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Abstract

Automatic number plate recognition is a Computer Vision technique which is able to recognize a license plate number. This system is useful in many field likes parking lots, private and public entrances, theft control. In this paper we designed such a system. First we capture the image from camera then load into system after that we used opencv library tools. Then we make the training set of different characters of different sizes. On the basis of these training set we extracted the character from images. When the license plate is detected, its digits are recognized and displayed in the GUI. In this mainly focuses on Neural Network and proprietary tools opencv in which ANPR systems implementing using Free Software Open Computer Vision Library including Python.

Acknowledgements

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Lastly, we would like to thank our parents, grandparents and other members of the family for their years of unyielding love and encouragement.

They always wanted the best for us and we admire their sacrifice and determination.

Ashish Varshney and Pankaj

19-November-2018

Acronyms

OCR	Open Character Recognizition.
ALPR	Automatic License Plate Recognizition.
ANPR	Automatic Number Plate Recognizition.
AVI	Automatic Vehicle Identification.
CPR	Car Plate Recognizition.
RTO	Regional Transport Authority.
OS	Operating System.
UML	Unified Modeling Language.
LPR	License Plate Recognizition.
ASCII	American Standard Code For Information Interchange.
IDE	Integrated Development Environment.
CV	Computer Vision

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Chapter 1: Introduction

ANPR is an image-processing innovation which is used to perceive vehicles by their tags. This expertise is ahead of time ubiquity in security and traffic installation. Tag Recognition System is an application of PC vision. PC vision is a technique for using a PC to take out abnormal state information from a digital image. The useless homogeny among various tags for example, its dimension and the outline of the License Plate. ANPR, also known as Automatic License-Plate Recognition ALPR, AVI, or CPR, is a surveillance method that uses Optical Character Recognition (OCR) and other methods such as segmentations and detection to read vehicle registration plates. The ANPR system consists of following steps:-

i. Vehicle image capture.
ii. Preprocessing.
iii. Number plate extraction.
iv. Character segmentation.
v. Character recognition.

The ANPR system works in these strides, the initial step is the location of the vehicle and capturing a vehicle image of front or back perspective of the vehicle, the second step is the localization of Number Plate and then extraction of vehicle Number Plate is an image. The final stride use image segmentation strategy, for the segmentation a few techniques neural network, mathematical morphology, color analysis and histogram analysis. Segmentation is for individual character recognition. Optical Character Recognition (OCR) is one of the strategies to perceive the every character with the assistance of database stored for separate alphanumeric character.

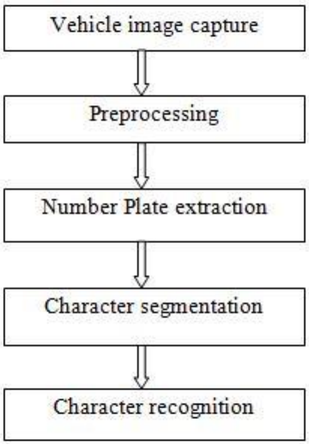


Fig1.1:- *Block diagram of ANPR system*

1.1 Motivation

In this project we aim to make an application which will help for police and mostly for traffic police in each state for doing thier work very efficiently and in very small time. Also we implement this project with help of android phone which easily available with all traffic police. And which make this application very easy to handle. And for this we provide centralised website of RTO as well as dummy website.

1.2 Objectives and Scope

As it is not possible to judge which approach is better different papers, which are based on steps are surveyed and categorized based on the methodologies in each approach. For each approach whenever available parameters like speed, accuracy, performance, image size and

platform are reported. Commercial product survey is beyond the scope of this paper as sometimes these products claims more accuracy than actual for promotional purposes.
Remainder of this paper is divided as follows: Section 2 contains survey of different techniques to detect number plate. Character segmentation methods are reviewed in section 3 and
section 4 contains discussion about character recognition methods. The paper concludes with the discussion of what is not implemented and what kind of research is possible in
ANPR.

1.3 Organization

The main body of the report is preceded by detailed contents including lists of figures, list of tables, and acronyms used. This is followed by the executive summary giving briefly the scope and objectives of the project, importance of the topic, methodologies, major observations and the action plan.

Chapter 1 explains the importance of the topic and scope of our work.

Chapter 2 provides the insight to some of the research work that has already been done and helped us to understand the topic deeply.

Chapter 3 discusses about the concepts used in this project.

Chapter 4 detail about the tools and libraries used in this project.

Chapter 5 and chapter 6 explains the overall proposed system and then the flow of work for this project i.e. how the ultimate goal was achieved.

Chapter 7 gives the conclusion and ideas for improvement of the project.

The main report is followed by the references that have been used while understanding the project and working on it. Wherever these references have been used, they are cross referred by their serial number in the list of references.

Chapter 2 : Literature Review

The growing affluence of urban India has made the ownership of vehicles a necessity. This has resulted in an unexpected civic problem - that of traffic control and vehicle identification. Parking areas have become overstressed due to the growing numbers of vehicles on the roads today. The Automatic Number Plate Recognition System (ANPR) plays an important role in addressing these issues as its application ranges from parking admission to monitoring urban traffic and to tracking automobile thefts. There are numerous ANPR systems available today which are based on different methodologies. In this paper, we attempt to review the various techniques and their usage. The ANPR system has been implemented using template Matching and its accuracy was found to be 80.8% for Indian number plates.

Muhammad Tahir Qadri In this anticipate [2] for the recognition the OCR techniques is used which is susceptible to misalignment and to various sizes. The affine transformation can be used to advance the OCR recognition from various size and angles. The programmed vehicle identification system using vehicle license plate is exhibited. A series of image processing techniques of the system for identifying the vehicle from the database stored in the PC.

S.Kranthi, K.Pranathi In this paper they [3] proposed that Automatic Number Plate Recognition (ANPR) is a method that catches the vehicle image and confirmed their license number. ANPR can be used in the presentation of stolen vehicles. ANPR can be used in various manners by using to identify it stolen vehicle on the highway.

