementation of elements of the project is done successfully.

4.3.1.5.5 Risks and Contingencies

- People risk
- Language risk
- Technology risk

4.3.1 Assignments

Task	**Responsibility**
Planning	Archit, Vitrag, Saurabh
Design	Archit, Vitrag, Saurabh
Implementation	Vitrag, Saurabh
Testing	Archit, Saurabh
Documentation	Archit, Vitrag

Table 4.2 Assignments

4.3.2 Time Table

Task	**Description**	**Start Date**	**End Date**	**Deliverable**
Requirement Gathering	Collection of information and Literature Survey	March 2015	April 2015	Seminar Report
Designing	Overall basic designing of the system with the help of design modules	Aug 2015	Sep 2015	UML Diagrams
Coding (Phase 1)	Implementation of Localization	Oct 2015	Nov 2015	Partial Implementation
Coding (Phase 2)	Implementation of Segmentation	Dec 2015	Jan 2016	Partial Implementation
Coding (Phase 3)	Integration of Neural Network and GUI	Feb 2016	Mar 2016	Final System
Testing	Testing various modules	April 2016	May 2016	Test Cases
Documentation	Generation of various reports as per requirements	April 2016	May 2016	Project Report

Table 4.3 Time Table

Chapter 5

5. Software Requirements Specification

5.1 INTRODUCTION

5.1.1 Product Overview

- The product is a vehicle license plate detection and recognition system that recognizes the characters from the license plate which has been localized from the image of a vehicle.
- Furthermore, this system uses neural networks which comprise of a learning mechanism that is effective in identifying characters with various fonts and styles.
- The system consists of 3 modules mainly
  - Localization
  - Segmentation
  - Recognition

5.2 SPECIFIC REQUIREMENTS

5.2.1 External Interface Requirements

5.2.1.1 User Interfaces

The UI provided is very simple with buttons indicating the operations to be performed on the image. Using the input button the user will be allowed to choose the image of his choice from the system. Using the localization, segmentation and recognition buttons, the respective operations are performed on the image. At the end of each operation, the result will be displayed on the screen. After the recognition operation, the result will be stored in a database.

5.2.1.2 Hardware Interfaces

Hardware interfaces required are mouse, keyboard and monitor for the use of application.

5.2.1.3 Software Interfaces

- Windows 7 OS: Operating system for the application to work on.
- MATLAB: Software to implement the system.
    - Neural Network Toolkit: For recognition.
    - Database Toolkit: For storage.

5.2.2 Software Product Features

5.2.2.1 Image Input

5.2.2.1.1 Description

Providing the input image is the most basic and fundamental operation of the system. Without providing the input no further processing steps can be performed in the system.

5.2.2.1.2 Stimulus/Response

Stimulus: Image is selected from the computer.

Response: Selected image is displayed on the interface screen.

5.2.2.1.3 Functional Requirements

REQ-1: Image selected should be clear and of a good enough size.

REQ-2: The license plate of the vehicle in image should be clearly visible.

5.2.2.2 Localization

5.2.2.2.1 Description

This feature involves converting the image into greyscale and performing filtering operations on it for noise removal to display an isolated license plate.

5.2.2.2.2 Stimulus/Response

Stimulus: The image is given as input to the localization operation.

Response: Localized license plate is displayed on the interface screen.

5.2.2.2.3 Functional Requirements

REQ-1: Preferably, the image should be of the front-end or back-end of the vehicle.

REQ-2: Image should not contain multiple vehicles with license plates clearly visible.

5.2.2.3 Segmentation

5.2.2.3.1 Description

In segmentation, the characters of the localized license plate are segmented in distinct images and displayed on a secondary window.

5.2.2.3.2 Stimulus/Response

Stimulus: Localized license plate is given as input.

Response: Segmented characters are displayed on a secondary window.

5.2.2.3.3 Functional Requirements

REQ-1: Preferably, there should not be any other characters on the license plate which are not a part of the number.

REQ-2: The colour of the characters and the background colour should be contrasting enough to be distinguished.

5.2.2.4 Recognition

5.2.2.4.1 Description

In this feature, the segmented characters are recognized using trained neural networks. The neural network toolkit in MATLAB is used for this feature.

5.2.2.4.2 Stimulus/Response

Stimulus: The segmented character images are given as input.

Response: The recognized characters are displayed in text format.

5.2.2.4.3 Functional Requirements

REQ-1: For the current system the neural network is trained only for English characters, hence, the license plate characters should be in English.

REQ-2: The current system has been trained for limited fonts and styles.

5.2.2.5 Storage

5.2.2.5.1 Description

The output of the recognition stage is stored in the database in text format. It can also be stored along with other details like date, time etc.

5.2.2.5.2 Stimulus/Response

Stimulus: The recognized characters are given as input.

Response: The characters are stored in the database.

5.2.2.5.3 Functional Requirements

REQ-1: In the current system the characters should only be in English.

5.2.3 Software System Attributes

5.2.3.1 Reliability

The specified system can prove to be highly reliable provided that the images captured are of best quality with reduced noisy components. The reliability of the system also increases if the fonts used by the number plates are of standard format specified by laws based on which the system is configured. Also lower the error rate higher the reliability of the system.

5.2.3.2 Availability

The availability of the system is quite high as the system is less prone to external errors provided the user knows the proper working of the system. Also the user might restart the system if any fault in the normal working of the software occurs.

5.2.3.3 Security

Only the system administrator shall have access to the database where the license plates are stored.

5.2.3.4 Portability

This software is portable to many other systems running different operating systems provided that MATLAB is available and works perfectly for that particular OS. The code written in MATLAB is platform independent and can be used on different host machines running MATLAB.

5.2.3.5 Performance

The performance of the system is provided such that the criteria required for running the system is satisfied. Also provided that the images captured are of best quality with reduced noisy components. The performance and reliability of the system also increases if the fonts used by the number plates are of standard format specified by laws based on which the system is configured.

The performance of the system is quite high provided that there are optimal number of users using the system running on the same single database.

Chapter 6

6. Software Design Description

This Software Design Document (SDD) describes the design specifications used in the development of the Vehicle License Plate Detection and Recognition System. It explains the system and architectural design, as well as the user interface design. It also consists of requirement traceability matrix that maps and traces user requirement with test cases.

6.1 INTRODUCTION

The purpose of the project is to design vehicle license plate detection and recognition system which will recognize the characters from a license plate which has been localized from the image of a vehicle.

6.1.1 Design Overview

Vehicle license plate detection and recognition system is a very effective system to store the license plate of vehicle directly from its image in the database. Its accuracy is complemented by the usage of neural networks. The learning mechanism of the neural networks aids in teaching the system to recognize new fonts and styles of characters. Using neural networks also increases the systems flexibility and potential to expand.

