Automatic License Plate Recognition

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Abstract— **License plate recognition (LPR) is a technology that enables computer systems to read automatically the registration number (license number) of vehicles from digital pictures. This paper deals with the recognition of Indian car license plate recognition. The LPR system consists of four steps Plate Localization, Preprocessing, Segmentation and Normalization and Optical Character Recognition (OCR). Morphological operator is applied to the image to identify the plate location. Then the plate region is then preprocessed by applying the histogram equalization technique. The smearing and morphological algorithms are used to segment the characters and the segmented result is normalized and fed to the OCR part. The characters are then recognized using the template matching algorithm.**

Keywords- License plate recognition; Optical Character Recognition; segmentation; template matching.

I. INTRODUCTION

LPR has a wide range of applications, which use the extracted plate number to create automated solutions for various problems. These include the following Access control, tolling, border control, Traffic control, to find out the stolen cars, Airport Parking and so on. The feature of the image is extracted to locate the number plate using the morphological operator (Rectangle). The located plate is preprocessed to remove the noise and the result is passed to the segmentation part to segment the individual characters in the license plate after segmentation the output is normalized and passed to OCR algorithm. Finally the characters are recognized using template matching algorithm. Figure1 shows the license plate recognition system.

II. RELATED WORK

[1] Morhopological operator is used to locate the plate and template matching for character recognition.[2] The plate region is extracted using the edge detection and smearing algorithm and template matching for OCR. [3] Gabor filter is used to extract the feature and location of the number plate. [4] Number plate is located using the edge detection and vertical projection method and the character is recognized using the chain code method. Apart from this several other neural network algorithms are applied to recognize the characters[6]-[9].

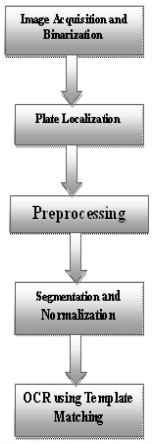


Figure1 LPR System

TABLE I COMPARISON OF THE RELATED WORK

Reference	Extraction of Plate Region	Recognition of Character
[1]	97.3%	92%
[2]	97.6%	98.8%
[3]	--	96.6%
[4]	98%	--

III. PLATE REGION EXTRACTION

To start with the morphological operation the image captured in RGB format is converted into gray scale image and into binary image. [5] Otsu's Global thresholding method is used to convert the gray scale image to binary image. After applying the otsu's algorithm the characters are properly segmented from the background. The morphological operator is the applied to the image to localize the plate region. Morphology is a image processing operation that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size. The most basic morphological operations are dilation and erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image. In this paper rectangle (of length = 6 and height=3] was chosen as the structuring element as the number plate will be in that shape. The edge image is then processed by the closing operation

which yields the plate candidates. So in-order to acquire the correct plate region and to discard the other duplicated regions the aspect ratio and shape and size of the plate is applied to all the regions the one that accurately matches with the region will be located as the plate region.

IV. PREPROCESSING

The morphological output is then preprocessed since morphological operation may sometimes degrade the image quality so in-order to enhance the image the preprocessing is performed. The intensity of the image is adjusted using histogram equalization, which enhances the contrast of images by transforming the values in an intensity image, or the values in the color map of an indexed image, so that the histogram of the output image approximately matches a specified histogram. The final output of this step is the plate region without and noise.

V. SEGMENTATION AND NORMALIZATION

The noise removed image is then given as input to the segmentation part of LPR system. At first dilation operation is applied to the image to separate the characters from each other if there are very close to each other. Then horizontal and vertical smearing algorithm is applied to identify the region of the characters. The next step is to cut the plate characters by referring the starting and ending of the no extra white spaces in all the direction of the character finally the characters fit to equal character in the plate region. Then the result is normalized into the character set of size 36 X 18 as the size of the images in the database, so as for easy comparison of the input character with the character in the database.

VI. OPTICAL CHARACTER RECOGNITION

Character is recognized using the following algorithm Template Matching and currently I am working on this part. The character recognition module includes the recognition engine and the validation phase. Character recognition system faces the following types of errors, namely rejection and substitution (False positives). In the rejection error the system is unable to read the input character, in my paper I haven't got this type of error. In substitution error, the system miss recognizes the character and substitutes the character with high level of confidence. In most of the cases this error may occur. There are many techniques available to solve this problem .

- Predefining the thresholds or confidence levels for rejection when fields are defined.
- Another approach to reduce false positives is to process the image twice for recognition, first the input image is passed to recognition engine and is processed again the image is dilated and once again fed into the recognition engine. The result of the two passes are compared, if any differences are found then once again the image is processed and reviewed.
- The third technique is to apply the logic edits during the validation phase of the character recognition.

