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Automatic Vehicle Identification by Plate Recognition

Prasun Gokhlani[1] Ridhi Jhamb[2], Suyash Lakhani[3]

[12,3]*Dept. of Computer Science, Vellore Institute of Technology*

Abstract - *With the ever-growing population and their increasing needs there has been a significant rise in the number of vehicles that hit the roads today. Hence tracking and controlling of vehicles has become a tedious problem to cater to. Tracking of vehicles requires identifying their numbers assigned by Regional Transport Office (RTO). Image Processing is a useful technique for identifying characters from the images of the vehicles' number plates. License plate recognition is a form of automatic vehicle identification. Automatic vehicle recognition is an effective way to track vehicles and control congestion. Real time recognition of license plate plays a major role in automatic monitoring of traffic rules and maintaining law and order on public roads. Since every vehicle carries a unique license plate, there is no need for tags, transmitters or any other form of external cards. In this paper, a simple method has been implemented for vehicle's license plate recognition system. The proposed method/solution consists of three major parts: Extraction of number plate from the image of the car, segmentation of plate characters and recognition of characters present in the image. The performance of the proposed method has been tested on real images.*

***Key Words*: License Plate Recognition, Image Processing, Image Capturing, Extraction, Segmentation.**

1.INTRODUCTION

With the improving lifestyle, there is an increase in demand of personal vehicles. This has caused increased congestion on roads and has made it difficult to ensure security and order. To distinguish between the vehicles, every nation has adopted a way to assign a number to each vehicle. This number is present on all vehicles, both on the front and the rear end. It helps traffic brigades, toll booth agencies, paid parking agencies, security agencies and cab agencies to maintain a database of the vehicle details. However, with the rapid increase in the number of vehicles, the process of identifying vehicles and the operations pertaining to those processes have slowed down and have become cumbersome. Automatic vehicle identification is a technology to identify vehicles by capturing images of their number plates and processing them. This system is used for efficiently monitoring traffic and in several applications regarding security such as controlling access to prohibited/restricted areas and tracking of wanted vehicles. Experiments related to number plate detection have been conducted for many years, however accuracy and efficiency are yet to be obtained. Number plate detection system investigates an input image and identifies some local patches containing license plates. Since a plate containing the unique identification number can exist in different positions in the captured vehicle image and have various sizes, it is implausible to check every pixel of the image to locate it.

License plate location algorithm consists of steps such as Edge Detection, Morphological operations such as Dilation and Erosion, Smoothing, Segmentation and Recognition of Plate Characters, which have been described in detail throughout the forthcoming sections IV, V, VI. Automatic number plate recognition has a number of applications in the real world. There is a dire need for an efficient automatic number plate recognition system which will help co-ordinate all vehicles and issues related to them on the road.

The remainder of this paper is organized as follows - The literature survey has been illustrated in Section II. In Section III, we give a formal description of the overall system. Extracting the number plate region from the vehicle image is explained in Section IV. Section V explains the segmentation procedure used in our proposed system. Section VI deals with the recognition of individual plate characters. Experimental results and analysis are shown in Section VII with applications of the proposed system explained in Section VIII and the paper concludes with Section IX.

2. LITERATURE REVIEW

Bhat and Mehandia (2014) have proposed an efficient method for recognition of the number plate. The proposed method consists of three major parts: Extraction of number plate location, Segmentation and finally recognition of number plate characters. For extraction of number plate location simple yet efficient morphological operation and sobel edge detection method is used. Bounding box technique is used for segmentation. Finally template matching is applied with the use of correlation for recognition of plate characters. **Kumar and P. Vasantha (2010)** have proposed a simple and efficient algorithm which is mainly designed for the recognition of Indian vehicle number plates. Their algorithm also consists of three major parts: Extraction of number plate location, segmentation of the characters and recognition of the plate characters. For extracting the plate region, edge detection algorithm is used. For the segmentation part, processes such as filtering, thinning, vertical and horizontal projection have been used. And finally the chain code concept with different parameter is used for recognition of characters. **Garg and Kaur (2014)** have proposed a Vehicle License Plate Recognition (VLPR) system. Their proposed system focuses on two parts, first is feature extraction and second is classification that involves recognition of texts and numeral objects embedded on number plates. **Akash Ashokan et al.**