Abd KadirMahamad In this paper they explained [8] an automatic number plate inspection of letter sets of plate using image processing and optical character recognition. An imperative system has been created of training interface using LABVIEW software.

Kuldeepak et al. In this paper [1] they introduced that high level of precision has been required by the number plate recognition when streets are occupied and number of vehicles are passing through. In this paper, by optimizing different parameters, they have accomplished an exactness of 98%. It is essential that for the tracking stolen vehicles and monitoring of vehicles of an exactness of 100% can't be bargained with. Therefore to accomplish better precision streamlining is required. Additionally, the issues like stains, blurred regions, smudges with various text style and sizes ought to be remembered. This work can be further boundless to minimize the errors because of them.

AmrBadr et al. In this paper [8] Automatic recognition of car license plate number got to be indispensible part in our day by day life. This paper mainly explains an Automatic Number Plate Recognition System (ANPR) using Morphological operations, Histogram manipulation and Edge discovery Techniques for plate localization and characters segmentation. Artificial Neural Networks are used for Character classification and recognition.

The techniques based upon combinations of edge statistics and mathematical morphology [2–5] have been proven to give good results. Typically in these methods, gradient magnitude and their local variance in an image are computed. They are based on the property that the brightness change in the license plate region is more prominent and easily detectable than otherwise. Then, regions with a high edge magnitude and high edge variance are identified as possible license plate regions. A disadvantage is that edge-based methods alone can hardly be applied to complex images, since they are too sensitive to unwanted edges, which may also show high edge magnitude or variance.

Chapter 3: Proposed System

In India, basically, there are two kinds of license-plates, black characters in white plate and black characters in yellow plate. The former for private vehicles and latter for commercial, public service vehicles. The system tries to address these two categories of plates. The high-level block diagram of the proposed system is shown in Fig. 3.1 .

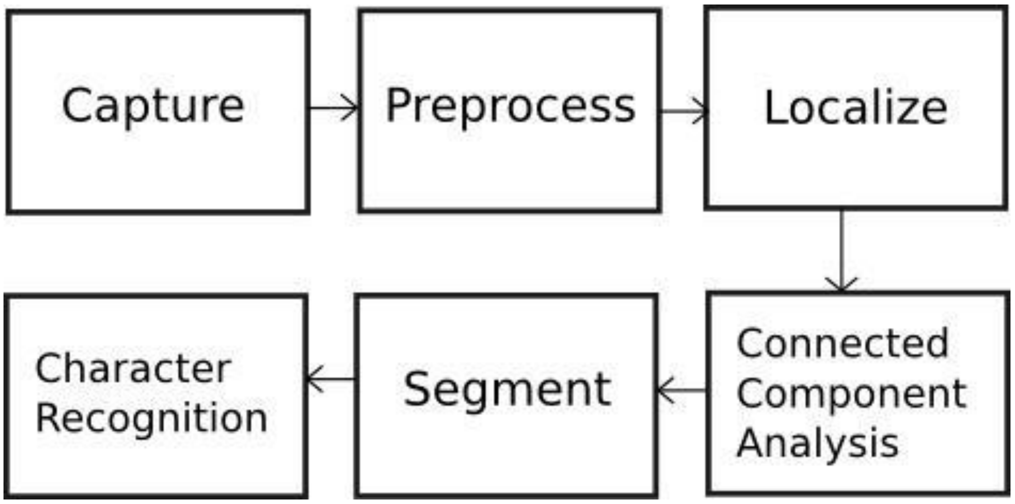


***Fig3.1:-** Proposed Systems*

3.1 Capture

The image of the vehicle is captured using a high resolution photographic camera. A better choice is an Infrared (IR) camera. The camera may be rolled and pitched with respect to the license plates Character recognition is generally very sensitive to the skew. The readable characters can become distorted due to the obliqueness of the camera. Using a better camera with more definition and resolution will increase the success ratio of the system.

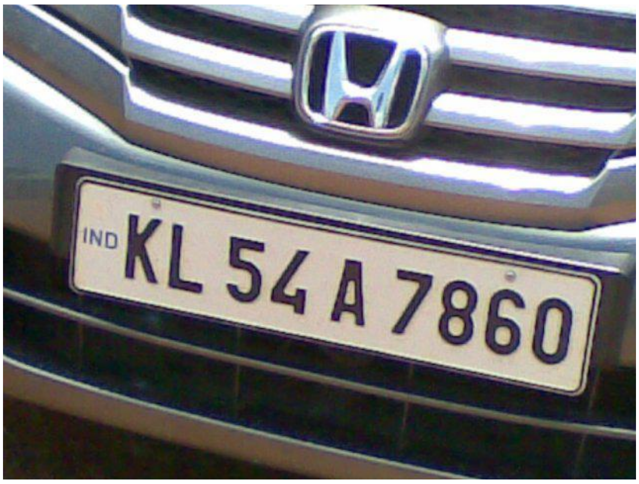


***Fig3.2:-**Captured Image*

3.2 Preprocess

Preprocessing is the set algorithms applied on the image to enhance the quality. It is an important and common phase in any computer vision system. For the present system preprocessing involves two processes: Resize – The image size from the camera might be large and can drive the system slow. It is to be resized to a feasible aspect ratio. Convert Colour Space – Images captured using IR or photographic cameras will be either in raw format or encoded into some multimedia standards. Normally, these images will be in RGB mode, with three channels (viz. Red, green and blue). Number of channels defines the amount colour information available on the image. The image has to be converted to grayscale.

3.3 Localize

Rear or front part of the vehicle is captured into an image. The image certainly contains other parts of the vehicle and the environment, which are of no requirement to the system. The area in the image that interests us is the license plate and needs to be localized from the noise. Localization is basically a process of binarizing the image. As shown in Fig. 3.3, the image is converted to black and white. There are two motivations for this operation –
1. Highlighting characters
2. Suppressing background.

