INDIAN VEHICLE NUMBER PLATE RECOGNITION SYSTEM

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Abstract: In today's modern world, with the increase in number of vehicle, the need to recognize the license plate automatically has also increased for the motive of parking, entry control, security, automatic tolling system for highway, border control, law implementation etc. Generally, Vehicle Number Plate Recognition (VNPR) system consists majorly of three parts: identifying the plate region, segmenting the characters and recognition of the characters. In this paper, we have used pre-captured images of different Indian cars with variations in intensity, color and background. The system executes various operations on the pre-captured image such as improving the image to thin out the unwanted signals (noise), morphological operations, edge detection and recognizing the region of interest. Features of characters are extracted which will help in differentiating them from undesired signal. These features are then used for segmenting each character for recognition using template matching.

Keywords **- Number plate recognition; MATLAB; Template matching; Character recognition**

I. INTRODUCTION

The Vehicle number plate recognition (VNPR) system is a large-scale observation method that grabs the images of the vehicle and uses optical character recognition on images to read the license plates. It plays a pivotal part in smart transport system, effective administration of traffic and public security. The requirement to establish such system has wakened quite a while ago and accordingly many studies have been carried out on this subject. The VNPR system can be divided into three parts: localizing the plate region, segmenting the characters from the plate and identifying each of them [1]. In the first stage, the region of interest i.e. number plate is recognized from the image captured; this is known as plate localization. Based on certain features of the license plate characters of such as shape, height to width ratio, colour of background region, the candidate regions are determined. In the subsequent step, the individual characters are segmented to be further processed.

The characters in each country have distinguished features such as language, font size, aspect ratio which helps in identifying them. The final step involves comparing each character from the database. This is known as template matching.

The VNPR system can be implemented for versatile applications ranging security systems, security at border, entry control where it restricts unapproved access, to areas such as automatic highway road tolling, traffic law implementation etc.

Since last few decades, Vehicle Number Plate Recognition (VNPR) is the prominent and active research area in image processing domain.

II. IMPLEMENTATION STEPS

Capture of Image: In our system, we are using pre-captured images from various databases.

Pre-processing: The objective of pre-processing is strengthening the image, i.e. it suppresses distortions and highlights certain attributes which are important for subsequent steps.

Plate region extraction and segmentation: Under this step, our region of interest i.e. the plate area is identified and determined from the image. One of many image segmentation techniques is used for this step. This step is crucial for the overall accuracy of the system.

Character segmentation: In this step, each of the ten characters in the license plate is separated using bounding box technique and histogram analysis, thereby taking one character at a time to compare it with the ones stored in database for successful recognition.

Display of recognized character: The characters identified in the previous step are then displayed in the form of text.

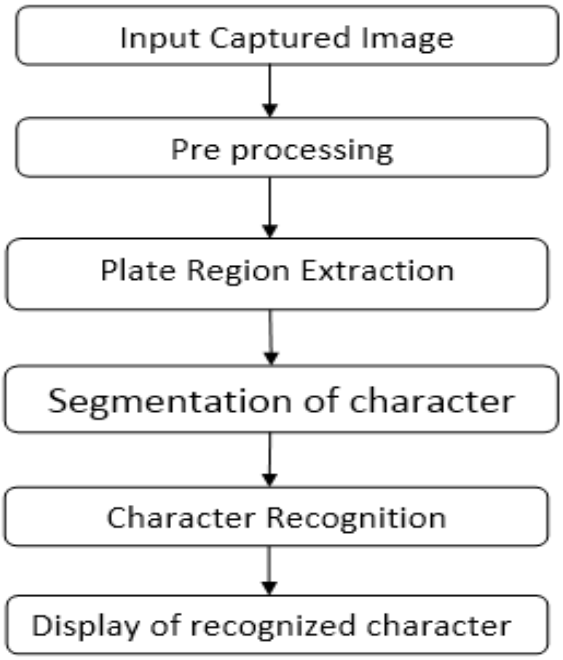

Figure 1: Flowchart

III. PRE-PROCESSING OF IMAGE

Pre-processing of image is done to remove all the redundant data in the image and take into consideration just the plate region. Steps for pre-processing of image are shown below with after processing results.

Step 1: Applying Median Filtering on captured image

Filtering is done to adjust or enhance an image to highlight certain attributes of the image or remove them. The value of any given pixel in the output image is dictated by carrying out operations to the values of the pixels in the neighborhood of the respective input pixel. The median filter is a technique used to remove noise from an image. It is an essential pre-processing step for increasing the accuracy for further processing steps.

