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# License Plate Recognition System for Moving Vehicles Using Laplacian Edge Detector and Feature Extraction

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**Abstract -** *License Plate Recognition is an important field of research for various reasons. When it comes to recognising the number of a moving vehicle, it has its own challenges needed to be taken care of. In this paper, a real time system has been proposed to locate and identify the license plate of moving vehicles. First, the Otsu method is applied to handle the noise in the captured image of the vehicle. The image is then binarized and the license plate is located using the Laplacian operator. Further the characters in the plate are segmented and normalised. Lastly, characters in the plate are recognised using the Feature Extraction technique. The proposed system has the capability of extracting the characters under different environmental conditions. It can also detect broken characters in the license plate and characters written in multiple scripts. The experimental results applied on the proposed system promise a high efficiency rate . The end of this paper suggests some future advances to the License Plate recognition system.*

***Key Words:*** *Binarization, Laplacian operator, Feature extraction, Segmentation, Normalization*

## 1. INTRODUCTION

The number of vehicles on the roads is increasing day by day. This has led to the need and development of latest technologies like Intelligent Transportation Systems (ITS). Vehicle License Plate recognition (VLPR) is a popular application of this technology. This system is widely being used to curb criminal activities around the globe. Other areas using this system include parking facilities, traffic management by ensuring the enforcement of traffic rules and regulations, and automating the task of manually comparing vehicle number plates thereby reducing human efforts . An efficient VLPR system can be used for the real time tracking of the vehicles which proves to be a boon for the traffic management system.

Although the plate recognition system seems to be a very useful model, it has certain challenges to be resolved before a solution can be proposed. This system takes as an input the image of the vehicle captured by an optical device ( typically a high resolution camera with night vision capability ). The image received might still be blurred due to the motion of the vehicle. The number plate of the vehicles is sometimes dirty which further increases the complexity of handling such images. Most of the times, The camera captures the image of the vehicle from a different height which results in tilted images and skewness. Another major issue faced by number plate recognition systems is the different fonts and styles of writing the number .

Most of the countries have a standard format of writing the number on a vehicle plate. Due to this fact, it happens that a system designed to recognise the number from the license plate of one country does not work successfully in another. Countries like France, Russia, America are using recognition systems at real time for traffic management. But in India we rely upon manual traffic control and such systems are still under research. A main challenge to design the license plate recognition system in India is that we do not have a standard format of the license plate.The numbers are written in multiple scripts like English, Hindi and sometimes even in other regional languages. The system proposed in this paper can handle numbers written in English as well as in Hindi.

A typical VLPR system input and output is shown in the Figure 1. It can be divided into three major processes – License plate localization, character segmentation and finally character recognition. The most crucial step and also the most complex one is the localization of the plate in the image of the vehicle.There are a number of techniques for localization like mathematical morphology, edge detection, wavelet analysis, sliding window technique, connected component analysis etc.

The efficiency of the systems using any of these approaches generally varies between 80 to 97 %. It is noteworthy that no single technique is sufficient in itself to segment the number plate in all types of images. Due to the additional issues faced in Indian number plates ie. varying formats and multiple scripts, two techniques have been combined together in the approach presented in this paper for efficient detection of the plate in the image. In India we have two forms of the license plates. Black characters on white background for private vehicles and yellow background for commercial vehicles like taxis, buses, trucks etc.[5] An example of an Indian license plate is HR26 AC 4343 where the first two characters “HR” represent the state, 26 represents the district and the remaining number, AC 4343 is the unique identification number of the vehicle.
The license plate recognition system works on the principles derived from Image Processing and Pattern Recognition.

With the advancement and research in this field, it is nowadays possible to develop a fast, cheap and robust mechanism to achieve the desired goal. The block diagram of the proposed VLPR system is shown in the figure 1.