Localization is done by an image processing technique called Thresholding. The pixels of the image are truncated to two values depending upon the value of threshold. Threshold requires pre-image analysis for identifying the suitable threshold value. Adaptive thresholding technique determines a local optimal threshold value for each image pixel so as to avoid the problem originating from non-uniform illumination.

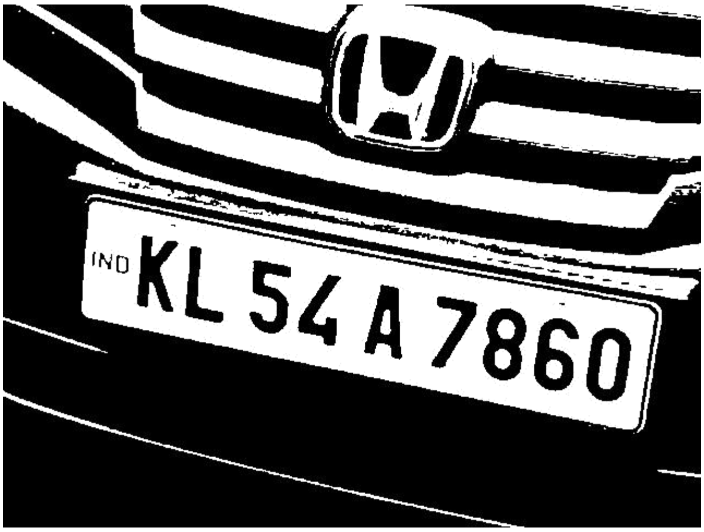


Fig3.3:-*Localized Image(Threshold)*

3.4 Connected Component Analysis

In order to eliminate undesired image areas, a connected component algorithm is first applied to the binarized plate candidate. Connected component analysis is performed to identify the characters in the image. Basic idea is to traverse through the image and find the connected pixels. Each of the connected components (blobs) are labelled and *extracted*. Fig. 3.4 shows the filtered blobs.

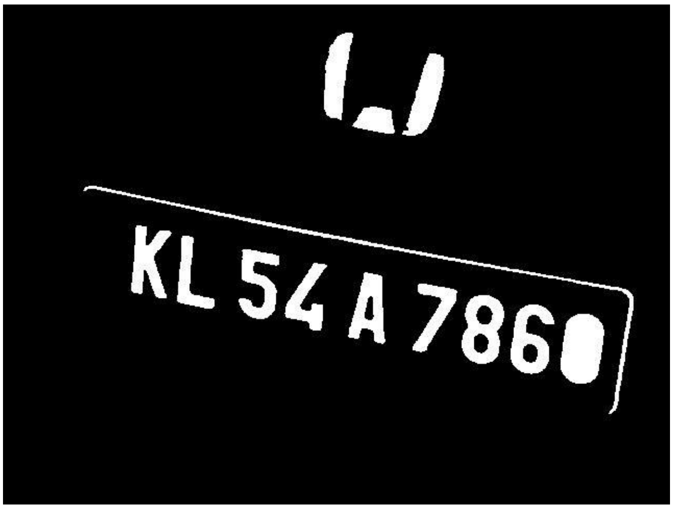


Fig3.4:-*Connected Component Analysis*

3.5 Segmentation

Segmentation is the process of cropping out the labelled blobs. These blobs are expected to be the required portion of the license number. A special algorithm called Image Scissoring[1] is introduced here. In this algorithm, the license plate is vertically scanned and scissored at the row on which there is no white pixel and the scissored area is copied into a new matrix, as in Fig. 3.5.

There are unwanted blobs even after segmentation. These are classified using special algorithms as in Fig 3.6.

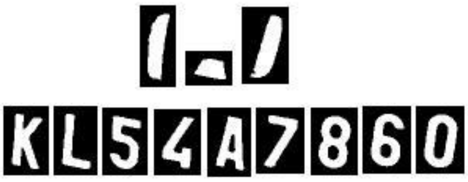


Fig3.5:-*Segmentation Image*

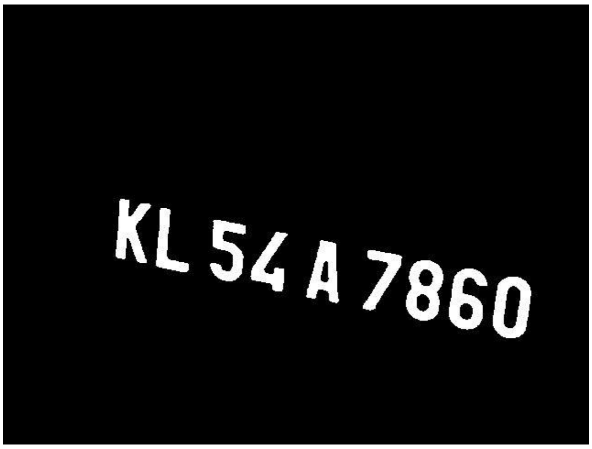


Fig3.6:-*Classified Blobs*

3.6 Character Recognition

Finally, the selected blobs are send to a Optical Character Recognition (OCR) Engine, which returns the ASCII of the license number.

Chapter 4: Tools

4.1 Python

Python is a remarkably powerful dynamic, object-oriented programming language that is used in a wide variety of application domains. It offers strong support for integration with other languages and tools, and comes with extensive standard libraries. To be precise, the following are some distinguishing features of Python:

- Very clear, readable syntax.
- Strong introspection capabilities. Full modularity.
- Exception-based error handling
- High level dynamic data types.
- Supports object oriented, imperative and functional pro-gramming styles.
- Embeddable. Scalable
- Mature

With so much of freedom, Python helps the user to think problem centric rather than language centric as in other cases. These features make Python a best option for scientific computing.

