# *Characters Feature based Indian Vehicle License Plate Detection and Recognition*

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***Abstract*— Vehicle license plate recognition is well known system comes under machine vision which employed mostly for traffic management, preventing vehicle crime, parking system, road tolling which can able to recognize number from vehicle license plate. This paper present an approach which is based on characters of the number plate, for that an adaptive preprocessing method was used because not every time the illumination condition is constant ,then segmentation of character were done using vertical and horizontal projection of the extracted license plate. Finally character recognition were done using K-nearest neighbor classifier based on feature vector which was extracted from the boundary analysis of the character. This system was tested on various vehicle images taken in different illumination condition.**

***Index Terms*— VLPR, License plate localisation,Horizontal projection,Vertical projection,Feature extraction,Otsu.**

## I. INTRODUCTION

Vehicle license plate recognition (VLPR) is a task comes under computer vision. In which system is trained to automatically locate the license plate of the vehicle and then recognize the character from the license plate in order to retrieve the information of the vehicle and it's owner. This system is mostly employed for traffic management, tolling purpose, parking system. This system acquired much attention in recent decade as vehicle density on road is increasing day by day and so the criminal activities related to the vehicle. The efficiency of this system is based on how much adaptive it is to the surrounding environment ,because it has to work for all illumination and weather conditions.

Any VLPR system perform the overall task in a sequence as follow:-
1) Acquiring the image of vehicle from dynamic or static scene.2) Preprocessing the image in order to enhance the region of interest.3) Localizations of license plate based on specific algorithm.4) Character segmentation 5) Character recognition .

For this purpose, the database used here for system development is Indian four wheeler images specially cars. As per the regulation for Indian registered vehicle, there are four different color number plate categories as : Private vehicle number plate has black character on white background, Commercial vehicles plate has black text on yellow background, vehicle which are available on rent has yellow letter on black background, foreign admirals vehicles has white text on blue background. The proposed system has been developed by considering all above mentioned formats.

In the paper the overall system workflow is divided into four major section as II) Related work, III) Proposed Methodology IV) Experimental setup and result, V) Conclusion and future scope

## II. RELATED WORK

There has been done a lot much research in this field as each country has its own rule and format for license plate and the character. So not a single method can serve the purpose for all country. In [1] author present an "A state of Art review" where they describes the various research that has been done with significant rate of accuracy from number plate location to its recognition. In [2] character width and difference between plate background and character based plate detection method is describes which also consider the difference between consecutive character where they archived accuracy up to 99.5%.

In [3] author proposed a method based on Morphological operation like opening and closing and used harris corner detection algorithm for angle correction. In [4] author proposed a method based on discrete wavelet transform in order to extract horizontal and vertical border of license plate and uses the same technique for character localization and for recognition neural network is used with extracted feature. In [5] Signature analysis is used for license plate localization and used character thinning operation and dividing each character in 3*3 window and then extract the feature using pixel location from each window and then fading the feature vector to Artificial neural network for recognition. As neural network can be train for huge database the recognition accuracy is also higher than any other technique.

In [6] histogram based localization is proposed which search for upper horizontal line and lower horizontal line for plate location.

## III. PROPOSED METHODOLOGY

### A. License Plate Localization:-

The proposed method for license plate localization is focused on highlighting the character from license plate for its location.

*1) Preprocessing:-*

Initial pre-processing which uses morphological gradient operation followed by contrast stretching which enable to adjust the intensity of the image within particular range. Morphological gradient is obtained by subtracting eroded image from dilated image.

As the proposed method is develop by keeping in mind that the images would have different illumination condition. By computing the mean of pixels intensity, the overall intensity adjustment were done in order to brighten the edges that were obtained in gradient operation.The morphological gradient leave image with single pixel connected edges. Filtering the image using following mask in order to obtain image with only vertical edges.

| | | |
|---|---|---|
| -1 | 2 | -1 |
| -1 | 2 | -1 |
| -1 | 2 | -1 |

Fig.1 Mask for retaining vertical lines

*2) Rough Location Estimation:-*

As most of the character has prominent vertical lines which is used to locate license plate. Plotting horizontal projection of that image as shown in Fig.3 and get the location of row having highest pixel density(Fig.4) from lower half of the image as number plate is possibly located in lower half, which can give an rough location of the license plate region. Once we get rough location of license plate region as shown in fig.5, Now the area of search is reduced to locate license plate.Again doing appropriate contrast stretching so that character get visible.

As character on number plate has always have considerable intensity difference with respect to plate region .By using otsu thresholding method to binarize the image.


