

## Number Plate Recognition System For Indian Vehicles

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### Abstract

*Vehicle number plate recognition (NPR) has been intensively studied in many countries. Due to the different number plates being used, the requirements of a number plate recognition system are different for each country. Project implements a number plate localization and recognition system for vehicles in India. The system is based on digital images and can be easily applied to commercial car park systems for the use of documenting access of parking services, secure usage of parking houses and also to prevent car theft issues. System recognizes the number plates written in standard format. Different algorithms are implemented for different functions of the system. Adaptive Otsu's Method is used to binarise the grayscale image. Canny's Edge Detection is used to detect the edges. Feature Extraction is used to localize the number plate from the image. Back propagation neural network will be used for recognition of the characters. These various algorithms work efficiently for the Indian conditions hence overall system efficiency increases.*

### 1. Introduction

Number Plate Recognition (NPR) is probably the next growth product to take off in the whole world. NPR is a mass surveillance method which works on images to read vehicle registration plates. They can use existing closed-circuit television or ones specifically designed for the task. They are used by various police forces and as a method of electronic toll collection on pay-per-use roads and cataloguing the movements of traffic or individuals. NPR can be used to store the images captured by the cameras as well as the text from the license plate. They are meant to detect or prevent any sort of activity from unauthorized

people. They are necessarily meant for improving the security.

In tradition, a general recognition method of supervisory vehicle apparatus usually uses human to recognize the license number monitored by a camera. Basically, using human to recognize vehicle license number in this way may solve the problems. But using people to do the recognition takes time and needs many workers to do this work. Hence, NPR is developed for the vehicle identification to help a human operator and improve the service or work quality. Some applications of an NPR system are, automated high-way toll collection systems, automation of petrol stations, journey time monitoring.

The task of recognizing number plate in Indian conditions becomes a bit difficult as many Indian vehicles do not follow the standard format of the number plates. Indian number plates can have single row or double row. It can also have few types of variations.

The existence of a multitude of variations across number plates adds a considerable amount of complexity to the process of reading them. In order to offer a reliable solution in Indian conditions where number plates are far from standardized, it has two modules that comprise NPR. In many cases, the number plate/license plate of a vehicle is not affixed in the prescribed location. The Number Plate Extraction tool automatically analyzes an image of the vehicle and locates the position of the license plate and extracts the same and stores it. Once the Number Plate Extraction extracts the license plate from an image of the vehicle, this is passed to the Number Plate Reading module that reads the numbers and characters on the license plate and passes it onto a computer. This module can be integrated with a database for further functionalities.

## 2. Problem Formulation

2.1 Problem Definition –Given the input image of vehicle number plate, system should extract that number from the image and should search the database for that recognized number plate. The number plate recognition should be robust i.e. It should recognize the number plates even in the low light or shadow like conditions.

2.2 Problem Output - The main objective of NPR system is to recognize the number plates reliably and with greater efficiency without any human intervention. The functionality of the system provides the ability to track a vehicle in any state, to find a stolen vehicle ,or for managing the parking in the malls etc.

Real time inputs are taken from the front camera. The images are processed and the number plate will be detected. The detected number plate is then be used to search in the database to see if it exists or not.

## 3. Mathematical Modelling

We now provide a model of the system in terms of Set Theory domain.

1. Let us consider **S** as a system for Number Plate Recognition System FOR Indian Vehicles including the set of inputs, set of outputs, set of function, set of limitation, set of condition.

2.  $S = \{ \dots \}$

3. Identify the inputs

$$S = \{I, \dots\}$$

Input set:

$$I = \{R\}$$

- **R** is the set of image given as the input to the NPR system.

$$R_i = \{i \mid i \text{ 'images retrieved from database'}\} \\ = \{i \mid i=1\}$$

4. Identify the outputs

$$S = \{I, O, \dots\}$$

Output set:

$$O = \{RN, RS, PI\}$$

- **RN** is the set of recognized number from the number plate.

$$RN_i = \{i \mid i \text{ is the recognized number}\}$$

- **RS** is the set of records associated with the number plate

$$RS_i = \{i \mid i \text{ is the number of records}\}$$

$$= \{i \mid i=1\}$$

- **PI** is the set of image after preprocessing of the number plate.

$$PI_i = \{i \mid i \text{ is the preprocessed image}\}$$

5. Identify the functions

$$S = \{I, O, F, \dots\}$$

Function set:

$$F = \{M1, M2, M3\}$$

- **M1** is the set of Functions used for preprocessing of the input image

$$M1 = \{E, B, L, S, SG\}$$

- **E ( )** enhances the features of the image captured by the camera.
- **B ( )** is a function that is used to binarise the enhanced image
- **L ( )** is a function that is used to locate the number plate in the image.
- **S ( )** is a function that is used to sharpen the image.
- **SG ( )** is a function that segments the characters of the localized number plate.

$$M1(R_i) = PI_i$$

$$M1_i = \{i \mid i \text{ 'the preprocessed image'}\}$$

Where **M1** preprocesses on the image **R<sub>i</sub>** and gives the output as preprocessed image **P<sub>i</sub>**.



