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Vehicle Authentication Using Automatic License Plate Recognition by OCR

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ABSTRACT: Automatic license plate recognition (ALPR) plays an important role in real-life applications because the usage of vehicles by the people has been increasing day by day due to population growth and human needs. So it is necessary to control the vehicles and to provide security to the vehicles. Main process of ALPR is divided into 5 stages: Image Acquisition, Pre-processing, Extraction of vehicle licence plate(VLP) from an image, Segmentation of each character in VLP and Recognition of each character in the licence plate by OCR, by following different methods in each stage. ALPR is most efficient and used in many applications like automatic car gate opening(ACGO), automatic ticketing of vehicles at parking area, traffic monitoring, tracking vehicles during signal violation, stolen car detection without direct human intervention. This paper also presents one real time application i.e., Authentication.

KEYWORDS: Automatic license plate recognition(ALPR); Vehicle license plate(VLP); Optical character recognition(OCR); Automatic car gate opening(ACGO); Extraction

I. INTRODUCTION

Automatic licence plate recognition(ALPR) is a image processing technology that identifies vehicles by their license plate. Vehicles play important role in transportation. ALPR system is important method used in Intelligent Transportation System. Aspect ratio is very important factor in standardized vehicle's number plates, Aspect Ratio=Width/Height. Recognition of Indian number plate is difficult when compared to foreign number plate because it follows particular standard shown in fig.1 in which 1 represent two-letter state code, 2 represent two-digit district code, 3 represent series code, and 4 represent actual registration number that is unique for each vehicle.



Fig.1: Indian vehicle number plate

ALPR system as shown in fig. 2 consists of five phases:-

1. Image Acquisition
2. Pre-processing
3. Extraction of Number Plate
4. Segmentation
5. Recognition

The first phase is Image acquisition in which input is acquired through camera with high resolution and then pre-processing is done to improve contrast of the input image which includes two steps in pre-processing 1. RGB to gray conversion and 2. contrast enhancement using histogram equalization. Third phase is Extraction in which licence plate is extracted from the entire image. It is difficult task and plays major role in the entire system due to some reasons like Number plate is generally a small portion of the whole vehicle image so for a machine it is difficult to extract that

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accurate portion and Number Plates exist on different location for different vehicles. Depending on the output of the extraction phase further process will proceed. Fourth phase is segmentation in which each character in the licence plate is segmented using image binarization, connected component labelling and bounding box. Last phase is recognition in which all characters are recognised by the computer. This final result is used in many applications like Authentication, which is also showed in this paper.

II. RELATED WORK

In [1] authors Sarbjit Kaur and Sukhvir Kaur proposed a efficient method of Indian vehicle number plate extraction using morphological operations, thresholding, sobel edge detection and connected component analysis, the accuracy of this method is 90% out of 40 vehicles for license plate extraction. Ronak P Patel [2] proposed new algorithm for number plate extraction using bounding box and morphological operations for recognition. In [3] author Shan Du presented a comprehensive survey on all existing techniques of Automatic licence plate recognition by comparing all methods with their pros and cons, which gives a better idea regarding all the methods. Najeem Owamoyo [4] proposed method for number plate extraction using Sobel filter and morphological operations. In [5] Divya Gilly presented an efficient method for license plate detection by connected component analysis. Isack Bulugu [6] to find the location of the plate has proposed edge finding method. Rupali Kate [7] proposed algorithm for number plate localization based on a combination of morphological operation with area criteria tests. Hadi Sharifi [8] has study and evaluates most important license plate detection algorithms and compared them in terms of accuracy, performance, complexity, and their usefulness in different environmental condition. P.Vasantha Kumar [9] proposed algorithm for extracting the Plate region using vertical projection method and edge detection algorithm.

This paper presents a simple method for the extraction, segmentation and recognition by following different methods with the help of existing method.

III. PROPOSED METHODOLOGY AND DISCUSSION

This section explains proposed method of licence plate recognition of Indian vehicles. Below figure shows main block diagram of this proposed method.