(2015) have proposed Automatic Vehicle Identification (AVI) algorithm for recognition of vehicle number plate. For extraction of the plate region, smearing and edge-detection algorithms are used. In segmentation method, smearing algorithms along with filtering and some morphological operations are used. Lastly genetic algorithm is used to recognize the plate characters. **Vijayalakshmi et al. (2012)** have proposed a method for recognition of number plate based on Genetic Algorithm. Genetic algorithm (GA) is incorporated at two levels: firstly, for identifying the vehicle from traffic image and secondly, for recognizing character from the number plate. **Fukumi et al. (2009)** have proposed a system for automatic detection and recognition of vehicle license plates using advanced template matching techniques, genetic algorithms and neural networks. **Wenshuo GAO Et Al. (2010)** have proposed a method which combines Sobel edge detection operator with soft-threshold wavelet denoising technique to perform edge detection on images that include White Gaussian noises. **Victor Lempitsky et al.(2009)** discuss how the bounding box method can be further used to impose a powerful and efficient topological prior, which would prevent the solution from shrinking excessively and would ensure that the user-provided box bounds the segmentation in a sufficiently tight way. The proposed algorithms were evaluated on a publicly present dataset, and demonstrated the practical benefits of the new prior qualitatively and quantitatively. Edge detection refers to the process of identifying and locating sharp discontinuities in an image. Edge detection process significantly reduces the quantity of raw data and clears away useless information, while preserving the essential structural properties in an image. In this paper, the main aim is to analyse edge detection process based on different techniques. **Raquib Buksh et al. (2014)** deals with the implementation of various MATLAB functions present in image processing toolbox of MATLAB and using it to create a basic image processing system having different properties such as, viewing the RGB components of a colour image separately, colour detection and other features that is used in a basic image editor along with object detection and tracking. Optical Character Recognition by using Template Matching is a system prototype that is useful to recognize the character or letter by comparing two images of the letter. The aim of this system prototype is to develop a algorithm/system for the Optical Character Recognition (OCR) system and to make use of the Template Matching algorithm in developing the system prototype. In this paper **Qadri MT (2009)** et al. Automatic Number Plate Recognition (ANPR) is an image processing technology which uses a unique number (license) plate to identify/recognize the vehicle. Vehicle number plate region is extracted using the image segmentation technique from an image. Optical character recognition technique is used for character recognition.

3. GRAPHICAL ILLUSTRATION

The architecture of the system has been explained in brief in the following section. It describes the three main steps involved in recognizing the number plate of any vehicle. Block diagram of the proposed system is shown in fig. 1

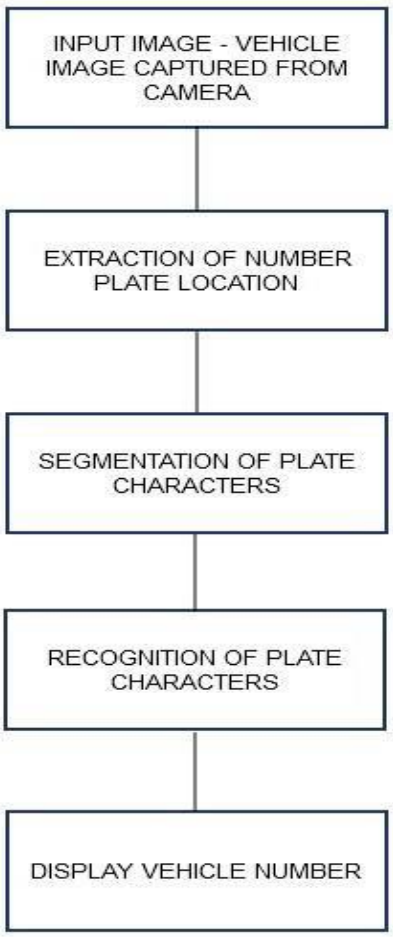

Fig -1: System Block Diagram

3.1 Vehicle Image Captured by Camera

The image of the vehicle whose number is to be identified is captured using a digital camera.