Step 2: Histogram Equalization

Histogram Equalization is a technique of image processing for adjusting contrast using the image's histogram. Contrast is the difference in luminance or colour that makes a thing distinguishable. Histogram equalization carries this by efficaciously distributing out the intensity values of highest frequency. The method is fruitful in images with backgrounds and foregrounds having both bright or both dark colour intensities.

Step 3: Morphological operation

First, input image (Figure 1) is converted from RGB to grayscale (Figure 2) and after applying median filter, we apply different morphological operations on it.

Dilation: The two basic morphological operations are dilation and erosion. They are applied on binary image, but new versions can adapt to grayscale images. The dilation's basic effect of the operator on a binary image is that it adds pixels to the boundaries of object in the image. The dilated image is shown in Figure 4.

Figure 2: Input captured image

Figure 3: rgb2gray image

Figure 4: Dilated image

Erosion: Erosion does the exact opposite of dilation. It removes the pixels from the edges of the object. (Figure 5)

Figure 5: Eroded image

Subtraction of dilated and eroded image: The subtraction of the images obtained at the output of dilation and erosion respectively results into figure 6. The number plate region can be seen from figure 6 where each character is visible while removing majority of redundant data from the image.

Figure 6: Subtracted image

Step 4: Convolution and color mapping of image

Convolution is the technique of augmenting each pixel to its local neighbour, weighted by the kernel. This is related to a form of mathematical convolution. As observed in figure 7, the edges of the objects are brightened after convolution. Colour mapping is a method that maps one image's colour into target image's colour. Colour mapping is also sometimes refer to as colour transfer or, when dealing with grayscale, brightness transfer function (BTF). Colour mapping is used for adjusting the colours of visual compatibility. It is used to enhance the edges around the objects as seen in figure 8.

Figure 7: Convolved image

Figure 8: Colour mapping of the image

Step 5: Image region filling and removing small objects

For boosting the accuracy of template matching we need to fill region in the characters present in the plate. After filling the holes and region in the previously obtained image, the result is as shown in figure 9. Based on the input image, small objects which are redundant to the system can be removed depending upon how many neighbouring pixels holds that value.

Figure 9: Pre-processed image

The obtained image after various processes is fed to segmentation process. As can be seen from the figure 9, much of the work is done before the main process, which results into easing the operation of segmenting the character and thereby identifying them.

IV. SEGMENTATION AND OCR

Segmentation of characters: The characters present in the license plate are separated or segmented [2] matching process. To be successfully segmented, they need to be identified first. Every license plate characters in each country has unique traits such as font, size of the plate, colour of the characters, aspect ratio etc. We can use these traits in our advantage to point the characters present in the image from other redundant data.

Bounding box technique: Bounding boxes are imaginary boxes (figure 10) that are around objects that are being checked for various purposes depending upon the application. In image processing, the bounding box gives the coordinates of the rectangular border that fully encloses an object in image when it is placed over the same. It is an area defined by two longitudes and two latitudes. They usually follow the standard format of: [left, top, width, height]

Figure 10: Bounding box on Fig 9

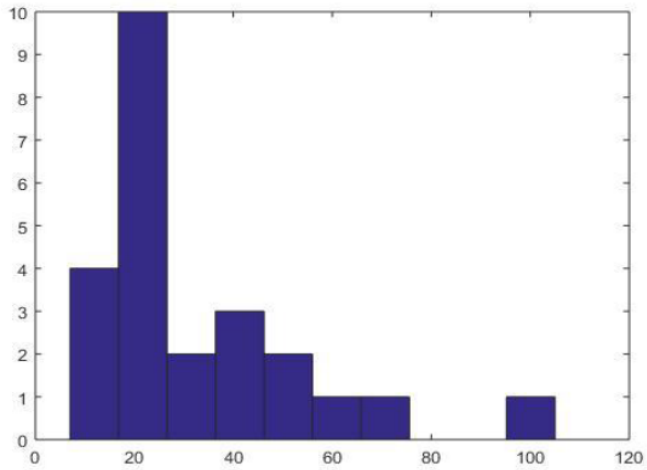

Figure 11: Histogram of height of bounding box

We can see from the histogram(figure 11) of the height values of bounding box, that there are ten bounding boxes whose value are nearly similar. They are our ten characters in the license plate. These heights corresponding to the bounding box are needed to be selected for optical character recognition. The central value of the histogram whose frequency is ten is found out.