The project is mainly in to five modules which are as follows:

- Image Input
- Localization
- Segmentation
- Recognition
- Database

6.1.2 Requirement Traceability Matrix

	Image Input	**Localization**	**Segmentation**	**Neural Networks**	**Database**
Image Input	**X**				
Image Processing		**X**	**X**		
Character Recognition				**X**	
Output Storage					**X**

Table 6.1: Requirement Traceability Matrix

6.2 SYSTEM ARCHITECTURAL DESIGN

6.2.1 Basic Architecture

Following diagram shows the basic architecture of the system.

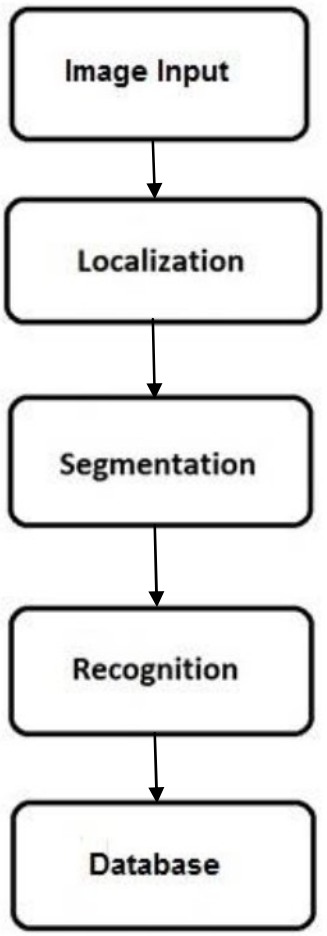

Figure 6.1 Basic Architecture

6.2.1.1 Components

Image Input: In this phase the user can browse the computer and select the image of the vehicle as per his choice.

Localization: The localization phase will perform various operations on the image using horizontal and vertical histograms and localize the license plate in the image.

Segmentation: In the segmentation phase, the system will segment the characters from the localized license plate into individual images using a threshold on the number of pixels.

Recognition: In this phase, the segmented characters are recognized using neural networks and converted to text format.

Database: Finally, the recognized characters are stored in a database.

6.2.2 Alternative Architecture Design and Style

The alternate design options explored were:

- Using Optical Character Recognition (OCR) instead of Neural Networks for character recognition, but, it was not chosen since it recognizes only a particular format of characters.
- Also, the idea of using template matching was dropped since, it has limitations of recognizing characters of different fonts and styles.

6.2.3 System Interface Description

The Graphical User Interface is provided in the form of a panel and buttons for the user to interact with the software. The buttons provided in the interface are:

- Image Input: Using this button the user can browse the computer and select the image of the vehicle as per his desire.
- Localization: Using this button the user can the user will be able to localize the license plate from selected the image of the vehicle.
- Segmentation: Using this button the user will be able to segment the characters from the localized license plate in to individual images.

- Recognition: Using this button the user can recognize the segmented character images and store in a database in text format.

A display area is also provided in the interface in which the output is displayed after every operation is performed.

6.3 Detailed Description of Components

6.3.1 Project Components

6.3.1.1 Image Input

In this module, the user can browse the computer to select the image of the vehicle as per his choice. The image must be clear enough for the system to process and the license plate of the vehicle should be clearly visible in the image. Preferably, the image of the vehicle should be of the front-end or the back-end. If the image is not selected, an error message is displayed stating that no image is selected.

6.3.1.2 Localization

In this module, the image which is given as input is first converted to a grey-scaled image. To remove the noise from the image dilation and erosion operations are performed on the image. The horizontal and vertical histograms are plot by processing the horizontal and vertical edges respectively. These histograms are smoothened by applying a low pass filter on them and later filtered by applying a dynamic threshold. The probable candidates for the license plates are identified by analyzing these histograms and the regions of interested are extracted. The most probable region of interest is identified and isolated on further processing. Thus, a localized license plate is obtained.

6.3.1.3 Segmentation

In this module, the grey-scaled image is converted to a binary image to remove all the objects containing less than 30 pixels, thus, removing the noise from the image. A bounding box is plot

by labeling the connected components and measuring the image properties of the noise free image. Finally, the objects i.e. the characters are extracted and segmented into individual images.

6.3.1.4 Recognition

In this module, the artificial neural network in the neural network toolkit available in MATLAB comes into play. The segmented characters are recognized using a trained neural network which has been trained using supervised learning technique. For training the neural network an input is given with its corresponding output which is the desired output from the neural network. Feature extraction is used to extract the particular features so as to compare the actual and the desired output to calculate the error. This error is used to adjust the parameters of the neural network like connection weights and thresholds. This adjustment of the parameters helps in improving the accuracy of the neural network and to achieve the desired result.

6.3.1.5 Database

In this module, the license plate characters are stored in the database in text format along with the date and time when the image was processed. The database toolkit from MATLAB is used which makes it easier to incorporate the database with the rest of the system.

