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Correlation Based Vehicle Number Plate Recognition Using Template Matching

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Abstract— Number Plate Recognition is one of the most important elements in vehicle identification. Nowadays number of vehicles are increased everywhere, so it becomes very essential to identify licensed vehicle. In this paper an algorithm for Automatic Number Plate Recognition uses Optical Character Recognition (OCR) with template matching technique. The proposed algorithm is mainly consisting of three main parts, Detection of Number Plate, Image Segmentation, and Number plate Identification. The proposed system is implemented in MATLAB, and its performance is tested on real images of number plates. The system successfully detects and recognizes the number plates of three types of fonts: Arial, Times New Roman, Verdana.

Keywords - Automatic Number Plate Recognition (ANPR), Optical Character Recognition (OCR), Image Extraction, Image Segmentation, Template Matching.

I. INTRODUCTION

The number plate recognition of a vehicle is one of the important parts of an intelligent traffic control system. License number plate is unique identification of any vehicle. Due to growth of population and human needs, it becomes very difficult to control the vehicles. Hence Number Plate Recognition is designed to make the task of controlling vehicles easy.

Number plate recognition is basically an Image processing technology, which plays important role in maintaining traffic rules and law enforcement. Number Plate Recognition has variety of applications like speed enforcement, toll collection, parking lot management, control and detect criminal activities, security control of restricted areas like military zones, border areas or top government office areas.

The proposed system is basically consist of three steps, detection of number plate of the vehicle using image extraction & RGB to binary conversion, Image segmentation where characters in captured image are segmented and finally recognition of the number plate by using Optical Character Recognition technique.

The rest of the paper is scheduled as follows: Section 2 Gives Literature survey, Section 3 gives the system overview, Section 4 shows the Extraction of the image & Section 5 performs the Image segmentation, in section 6 recognition of number plate is done by OCR technique, Section 7 shows the Experimental Results and the Paper concludes with Section 8.

II. LITERATURE SURVEY

Automatic Number Plate Recognition was firstly invented in 1976 .There are various algorithms used by many researches for extracting and recognising number plate of vehicles. Some of the

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related work is as follows. Automatic number plate recognition using optical character recognition techniques are proposed by. Lotufo, Morgan and Johnson [2]. Knowledge-guided boundary following and template matching for automatic vehicle identification is proposed by Johnson and Bird [3]. Bidirectional associative memories (BAM) neural network for number plate reading is proposed by Fahmy [4].which is suitable for small numbers of patterns only. Fuzzy logic and neural networks for car LPR is proposed by Nijhuis, Ter Brugge, Helmholf J.P.W. Pluim, L. Spaanenburg, R.S. Venema and M.A.Westenberg [5].For segmentation and discrete-time cellular neural networks (DTCNN'S) for feature extraction, fuzzy logic is used. The method based on vertical edge using Hough Transform (HT) for extracting the license plate is invented by Choi [6] and Kim [7].Park et. al. [13] invented a method to extract Korean license plate depending on the colour of the plate. A method of extracting plate region based on colour image segmentation by distributed genetic Proposed by H.J. Kim, D.W. Kim, S.K. Kim, J.V. Lee, and J.K. Lee [14].

III. SYSTEM OVERVIEW

In proposed system image is captured through camera and processed. Image is converted into text form, by converting RGB image into grayscale and then grayscale into binary. Segmentation is performed on image by filtering first and separating out every character of image from each other. Final stage is Optical character recognition by using template matching method.

