AUTOMATIC LICENSE PLATE RECOGNITION

Mirza Tairin Tarique	**15.01.04.063**
Md. Neaz	**15.01.04.065**
Md. Shakhawat Hossain Mridha	**15.01.04.067**
Farzana Sharmin Mou	**15.01.04.076**

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
DHAKA, BANGLADESH

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By

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Farzana Sharmin Mou	15.01.04.076

Supervised by
Mr. Md. Khairul Hasan
Assistant Professor
Department of Computer Science and Engineering

AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
DHAKA, BANGLADESH

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ABSTRACT

ALPR means Automated License Plate Recognition. This is a technology solution that takes photographs of license plate and converts these images to text. They are used by various police forces and as a method of electronic toll collection on pay-per-use roads and cataloging the movements of traffic or individuals.

ALPR is divided in two main steps: plate detection and plate recognition. Plate detection has the purpose of detecting the location of the plate in the whole camera frame. When a plate is detected in an image, the plate segment is passed to the second step—plate recognition—which uses an OCR algorithm to determine the alphanumeric characters on the plate.

License plate capture is typically performed by specialized cameras designed specifically for the task. To maximize the chance of effective license plate capture, installers should carefully consider the positioning of the camera relative to the target capture area. Exceeding threshold angles of incidence between camera lens and license plate will greatly reduce the probability of obtaining usable images due to distortion.

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CHAPTER 1
INTRODUCTION

Automatic License Plate Recognition (ALPR) system is an image processing technology that identifies the vehicles by tracking their number plate without direct human intervention and an application of computer vision. ALPR is an important method used in Intelligent Transportation System (ITS). The four phases of the ALPR system: Image acquisition and pre-processing, license plate extraction, character segmentation and character recognition are discussed in this paper. License Plate Extraction is most crucial step in the ALPR system which affects the overall accuracy and efficiency of whole ALPR system. The quality of acquired vehicle image is a major factor in the success of ALPR. In this paper we have proposed an efficient approach for ANPR in which the input vehicle image is firstly pre-processed using median filter and adaptive histogram equalization and license plate is extracted from pre-processed vehicle image using morphological operations, image subtraction, thresholding, sobel edge detection and boundary box analysis.

1.1 Overview

ALPR means Automated License Plate Recognition. This is a technology solution that takes photographs of license plate and converts these images to text. They are used by various police forces and as a method of electronic toll collection on pay-per-use roads and cataloging the movements of traffic or individuals. While the idea may seem simple, the behind the scenes complexity that goes on is quite amazing.

ALPR is divided in two main steps: plate detection and plate recognition. Plate detection has the purpose of detecting the location of the plate in the whole camera frame. When a plate is detected in an image, the plate segment is passed to the second step—plate recognition—which uses an OCR algorithm to determine the alphanumeric characters on the plate.

Some license plate arrangements use variations in font sizes and positioning-ALPR systems must be able to cope with international variants, though many programs are individually tailored to each country.

License plate capture is typically performed by specialized cameras designed specifically for the task, although new software techniques are being implemented that support any I.P.-based surveillance camera and increase the utility of ALPR for parameter security application.

To maximize the chance of effective license plate capture, installers should carefully consider the positioning of the camera relative to the target capture area. Exceeding threshold angles of incidence between camera lens and

license plate will greatly reduce the probability of obtaining usable images due to distortion.

1.2 Motivation

1.2.1 Reduce traffic jam:

- Automated toll collection:

  Everyday there is created a huge traffic jam because of toll collection. If this toll collection was automated like foreign countries then we could avoid this traffic jam which would save our precious times.

1.2.2 Application in law enforcement:

- Search targeted cars:

  It will have option to input certain license plates according to category like “Wanted”, “Suspicious”, “Stolen”, “Expired” etc. by authorized personnel. On successful recognition of the number plate, system will be able to generate automatic alarm to alert the control room for such vehicles and also sends email & message to authorized personnel.

- Fine the cars parking at wrong place:

  There are many cars which park on the road at the wrong place and sometimes because of this there occurs a huge traffic jam. Sometimes traffic police grab them and fine but most of the times it is not possible to grab all law breakers. So, if there is an automated system to recognize the cars and fine them then people will be cautious to break the law.

1.3 Purpose

1.3.1 Electronic Toll collection:

By ALPR we will check which car passes the toll plaza and will send the bill to owner.

1.3.2 Monitor vehicles:

Authorized personnel will be able to monitor vehicles if there occurs any unlawful did then authority will be able to take action against that car owner.

1.3.3 Search stolen car:

Police will be able to search the stolen car easily as ALPR will have track which car is passing which road.

1.3.4 Suspicious car detection at border crossing:

At criminal cases, the criminals try to elope from the country. If they try to cross the border then it will be scanned by the ALPR camera and automatic alarm will alert the control room.

1.3.5 Automated parking garages:

At crowdie places like-shopping malls, there is created a huge line of parking outside of the gate. If it was an automated parking garage where the bill would be generated by scanning the license plate then this would be easier.

1.3.6 Scan crime related cars:

Most of the time, when an accident is occurred by a vehicle, the owner or driver elope from the place immediately. So in most of the cases the culprit cannot be caught. But ALPR will be able to record that vehicle number, so the culprit will be punished.

1.3.7 Traffic jam control:

If there is automated toll collection, if the cars abide by the speed limit, if the cars are not parked at wrong place then the traffic jam will be controlled.

1.4 Proposal

Here the system will take the images first then it will process the image and convert the images to text by optical character recognition.