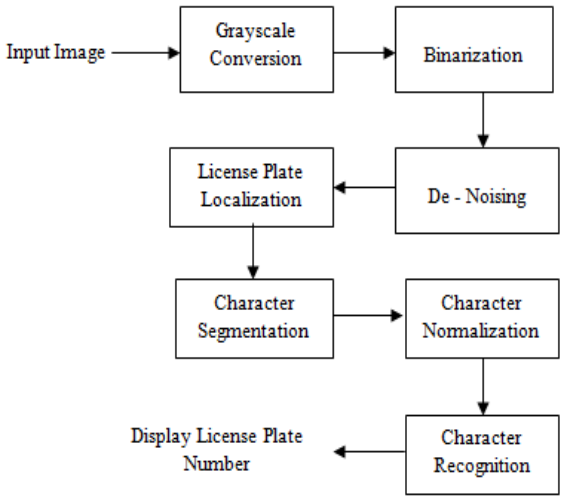


Fig – 1 : Block Diagram of the VLPR System

The main steps involved in the process can be summarised as :

a) Capturing the image using a camera – The cameras used to capture the images are generally located along the roadsides on the poles or alongwith the traffic lights. The acquired image of the vehicle might have blurred contours and noisy patterns which have to eliminated. Image pre-processing techniques are used for this purpose.

b) Grayscale conversion and Binarization -- The captured image is converted into grayscale image which will then be binarized. A binarized image has only two levels of color ie. black and white.

c) License Plate Localization – The edge detection technique combined with the contour analysis is used to segment the license plate from the image of the vehicle.

d) Character Segmentation – Once the plate has been localized, the characters in the plate can now be partitioned for recognition. The row column scan is used for this purpose in the proposed method.

e) Character Normalization – It may happen in a license plate that the characters are of varying width and height. They may also be broken or blurred. Image morphological operations like erosion and dilation have been used to obtain the clear image of each character and then convert them to a standard size of the character.

f) Character Recognition – In most of the systems previously developed for VLPR, template matching is used for recognising each character. The drawback of this approach is that it can detect only the characters stored in the database as templates. In this paper, the system uses feature extraction technique to recognise the characters which has been proved to be efficient in detecting characters in both English and Hindi.

## 2. EXISTING METHODOLOGY

The Vehicle License Plate recognition has been a field of interest of researchers since a long time due to its applications in various real time situations that have been discussed earlier in this paper. The main task in the system is to locate the plate in the image of the vehicle. A number of techniques have been proposed and implemented for this purpose in many different countries.

An edge based multi – stage approach for the localization of the license plate [13] was presented in the year 2009 in which Sobel operator was used to find the edge gradients. The grayscale image was first de – noised using the median filter and Contrast enhancement was applied on it. The results obtained also contain certain cases in which either no license plate was detected or false locations were localized as the plate region. An overall efficiency of 89.2 % was achieved in this technique.

A novel 'feature based number plate localization' approach was used in 2011 to detect the license plates in a mass surveillance system [11]. The system focused on two algorithms ie. Edge finding and Window filtering. This approach was based on the concept of convolution from Image processing in which a window having the size equal to the size of the plate is scanned throughout the image of the vehicle to detect the actual position of the license plate. Characters are recognised from the plate using template matching where standard characters are stored in the database and are later compared with the characters in the license plate. This approach was restricted to analysing only the rear image of the vehicle.

Different countries have different standards for the license plates on the vehicles as discussed earlier in this paper. Considering this fact, an approach to detect the plate from passenger cars in China [8] was proposed in the year 2012. The image was first pre – processed using median filters. The license plate was localized on the basis of the size of the number plate as it is fixed for every vehicle in China. The characters were recognised by a fuzzy decision making method. Experiments conducted on the system showed an accuracy of upto 92%. Another approach based on Vertical edge analysis for localizing the license plate in real time was proposed by P. Tarabek [9] in the same year where two stage detection process was used to detect the plate. The method could also locate multiple license plates with different sizes in the same image. The results were found to be accurate upto 97.4% when the system was tested.

A VLPR system based on Morphology and Neural Network [6] was proposed by S. G. Patel in 2013. Sobel operator was used to detect the edges and then morphological operations like erosion and dilation were used to get smoother binary image of the license plate. The characters extracted from the plate were recognised using Neural Network by analysing the statistical features of the characters. The issues

generated in this approach were mainly regarding the computation costs and the difficulty of implementing neural network for character recognition. The system needed to be trained to recognise each character from the plate. It could also not identify the characters written in the scripts other than English.