Fig -2: Original Car Image

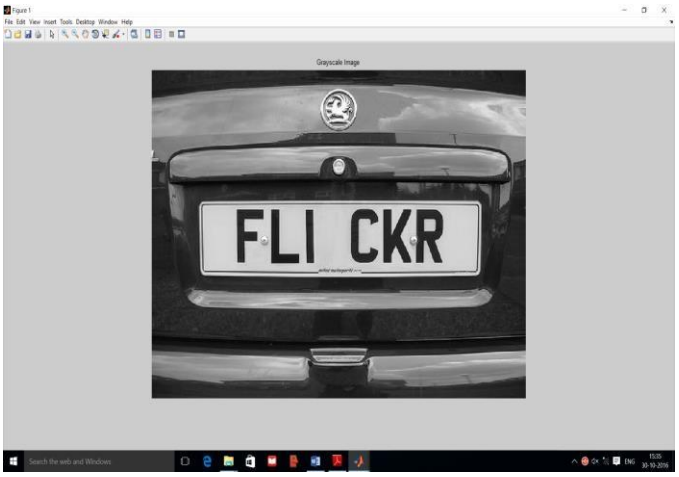

Fig -3: Grayscale Image

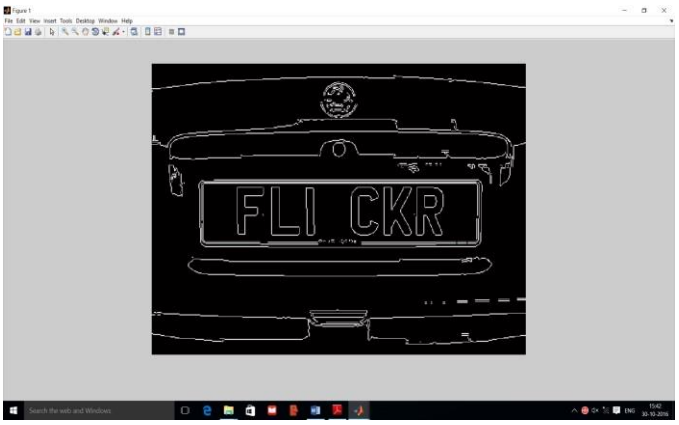

Fig -4: Binary Image with edge detection

3.2 Extraction of number plate location

This step involves in converting the captured RGB image to grayscale image in order to extract the number plate location. The basic step in recognition of vehicle number plate is to detect the plate size. The segmented image is multiplied with grayscale image so that we only get the number plate of the vehicle.

3.3 Segmentation of Plate Characters

In this method bounding box technique is used. The image region properties can be measured using the bounding box technique and mathematical morphological operators are used to detect the number plate region. Also the threshold value is calculated using Sobel operator. After this we get a dilated image which is then filled so as to get a clear binary image.

3.4 Display Vehicle Number

After processing the above steps the number plate is displayed in a text file.

4. EXTRACTION OF NUMBER PLATE REGION

This is the first stage in the proposed method. In this step, we obtain the useful information from the image by highlighting areas in which the number plate is captured. The captured colour image of the vehicle (stationary) is first converted to the binary image consisting of only 1's and 0's, i.e. only black and white, by using a threshold value. The obtained output image replaces all the pixels in the input image with luminance greater than a stipulated "level (Range [0-1])" with the value 1(white1) and replaces pixels with luminance value lesser than that with the value 0(black-0). To find the level argument, you can use the function graythresh. Captured image (original image) and grayscale image are shown in Figure 2 and 3 respectively. The binary image is then processed using some Morphological methods. Morphological operations are applied to the image for specifying the plate location.

There are two main operations under Morphology:

4.1 Dilation

Dilation expands the boundary of an object in the image. A structuring element is used for this purpose. It is a matrix of binary values used to perform operations with the image pixel matrix. The effect of dilation on the image depends upon the size and the shape of the structuring element. Large structuring elements tend to smooth object boundaries and small structuring elements preserve boundary shape while shaped structuring elements preserve features, which are similar, along the boundary.