4.2 OpenCV

Opencv is a library of programming functions for real time computer vision originally developed by Intel and now supported by Willogarage. It is free for use under the open source BSD license. The library has more than five hundred optimized algorithms. It is used around the world, with forty thousand people in the user group. Uses range from interactive art, to mine inspection, and advanced robotics. The library is mainly written in C, which makes it portable to some specific platforms such as Digital Signal Processor. Wrappers for languages such as C, Python, Ruby and Java (using javacv) have been developed to encourage adoption by a wider audience. The recent releases have interfaces for C++. It focuses mainly on real-time image processing. Opencv is a cross-platform library, which can run on Linux, Mac OS and Windows. To date, opencv is the best open source computer vision library that developers and researchers can think of.

4.3 Tesseract

Tesseract is a free software OCR engine that was developed at HP between 1984 and 1994. HP released it to the community in 2005. Tesseract was introduced at the 1995 UNLV Annual Test OCR Accuracy [2] and is currently developed by Google released under the Apache License. It can now recognize 6 languages, and is fully UTF8 capable. Developers can train Tesseract with their own fonts and character mapping to obtain perfect efficiency.

4.4 Numpy

Numpy is a general-purpose array-processing package. It provides a high-performance multidimensional array object, and tools for working with these arrays.

It is the fundamental package for scientific computing with Python. It contains various features including these important ones:

- A powerful N-dimensional array object
- Sophisticated (broadcasting) functions
- Tools for integrating C/C++ and Fortran code

- Useful linear algebra, Fourier transform, and random number capabilities

Besides its obvious scientific uses, Numpy can also be used as an efficient multi-dimensional container of generic data.

Arbitrary data-types can be defined using Numpy which allows Numpy to seamlessly and speedily integrate with a wide variety of databases.

4.5 K-Nearest

K-Nearest Neighbors is one of the most basic yet essential classification algorithms in Machine Learning. It belongs to the supervised learning domain and finds intense application in pattern recognition, data mining and intrusion detection.

It is widely disposable in real-life scenarios since it is non-parametric, meaning, it does not make any underlying assumptions about the distribution of data (as opposed to other algorithms such as GMM, which assume a Gaussian distribution of the given data).

We are given some prior data (also called training data), which classifies coordinates into groups identified by an attribute.

As an example, consider the following table of data points containing two features:

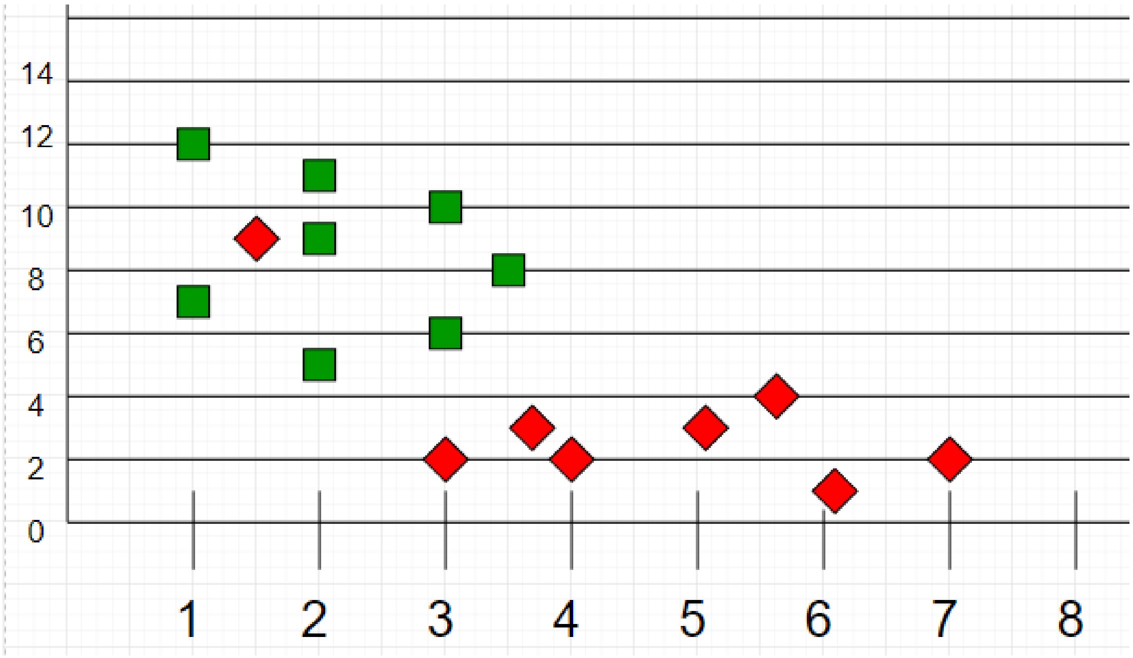


Fig4.1:-*Table Data of Two Points*

Chapter 5: Implementation

Opencv with Python is a deadly combination for computer vision. We will now revisit each phase in the pipeline and see how they are implemented using the above tools.

5.1 Capture

Starting from point one of capturing the image, opencv library has highly optimized algorithms for all image processing operations. Opencv provides interface for different camera models. The following code snippet explains how to interface an in-built web camera and capture a frame.

```
From opencv import highgui as hg capture = hg.cv2createcameracapture(0)
Hg.cv2namedwindow("Snapshot") frame = hg.cv2queryframe(capture)
Hg.cv2showimage("Snapshot", frame)
```

5.2 Preprocess

As Seen before, preprocessing invoves resizing and changing colourspace of original image ,Like Other imageprocessing toolkits,opencv provides also fast and quick procedure.

Resize

```
original = cv2.LoadImageM("image.jpg") thumbnail = cv2.CreateMat(original.rows 10,
original.cols / 10, original.type) cv2.Resize(original, thumbnail)
```

The original image is resized to the dimensions specified in the thumbnail object. Colour space conversion CvtColor(original,gray,CV2_RGB2GRAY)
The above line of code converts the original image to gray. More image conversion codes are available at the OpenCV Wiki[3].