In the above techniques mentioned I am going to use the threshold value and I am referring papers for the threshold value to be used.

A. Template Matching

Template matching algorithm includes the following steps

- Initially the character from the detected string is selected.
- Then the image to the size of the first template is rescaled.
- After rescale the image to size of the first template (original) image the matching metric is computed.
- Then the highest match found is stored. If no match was found then repeat step 3.
- The index of the best match is stored as the recognized character.

This process involves the use of a database of characters or templates. Templates will exist for all the characters (A-Z) and (0-9). To recognize the character the current input character is compared to each template to find either a exact match or the template with closest representation of input character. If X(i) is the input character, M(x,y) is the template n, then the matching function r(d) will return a value indicating how well a template n matches the input character. The matching function used is Normalized Correlation given as below

$$r(d) = \frac{\sum_i [\,(x(i) - mx) * (y(i-d) - my)\,]}{\sqrt{\sum_i (x(i) - mx)^2}\sqrt{\sum_i (y(i-d) - my)^2}}$$

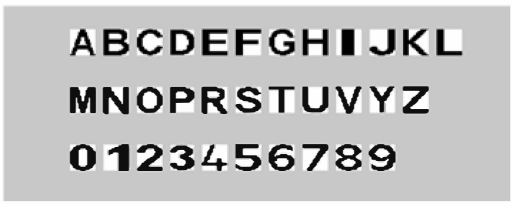


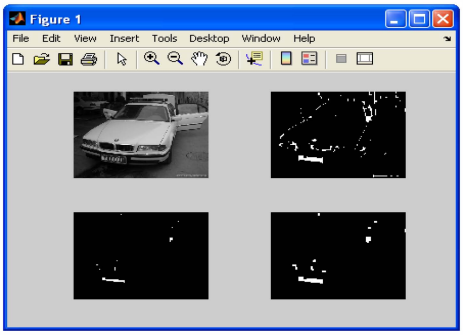
Figure 2 Database for OCR system

"Fig.2" shows the database of the Optical Character Recognition System. The segmented characters are read one by one and the features (correlation) calculated is matched with the features stored in the database (for example if the input character is D then the feature of that character is calculated and is compared with the features of the characters stored in the database one after the other, the one with the maximum match will be considered as the final recognized character). While matching some of the characters like Z and 2, S and 5 some errors may occur (False Positives / Substitution error) so to increase the recognition rate the recognized character is passed to the validation phase to test it.

VII. RESULTS

The input image is a color image it is converted in to gray scale and then into binary image. Figure2 shows the RGB input image figure3 and figure4 shows the result.

Figure 3 Input Image1



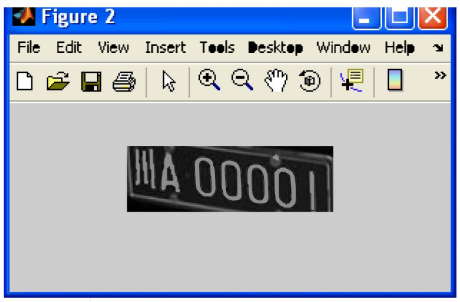


Figure 4 Input Image2

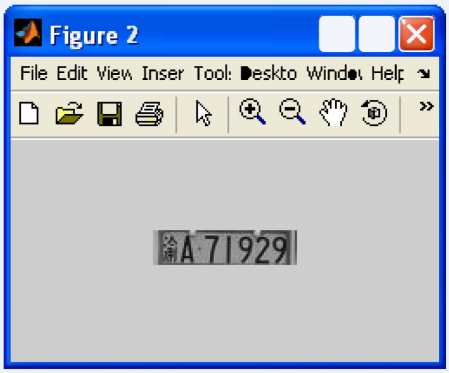
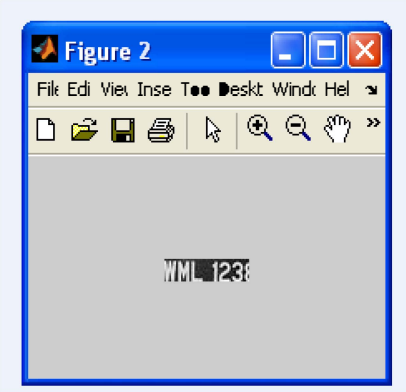


Figure 5 Input Image3

Figure 6 Input Image4



VIII. CONCLUSION

Thus the License Plate Recognition System helps to locate the license plate of the car and also recognize the characters using template matching algorithm.

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