There are seven primary algorithms that the software requires for identifying a license plate:

- Plate localization – responsible for finding and isolating the plate on the picture.
- Plate orientation and sizing – compensates for the skew of the plate and adjusts the dimensions to the required size.
- Normalization – adjusts the brightness and contrast of the image.
- Character segmentation – finds the individual characters on the plates.
- Optical character recognition.
- Syntactical/Geometrical analysis – check characters and positions against country-specific rules.
- The averaging of the recognized value over multiple fields/images to produce a more reliable or confident result. Especially since any single image may contain a reflected light flare, be partially obscured or other temporary effect.

The complexity of each of these subsections of the program determines the accuracy of the system. During the third phase (normalization), some systems use edge detection techniques to increase the picture difference between the letters and the plate backing. A median filter may also be used to reduce the visual noise on the image.

There will be a sensor which will calculate the speed of the car.

CHAPTER 2
BACKGROUND STUDIES

In this chapter, we will discuss about the topics which we needed to establish this project.

2.1 Software and hardware used

➢ Software used

- MATLAB R2018b

❖ What is MATLAB?

MATLAB (*matrix laboratory*) is a multi-paradigm numerical computing environment and proprietary programming language developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python.

Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

As of 2018, MATLAB has more than 3 million users worldwide. MATLAB users come from various backgrounds of engineering, science, and economics.

❖ Why MATLAB is used?

MATLAB has several advantages over other methods or languages:

- Its basic data element is the matrix. A simple integer is considered as matrix of one row and one column. Several mathematical operations that work on arrays or matrices are built-in to the MATLAB environment. For example, cross-products, dot-products, determinants, inverse matrices.

- Vectored operations. Adding two arrays together needs only one command, instead of a for or while loop.
- The graphical output is optimized for interaction. You can plot your data very easily, and then change colors, sizes, scales etc. by using the graphical interactive tools.
- MATLAB's functionality can be greatly expanded by the addition of toolboxes. These are sets of specific functions that provided more specialized functionality. Ex: Excel link allows data to be written in a format recognized by Excel, Statistics Toolbox allows more specialized statistical manipulation of data (Anova, Basic Fits etc.)

There are also disadvantages:

- It uses a large amount of memory and on slow computers it is very hard to use.
- It sits "on top" of Windows, getting as much CPU time as Windows allows it to have. This makes real-time applications very complicated.

USING MATLAB

MATLAB is not only a programming language, but a programming environment as well.

You can perform operations from the command line, as a sophisticated calculator.

Or you can create programs and functions that perform repetitive tasks, just as any other computer language.

One of the most important features of the MATLAB interface is the help. It is very thorough and you can learn almost anything you need from it.

➢ **Hardware used**

- Laptop

2.2 Language used

- Python

❖ **Why Python is used?**

- **Easy Syntax**

  Python's syntax is easy to learn, so both non-programmers and programmers can start programming right away.

- **Readability**

  Python's syntax is very clear, so it is easy to understand program code. (Python is often referred to as "executable pseudo-code" because its syntax mostly follows the conventions used by programmers to outline their ideas without the formal verbosity of code in most programming languages; in other words syntax of Python is almost identical to the simplified "pseudo-code" used by many programmers to prototype and describe their solution to other programmers. Thus Python can be used to prototype and test code which is later to be implemented in other programming languages).

- **High-Level Language**

  Python looks more like a readable, human language than like a low-level language. This gives you the ability to program at a faster rate than a low-level language will allow you.

- **Object oriented programming**

  Object-oriented programming allows you to create data structures that can be re-used, which reduces the amount of repetitive work that you'll need to do. Programming languages usually define objects with namespaces, like class or def, and objects can edit themselves by using

keyword, like this or self. Most modern programming languages are object-oriented (such as Java, C++, and C#) or have support for OOP features (such as Perl version 5 and later). Additionally object-oriented techniques can be used in the design of almost any non-trivial software and implemented in almost any programming or scripting language. (For example a number of Linux kernel features are "objects" which implement their own encapsulation of behavior and data structured via pointers, specifically pointers to functions, in the C programming language). Python's support for object-oriented programming is one of its greatest benefits to new programmers because they will be encountering the same concepts and terminology in their work environment. If you ever decide to switch languages, or use any other for that fact, you'll have a significant chance that you'll be working with object-oriented programming.

- **It's Free**

  Python is both free and open-source. The Python Software Foundation distributes pre-made binaries that are freely available for use on all major operating systems called CPython. You can get CPython's source-code, too. Plus, you can modify the source code and distribute as allowed by CPython's license. (Luckily, CPython has a permissive free software license attitude.)

- **Cross-platform**

  Python runs on all major operating systems like Microsoft Windows, Linux, and Mac OS X.

- **Widely Supported**

  Python has an active support community with many web sites, mailing lists, and USENET "netnews" groups that attract a large number of knowledgeable and helpful contributes.

- **It's Safe**

  Python doesn't have pointers like other C-based languages, making it much more reliable. Along with that, errors never pass silently unless they're explicitly silenced. This allows you to see and read why the program crashed and where to correct your error.

