Vehicle Registration Plate Recognition System Using Template Matching

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***Abstract*— Registration plate recognition is widely used in detecting speedy cars, traffic law enforcement and electronic toll collection. The problems associated with registration plate recognition are, plate images have different quality, illumination, view angle, distance, complex background and fonts. To address these problems, image processing tools are used for extracting only the region of interest. Then different luminance and background are removed by changing colored image to grayscale and then in to binary matrix form. Character recognition algorithm is applied on the binary images. All components of image are compared with pre-defined standard template and characters are recognized based on best match. Each matched character is displayed and stored in a log file. This algorithm is tested with vehicle images of different backgrounds and illumination. The camera focus, viewing plane and the distance from the vehicle were varied. The results of experiments are fascinating with good accuracy rate.**

Keywords*— *Vehicle Registration Plate Recognition (VRPR), Image Segmentation, character recognition, grayscale, binary image, Registration Plate (RP)

I. INTRODUCTION

In today's real world applications Image capturing and its processing has a vital role. It is used to detect an object and extract the valuable information from the captured image. Vehicle Registration Plate Recognition (VRPR) has always been a fascinating and challenging job in the field of image processing. With the development of electronics devices which have better image quality, portability and digital images, there has been a continuous work to improve the quality as well as efficiency of VRPR system.

The advantage of a digital image processing is that the data captured can be used in variety of applications. Registration plate recognition has gained the importance in intelligent traffic control systems. VRPR is a challenging job because vehicle images are captured in different conditions like in day, night or rainy day. Different formats are being caused in writing vehicle registration plate, distorted plates, different background, angle with respect to registration plate and distance from which the image is captured. VRPR comprises of three major processing steps, which include locating and enhancing the registration plate image, segmentation of the plate characters, recognition and extraction of each character separately.

A. Pre- processing Image

Various methods have been proposed for each processing step involved in recognizing a registration plate. Techniques used in localizing the registration plate (RP) are edge detection techniques, Color information based approach and mathematical morphology. D Zheng, Y Zhao, and J Wang proposed the method of locating the registration plate based on recognizing the registration plate pattern in the image [1]. S Park and et. al. gave method of locating the registration plate in the image by applying neural networks approach [2]. G Cao, J. Chen, and J Jiang used adaptive approach in localizing the registration plate [3]. V. Abolghasemi and A. Ahmadyfard worked on improving registration plate image by image enhancement method [4]. H. Bai, J Zhu and C Liu gave method for extracting the registration plate from complex background by using the image processing methods. T. Naito et al suggested a method [7] for recognition of Japanese registration plates consists of extracting geometrical features, such as width, length, and centroid coordinates of regions to detect the character regions in outside environment. The resulting image is made in binary form and characters are isolated from the RP sub-image.

B. Segmentation

Segmentation method is used to separate the pixels constituting the Registration plate character from the background image. The Hough Transform can be used to obtain the polar representation of the boundary lines that contains the region of character segments. Whole procedure is preceded with a binarization technique for character segmentation to eliminate background noise [12]. There are also direct methods for character recognition that do not explicitly segment the characters for example Xiaobo used pattern matching techniques for character localization and recognition [6].

C. Character Recognition

Character recognition process is mainly based on classification or template matching techniques. Anagnostopoulos used the classifier technique by applying probabilistic neural network. It takes vector form of the segmented character as input and uses distribution function to determine the class to which the character belongs [5]. Seetharaman used pattern vector formed on segmented characters to do recognition of characters [8]. Ahmed used the Hamming Distance between segmented characters and prototype characters to recognize characters [9]. The basic method for character recognition is template matching, it compares each segmented character by previously stored standard characters to select the best match of the segmented

character. For best results dimension of standard character is predefined and all the segments and prototype letters are resized to this dimension. The same approach is being applied in this paper.

D. Methodology

The method followed in this paper is, first converting the colored image in to grey scale and then in to binary matrix image. This process enabled to cope with outdoor conditions, different background and different plane of the image. In the second step the Regions of Interest (RoI) is detected based on the concentration of pixels in the image and then the stored image is segmented based on Sliding Concentric Windows (SCW). In the last step the segmented image is compared with stored template to give the actual characters in RP for creating a log file of registration plate. Region of interest and character recognition are proposed which can run on different size of image and for various character sets for registration plate recognition. This system can be used for low to high quality images with different background.

II. REGISTRATION PLATE RECOGNITION SYSTEM

This paper focuses on implementing the algorithm of template matching to recognize the characters in the Registration plate using MatLab. In VRPR, the first processing step is locating the approximate position of the RP in the image under consideration. It is assumed that the entire RP is captured in the image. This step includes extraction of Registration plate boundary has been defined using the edge detection method using Matlab. In the second stage the individual characters of the Registration plate is identified and their size is brought equal to the size of template in order to prepare the correct input for the next stage, this is called as character segmentation. The input image containing a single RP is provided and the system divides the complete image in to sub images of the character contained in the RP. As a final step, individual characters are isolated from the remaining RP elements. Now, the individual character is compared with the existing database containing English alphabets and numerals. Database contains 26 English alphabets and 10 numeric characters of all possible fonts and of standard size. The closest match is recognized and its ASCII value is determined. The extracted alphabet or number is displayed and stored in the database.

A. Basic Character of Indian Registration Plate

In India two different class of Vehicle RP are being followed. The private vehicle have registration plate with black character on white back ground, where as taxies have black character on yellow background. Military vehicles also follow the same pattern as that of private vehicles but have some special character like upward arrow. To detect the military vehicles, special character can be added in templates. In this work, our main focus is on taxi and private vehicle as they are major part of traffic on road.