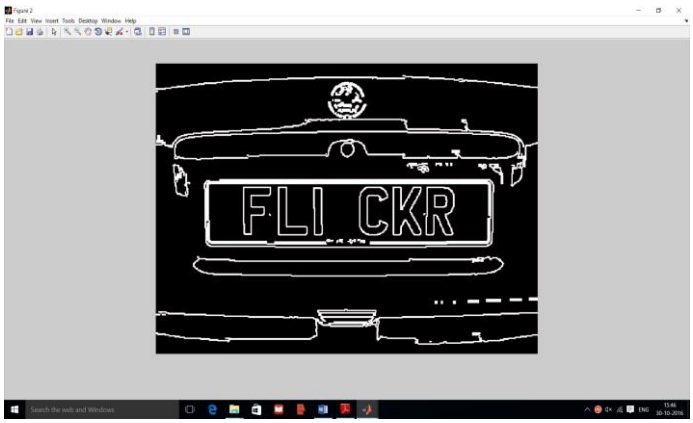

Fig -5: Dilated Image

4.2 Image Filling

The process can be described differently for binary images and grayscale images. For binary images, the pixels having value 0 inside the object boundary are replaced with the value 1. For grayscale images, the intensity values of dark areas are normalised according to the intensity levels of the surrounding pixel values. This process uses the concept of

connected components and structuring element to eliminate irrelevant artefacts.

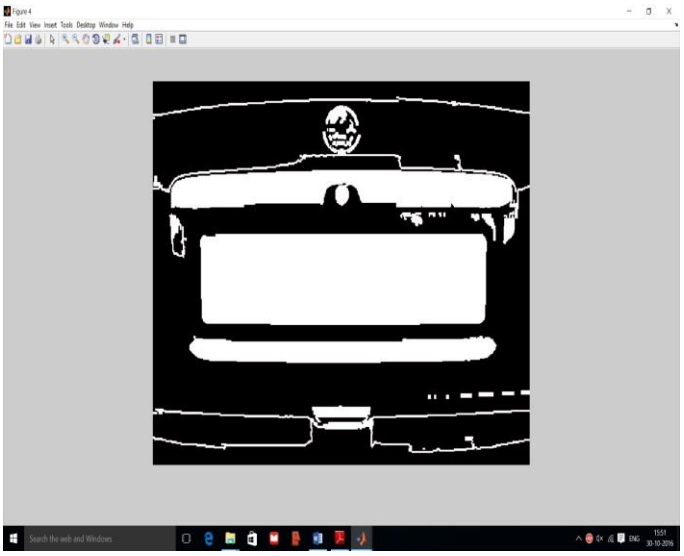

Fig -6: Binary Image with filled holes

In order to make the segmented object look natural, the image is eroded twice with one of the disk, diamond and line structuring element. This is required in extraction of the number plate area of the vehicle.

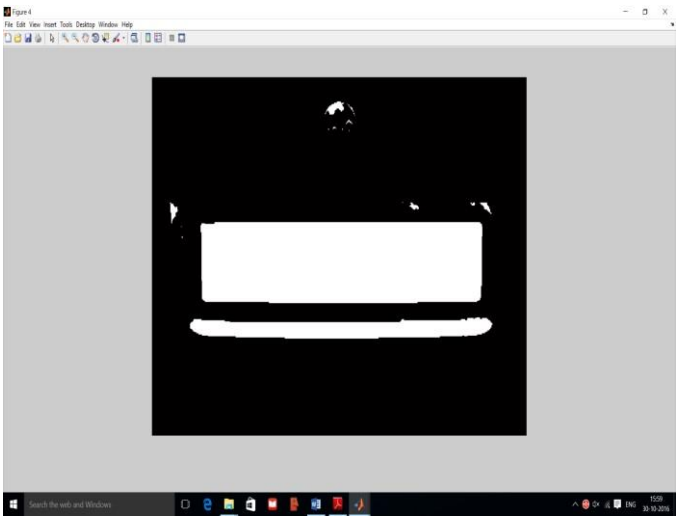

Fig -7: Eroded Image

To get only the number plate area from a vehicle image with characters and numbers present on it, the previous image should be multiplied with the grayscale image.