6.4 User Interface Description

6.4.1 User Interface

6.4.1.1 Initial Screen

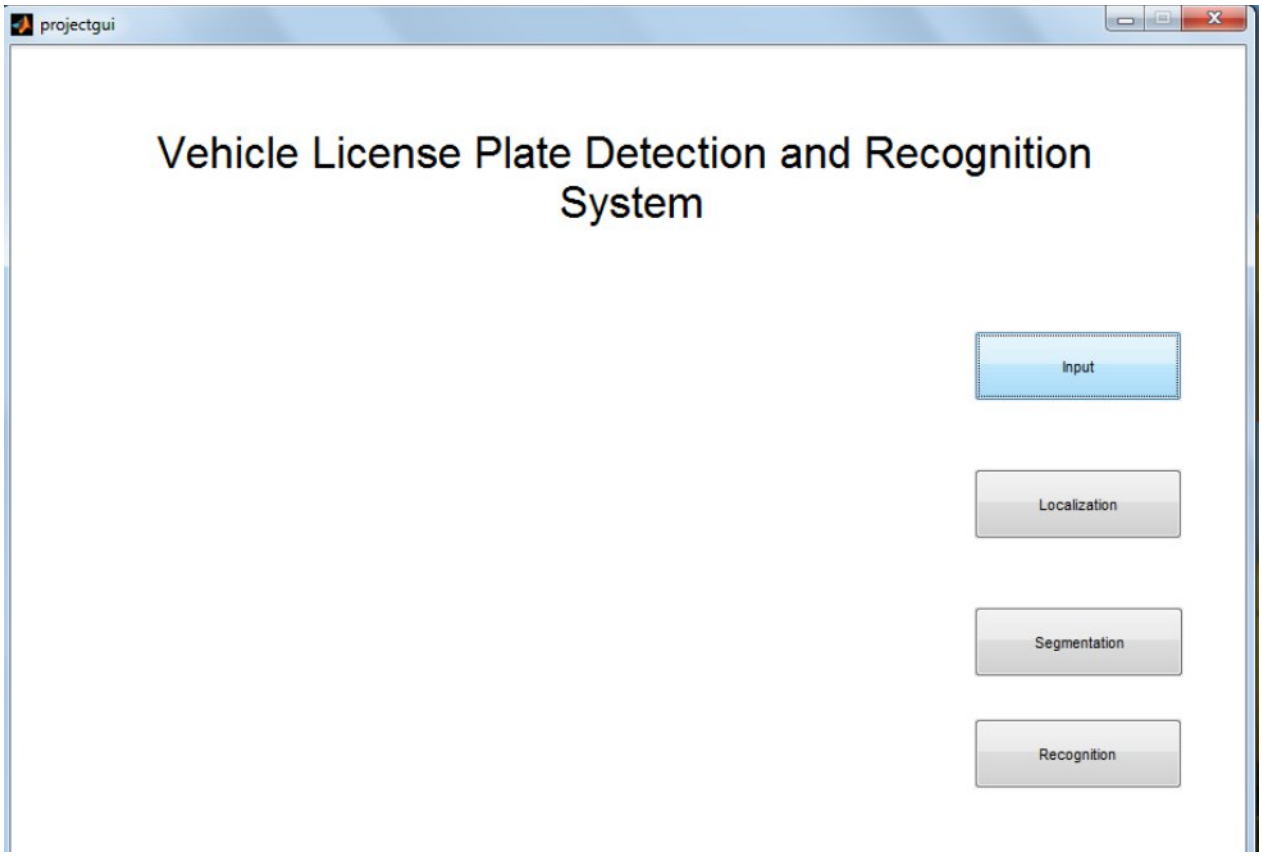

Figure 6.2 Initial Window

On initializing the system, the user first sees the project title and buttons to interact with the system.

6.4.1.2 Image Input

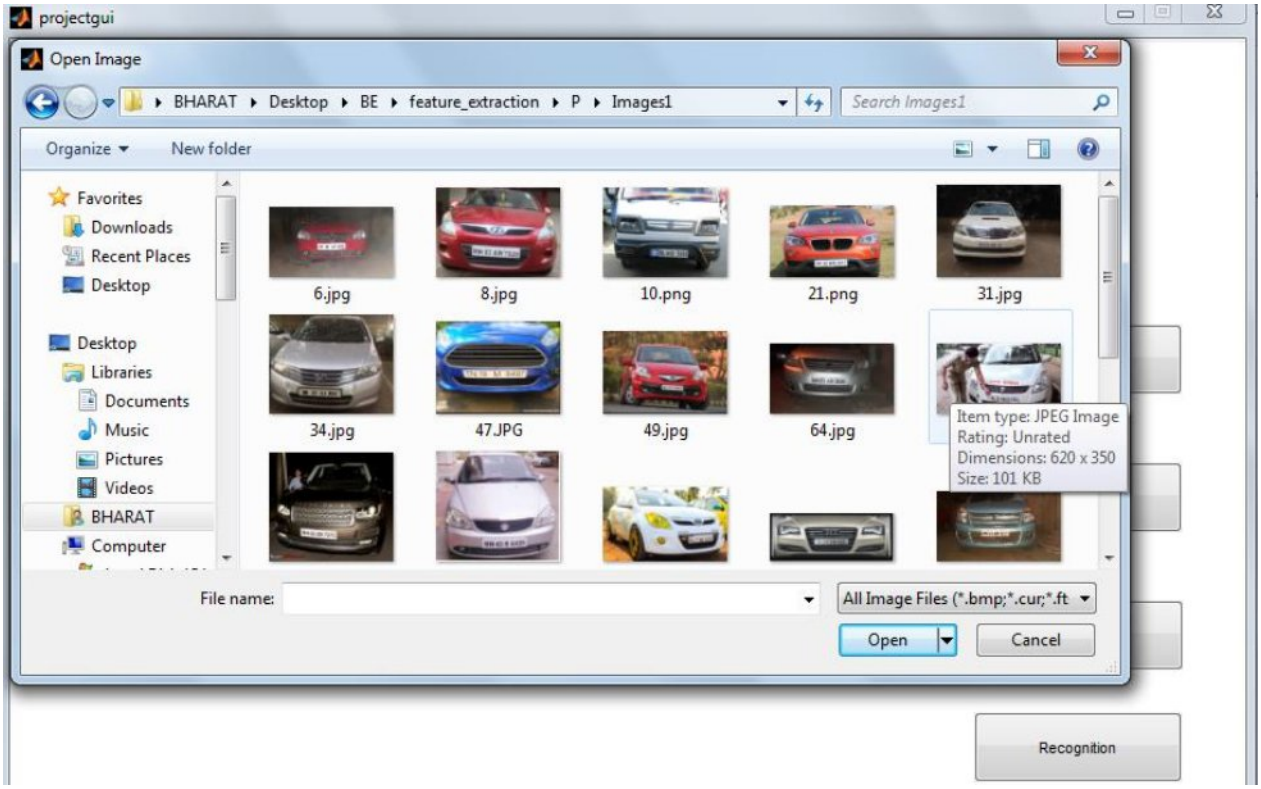

Figure 6.3 Browse Window

The user can browse the computer to select the vehicle image as per his choice.

