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INDIAN VEHICLE LICENSE PLATE EXTRACTION AND SEGMENTATION

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ABSTRACT

Automatic License Plate Identification (ALPI) has many applications in traffic systems (highway electronic toll collection, red light violation enforcement, border and customs checkpoints etc.). This paper presents Automatic Number Plate Extraction and Character Segmentation for Indian vehicles. In India, number plate models are not followed strictly. Characters on plate are in different Indian languages, as well as in English. Due to variations in the representation of number plates, vehicle number plate extraction and character segmentation is difficult. We work on plates that contain English characters. The proposed algorithm consists of three major parts: Preprocessing of Image, Extraction of plate region and Segmentation of characters. For preprocessing of the image, histogram equalization has been applied. For extracting the Plate region, edge detection algorithm and various morphological operations are used. Character segmentation is done by using connected component and bounding box method. The accuracy of our algorithm for license plate extraction is 91.02% and for segmentation is 88.46%.

1. INTRODUCTION

Automatic vehicle identification is an essential stage in intelligent traffic systems. Nowadays vehicles play a very big role in transportation. Also the use of vehicles has been increasing because of population growth and human needs in recent years. Therefore, control of vehicles is becoming a big problem and much more difficult to solve. Automatic vehicle identification systems are used for the purpose of effective control. License plate recognition (LPR) is a form of automatic vehicle identification. It is an image processing technology used to identify vehicles by only their license plates. Real time LPR plays a major role in automatic monitoring of traffic rules and maintaining law enforcement on public roads. This research work will present an approach to get scheme that can identify license plate in more accurate and efficient manner.

The remainder of this paper is organized as follows. Section-2 describes the related work. The proposed technique and step of system are explained in Section-3. Experimental Results are discussed in Section-4. Finally, the conclusion is concluded in Section-5.

2. RELATED WORK

In general, License plate recognition consists of four modules: image acquisition, license plate extraction, character segmentation, and character recognition.

Shidore, Narote [1] developed Number Plate Recognition for Indian Vehicles. Number plate extraction had been done by using Sobel filter, morphological operations and connected component analysis. Character segmentation was done by using connected component and vertical projection analysis. Character recognition as carried out using Support Vector machine (SVM). Images had been taken in different background, illumination conditions, and at various distances from the camera to vehicle. Images were resized to 1024 *768. The accuracy of segmentation has been reported to 80% and of recognition is 79.84 %. Firdaus et al. [2] developed Malaysian Car Number Plate Detection System In their method they combined the color information method with the output from the template matching algorithm. The entire tests are implemented on MATLAB and executed by an AMD Athlon 64, 2GHz, under Window XP. Total of 71 samples were used as input where the size of the image is 640 x 480 pixels. After implementing the proposed method, the result improved to 97.1%, compared to 66.19% using color information, and 88.7% using template matching. From these results, we can conclude that proposed method performed better than the color information and template matching while giving 'Best' grade of detection and high accuracy detection. Suri,Walia,Verma [3] developed Vehicle Number Plate Detection using Sobel Edge Detection Technique. To smoothen the edges, the technique of convolution had been used. Thereafter, the connected components (mx) were detected. Finally, the image was stored in the form of a matrix and the output was displayed in the form of detected numbers. Scope of the plate extraction in this process lies in enhancement of the resultant image under variable illumination. Hamidreza Kasaei, Mohammadreza