Fig -8: Extracted Number Plate Image

5. SEGMENTATION OF PLATE CHARACTERS

Image segmentation is the process of dividing a digital image into a large number of segments. The objective of segmentation is to simplify and/or change, if necessary, the representation of an image into a more meaningful and easier piece of information to analyze. Image segmentation is generally used to locate objects and boundaries in images. As a prerequisite to segmentation using bounding box technique, Blob Analysis is employed. Blob is a connected region. The basic scenario of the Blob Analysis technique consists of the following steps:

5.1 Extraction

Thresholding techniques are applied to get a region which corresponds to the objects (or single object) being inspected. This step is explained in the previous subsection where morphological operations such as dilation and image filling is described.

5.2 Refinement

The extracted region is often flawed by noise of various kinds (e.g. due to inconsistent/poor lightning or bad image quality). In this step the region is enhanced/improved using region transformation techniques along with noise reduction methods.

5.3 Analysis

The refined region is subject to measurements and the final results are computed. If the region consists of multiple objects, it is split into individual blobs, each of which is inspected separately.

First the connected regions (blobs) are labelled. And the properties of these blobs are identified. Blob Analysis with respect to our method requires calculating bounding box, reshaping the objects and plotting the object location.

5.4 Bounding Box

The bounding box is used to measure and analyse the properties of the image region. It returns extents for the set of objectives specified by properties for each component that is connected (object) in the binary image. Bounding Box is a property returned from regionprops.

The function used, rectangle ('Position', pos), builds a rectangle in two-dimensional coordinates. Specify pos as a four-element vector of the form [x y c d] in data units. The x and y elements determine the location whereas the c and d elements determine the size. The function plots into the current axes without clearing existing content from the axes.

In order to display the segmented image separately the find() function is responsible. It matches each object iteratively with the image. Then the values of that row number and column number is stored in the vector which is later used to trim the image and display only the segmented part.

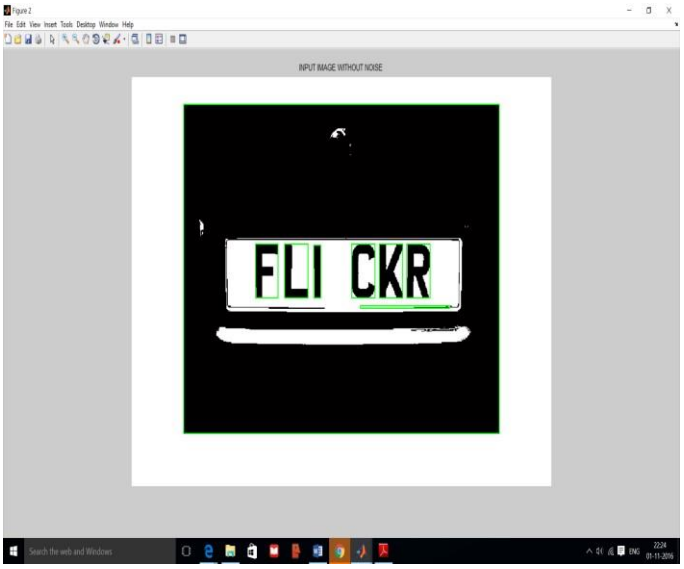

Fig -9: Bounding Box Image

6. RECOGNITION OF PLATE CHARACTERS

The images of text obtained are recognised and converted into characters in this final step. A database containing alphanumeric characters is used to compare each individual character using the concept of template matching. How well the template matches the image in that particular position is done with the help of a matching process which moves the template image to all possible locations in a bigger source image. Matching is done on a pixel by pixel basis. The template used is of fixed size and hence this leads to accurate recognition.