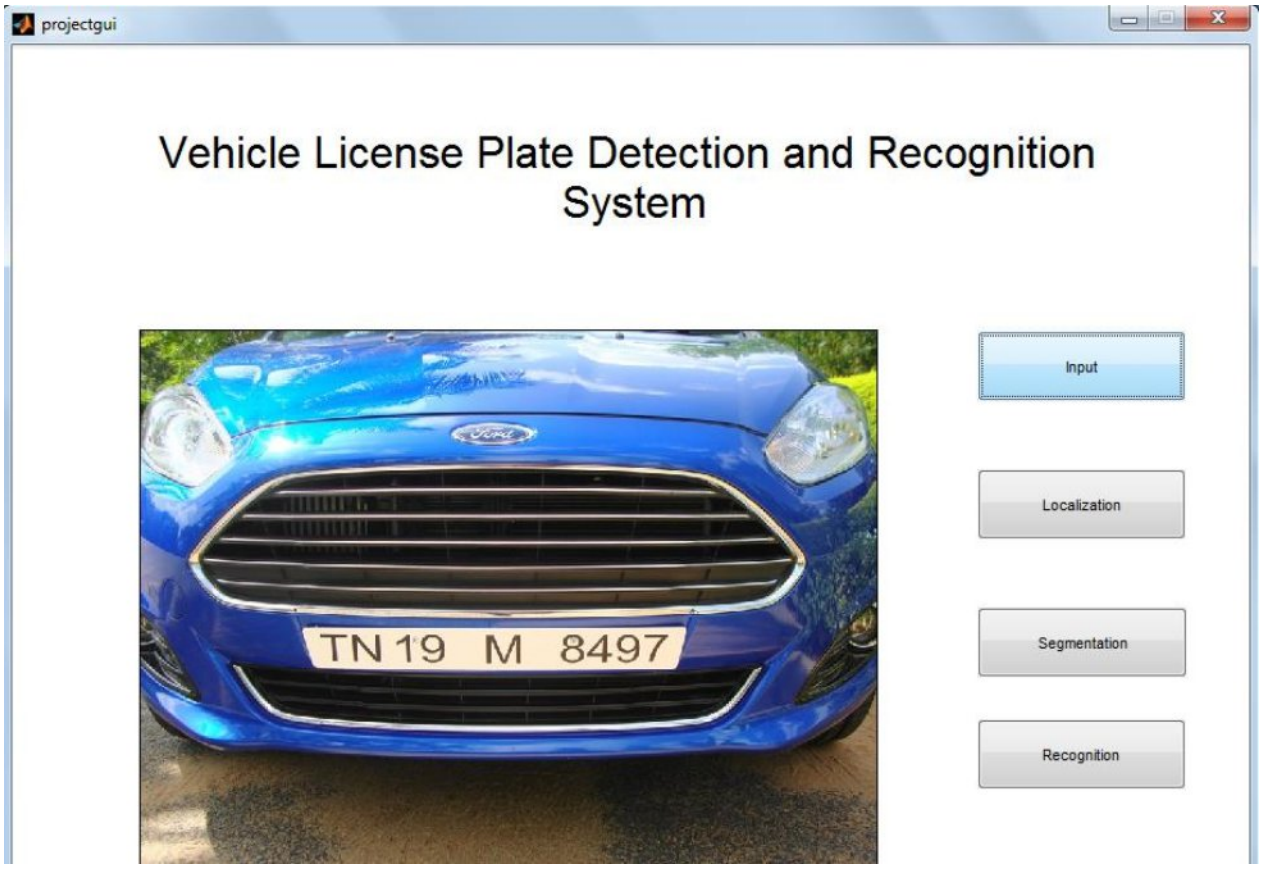

Figure 6.4 Selected Image

The selected image is presented in the display area of the interface.

6.4.1.3 Localization

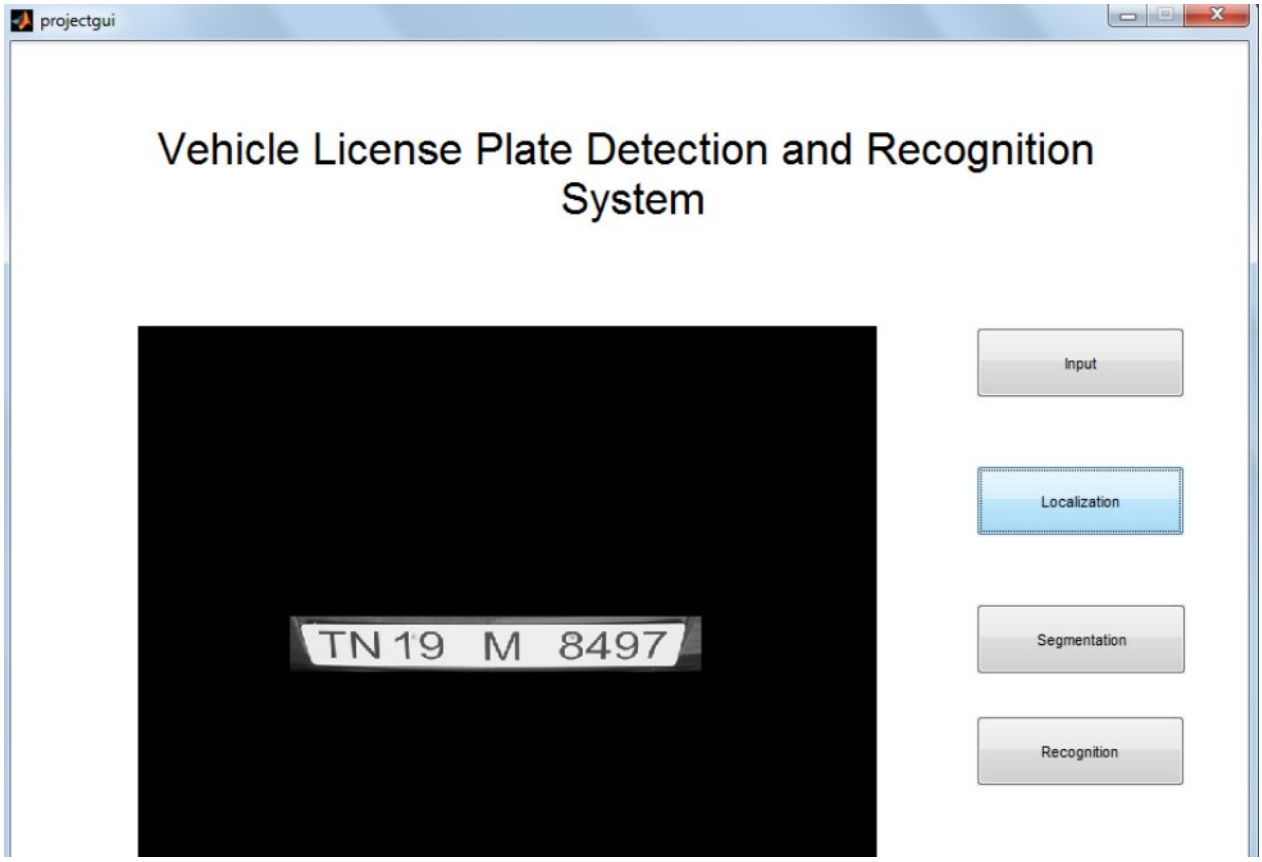

Figure 6.5 Localization

On clicking on the localization button, the license plate is localized from the vehicle image and presented in the display area of the interface.