In one of the recent researches in 2015, Dynamic Image Processing techniques and Genetic Algorithm were used for license plate recognition [2]. The system developed using these techniques could detect the plate in the image irrespective of the distance between the camera and the vehicle. The system was flexible to broken or smeared license plates and also works at a high speed. But the limitation of the system was that the genetic algorithm could detect the license plates of fixed size only.

The main drawback of the techniques mentioned above was their computational complexity and also the systems implementing these methods were sensitive to the presence of other rectangular areas in the image of the vehicle. Some of the systems could also not handle complex backgrounds and required the image of the vehicle to be taken at a certain angle. Another requirement of the VLPR system to be developed for Indian vehicles is to deal with other texts in the license plate of the vehicles and stickers which could be detected as the plate resulting in incorrect results.

## 3. PROPOSED SYSTEM

The VLPR system proposed in this paper focuses on two major issues upon which the previously developed approaches have resulted in false results. The first issue is to handle the varying sizes of the Indian license plates. The second major challenge is to recognise the characters written in multiple scripts which are mainly English and Hindi. The system is divided into two components ie. online VLPR and offline VLPR. The online module consists of a high resolution camera or any other visual device mounted alongside the roads which is used to provide input frames to the system. The other component performs all the processing on the frames received from the camera, localizes the license plate and finally recognises the characters written on the plate to identify the vehicle. The complete working of the proposed system is described as a series of following steps.

### 3.1 Image Acquisition

The images of the vehicles moving on the road are captured by the digital cameras installed on the roadsides or alongwith the traffic signals. With the advancements in the field of visual machines, it is possible to obtain high resolution images of the vehicles moving at high speeds of upto 150 km/hr. The cameras should be enabled with infrared technology for capturing images during the night hours as well. A test image to the proposed system is shown in the figure below.

### 3.2 Grayscale Conversion

The image of the vehicle received from the camera is in digital form as shown in Figure 2(a). It is a colored RGB image which is to be converted into a grayscale image before processing. In the proposed system, we have used the luminosity method to obtain the grayscale image. Each pixel intensity is calculated by the following equation.

Grayscale image = (0.33*R) + (0.59*G) + (0.11*B)

The converted grayscale image is shown in the Figure 2(b).

Fig - 2 : (a) Input image in RGB form


Fig – 2 : (b) Grayscale Image

### 3.3 Image Binarization

The gray scale image is now Binarized ie. converted into a black and white image. The Otsu thresholding method is used to perform this operation where we choose a threshold value to distinguish the colors of the image. The values lesser than the threshold are assigned black color ie. 0 and rest are assigned white color ie. 1.

This method is used mainly because of its accuracy in calculating the threshold value and low computational cost. The resulting image is shown in the figure 3.


Fig – 3 : Binarized image using Otsu method

### 3.4 Image De - Noising

The purpose of eliminating noise( unwanted information ) from the image is to reduce the effort of the edge detection operator which is sensitive to noise. The median filter is used to remove noise in the image. There are other filters also which can be used but the advantage of using median filter is that it does not blur the edges in the image.

### 3.5 License Plate Localization

This is the most important step of the VLPR system and determines the overall success of the recognition process. In this approach we have used the Laplacian operator to first detect the edges in the image. The laplacian operator works on the principle of convolution and unlike other edge detectors like Sobel or Prewitt, it uses a second order derivative mask. Thus the Laplacian operator can detect both vertical and horizontal edges at the same time as shown in the figure 4.

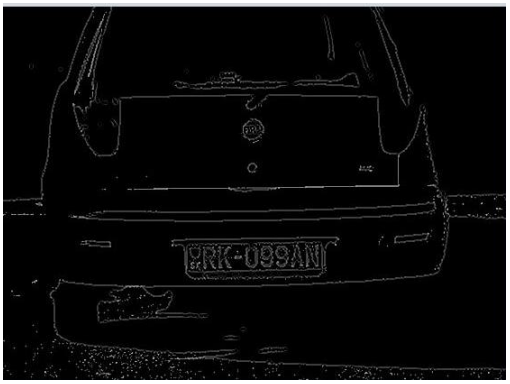

Fig – 4 : Edge Detection using Laplacian Operator

After applying the Edge detection, contour analysis has been performed on the image to detect the exact location of the license plate as in Figure 5. The plate area in an image is generally a high intensity region which can be defined by contours having similar characteristics.