- **M2** is the set of functions used for recognition of characters from preprocessed image.

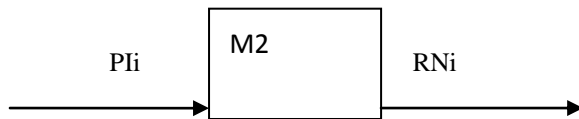
$$M2 = \{Rec\}$$

- **Rec** recognizes the characters of the number plate.

$$M2(P_i) = R_{Ni}$$

$M2_i = \{i \mid 'i' \text{ are the recognized characters} \}$

Where M2 recognizes characters from the image  $P_i$  and gives the output as  $R_i$



- M3 is the set of functions used for searching and displaying records from the database.

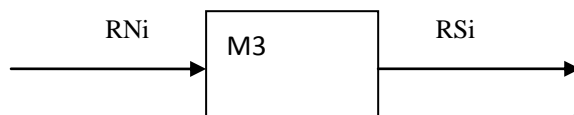
$M3 = \{SE, D\}$

- SE searches the recognized number plate in the database.
- D displays the details corresponding to the recognized number plate

$$M3(R_{Ni}) = R_{Si}$$

$M3_i = \{i \mid 'i' \text{ are the recognized characters} \}$

Where M3 searches and displays the details of the recognized number plate the image  $R_i$  and gives the output as  $R_s$



## 6. Identify the Limitations

$S = \{I, O, F, P' \dots\}$

### Limitation Set:

$P' = \{Fz, Br\}$

- Fz states that the number plate to be recognized should not be fancy.
- Br states that the number plate to be recognized should not be broken.

## 4. Framework

The basic framework for Number Plate Recognition consists of 3 main phases:

Phase 1(Receive Input image) Receives the image from the camera and sends them to the next phase.

Phase 2(Process image) Preprocesses the image to enhance its features and to binarise it, number plate localization to detect the location of number plate in the image, character segmentation, character recognition through back propagation neural network .

Phase 3(Display Information) Receives the recognized Number and it is searched in the database to get the

information about that particular vehicle, then this information is displayed.

## 5. Image Processing

The following functions shall be used to process the image.

### 5.1 Preprocessing

The RGB image is converted into a greyscale image for easy analysis as it consists of only two colour channels. Filtering is then implemented for the effective removal of speckle noise, salt and noise pepper noise (impulsive noise)[1].It enhances the features of the image captured by the camera using the function E().



Figure 1: Grayscale Image

### 5.2 Binarization

After the preprocessing of the image binarization of the image has to be done so that further image processing becomes easier. Binarization of the image is implemented using adaptive Otsu's method[6] which considers the shadow and light intensity in the image. This binarised image will be used for the purpose of localizing the number plate. B () is a function that is used to binarise the localized image.



**Figure 2: Binarized Image**

### 5.3 Plate Region Extraction (localization)

For the purpose of number plate localisation in the image Feature Extraction has been used. We have also made use of Canny's method for edge detection as it has an accuracy of 98% which is far more than the other edge detection methods. We have made use of the features of a number plate[4]. A number of candidate rectangles are found out. The candidate rectangles are found out by finding out those regions having 11 continuous white vertical pixels and 18 continuous white horizontal pixels.

**Figure 3: Localised Image**

### 5.4. Segmentation

Characters present in the number plate have to be segmented so that each character can be recognized separately. This segmentation will be implemented by the method of projections[5]. Horizontal and vertical projections are used for segmenting each character[4]. These segmented characters will then treat as the input for the neural network. SG() is a function that segments the characters of the localized image.

**Figure 4: Segmented Image**

### 5.5. Recognition

Back propagation neural network is used for the recognition of the individual characters[3]. Neural network will consist of various nodes with different classifiers. Neural network is trained under supervised training where a teacher is needed and unsupervised training where no such person is needed and the network tries to learn it. M2 is a set of functions that is used to recognize the characters in the number plate.

### Result

The result is the successful recognition of the number plate of a vehicle which is searched in the database for detailed information.

### Conclusion

Thus we have presented a paper for number plate recognition using different algorithms. We have also described the Mathematical Model for the same.

### Acknowledgement

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