5.3 Localize

Threshold operation is performed in this phase. To retain the image quality, adaptive threshold algorithms are to be used.This have concluded that Otsu's[5] thresholding algorithm is the efficient way of binarizing the image. Opencv provides complex and efficient adaptive thresholding algorithms including Otsu method. Cv2threshold(image, binary_image,128,255, CV_THRESH_OTSU)
The above line of code returns a binary image which is adaptively threshold. The arguments follow the order:

- Source image,
- Destination image,
- Threshold value,
- Resultant value,
- Type of threshold. The type CV_THRESH_OTSU performs Otsu algorithm on the source image.

5.4 Connected Component Analysis

Cvblobslib is a library to perform binary images connected component labelling. It also provides functions to manipulate, filter and extract results from the extracted blobs. The library provides two basic functionalities:

- Extract 8-connected components in binary or grayscale images.
- Filter the obtained blobs to get the interest objects in the image. This is performed using the Filter method from cblobresult.

The library is thread-safe if different objects per thread are used.

```
Myblobs = cblobresult(binary_image, mask,0, True)
Myblobs.filter_blobs(325,2000)
Blob_count = myblobs.getnumblobs()
```

The connected components are labelled using the above code snippet. Filter_blobs method is used to filter out the blobs of required dimensions.

5.5 Segmentation

Image Scissoring is hard-coded in Python by scanning the image vertically and cropping out white portions. The algorithm, is fast and efficient than compared to other pre-defined image cropping techniques. Segmentation phase also involves classification of the collected blobs and recording only the essential ones. Undesirable blobs occur even after segmentation. These are removed by two methods:

- Aspect ratio based elimination.
- Pixel coordinate based selection.

Aspect ratio based elimination: The aspect ratio (row/column) of each blob is calculated and recorded. A binarized candidate is sure of containing more characters than unwanted blobs. The mean of the aspect ratios are calculated and compared to all the blobs in turn. The process is explained briefly in the flowchart Fig. 5.1.

Pixel coordinate based selection: This algorithm thrives on the fact that license numbers are occuring in the plate in a single set of rows. Effectively, we can detect the edge of the license plate, and select the blobs coming between the minimum and maximum row coordinates. This can reduce the amount of unwanted blobs and make the system more accurate. The algorithm is explained in Fig. 5.2.

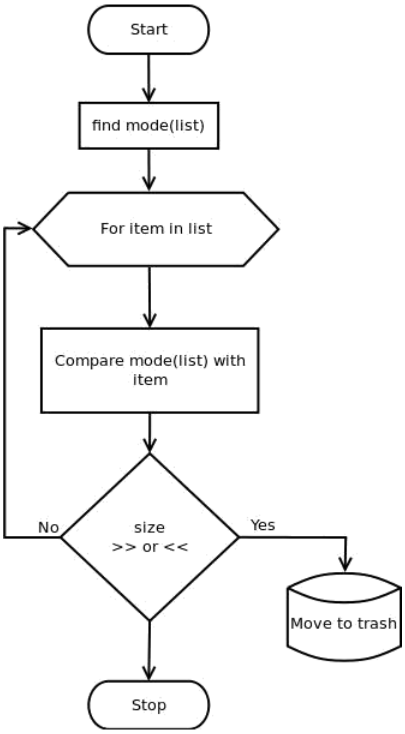


Fig5.1:-*Aspect Ratio Based Elimination*

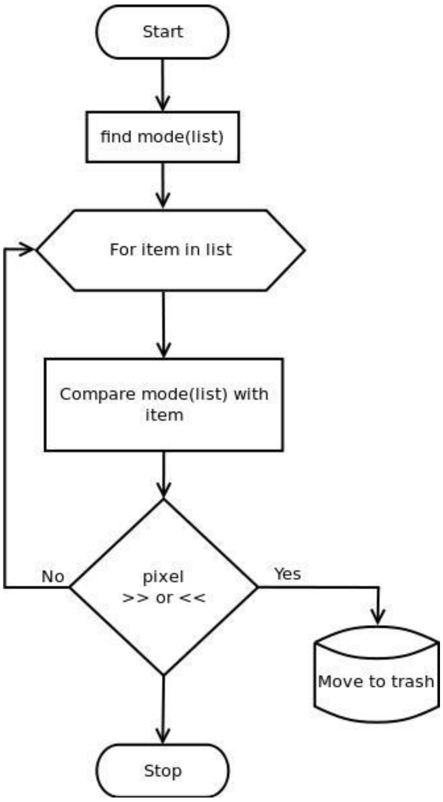


Fig5.2:-*Pixel Coordinate Based Elimination*

5.5 Character Recognizition

Tesseract OCR engine has a Python wrapper which make character recognition Quick and easy. From tesseract import image_to_string.

Image = open("blob.jpg")
Text = image_to_string(image)

Chapter 6: Statistics and Results

The system has been put to test for various measurements of performance and accuracy.

6.1 Accuracy Analysis

Operation	Sample	Success	Fail	Success Ratio
License plate localization	100	92	8	92%
Character Separation	92	88	4	95.7%
Character Recognition	88	83	5	94.3%

Table 6-1:-*Accuracy Analysis*

6.2 Performance Analysis

During the initial days, the system suffered severe per-formance faults. It took more than eighteen seconds for recognizing the license plate and extracting the number. Subse-quent research on algorithm and code optimization drastically brought down the operation time to two seconds. One of the key factor that determined performance was the size of input image. The Fig. 6.1 indicates this relationship.