- **Batteries Included**

  Python is famous for being the "batteries are included" language. There are over 300 standard library modules which contain modules and classes for a wide variety of programming tasks. For example the standard library contains modules for safely creating temporary files (named or anonymous), mapping files into memory (including use of shared and anonymous memory mappings), spawning and controlling sub-processes, compressing and decompressing files (compatible with gzip or PK-zip) and archives files (such as Unix/Linux "tar"), accessing indexed "DBM" (database) files, interfacing to various graphical user interfaces (such as the TK toolkit and the popular WxWindows multi-platform windowing system), parsing and maintaining CSV (comma-separated values) and ".cfg" or ".ini" configuration files (similar in syntax to the venerable WIN.INI files from MS-DOS and MS-Windows), for sending e-mail, fetching and parsing web pages, etc. It's possible, for example, to create a custom web server in Python using less than a dozen lines of code, and one of the standard libraries, of course.

- **Extensible**

  In addition to the standard libraries there are extensive collections of freely available add-on modules, libraries, frameworks, and tool-kits. These generally conform to similar standards and conventions; for example almost all of the database adapters (to talk to almost any client-server RDBMS engine such as MySQL, Postgres, Oracle, etc.)

conform to the Python DBAPI and thus can mostly be accessed using the same code. So it's usually easy to modify a Python program to support any database engine.

2.3 What is image processing?

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too.

Image processing basically includes the following three steps:

- Importing the image via image acquisition tools;
- Analyzing and manipulating the image;
- Output in which result can be altered image or report that is based on image analysis.

There are two types of methods used for image processing namely, analogue and digital image processing. Analogue image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display, information extraction.

2.4 Used MATLAB functions

Which built in functions we used are described here.

2.4.1 imread()

To take input.

2.4.2 imresize()

To resize image.

2.4.3 imshow()

To show output.

2.4.4 rgb2gray()

Converting colored image to grayscale.

2.4.5 median()

For median filtering to remove noise.

2.4.6 edge()

To detect edge.

2.4.7 strel()

Disk shaped structuring element.

2.4.8 imdilate()

For dilation operation.

2.4.9 imfill()

To fill bordered areas.

2.4.10 imopen()

For open operation.

2.4.11 imerode()

For erosion operation.

2.4.12 regionprops()

To detect the parameters of the objects.

2.4.13 imcrop()

To crop the files.

2.4.14 imbinarize()

Bound the image in two colors.

2.4.15 imcomplement()

Complement the result.

2.4.16 bwconncomp()

Function for connected component analysis

2.4.17 ismember()

Member of connected component. Use with bwconncomp().

2.4.18 readletter()

To read letter.

2.5 Approach of selected paper

Automatic Number Plate Recognition (ANPR) system is an image processing technology that identifies the vehicles by tracking their number plate without direct human intervention and an application of computer vision. ANPR is an important method used in Intelligent Transportation System (ITS). The four phases of the ANPR system: Image acquisition and pre-processing, number plate extraction, character segmentation and character recognition are discussed in this paper. Number Plate Extraction is most crucial step in the ANPR system which affects the overall accuracy and efficiency of whole ANPR system. The quality of acquired vehicle image is a major factor in the success of ANPR. In this paper we have proposed an efficient approach for ANPR in which the input vehicle image is firstly pre-processed using iterative bilateral filter and adaptive histogram equalization and number plate is extracted from pre-processed vehicle image using morphological operations, image subtraction, thresholding, sobel edge detection and boundary box analysis. We compared the result of our proposed approach with existing method of ANPR.

Flow chart of selected paper:

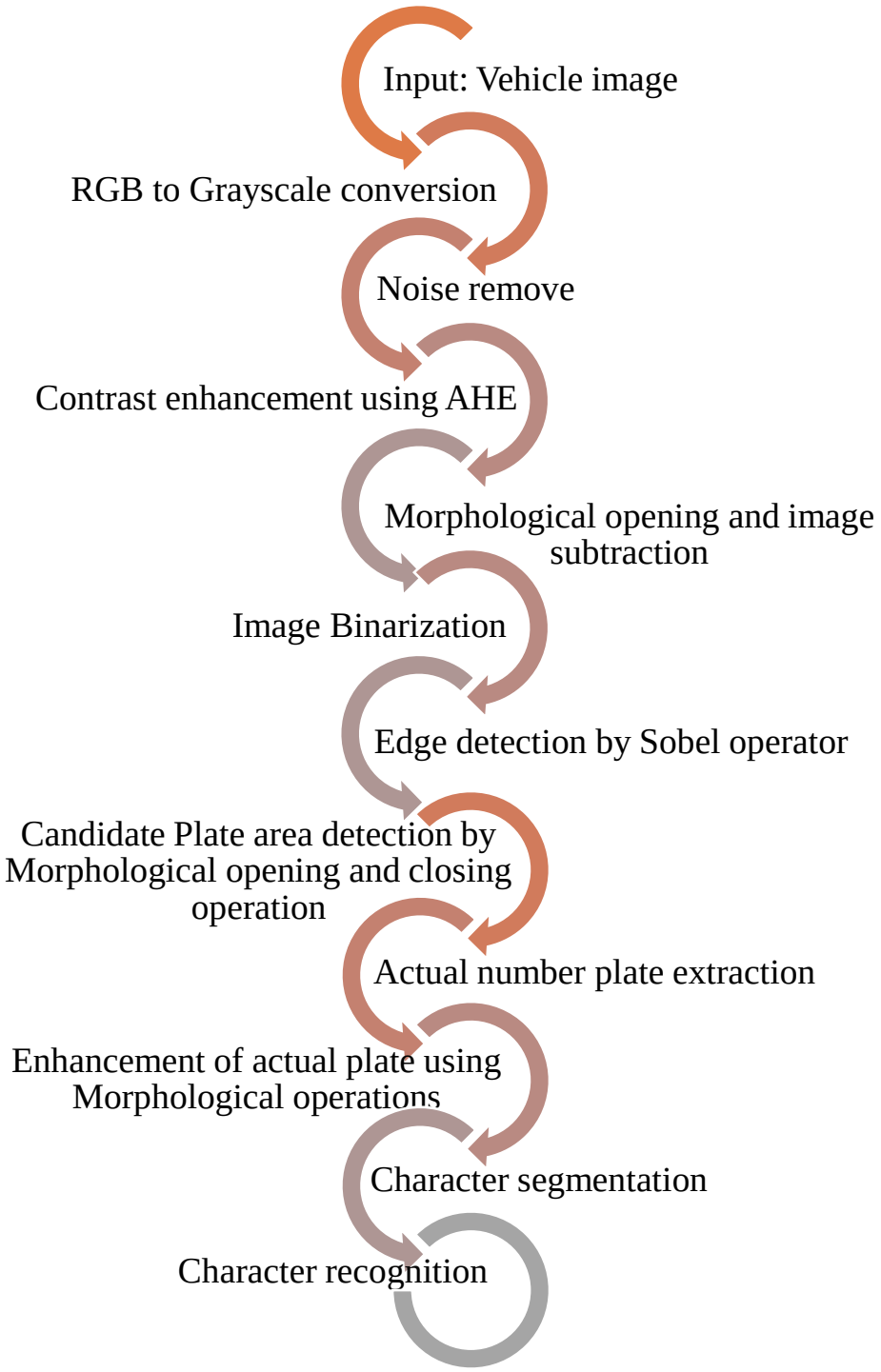


Fig-2.4: Flow chart of the selected paper

Table-2.4: Output of the selected paper

Car No.	Step of the Algorithm											
	(1) Input	(2) Rgb to gray	(3) Denoi-sing	(4) AHE	(5) Morpho-logical operation	(6) Binari-zation	(7) Sobel Edge	(8) Plate detec-tion	(9) Plate extrac-tion	(10) Enhance-ment	(11) segmen-tation	(12) Character Recog-nition
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✕ (6 -> G)
5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✕
7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✕ (2->Z, O->U ✕)
9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10	✓	✓	✓	✓	✓	✓	✕	✕	✕	✕	✕	✕
11	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	✓	✓	✓	✓	✓	✓	✓	✕	✕	✕	✕	✕
13	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✕
14	✓	✓	✓	✓	✓	✓	✕	✕	✕	✕	✕	✕
15	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✕
16	✓	✓	✓	✓	✓	✓	✓	✕	✕	✕	✕	✕
17	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✕
18	✓	✓	✓	✓	✓	✓	✓	✕	✕	✕	✕	✕

CHAPTER 3
PROPOSED MODEL

The approach for making this project is shown in the following flowchart:

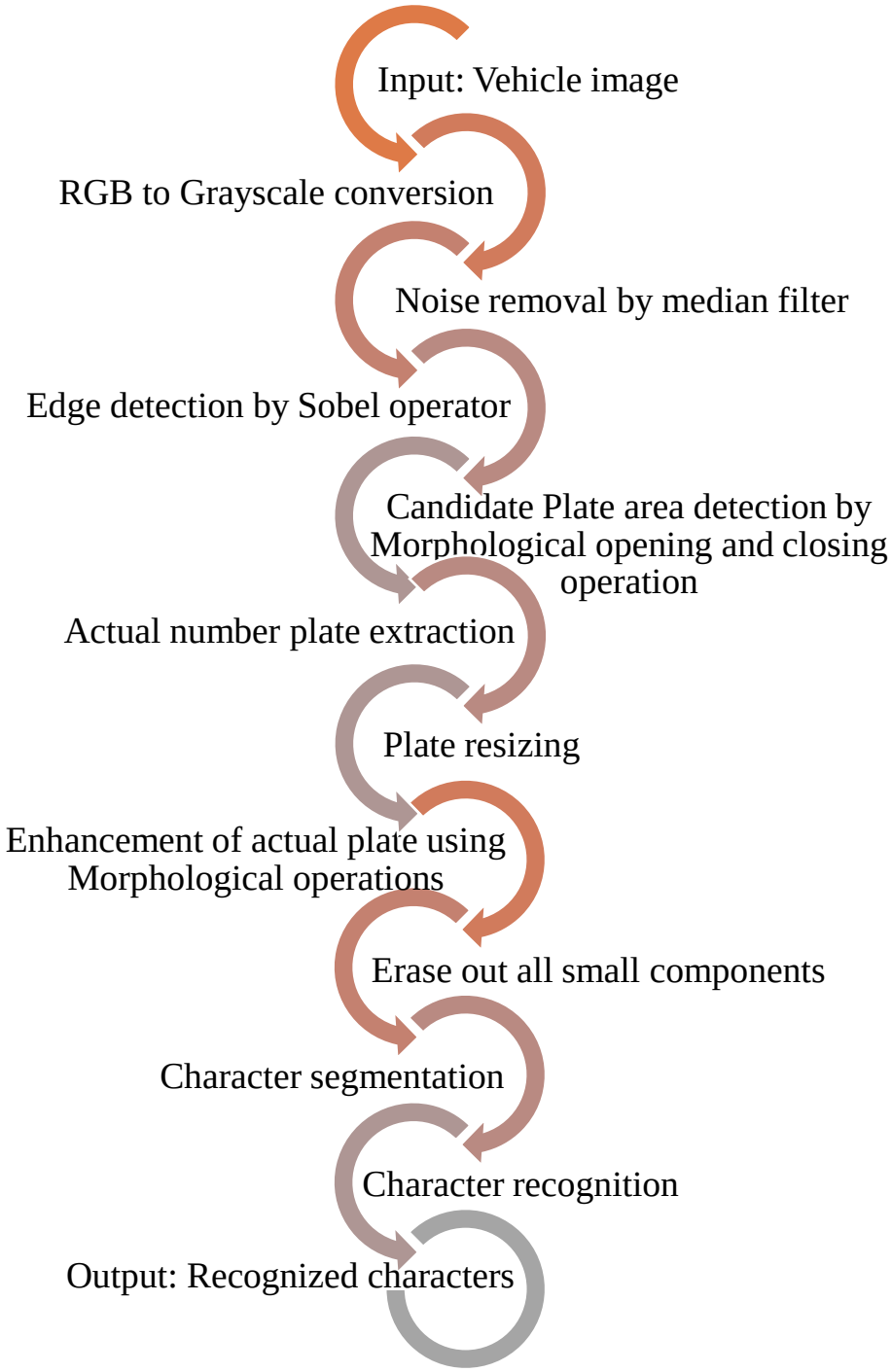


Fig-3.0: Flowchart of the proposed model

3.1 Input: Vehicle image

Image is acquired by camera. Images are taken in different background and illumination conditions and at various distances from the camera. Due to poor illumination conditions the acquired image can be of low contrast. Weather conditions (fog, snow, rain) are responsible for introducing "noise" during camera capturing. Different types of images can be acquired during camera capturing that is Light Images, Dark Images, Low Contrast Images, Blurred Images and Noisy Images.

3.2 RGB to Grayscale conversion

The captured input image is RGB format. The first step of pre-processing is to convert RGB image into gray-scale image.

3.3 Noise removal by median filter

The median filter is a nonlinear digital filtering technique, often used to remove noise from an image or signal. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise, also having applications in signal processing.

3.4 Edge detection by Sobel operator

Edges are detected by Sobel operator. Sobel operator consists of two types of masks. One is horizontal Sobel mask and vertical Sobel mask.

3.5 Candidate Plate area detection by Morphological opening and closing operation

In the proposed ANPR approach for the detection of candidate plate area, firstly dilation operation is applied on Sobel edge detected image and then the holes are filled in this dilated image using MATLAB imfill function. After this the unwanted portion of image is removed by using opening operation and finally the candidate plate area is detected by using erosion operation.

3.6 Actual number plate extraction

After the detection of number plate area that area is extracted from the image. The efficiency of number plate extraction depends on accurate detection of number plate area. In the approach, after the detection of candidate plate area, the row and column indices of plate area plate area are found by Boundary Box Analysis (BBA) and then that portion is extracted from the image.

3.7 Plate resizing

After the actual plate extraction we need to resize the plate so that all images come to a fixed size.

3.8 Enhancement of actual plate using Morphological operations

The extracted number plate may consist of various noise, unwanted holes, frames, bolts etc. So enhancement of plate region is done. In the approach the enhancement of extracted plate region is done by using various morphological operations. Plate region is enhanced by morphological dilation, erosion, opening and closing operation, binarization on extracted plate region.

3.9 Erase out all small components

We need to erase all small components so that the characters are well recognized.

3.10 Character segmentation

Character Segmentation (CS) step acts as bridge between the number plate extraction and character recognition phase. In this phase the characters on number plate area are segmented. There are many factors such as image noise, space mark, plate frame, plate rotation and illumination variance etc. that make the character segmentation task difficult. In the proposed approach the character segmentation is done by Connected Component Analysis (CCA) and Boundary Box Analysis (BBA). Firstly labels are assigned to connected components and the labeled characters are extracted using boundary box analysis.

3.11 Character recognition

Character recognition (CR) is the last phase of ANPR system. The inputs to this phase are segmented characters and output of this phase is license plate number. Difficulties are faced during character recognition. The character recognition is done by Template Matching using Correlation. In the proposed approach for ANPR, in the character recognition step firstly make template by taking 42 X 24 pixel A to Z alphabet and 0 to 9 number images. Read all image and store them in database and this result into 36 character templates. After this step character normalization is done. In character normalization, all the segmented characters are resized to template size 42 X 24. The main benefit of character normalization is that sometimes the segmented characters do not have the same size. The better way to overcome this problem is to resize the characters into one size before actual recognition starts. In last the segmented characters are matched with template characters using correlation. The similarity between the template characters and segmented characters is measured and the template that is most similar to the character is recognized as target. The value of correlation is calculated by comparing the normalized segmented character image with each template character image and selecting the most relevant image and writes that character into text file.

CHAPTER 4
IMPLEMENTATION

Here are all the screenshots of the outputs with description.

4.1 Input: Vehicle image

This is the initial taken image.

Fig-4.1: Input image

4.2 RGB to Grayscale conversion

The real image is in RGB format. Here it is converted into Grayscale.

Fig-4.2: RGB to Grayscale conversion

4.3 Noise removal by median filter

Here salt and pepper noise is added first then it is removed by median filter.