Fig – 5 : Localized License Plate

### 3.6 Character Segmentation and Normalization

Once the license plate has been located in an image, the characters in the plate are segmented using row column scan method as shown in figure 5. In this approach, we first scan the plate horizontally to obtain the height of the characters and then vertically to calculate the width of each character.

If the characters have different sizes in the plate, they are compared to a standard size and are equalized. This is also called as normalizing the characters. Morphological operations like erosion and dilation are used to normalize the characters to a standard size. This operation also helps in handling broken characters.

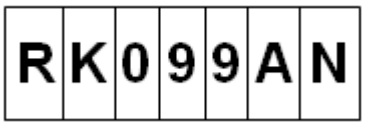


Fig – 6 : Character Segmentation

### 3.7 Character Recognition

Most of the optical character recognition techniques are based on template matching technique. The drawback of this approach is that it can only identify the characters whose templates have been stored in the database. The system proposed in this paper uses Feature extraction technique to detect the characters. The figure 7 below represents eight components of a character.

Fig – 7 : Eight components of a character

Rather than storing the templates for each character, we train the system to extract the grid features of each character irrespective of the script in English or Hindi. Each character is divided into a grid and the number of black pixels in each part is calculated. If two characters have same features eg. B and 8, the internal structure analysis is done using Chain coding technique for further accuracy.

## 4. EXPERIMENT AND RESULTS

The license plate recognition system proposed in this paper was successfully developed in Java and tested on an Intel core i5 system with 4GB of RAM. A database was created to store the images received from the camera and also the recognised license plate numbers. The output of the system was displayed to the user as a text file. The images taken as input were captured under different environmental conditions like day, night, shadows on the plate etc.

**Table – 1 :** Comparison of various approaches to License Plate Recognition

| Approach | Merit | Demerit |
|---|---|---|
| Morphological Operations [6] | Easier to implement | High computation costs due to statistical features |
| Sliding Concentric Window [11] | Efficient in bright and illuminated images | Must adapt to the varying sizes of the license plates |
| Localization based on color information [8] [14] | Ability to detect deformations in the license plate | Not suitable during night hours |
| Genetic Algorithm [2] | Gives a high accuracy rate | Highly dependent on the training provided to the system |
| Edge Detection techniques [9] [11] [13] | Easier to implement | Highly Sensitive to noise resulting in false results |
| Proposed approach – Laplacian and Contour Analysis | Gives accurate results during day and night, detects plates of any size | Can handle blurred images upto a certain level only |

On the dataset of 150 images, 144 images were successfully recognised by the proposed system rendering an accuracy of upto 96%. In certain images where more than one vehicles were passing through the camera, the system successfully recognised multiple plates unless they were hidden by another vehicle or object. The comparison of the proposed system with other approaches in the field of license plate detection is shown in the table 1.

## 5. CONCLUSION AND FUTURE WORK

This paper presents a fast and efficient license plate recognition approach based on Edge detection using Laplacian operator which is capable of detecting multiple license plates in an image when combined with contour analysis. Another major issue solved by this system is to detect the plates where characters were written in multiple scripts. The stroke method based on Chain coding is used for this purpose. The system thus solves the two major issues faced with Indian license plates. Apart from these, this paper also presents an approach to handle blurred images of the vehicles by using morphological techniques.

The method proposed in this paper works in real time and can be used in various applications like Parking systems, automatic toll collections, traffic management, reducing criminal activities etc.
The future advancements in the field of license plate recognition may involve the use of better optical technologies to capture fine images of the vehicles moving at very high speeds. The location and segmentation of the plate region against complex backgrounds continues to cause troubles to the VLPR systems all around the world and further study is required in this field.

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