The index values of those bounding box are found out whose height value are nearer to this central value. These index values will be passed to optical character recognition. Template matching: Each character extracted from the bounding box is sent to template matching from the database (template samples are shown in figure 12) [3]. A correlation function is used to get the output. The correlation function[4] outputs a value between 0 and 1 by comparing two images based on their similarity. The correlation function is made to compare bounding box character to each of the images in the database [5]. The maximum value of output is taken which gives the information about which template is matched. According to the template matched, the string value is extracted and stored inside a variable. This process is repeated for the ten bounding box that were extracted. The final result will be stored in a variable which contains string value of the license plate. A notepad file will be created which will display the obtained string.

Figure 12: Template samples

V. EXPERIMENTAL RESULTS

We have taken a database of thirty number plates of varying attributes and processed it in our system. The images which are taken from a distant camera are the ones which resulted into character error or complete error. The result is shown in the table below:

Table 1: Result Data

Type of image	Accuracy	Remarks
Zoomed image	95-100 %	Sometimes, 1 character is wrongly interpreted
Distant image	80-83%	2 Characters are wrongly interpreted

Figure 13: Result of sample 1

Figure 14: Result of sample 2

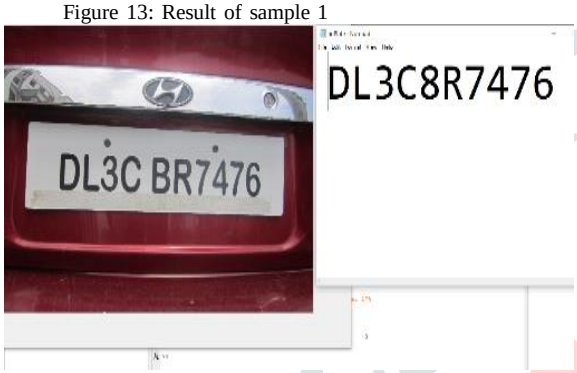

Figure 15: Result of sample 3

Figure 16: Result of sample 4 (Zoomed image-No error)

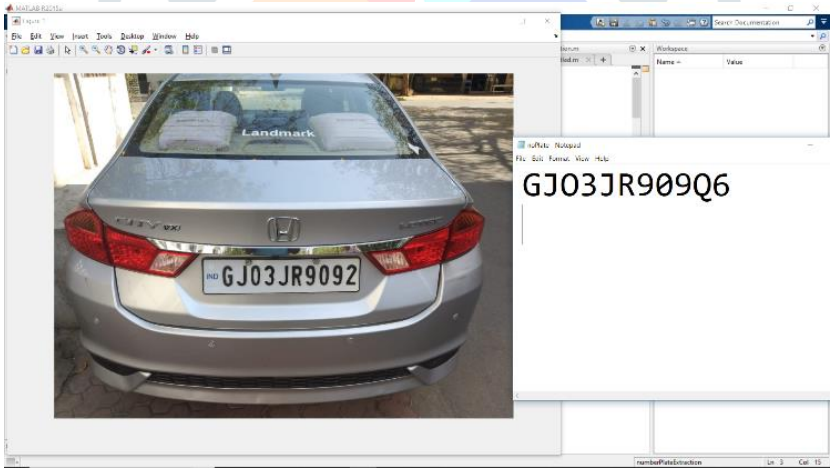

Figure 17: Result of sample 5(Distant image - 2 characters error)

VI. CONCLUSION AND FUTURE WORK

The images taken which focuses only on the license plate region are accurately identified without any errors. Indian number plates starts with two alphabets, which is taken into account when comparing the characters with the database. So the first two segmented characters are compared only with alphabet images from the database. This helps in increasing the overall efficiency of the system. The images taken at a distance from the car are the major problem for the system, as the system is not able to accurately distinguish between the object noise and the characters in the license plate. Thus, better pre-processing techniques are needed to be implemented which deals with varying conditions which will boost the accuracy.

The VNPR system can be further expanded to identify multiple cars on the road in a single frame captured from a distant camera and identify the plate. It can also used to detect the car and extract number plate from the car which contains a lot of noise. The toll booth in the highway can be upgraded wherein the database of all the license registered cars can be linked directly to the bank account of the owner, and based on the captured image the number plate's owner can be identified and the toll fee can be automatically deducted from owner's bank account.

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