III. III. PROPOSED VRPR SYSTEM

Proposed Vehicle Registration Plate Recognition (VRPR) system was designed based on the following fundamental steps:

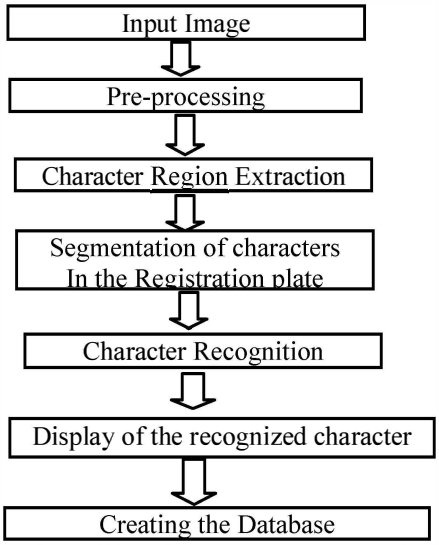

Fig.1. Proposed System for Registration Plate Recognition System

A. Input Image

A variety of images of different background were captured by a digital camera placed at a distance of 5-6 metes away from the vehicle. The camera used has a resolution of 9.0 mega pixels. The image captured is mainly focused on registration plate, so that captured image consists of only the Registration Plate. The images are taken from both front and back side of the vehicle and are captured in the plane normal to the registration plate. Some of the captured images and their processing are shown in next figures.

Fig. 2 Input images from camera

B. Preprocessing

The input image is in the RGB (color) format. In this step the input image is converted in to the grayscale image for easy analysis as it consists of only two colors. After converting the image in to gray scale it is to be converted in to binary image so that it may be compared easily with templates. A threshold

parameter is applied on grayscale image to convert it in to binary image. This binary image is stored in the form of matrix. By this process any background ambiguities like different color or small screw spots are removed. RP characters which are in black color on white/yellow back ground color are reversed to white and black respectively. Doing this will make white and black pixel density recognizable, help in segment the image as per no of characters.

Fig 3. Images after pre processing

C. Character Region Extraction

Character Region (high character density region) is extracted from the binary image by removing all the objects which are lesser than a pre decided no of pixel. The size of matrix pixels has been standardized after testing the process with many images to achieve the accuracy. The no. of pixels present in an object depends upon the resolution of camera. More the resolution of camera more is the pixel present in an object.

Fig 4. Images after character region extraction

D. Segmentation of Characters in Registration Plate

After the extraction of registration plate from the image, characters in a registration plate are recognized by defining the connected and non-connected components using MatLab function. Then using region props function (MatLab), draw bounding boxes around each character. It is similar to making frames. The no of frames are also calculated for comparing the individual frame. These individual frames are then compared with the stored templates database.

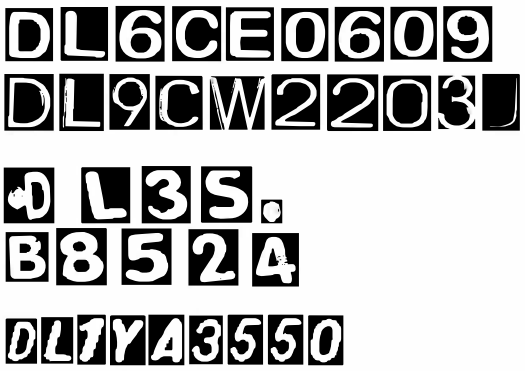

Fig 5. Images after character extraction

E. Character Recognition and Database Generation

The segmented frames are compared individual with stored templates and the closest matching character is recognized and displayed to the user. The ASCII value of these characters is generated and the extracted number of the Registration plate is stored in the file along with the date and time. The sample log file is as shown below.

Registration Plate:-DL6CE0609
Date:-08-Jul-2012

Registration Plate:- DL9CW2203
Date:-08-Jul-2012

Registration Plate:-DL3CM2603
Date:-08-Jul-2012

Registration Plate:-DL3S B 8524
Date:-08-Jul-2012

Registration Plate:-DL8CN2032
Date:-08-Jul-2012

Registration Plate:- DL3CAX0857
Date:-13-Jul-2012

Registration Plate:-UP13Q4417
Date:-13-Jul-2012

Fig. 6 Sample log file data

IV. EXPERIMENTAL RESULTS

All experiments are performed on Dell Intel(R) core i5 CPU @ 3.30 GHz processor with 3.8 GB RAM on Ubuntu operating system under MATLAB 2011b environment. The images were taken using DSLR (Sony) 9.1 MP camera.

A very high amount of accuracy was achieved in identifying the Registration plate even for a blurred image. This real time method is highly efficient in recognizing the characters in the registration plate. Sometimes, due to noise in the image and quality of camera, there can be a possibility of an error in identifying a character. A few examples of such common mistakes done by the algorithm are listed below.

TABLE I. SOME CHARACTERS WITH VARIATIONS IN RECOGNITION

Actual Character	Recognized Character
D	O
Q	O
M	H
M	V
B	8
1	I
5	S

V. CONCLUSION

In this paper an algorithm to identify the RP and store it in the database, is designed. Implementation of algorithm shows very high accuracy, it is the major achievement of the complete exercise. The algorithm works well for images taken in different backgrounds and for different fonts. In addition output being stored in log file with time stamping, adds the mark of completion to the work. The intermediate images generated for comparison are not saved after processing and only the text file with time stamp is saved in the end. This is an adaptive algorithm to all fonts based on template. The work can be extended further to add the functionality of using other languages apart from English and for computerized number plates also. New templates are to be designed and standardize the pixel matrix to gain accuracy level.

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