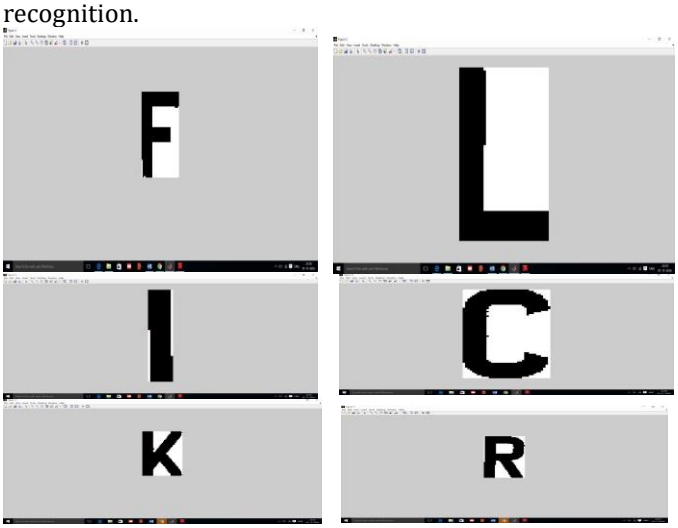

Fig -10: Segmented Plate characters recognized

7. EXPERIMENTAL RESULTS

In order to test the efficiency of our system, experiments have been performed. The implementation of the Number Plate Extraction and Segmentation methods has been done using MATLAB R2009b for recognition of license plates of various countries. One sample image has been shown in the Fig. 11 The images for the input to the system are coloured images with the size of 500x300 pixels and are taken under various luminous conditions. The results of the tests are recorded for each step and are included here as shown below in the table:

Table -1: Results

STEPS/MEASURES	EXTRACTION OF PLATE REGION	SEGMENTATION OF PLATE CHARACTERS
ACCURACY	47/50	45/47
PERCENTAGE OF ACCURACY	94%	95.7%

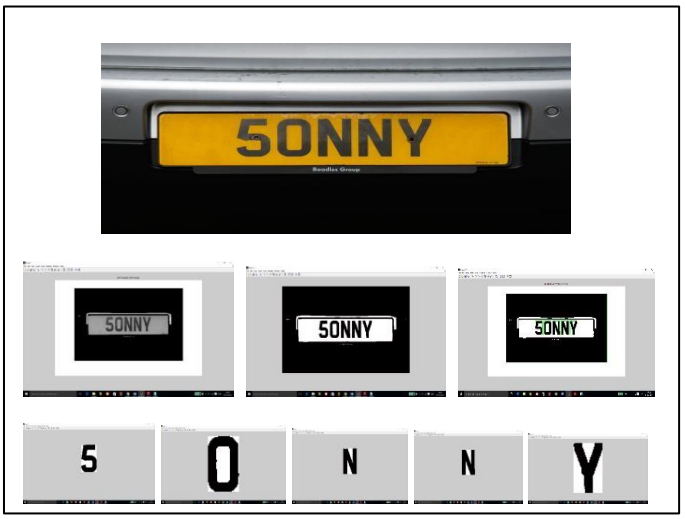

Fig -11: Example of all MATLAB Processed in a glimpse

8. APPLICATIONS

[1] Paid Parking Agencies*:* The system can be used to recognise the number plates of the vehicle entering the parking area and track the duration for which it was parked and calculate parking fee at the exit.

[2] Traffic Brigade: Traffic Police can track the vehicles who have broken driving rules and regulations. With the help of this system it can match the unique number obtained from the image to those stored in the database and obtain the driver details.

[3] Cab Agencies: The owner of the cab agency can access the database of the cab drivers by matching the number plate image obtained from the proposed system.

[4] Security Agencies*:* The incoming vehicles in restricted areas can be tested against a database of blacklisted vehicles and hence barring particular vehicles from entering these restricted zones.

[5] Toll Booth Agencies*:* The output image obtained from the system can be used to calculate the toll fee in a toll-road or used to double check the ticket.

9. CONCLUSION AND FUTURE WORK

In this paper, a method to extract characters from the image of vehicle number plate has been implemented. Simple morphological operation has been used for extraction of number plate location and bounding box technique is used for the purpose of segmentation. Finally, template matching is applied with for the recognition of plate characters. In future, more rigorous techniques can be used to extract the number plate location from images which are blurred or images with low resolution. Techniques can be developed to recognize characters from a range of character datasets to increase the accuracy of the recognition of characters. Experiments can be performed by capturing images of moving vehicles as opposed to images of stationary vehicles in the given implementation.

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