Kasaei and Alireza Kasaei [4] developed New Morphology-Based Method for Robust Iranian Car Plate Detection and Recognition. The algorithm was started with preprocessing and signals conditioning. Next license plate was localized using morphological operators. To segment character from extracted plate, dilation operator and partition scanning was used. Then a template matching scheme was used to recognize the digits and characters within the plate. To test the system accuracy, colored images with the size of 640x480 was used. The test images were taken under various illumination conditions .The performance was 97.3% of correct plates identification and localization and 92% of correct recognized characters. Tahir, et al. [5] developed a License Plate Recognition Algorithm for Pakistani License Plates. First, images were captured in various illumination conditions with a high resolution digital camera with the prior knowledge of size, angle and distance. Second, license plate was extracted by proposing vertical edge matching technique. Third, vertical and horizontal scanning method was utilized for character segmentation. Finally, template matching technique was proposed for recognition module. By this algorithm they had found the recognition rate of about 92%. Babu and Nallaperumal 2008[6] developed A License Plate Localization using Morphology and Recognition. Sobel mask was used to detect vertical edges in the input image. The resultant image was converted into a binary image. Morphological dilation and erosion was applied then to extract the image. The Character Recognition algorithm used the Cross Correlation Combined with Neural Network. The Database contained 353 images different in size, background, camera angle, distance, and illumination conditions. The Class 1 and Class 2 contained the images acquired from Tirunelveli and Tuticorin during day and night times. Class 3 and Class 4 images were acquired from those same places during day and night time. The performance for plate location of class 1, class 2, class 3, class 4 was 96%, 91.8%, 88.7%, 86.6%.Liu Ying Li Nannan [7] has developed Design of License Plate Recognition System Based on the Adaptive Algorithm. Original image is converted into gray level image. To process that image, they have used weighted average method. Finally, in order to save storage space and speed up the computing, they have adopted binarization processing through an adaptive threshold method in this step. In second plate position & segmentation step, horizontal scanning then the vertical projecting has performed. In Characters cutting step, combined crude cutting and fine cutting to cut characters is used. After this step, they have used multi-scale wavelet for feature extraction. They have extracted feature like low frequency image, vertical detail image, horizontal image etc. In last step, they have used RBF neural network to recognize the character. RBF is feed forward and 3 layer network. The experiment results of the actual images show that the average recognition rate can reach more than 92%. Wanniarachchi et al. Othman Khalifa et al. [8] developed Malaysian Vehicle License Plate Recognition. RGB image was converted to gray image and median filter was applied to remove noise. To extract plate, sobel operator, horizontal scanning, vertical scanning, cleaning and verification was applied in second step. In third step character segmentation was done. Character recognition using multilayer perceptron neural network was done in fourth step. Performance was 92.1% for plate location, 90.5% for segmentation and 93.2% for recognition.

3. PROPOSED TECHINQUE

The proposed system has three main modules Pre Processing of Image, License Plate Extraction and Segmentation of Character as shown in Figure 1. In first module, after the vehicle image is captured by the camera, it will be passed to preprocessing which prepares the image for further processing by the system. Its main operations are to eliminate noises caused by the image acquisition subsystem and image enhancement. In second module, license plate is extracted. In the third module, the elements (characters and numbers) in the extracted license plate are segmented by connected component and bounding box method.

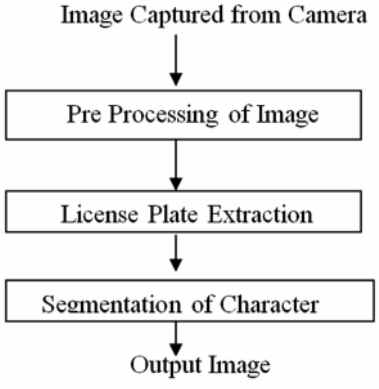

Figure 1: Block Diagram of License Plate System

3.1 Image Preprocessing

Preprocessing is mainly used to enhance the processing speed, improve the contrast of the image, and to reduce the noise in the image. We firstly converts RGB image to gray scale image.RGB images to grayscale conversion is done by eliminating the hue and saturation information while retaining the luminance. To convert RGB values to grayscale values we formulated it by forming a weighted sum of the *R*, *G*, and *B* components:

$$\text{Gray} = 0.2989 * R + 0.5870 * G + 0.1140 * B$$

After it, we have to adjust the intensity of the image and reducing the contrast in the image. The technique used for intensity adjustment is known as histogram

Figure 2(a): Captured Image

Figure 2(b): Gray Scale Image

Figure 2(c): Histogram Equalized Image

equalization. Histogram equalization 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. Captured image, Gray scale Image, Histogram equalized Image are shown in figure 2(a), figure 2(b) and figure 2(c) respectively.

3.2 Plate Extraction

Number plate extraction is the key step, which influences the accuracy of the system significantly. In this phase, histogram equalized image is converted to binary image.

3.2.1 Edge Detection

We have to find edged image from the histogram equalized image. For this we have many different methods like Roberts Edge Detection, Sobel Edge Detection, Prewitt edge detection, Canny Edge Detection. We have used canny operator to find the edged image. The Canny operator performs a 2-D spatial gradient measurement on image. The Canny method applies two thresholds to the gradient: a high threshold for low edge sensitivity and a low threshold for high edge sensitivity. Edge starts with the low sensitivity result and then grows it to include connected edge pixels from the high sensitivity result. This helps fill in gaps in the detected edges. Edged image is shown in figure 3(a).