6.4.1.2 Segmentation

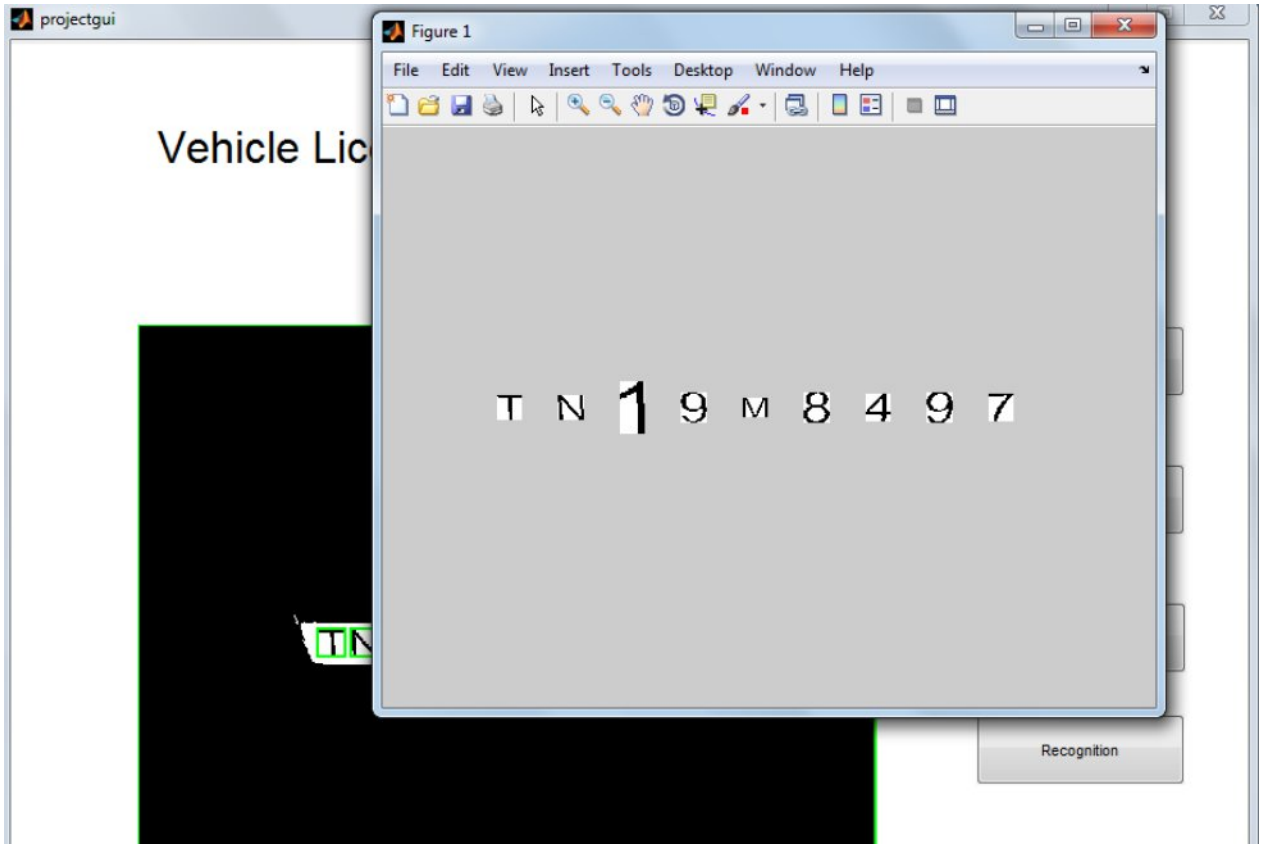

Figure 6.6 Segmentation

On clicking the segmentation button, the characters of the localized license plate are segmented and displayed on a second window

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6.4.1.3 Recognition

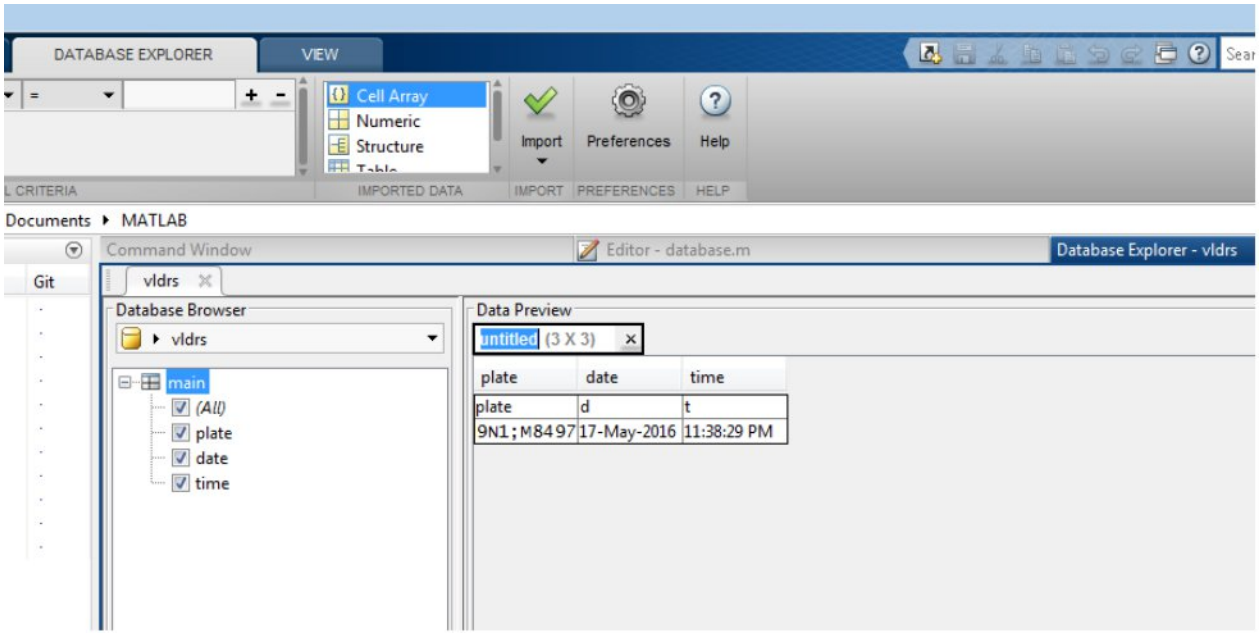

Figure 6.7 Recognition

On clicking the recognition button, the segmented characters are given as input to the neural network and recognized to be converted in text format. These recognized text format characters are stored in a database along with the date and time when it was stored.