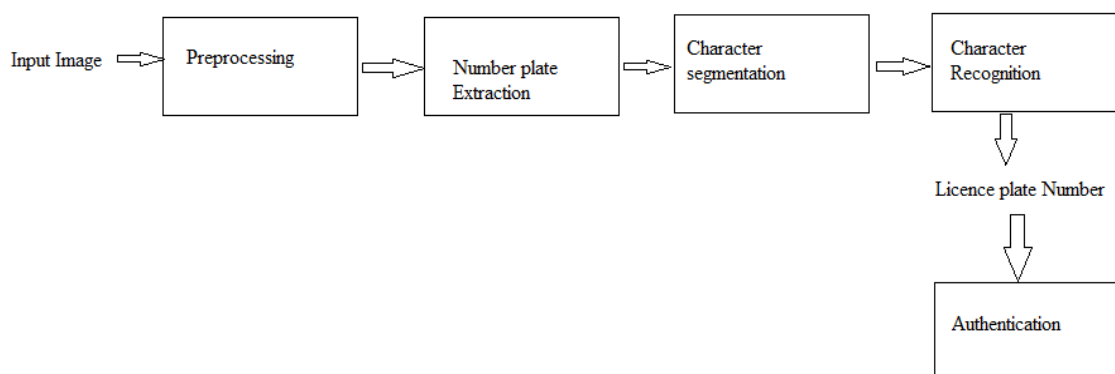


Fig 2: Block diagram of ALPR system

1. Image Acquisition:

This is the first step to acquire the image which is input image using digital camera with high resolution. Images are acquired in different background in different illumination conditions.

2. Pre-Processing:

Pre-processing is done mainly to improve contrast in an image. It involves two steps:

- RGB to Grayscale conversion
- Contrast enhancement using histogram equalization.



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2.1. RGB to Grayscale conversion

Here input image(RGB) is converted into gray scale image by formulating it by forming a weighted sum of R,G, and B components: $Gray=0.2989 * R + 0.5870 * G + 0.1140 * B$

2.2. Contrast enhancement using histogram equalization

Images are enhanced by using histogram equalization on gray scale image, to reduce the problem of low contrast and low quality in vehicle input images.

3. Extraction:

In extraction, license plate is extracted from entire vehicle image. It involves 4 steps:

- Morphological opening
- image subtraction operation
- Image binarization using thresholding
- Sobel Edge detection
- Morphological operations(dilation and erosion)
- Actual number plate area

3.1. Morphological opening

Morphological opening operation is performed on enhanced gray scale image to overcome brightness in the image. Morphological opening operation is performed by using structuring element and it is nothing but erosion followed by dilation operation.

3.2. Image subtraction operation

Image subtraction is the differences between two images. Here subtraction of opening operation on enhanced gray scale image using disk shape structuring element.

3.3. Image binarization using thresholding

Here gray scale image is converted into black and white image by using threshold value of 127, which is middle value of 0 to 255 using otsu's method. In the gray scale image, the pixels which are above the threshold value are converted into white and , the pixels which are below the threshold value are converted into black.

3.4. Sobel Edge detection

Here both vertical and horizontal edge detection is performed on the output of binary image by using sobel operator.

3.5. Morphological operations(dilation and erosion)

Morphological operations are mainly used to remove all the objects in the image, except licence plate area. In this firstly dilation operation is performed to overcome broken lines in the output of edge detection. Secondly, fully covered areas in the image are covered with holes. Thirdly, erosion operation is performed to remove unwanted areas.

3.6. Actual number plate

After the detection of number plate area, the actual number plate area is extracted by using connected component analysis and bounding box to find the row and column indices of plate area. With the help of indices, license plate is extracted from the gray scale image.

4. Segmentation

In segmentation stage, all the characters are segmented and extracted individually from the licence plate. It undergoes two stages

- Removal of unwanted objects in the license plate
- Extracting of each character in the license plate

4.1. Removal of unwanted objects in the license plate

Extracted licence plate is converted into binary image, then complement the binary image. Label each object in the binary image by using connected component labelling. Area is calculated for each object by using bounding box=[upper left corner xwidth ywidth]. Finally, by using threshold value the unwanted objects(like nails on the number plate, dust, towing accessories etc).