3.2.2 Candidate Plate Area Detection

A morphological operator is applied to the image for specifying the plate location. We can build a morphological operator that be sensitive to a specific shape in the input image. In our system rectangular box is employed as a structural element to detect the car plates. Using two basic operation of morphology (erosion and

Figure 3(a): Edged Image

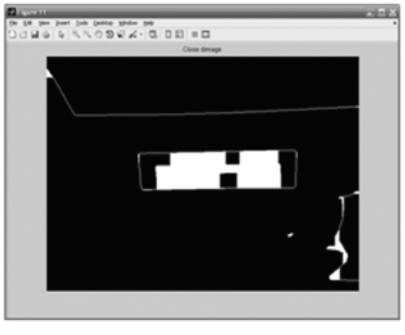

Figure 3(b): Closed Image

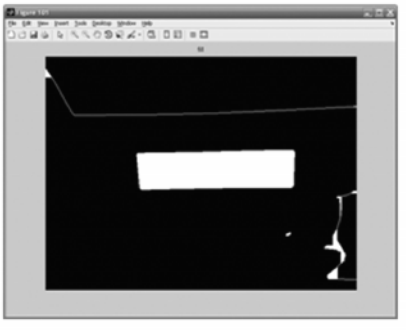

Figure 3(c): Filled Image

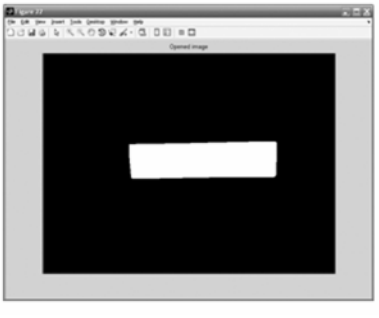

Figure 3(d): Opened Image

Figure 3(e): Extracted Plate

dilation), opening and closing of image is done. The opening of *A* by *B* is obtained by the erosion of *A* by *B*, followed by dilation of the resulting image by *B*. The closing of *A* by *B* is obtained by the dilation of *A* by *B*, followed by erosion of the resulting structure by *B*. In our system we have applied the closing of the edged image to extract the plate region. After this step we get image as shown in figure 3(b).

Now we have to fill the holes in this image. A hole is a set of background pixels that cannot be reached by filling in the background from the edge of the image. For this purpose imfill function is used. Filled image is shown in figure 3(c). As in this image there are some regions other than the plate. So to remove those regions, we have applied the opening operation on filled image. Figure 3(d) shows the detected plate.

3.2.3 True Number Plate Extraction

After the detection of candidate number plate area, logical AND is used to extract plate area from the original image. We have applied logical AND operation between figure 3(d) and figure 2(c).Extracted plate is shown in figure 3(e).

3.3 Segmentation

Character segmentation is an important stage in license plate recognition systems. In the step, license plate is segmented into its constituent parts obtaining the characters.

3.3.1 Filtering of Image

Preprocessing is very important for the good performance of character segmentation. Firstly, image is filtered for enhancing the image and removing the noises and unwanted spots. To remove the noise in image we have applied the median filter. Median filter (3*3) is nonlinear spatial filters whose response is based on ordering (ranking) the pixels contained in the image area encompassed by the filter, and then replacing the value of the center pixel with the value determined by the ranking result. In next step, to remove blurriness of image we have applied wiener filter. Wiener filter estimates the local mean and variance around each pixel. Figure 4(a) shows the filtered image.

Sharpening of image refers to enhancement technique that highlights edges and fine details in an image. Sharpening increases the contrast between bright and dark regions to bring out features. The sharpening process is basically the application of a high pass filter to an image. The original image is first filtered by a high-pass filter that extracts the high-frequency components, and then a scaled version of the high-pass filter output is added to the original image, thus producing a sharpened image of the original. The sharpened image is shown in figure 4(b).After this, we convert this sharpened image to binary image using a particular threshold value. Converted binary image is shown in figure 4(c).

3.3.2 Segmentation

Now, it is preferable to divide extracted plate into individual image, each containing one isolated character. There are some widely used methods for character isolation like static bounds, vertical projection, and connected component. In our system, we have used the connected component technique.