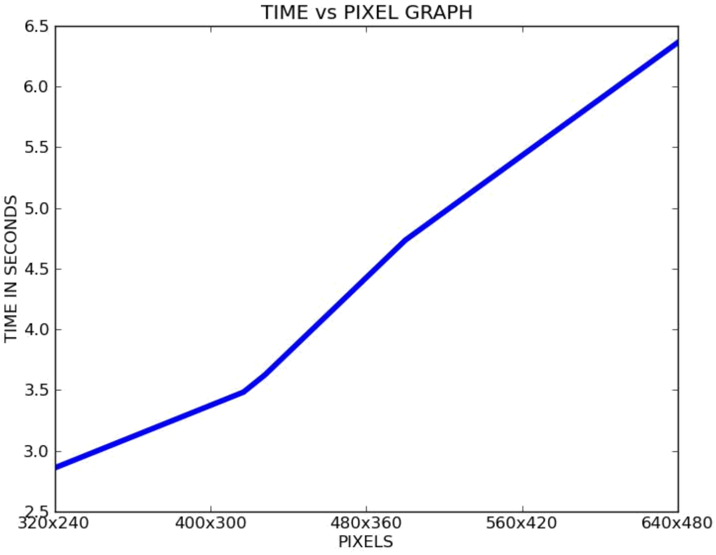
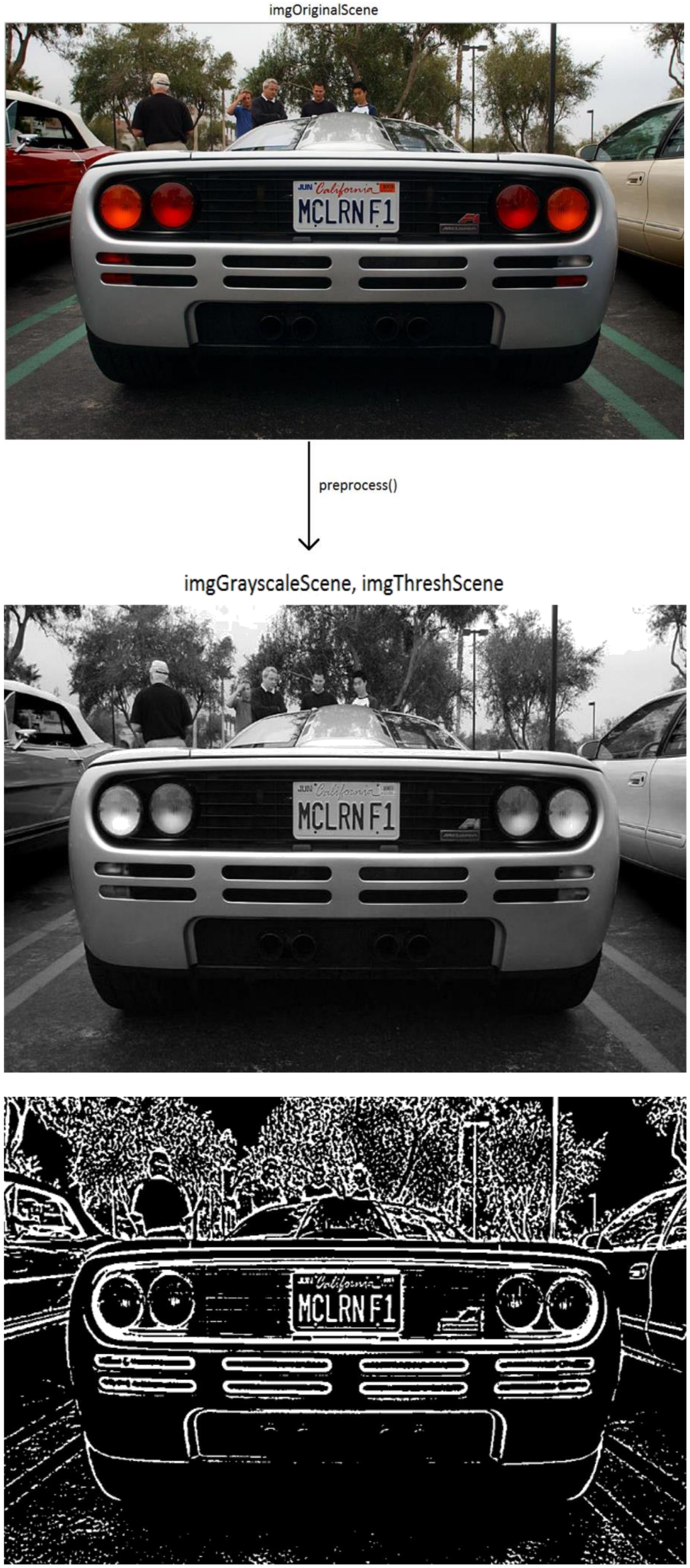


Fig 6.1:-*Performance Analysis*

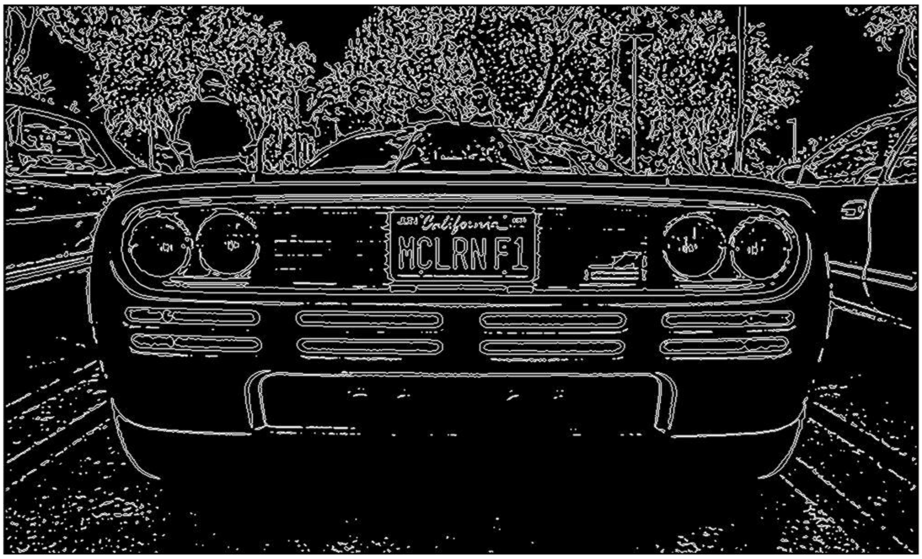
6.3 Results

Results and various stages image of number plate shown here.