Fig.2 Original Image

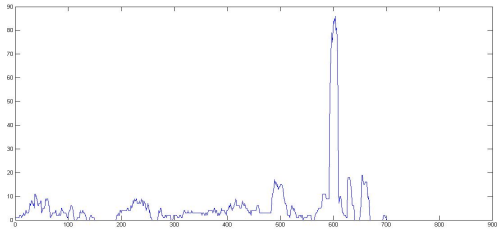


Fig.3 Horizontal projection for peak detection

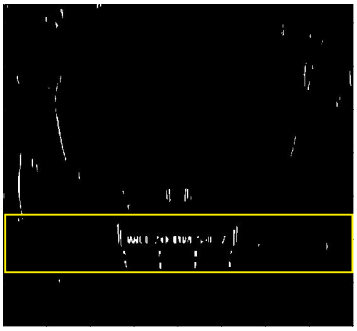


Fig.4 Region having highest pixel density


Fig.5 Rough location of license plate

*3) Centroid location of all connected component:-*

Plot the centroid of all the connected component in an image. By considering that the centroid of all character are in close proximity to each other with specified varying difference. So in order to locate the candidate license plate the search algorithm try to find out the number of centroid for each object within particular specified range. By locating the object with maximum no of centroids which satisfy the min. and max. difference in-between each object can be considered as character of the number plate and getting the bounding box region for that object will give an idea about the upper and lower horizontal edges of the candidate license plate. By searching for horizontal line upward and downward from that object will give upper and lower end of license plate as per fig.6

*4) Window Approach:-*

In order to get complete license plate after upper and lower ends was detected, window approach [9] was used whose length is considered approximately equal to the standard Indian license plate. As Characters and the gap between consecutive characters has distinguishable change in intensity level. So the window region having highest number of transition between this intensity level can give us the location of plate.


Fig.6 Upper and lower edges of license plate

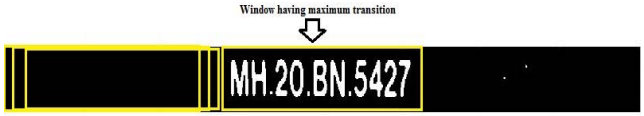



Fig.7 Window Approach

Now converting character in white pixel and background in black. After that moving the window from extreme left to right end and get the count of transition between foreground and background every time. The window having highest number of transition will be considered as candidate license plate as in figure 7. The Extracted plate is shown in fig.8.


Fig.8 Extracted license plate

*B. Character segmentation:-*

After the Accurate localization of license plate. The next important process is character segmentation [7] [8]. The approach used here for character segmentation consist of two main steps:

*1) Horizontal Projection*

*2) Vertical projection*

Before proceeding for horizontal projection the noise in license plate was removed using median filter and convert the image in black and white using Otsu thresholding method.

Projecting the pixel density horizontally(row wise)(Fig.10) of the license plate will gives an idea about upper and lower bound within which all character are located. Now area other than that will be discarded for next step. Then projecting the pixel density vertically (Fig.11) will gives the starting and ending location for each character. In fig. 9 the combine effect of horizontal and vertical projection was shown.

In some license plate ,there may be dash or dot between characters ,so after segmentation these objects can be come into consideration .By using area criteria, these object can be eliminated.

The area criteria is

$$\text{Area Criteria} = \frac{\text{Area of the Object}}{\text{Total area of the Box}} > \text{Threshold} \quad (1)$$

If the above criteria is satisfied by object then only it is considered as character otherwise neglect it. The value of threshold taken here is 0.3.


Fig.9 Character Segmentation

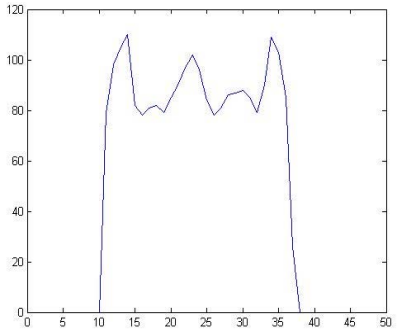



Fig.10 Horizontal projection of license plate

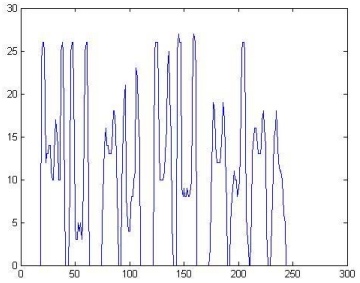



Fig.11 Vertical projection of license plate

*C. Character Recognition:-*

After successfully segmenting the character, character recognition is the final stage. The overall performance of the system is based on the accuracy of this stage. There are lot of method for character recognition.