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4.2. Extracting of each character in the license plate

Now only characters leftover in the license plate and is extracted each character individually by using bounding box.

5. Recognition

Each individual character obtained in segmentation stage, is recognized by the computer by using optical character recognition(OCR) and Correlation co-efficient. Each segmented character pixels are compared with all characters (0 to 9 & A to Z) of different font styles which is stored in database by using correlation coefficient r ,

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\left(\sum_m \sum_n (A_{mn} - \bar{A})^2\right) \left(\sum_m \sum_n (B_{mn} - \bar{B})^2\right)}}$$

where $\bar{A} = \text{mean2}(A)$, and $\bar{B} = \text{mean2}(B)$.

6. Authentication

Authentication is one of the real time application in which the system verifies the identity of a vehicle who wishes to access it. This application is used in automatic car gate opening, security purposes etc. This is done by comparing two files in the database, one file is stored with few vehicle numbers and another file contains output (License plate number of present vehicle which is recognized in the recognition stage), if output is matched with the any of the numbers in another file then it is authenticated otherwise unauthenticated.

IV. EXPERIMENTAL RESULTS

The entire proposed method is implemented with MATLAB. The outputs of each stage in proposed method is shown below. The output of first stage, Image Acquisition is shown in fig.1.1, Pre-processing result is shown in fig 2.1, Extraction output is shown in fig 3.1 to fig 3.8, Segmentation output is shown in fig 4.1 and Recognition output is shown in fig 5.1

1. Image Acquisition



Fig 1.1: Input Image

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2. Pre-Processing

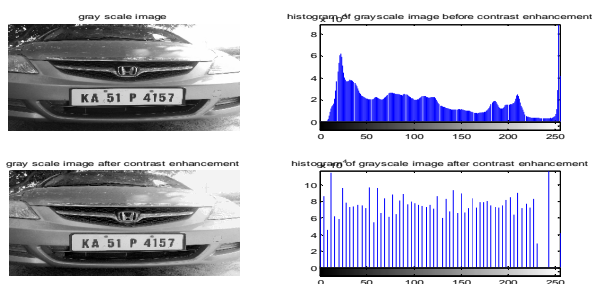


Fig.2.1: Gray scale and contrast image and their respective histograms

3. Extraction

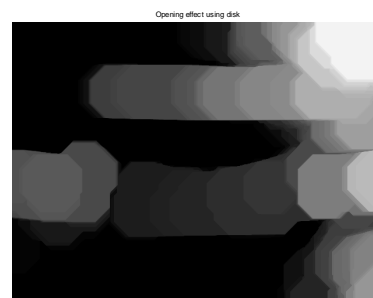


Fig.3.1: Morphological opening



Fig 3.2: Image subtraction

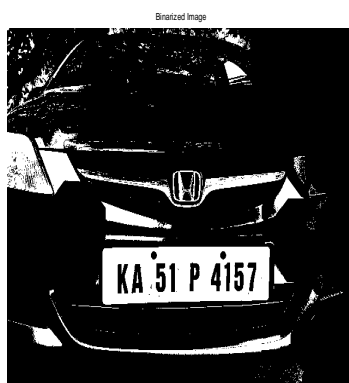


Fig 3.3: Binarized Image



Fig 3.4: Sobel Edge detection

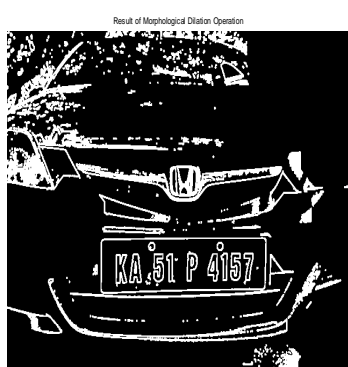


Fig 3.5: Dilation operation



Fig 3.6: Image after filling with holes



Fig 3.7: Number plate area detection

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Fig 3.8: Extracted Number plate