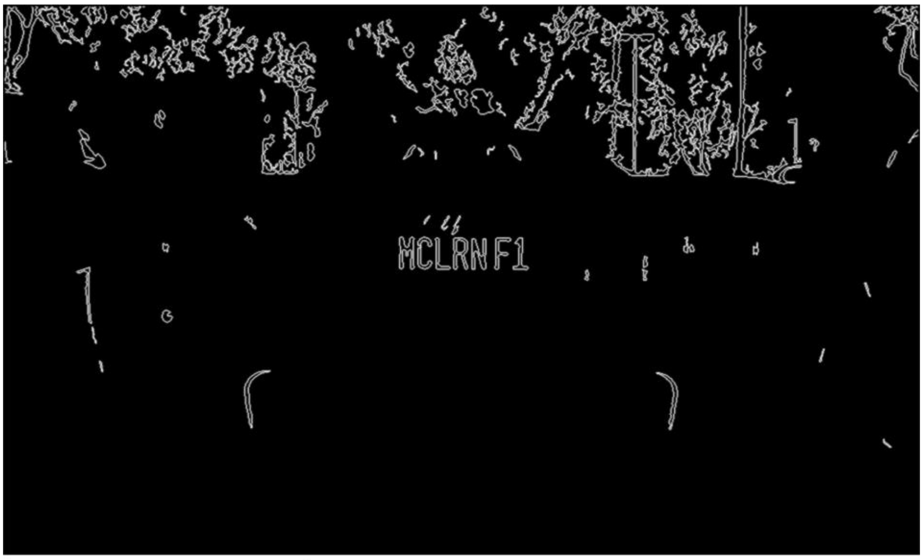

imgOriginalScene
preprocess()
imgGrayscaleScene, imgThreshScene
MCLRN F1

findPossibleCharsInScene()