We have detected the number of connected components and labeled them. After it we measured a set of properties for each labeled region. Bounded box is used to separate individual character from the license

Figure 4(a): Filtered Image

Figure 4(b): Sharpened Image

Figure 4(c): Binary Image

Figure 4(d): Segmented Plate

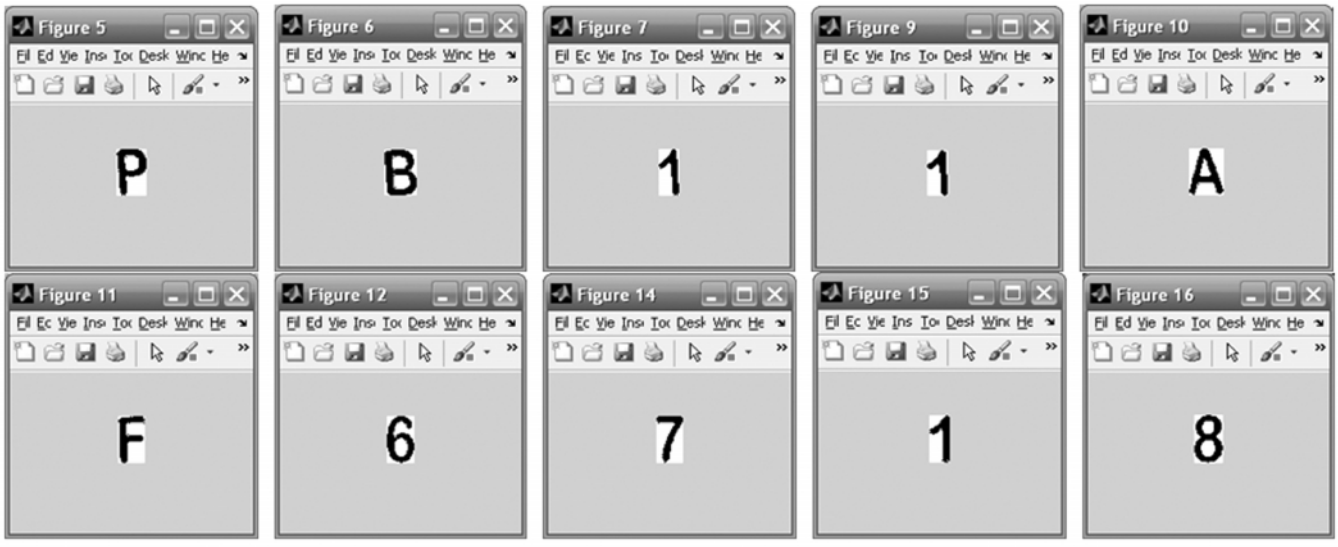

Figure 4(e): Isolated Characters

plate. Figure 4(d) and Figure 4(e) shows the segmented plate and individual character.

4. EXPERIMENTAL RESULTS

Experiments have been performed to test the proposed algorithm and to measure its accuracy. The system is simulated in MATLAB version 7.10.0.499(R2010a) for the extraction and segmentation of number plate.78 color images were used for testing the technique. All the images being normalized to size 640 x 480 because some images were double this size and also it is normal to use the size. The images were taken of different color and variable sized number plates. The distance between the camera and the vehicle varied from 3 up to 7 meter. However, the proposed method is sensitive to the angle of view, physical appearance and environment conditions. Table 1 tells about the percentage accuracy of the proposed algorithm:

Table 1
Experimental Result

Module	*Number of correct detection*	*Percentage of Accuracy (%)*
Extraction	71/78	91.02%
Segmentation	69/78	88.46%

It is shown that accuracy for the extraction of plate region is 91.02% and 88.46% for the segmentation of the characters. The overall system performance can be defined as the product of all units accuracy rates (Extraction of plate region and segmentation of characters). So overall accuracy of our system is 89.74%.

Following figures shows the license plate extraction of cars.

Figure 5(a): Original Car

Figure 5(b): Plate Area Detection

Figure 5(c): Plate Extraction

Figure 6(a): Original Car

Figure 6(b): Plate Area Detection

Figure 6(c): Plate Extraction

Figure 7(a): Original Car

Figure 7(b): Plate Area Detection

Figure 7(c): Plate Extraction

5. CONCLUSION

A simple but efficient license plate extraction method is presented in this paper. The proposed method is mainly designed for real-time Indian license plate. Our method is based on the morphological algorithms and connected components analysis. To measure the efficiency, our method has been tested over a large number of images captured at day time and achieved a satisfactory results. Finally it is proved to be 91.02% correct in the extraction of plate region and 88.46% correct in the segmentation of the characters.

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