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6.5 Additional Material

6.5.1 UML Diagrams

6.5.1.1 Use Case Diagram

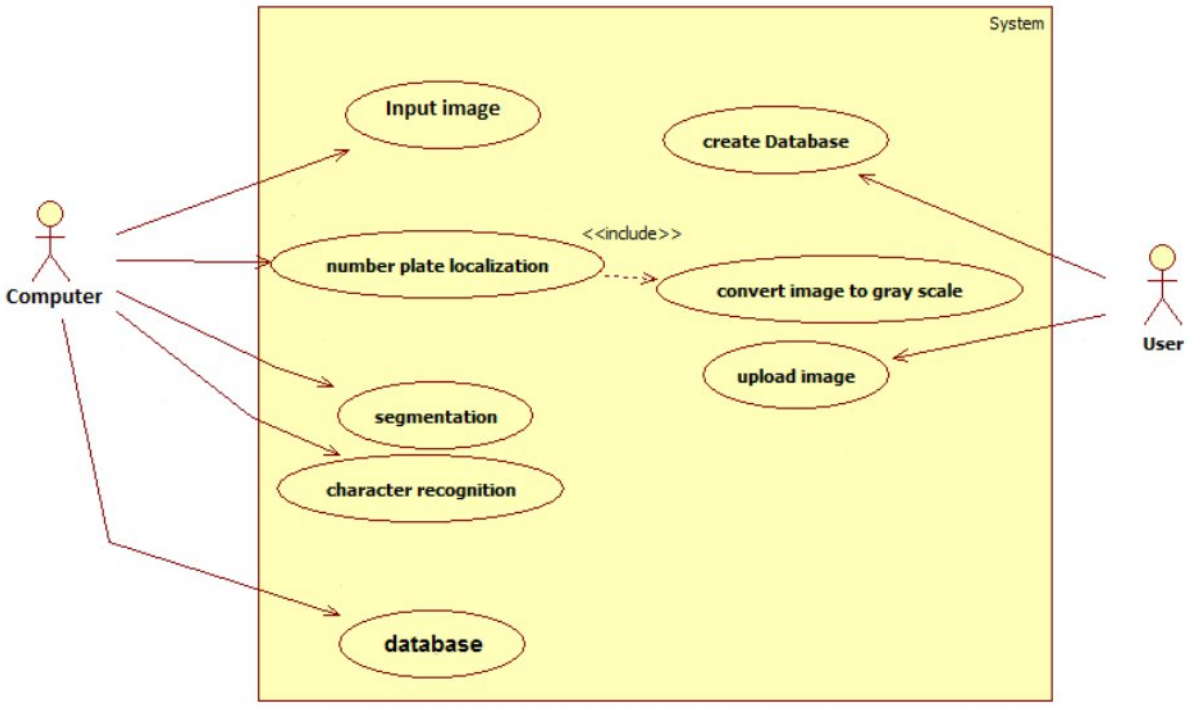

Figure 6.8: Use Case Diagram

6.5.1.2 Class Diagram

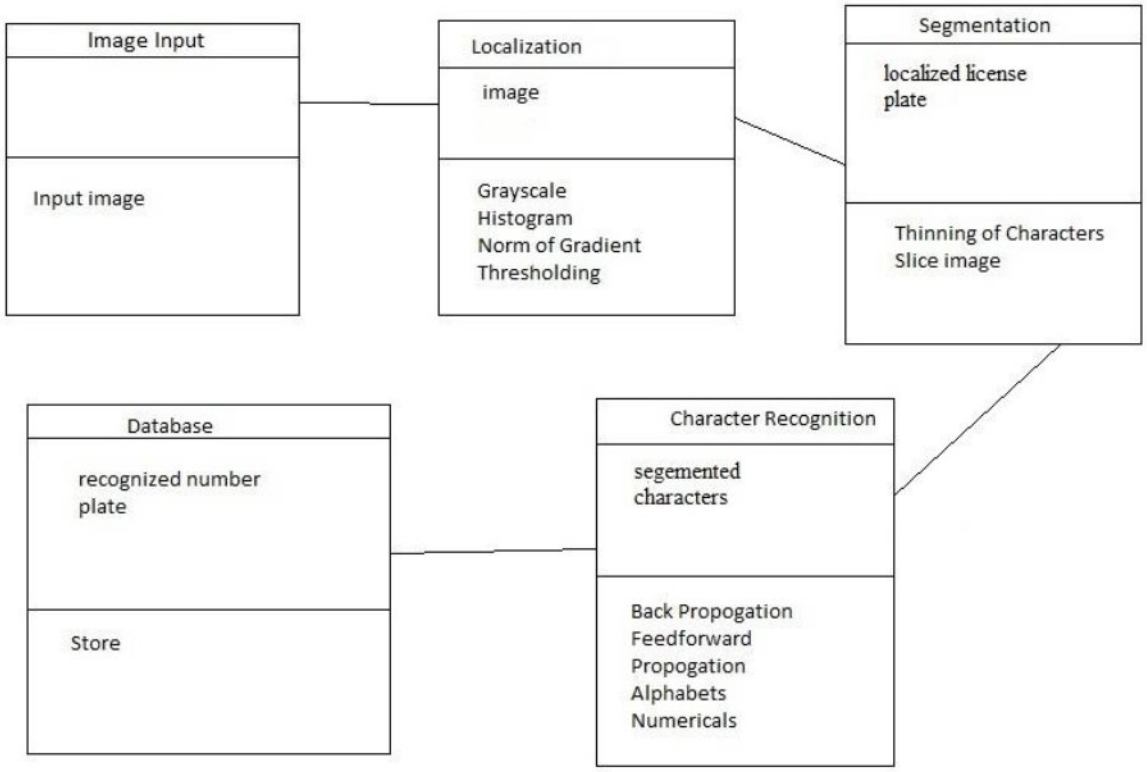

Figure 6.9: Class Diagram

6.5.1.3 Component Diagram

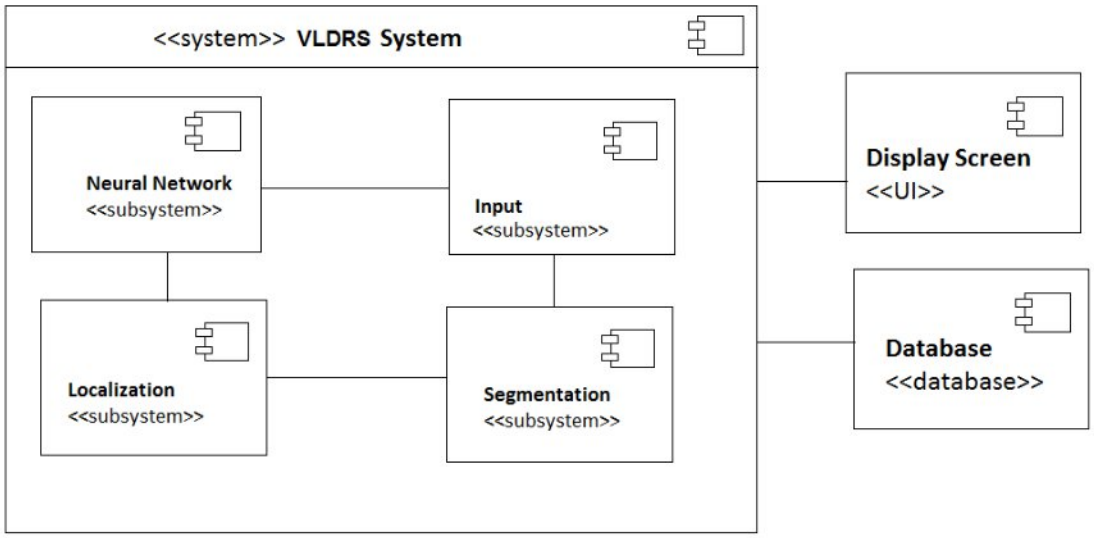

Figure 6.10: Component Diagram

6.5.1.4 Sequence Diagram

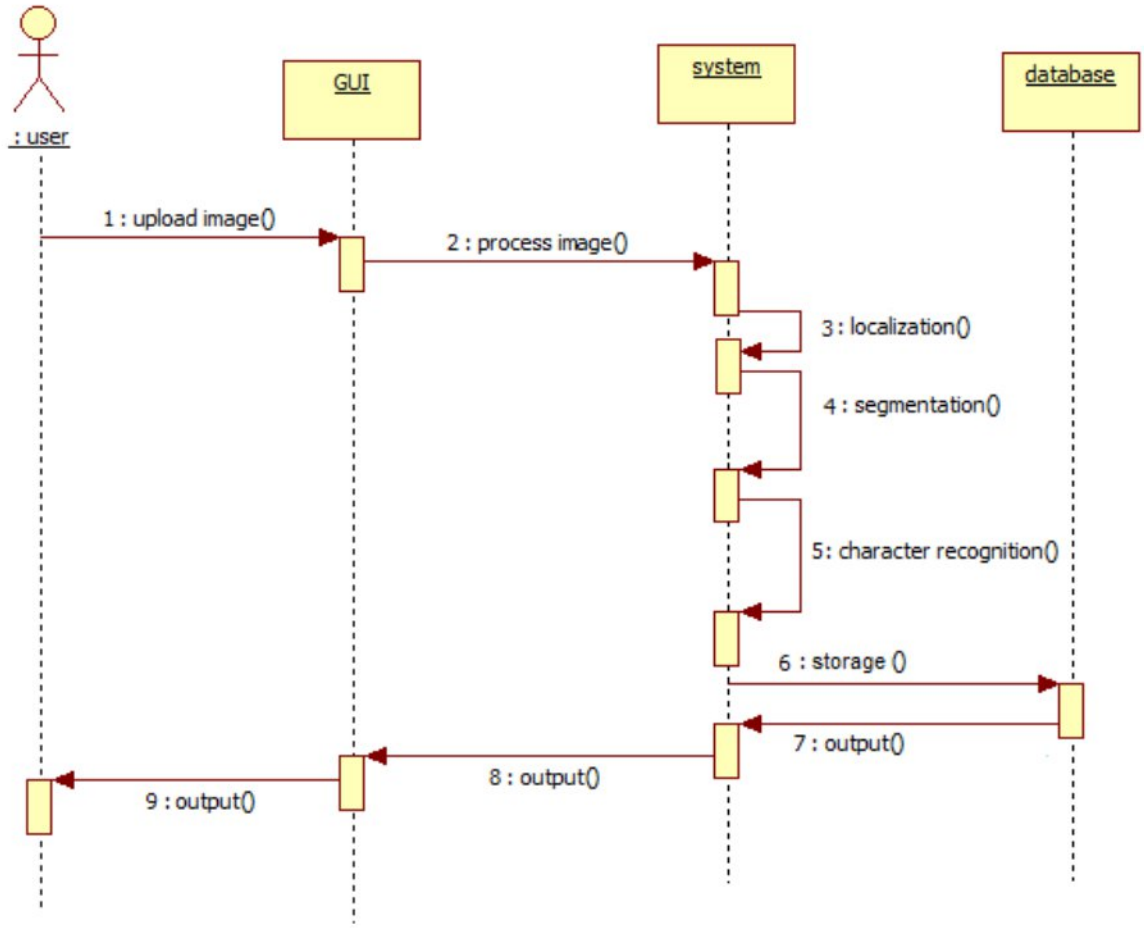

Figure 6.11: Sequence Diagram