all contours

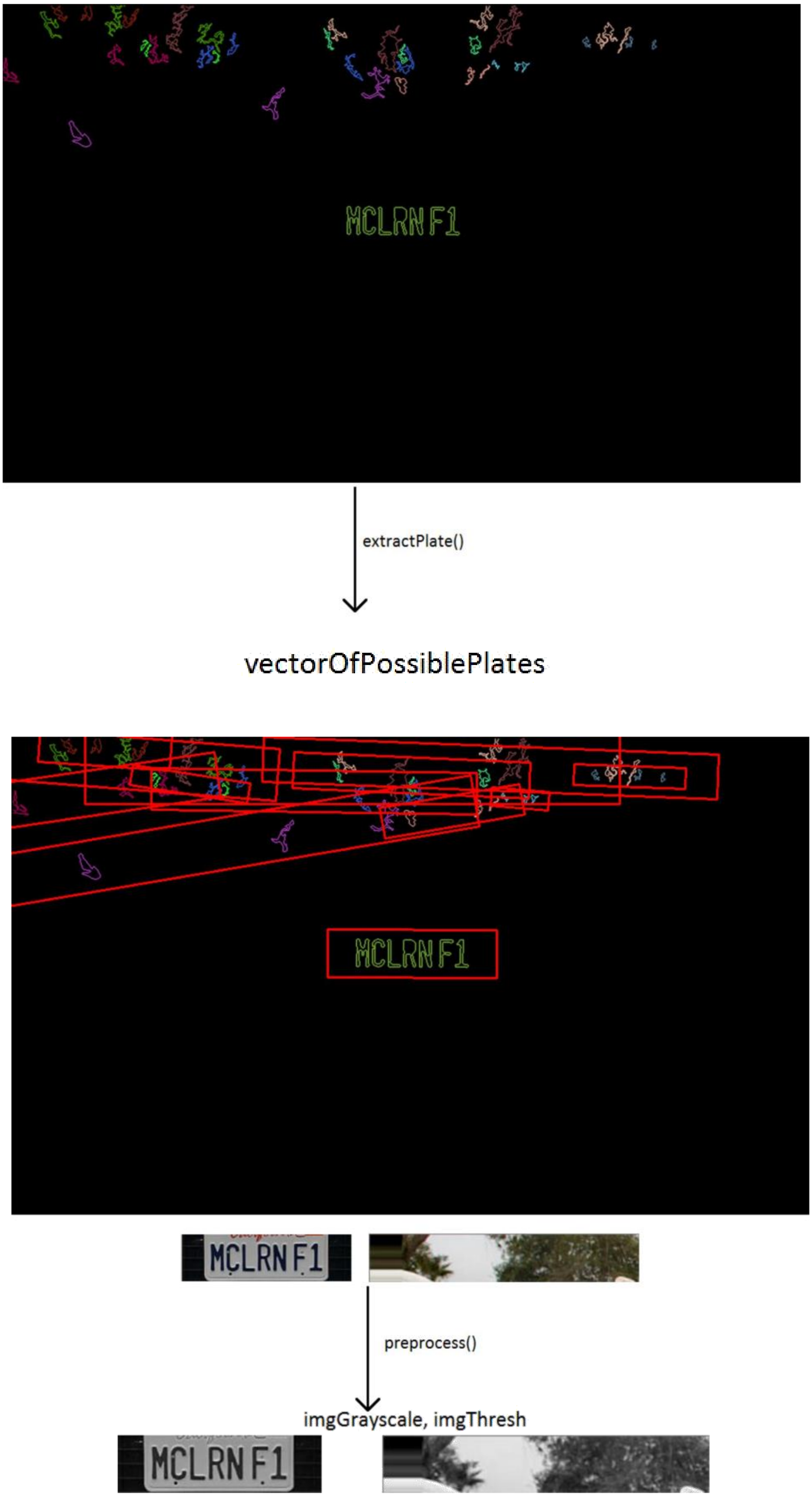


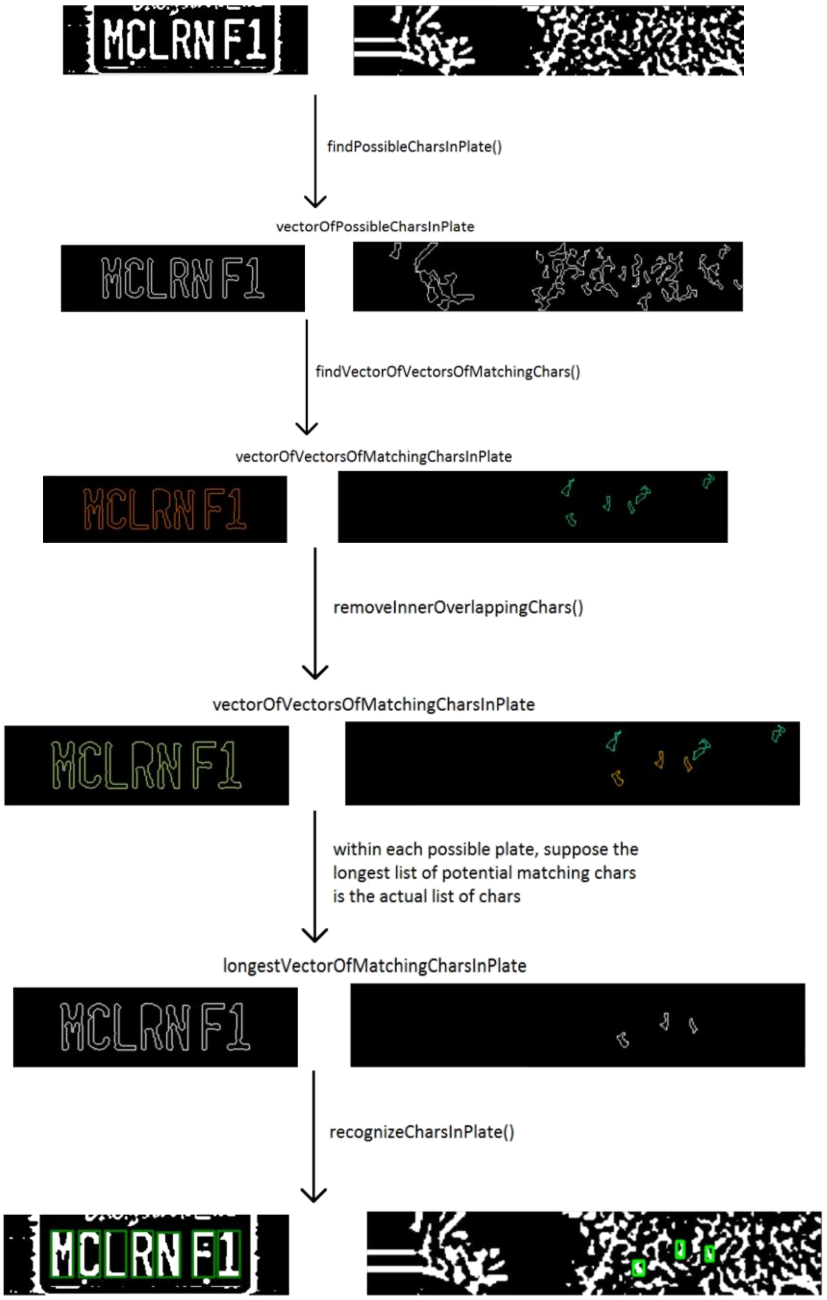
vectorOfPossibleCharsInScene



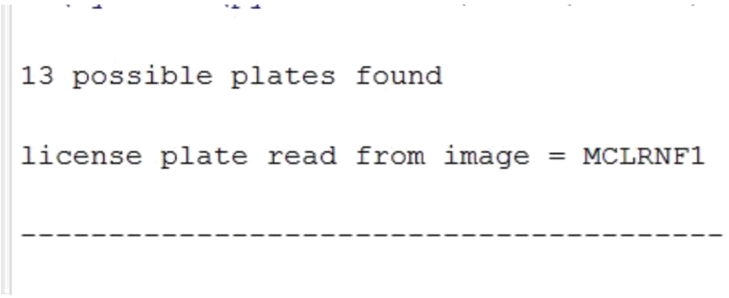
findVectorOfVectorsOfMatchingChars()

vectorOfVectorsOfMatchingCharsInScene


extractPlate()
vectorOfPossiblePlates
preprocess()
imgGrayscale, imgThresh


findPossibleCharsInPlate()
vectorOfPossibleCharsInPlate
findVectorOfVectorsOfMatchingChars()
vectorOfVectorsOfMatchingCharsInPlate
removeInnerOverlappingChars()
vectorOfVectorsOfMatchingCharsInPlate
within each possible plate, suppose the
longest list of potential matching chars
is the actual list of chars
longestVectorOfMatchingCharsInPlate
recognizeCharsInPlate()

```
chars found in plate number 0 = MCLRNF1,          chars found in plate number 5 = I1I,
```



```
13 possible plates found

license plate read from image = MCLRNF1

----------------------------------------
```

Fig 6.2:*-Steps with Image*

Chapter 7 : Conclusions and Future Work

7.1 Conclusions

No need to carry hard documents of vehicles everytime . Details of vehicles by using its number plate image can be viewed on the App. Target users of the App are Police and Traffic Police. So the App cannot be misused. ALPR system consists of four processing stages.In the image acquisition stage, some points have to be considered when choosing the ALPR system camera, such as the camera resolution and the shutter speed. The future research of ALPR should concentrate on multistyle plate recognition, video-based ALPR using tempo- ral information, multiplates processing, high definition plate image processing, ambiguous-character recognition, and so on.

System features

- Parking lot management
- Automatic toll booth on highway
- Border crossing
- Mass material management system

7.2 Recommendation In Future Work

ANPR technologies can be implemented in several scenarios whereby there is a need to monitor all vehicles that are accessing or exiting from a particular vicinity. For example ANPR technology can greatly enhance border patrol and border surveillance whereby all the vehicles entering exiting the country can be quickly checked to see if there are any known offences that relates to that particular vehicle before the vehicle is granted entry or exit into the country.

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