4.3.1 Salt and Pepper noise added

After adding noise:

Fig-4.3.1: Salt and Pepper noise added

4.3.2 Median filtering

After filtering:

Fig-4.3.2: Median filtering

4.4 Edge detection by Sobel operator

After applying Sobel mask:

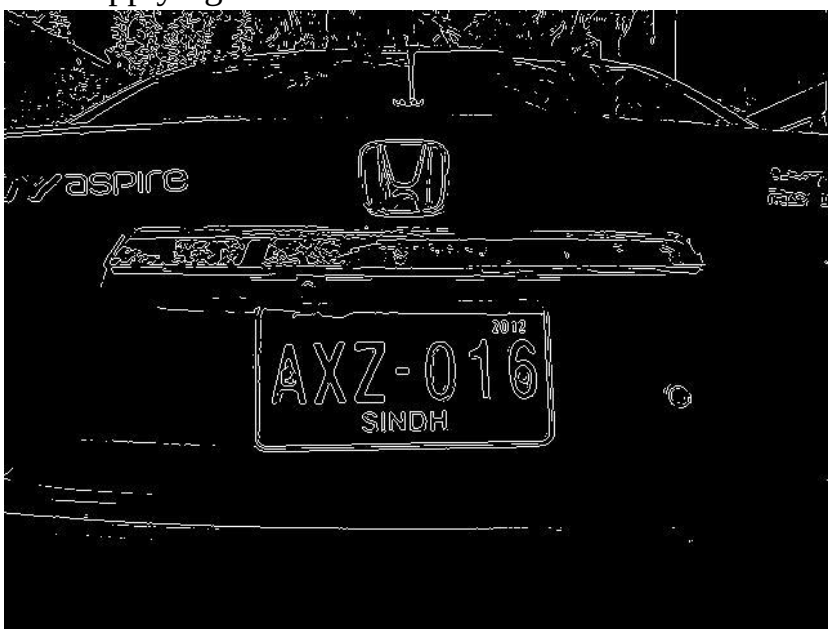


Fig-4.4: Edge detection using Sobel operator

4.5 Candidate Plate area detection by Morphological opening and closing operation

First we do dilation operation, then use imfill function, then opening and erosion operation.

4.5.1 Dilation operation

After dilation:

Fig-4.5.1: Dilation operation

4.5.2 Using imfill function

MATLAB imfill function implemented:

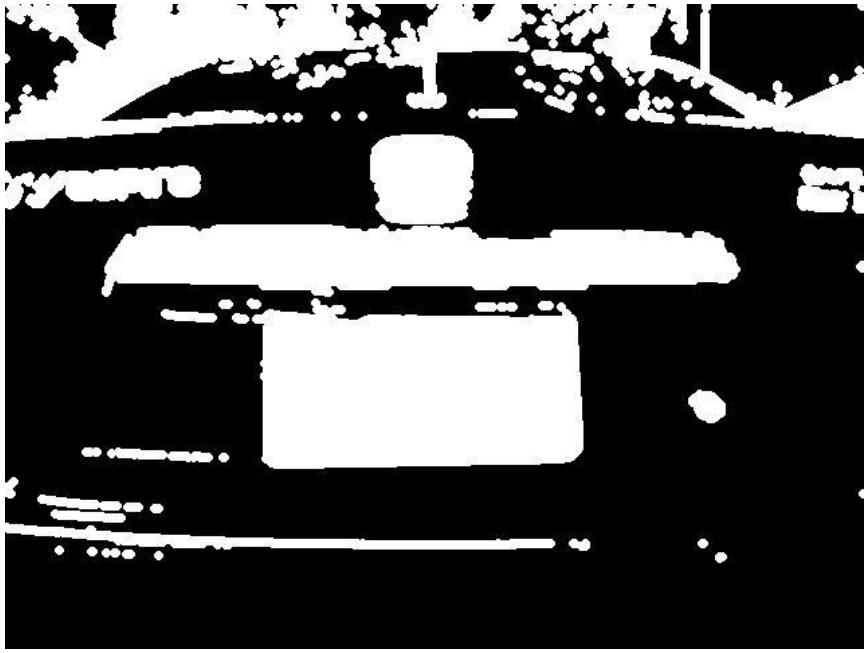


Fig-4.5.2: Using imfill function

4.5.3 Opening operation

Output of open operation:

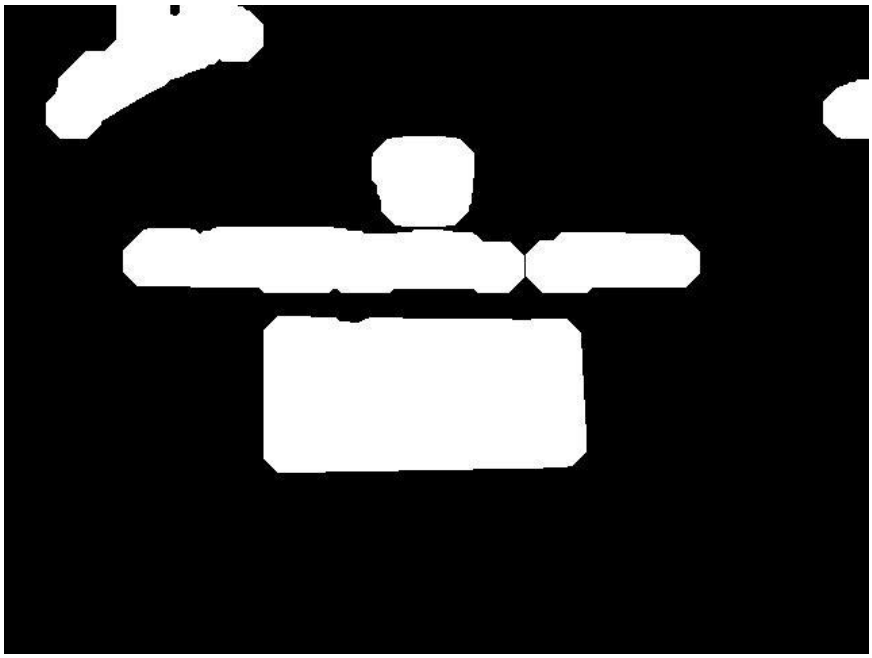


Fig-4.5.3: Opening operation

4.5.4 Erosion operation

Output of erosion operation:

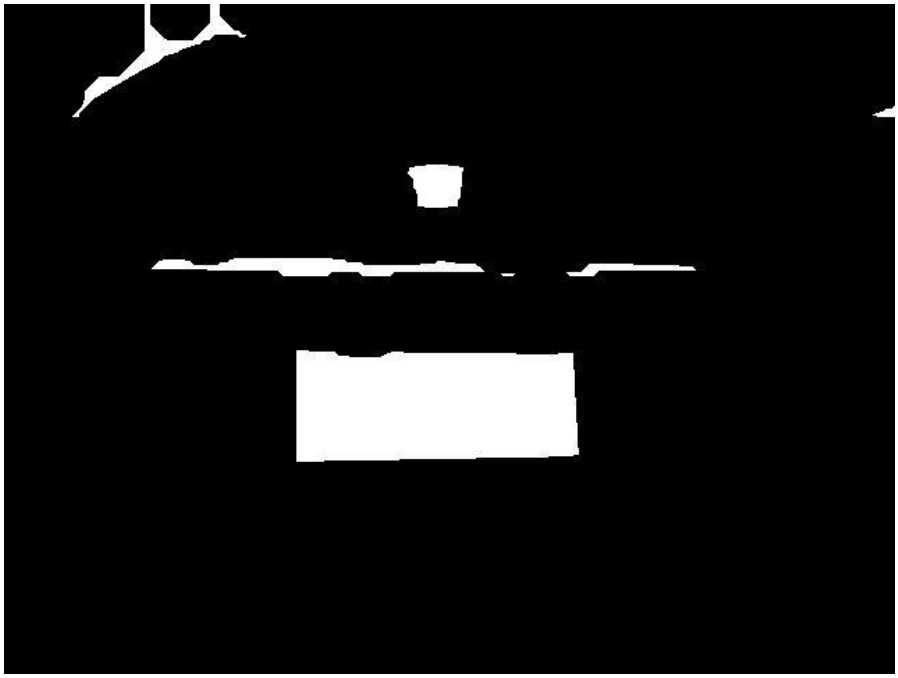


Fig-4.5.4: Erosion operation

4.6 Actual number plate extraction

After erosion here we will find the "area of interest" means the part of license plate only. So the white circle is omitted automatically.

Fig-4.6: Original plate extraction

4.7 Plate resizing

As from different image we get different sized plate extraction, so this is a fixed resized image.

Fig-4.7: Resized plate

4.8 Enhancement of actual plate using Morphological operations

Here the extracted plate is enhanced in many way.

4.8.1 Binarization

After using binarization:

Fig-4.8.1: Binarization

4.8.2 Complementation

As MATLAB finds white as object so we need to complement.

Fig-4.8.2: After complementation

4.9 Erase out all small components

Here all the small components are erased.

Fig-4.9: Erasing all small components

4.10 Character segmentation

After character segmentation:

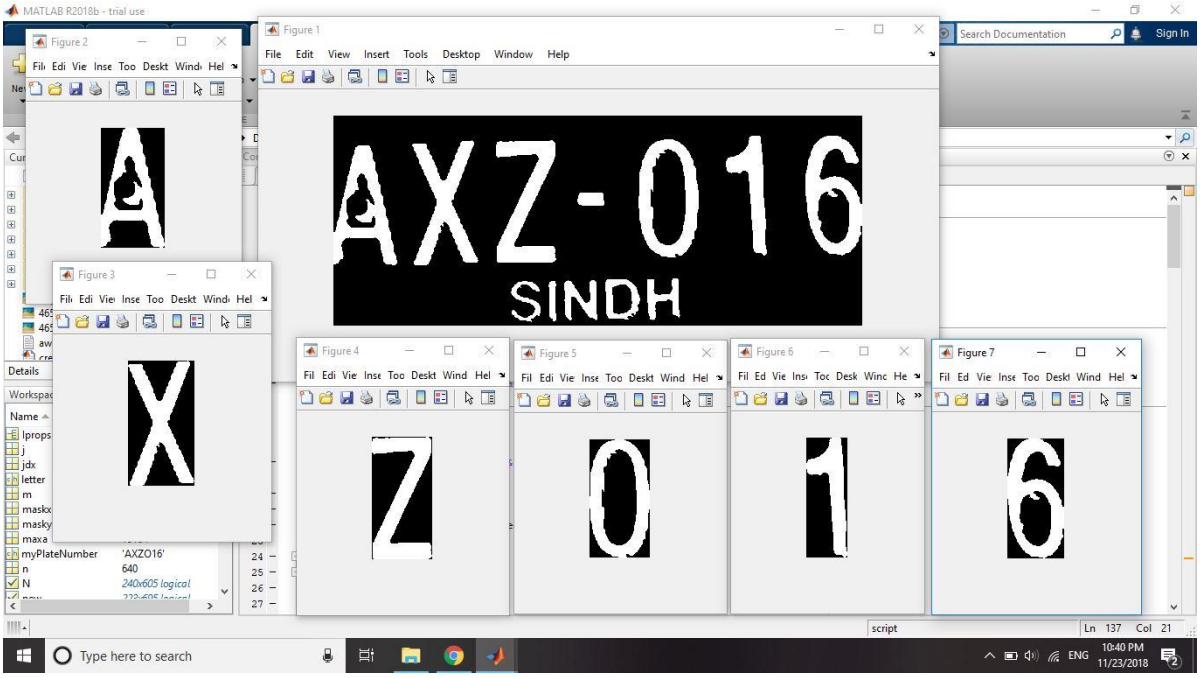


Fig-4.10: After character segmentation

4.11 Character recognition

Here readletter function is run on every segment. Then a character array is taken where the license plate number is stored as a string.

Fig-4.11: Character recognized

4.12 Result for some car images

Table-4.12: Output of proposed model

Car no.	Step of the algorithm										
	(1) Input	(2) Rgb to gray	(3) Noise reduct -ion	(4) Sobel	(5) Candidate plate area detection	(6) Actual number plate area extraction	(7) Plate Resiz ing	(8) Region enhance -ment	(9) Erase out small compo -nent	(10) Char segmen -tation	(11) Char reading
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	× (R->P)
8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	× (2->Z)
9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10	✓	✓	✓	×	×	×	×	×	×	×	×

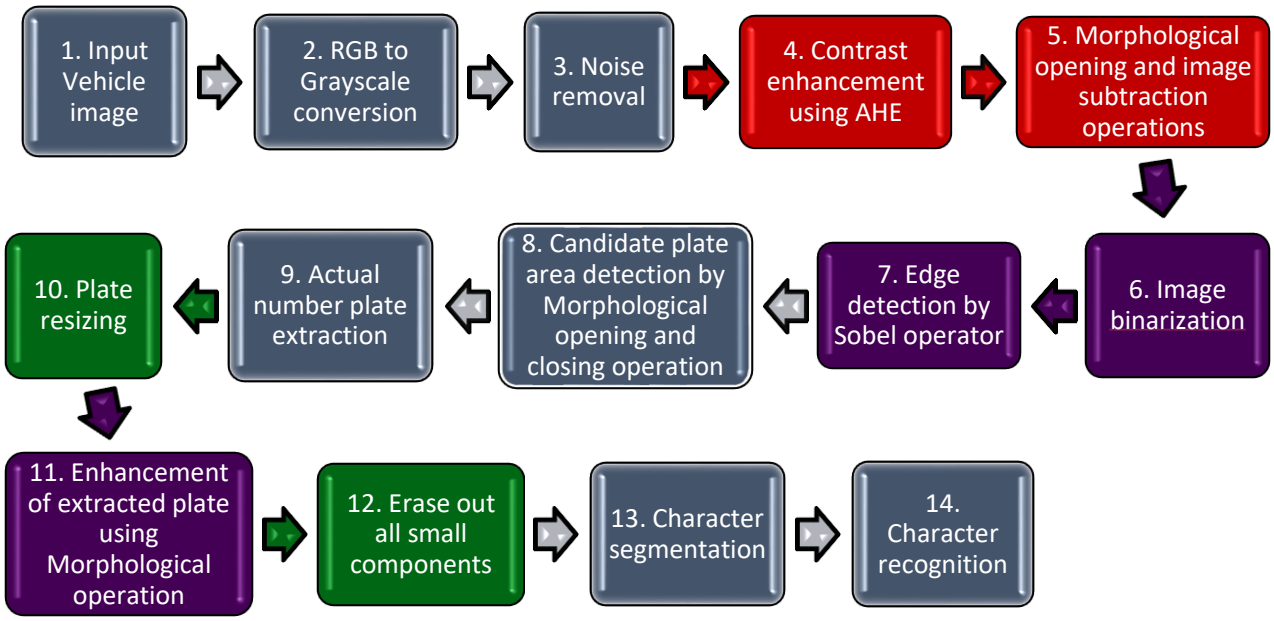
11	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	× (D->O)
13	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×
14	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×
15	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×
16	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	× (3->5)
17	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×
18	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×

4.13 Modification

Both model is combined here.

Meaning of the colours:

- **Followed the paper**
- **Omitted from paper**
- **Modified step**
- **New added step**



4.14 Comparison

Table-4.14: Comparison between two models

Input Image	Our Approach	Paper's Approach
	✓	✓
	✓	✓
	✓	✓
	✓	× (6->G)
	✓	✓
	✓	×

Input Image	Our Approach	Paper's Approach
	× (R -> P)	✓
	× (2 -> Z)	×(2 ->Z, O->U)
	✓	✓
	×	×
	✓	✓
	× (D -> O)	×

Input Image	Our Approach	Paper's Approach
	× (×)	×
	× (×)	×
	× (×)	×
	× (3 -> 5)	×
	× (×)	× (×)
	×	×

CHAPTER 5
FUTURE PLAN AND CONCLUSION

5.1 Future Plan

- Using bilateral filter to remove noise
- Use template matching for character recognition
- Use more steps to acquire more accuracy
- Real time implementation

5.2 Conclusion

If we can build up this system it will help to reduce the traffic jam by automated toll collection or parking at right place. It will also help to reduce the accident by speed control. Criminals will not be able escape from the country. The will not be able to disagree to their crime. They will fear to park at wrong place or to do any accident. Overall the system will help to enforce the law.