6.5.1.5 Activity Diagram

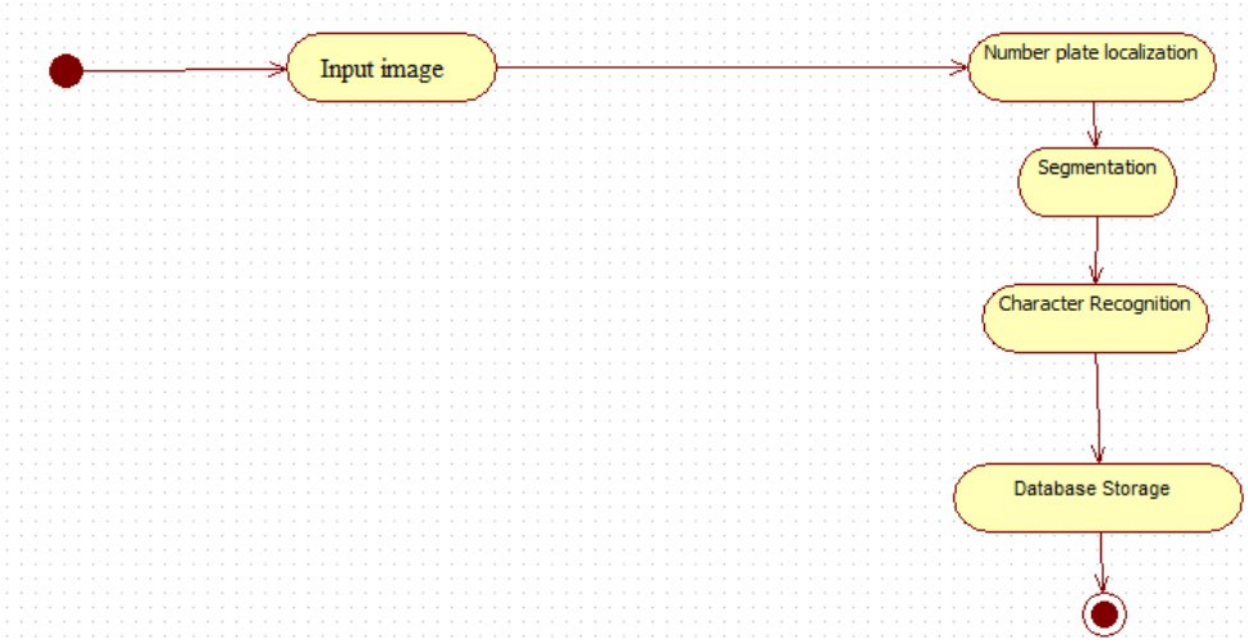

Figure 6.12: Activity Diagram

Chapter 7

7. Software Test Document

7.1 INTRODUCTION

7.1.1 System Overview

The system takes an image of a vehicle with its license plate visible as input and returns the recognized characters of the license plate as output. For testing the system, an image of a vehicle with visible number plate will be given as input and the output will be the license plate of that vehicle in text format.