*1) Template Matching:-*

The simplest one is the template matching in which there is a predefined character template which stored in database. By comparing each character with all template and template with best matches is considered as that character. But with the changes in fonts of character, for accurate recognition we need to increase the no.of template which leads to higher computational time. Also these method leads to false recognition for similar looking character such as '1' and 'I' ,'2'and 'Z','8' and 'B', '0' and 'O'.

*2) K-Nearest neighbor Method:-*

Character recognition is the multiclass classification problem. K-nearest neighbor is a non-parametric method which classify based on the higher number of votes from K nearest neighbor to query object which belong to the same class . It finds Euclidean distance between two point in the feature space. These distance can be calculated using

$$\text{Distance} = \sqrt{(x1 - x2)^2 + (y1 - y2)^2} \quad (2)$$

Where x1,y1 and x2,y2 are the coordinates of the two point.

But for character we need to extract some distinguishable feature which was done as follow.

*a) Feature Extraction:-*

Feature extraction is the process to extract specific feature from an objects which could be based on colour, shape, texture. For feature extraction we have used the approach here which is based on the characters outer boundary.

First of all, resized all the character to 30*30 size. After that pad a fix length of zeros to all sides of the character. After that get the boundary of the character, Now by computing Euclidean distance for equidistance line projection from all the four sides to the point of the boundary of the character. Computing the differences in consecutive distances will give an idea about whether there is straight line, falling diagonal line, rising diagonal line. But we need to check that these parameter are close to that side or away from it. For that we need to verify whether these parameter is below or above and toward or away from midpoint.

So from all sides computing only three parameter for both half

1) Straight line
2) Falling diagonal line
3) Rising diagonal line

Computing these feature for each side in both half ,so finally we get feature vector of fix size.

The another significant regional feature for character is euler number .Euler number is nothing but object minus number of holes in that objects. By giving priority to euler number we can classify all 26 alphabet and 10 digits into three different categories.

1) Characters having Euler number 0 : A,D,O,P,Q,R,4,6,9,0
2) Characters having Euler number 1 : C,E,F,G,H,I,J,K,L,M,N,S,T,U,V,W,X,Y,Z,1,2,3,5,7
3) Characters having Euler number -1 : B,8

For 36 character there are 36 subclass. So by giving higher priority to euler number KNN classifier classify each character into any of three classes and then into respective subclass.

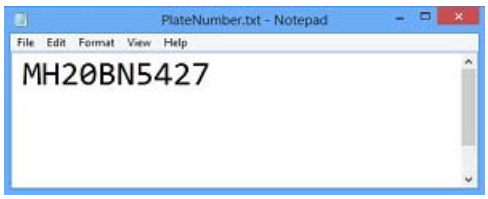



Fig. 12 Result for recognition

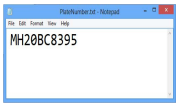
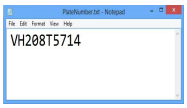
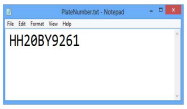
## IV. EXPERIMENTAL SETUP AND RESULT

The proposed system has been implemented on MATLAB 2014a software on 2.10 GHz INTEL processor and 4 GB RAM enabled computer system. All the images which was tested on the system was taken in different illumination condition from various location having different color number plate. Then all the images are set to 800*800 resolution, so that it performed well for higher resolution. For performance analysis of the proposed system we have tested system on 70 images taken in day time and 10 images taken in night time. For recognition, a dataset of 5 different fonts samples for all 36 characters was used to train the classifier.

TABLE .I PERFORMANCE ANALYSIS

| **Illumination condition** | **Day** | **Night** |
|---|---|---|
| Total Images | 70 | 10 |
| Successfully License Plate Extraction | 55 | 7 |
| Accuracy Percentage | 78% | 70% |

TABLE .II SOME RECOGNITION RESULT

| **Sr.no** | **Vehicle Image** | **Extracted License Plate** | **Recognise Result** |
|---|---|---|---|
| 1 |  |  |   |
| 2 |  |  |   |
| 3 |  |  |   |
| 4 |  |  |   |

## V. CONCLUSION AND FUTURE SCOPE

In this paper, the presented approach is effectively able to extract single line license plate and feature extraction technique which is based on boundary of the character. However the system can be able to locate all kind of license plate but it failed to segment the double line license plate as proposed segmentation method does not work for it. From Table.II for fig 3 and 4 some characters are false recognize.

For future work the Extracted feature can also be used to train neural network for higher accuracy. In recognition, too much variation in character geometry leads to misclassification. In order to overcome these, classifier is need to be trained with different character fonts which was extracted from separate training dataset.

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