4. Segmentation

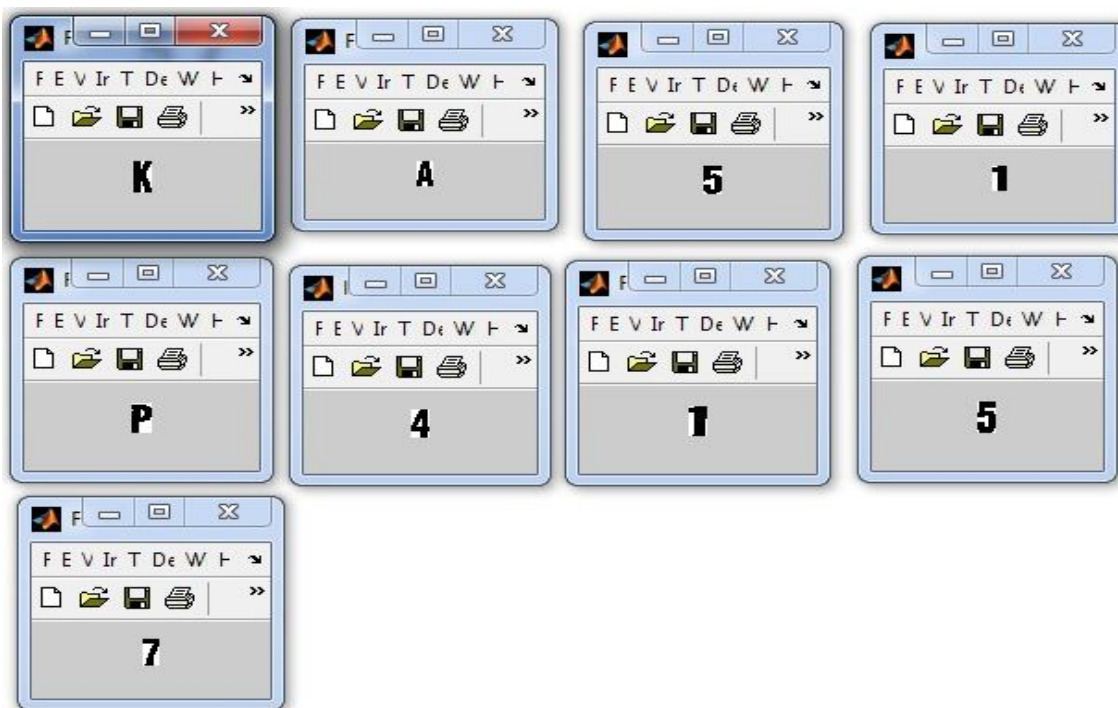


Fig 4.1: Segmentation of each character in the license plate

5. Recognition

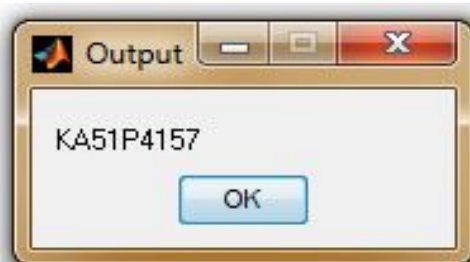


Fig 5.1: License plate is recognised by the computer



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Total vehicle images	Successful number plates	Success Rate(%)
50	48	96

Table 1: Final Results

V. CONCLUSION AND FUTURE WORK

The simulation results showed that the proposed algorithm performs better with 96% accuracy by taking 50 vehicles and by following all different methods as indicated above. It is simple and efficient method presented in this paper. The proposed method is mainly designed for real-time Indian vehicles number plate. This process is tested over more than one number plates of vehicles under different illumination and various weather conditions i.e. daytime, night time, rainy days, cloudy, sunny etc with good success rate. In future, video-based ALPR is done for above method.

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BIOGRAPHY

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