7.1.2 Test Approach

For testing, different images of vehicles are given as input. The variations in images are based on the angle, clarity, distance and different fonts used. The images are taken as input in MATLAB and later image processing is performed on them. Post processing, the localization operation is performed on the image which localizes the number plate from the entire image. After localization, the segmentation operation is performed on the image which segments the characters into individual images. These individual characters are recognized using neural networks and stored in a database. The overall operation takes a little time as MATLAB is a heavy software and the hardware used is not the latest version.

7.2 TEST PLAN

The test plan is drawn during the design stage and serves as a guide in carrying out the tests. The test plan includes:

1. A description of the conditions under which the test will run.
2. A description of the test data to be used.
3. A description of the expected result.

7.2.1 Features to be tested

The following features in the project are to be tested for accurate and efficient results:

7.2.1.1. Accuracy

To test the accuracy, vehicles with license plates of different fonts and styles must be used.

7.2.1.2 Performance

To test the performance of the system, images with variation in clarity must be considered. If the system gives accurate results then its performance is considered good enough.

7.2.1.3. Appropriate Character Recognition

The system must be tested to check if can recognize the characters accurately and store it in the database in text format.

7.3 TEST CASES

Test Case No	Purpose	Inputs	Expected Output	Actual Output
1	The accuracy of the localization module is to be tested	Images of vehicle with visible license plate	Localized license plate	License plate localized successfully
2	The accuracy of the segmentation module is to be tested	Images of localized license plates	Segmented characters	Characters segmented successfully
3	The accuracy of the recognition module is to be tested	Images of segmented characters	Recognized characters in text format	Some characters were not recognized
4	UI is tested for proper display of results	Selection of images to start the process	The UI displays the result on the screen	Same as expected

Table 7.1 Test Cases

8. Conclusion and Future Work

Conclusion

The experimental results show that the system works accurately to detect and localize the license plate from the image of the vehicle. The system is also able to segment the characters successfully from the localized license plates. There were some problems in the recognition module as there were some characters the neural network was not able to recognize accurately. The system was also able to store the license plate in the database along with the date and time when the license plate was recorded in the system.

Future Work

In future work, the system developed is just a basic mechanism to store license plates in text format from vehicle images. The system can be further developed to suit the needs as per the user requirements. The system can be used for toll tax collection or collecting the payment in an unmanned parking lot by linking a prepaid account to the license plate of the vehicle. This system can also be used by the police to identify stolen vehicles.

9. References

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Appendix

A. User Manual

A.1 User Interface

A.1.1 Image Input

- This button allows the user to browse the computer and select the vehicle image of his choice to give as input the system.
- The selected image is presented in the display area of the interface.

A.1.2 Localization

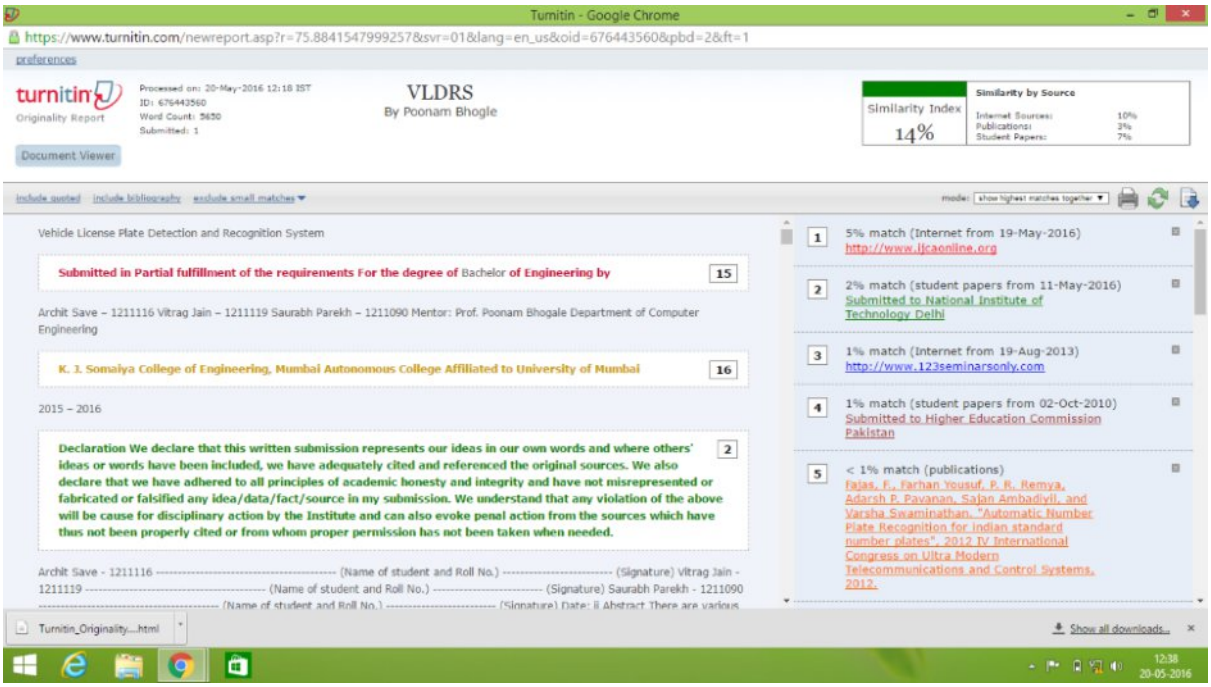
- This button allows the user to perform the localization operation on the selected image.
- The localized license plate is presented in the display area of the interface.

A.1.3 Segmentation

- This button allows the user to segment the characters from the localized license plate.
- The output is displayed in a second window.

A.1.4 Recognition

- This button allows the user to recognize the segmented characters and convert them into text format.
- The recognized text format characters can be accessed in the database.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