The flow of the proposed system is shown in figure 1:

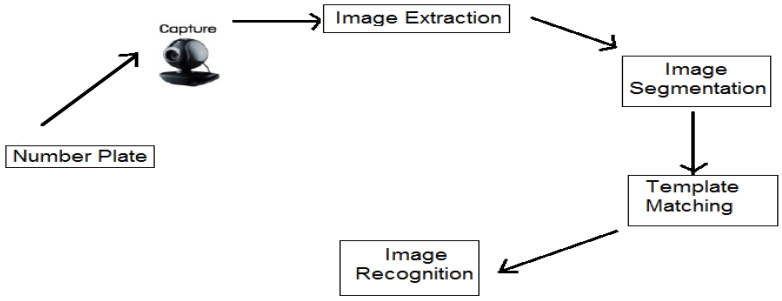

Fig.1. Proposed System

The Flow of Proposed System will start working when vehicle is approach to the area where camera is placed. The image is captured through camera from 4 to 5 meters away for exact identification. Captured Number plate image is converted into text form by using RGB to binary conversion. Segmentation is carried out to separate image character and then characters are labeled accordingly. Each separated character is compared with database elements by template matching technique. Finally every character of number plate is identified to get the number plate of the vehicle.

IV. IMAGE EXTRACTION

Number plate extraction is the first step of proposed algorithm. System will retrieve the properties of captured image such as width, height etc. With the help of these properties system extracts the number plate area from captured image. The conversion of captured image into grayscale image is done by calculating the average value of R, G, & B.

The RGB to grayscale conversion is performed by using equation 1.

$$\text{Gray} = 0.299r + 0.587g + 0.114b \qquad (1)$$

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The conversion is done by thresholding technique. When the pixel value is less than specified threshold value, output pixel becomes 0 (black) and all other pixels will remain 1 (white). Computation of Threshold TH is done using equation 2 [2].

$$TH = (\sum_{i-1}^{n} h(t) + i)/(\sum_{i-1}^{n} h(t)) \qquad (2)$$

B(x, y) = 1 when G (x. y) < TH.

B(x, y) = 0 when G (x. y) > TH.

The binary image converted from extracted RGB image is shown in Fig.2 & Fig.3.

Fig.2.Captured Image

Fig.3.Binary Image

V. IMAGE SEGMENTATION

Character Segmentation is the second part of algorithm. Segmentation is used to extract number plate elements such as characters and numbers from the plate's background. To improve the quality of extracted image noise removal is required. Segmentation starts with image filtering by Gabor filtering method. Characters are then separated out by dilation operation. Horizontal and vertical smearing is applied for searching of character regions. Plate characters are cut by finding starting and ending point of the characters, which indicates the location of each character as shown in Fig.4

The connected components can be 4 connected or 8 connected, hence need to convert image into 4 or 8 connected form. In the captured image, the numbers of small, big, square or rectangular shaped components are present. So it becomes very essential to analyze which components are of number plate and which are of others. For this horizontal analysis, height analysis and width analysis are used.

Fig.4. 4- Neighborhood and 8- Neighborhood connectivity

Depending on pixels connectivity, connected component analysis scans each character of image from top left to right bottom and assigns label to each component. The connected components are analyzed to filter out wide, long and big components, and the components which are based on defined values only remains. Each connected components are cropped and then extraction is carried out as formulated from [2].

The formula for extraction of connected component is given in equation (3)

$$X_k = (X_{k-1} + B) \cap A \qquad (3)$$

Where A is plate image and B is a suitable structuring element. The procedure will terminate when $X_k = X_{k-1}$.

Fig.4 Locations of Character

Fig.5. Individual Characters

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VI. IMAGE RECOGNITION

Character Identification or recognition is the last step of the system. Before recognition, the characters should be normalized. The Normalization is the process of refining the characters into a block, containing no extra white pixels in all four sides of the character. Character is centralized, and each character is resized in 24x42 format, with constant height and width. Each character is of equal size as shown in Fig7

Fig.7. Equal size characters

Optical Character Recognition is performed by template matching technique. For matching the characters with database element, the image character which is to be matched and database character, both should be are of equal size. Here characters are fit into 24x42 sizes, which are done by normalizing process.

A. Template Matching:

In template matching, character image is compared with database image and the image, which is having best similarity, will be selected from the database. To find the best similar match a simple method known as correlation is used. Matching of character is done pixel by pixel. Recognition is performing by comparing whole string with database and best match is taken out of them. Priorities are given for template matching as templates for each character are loaded one by one. For certain templates higher priority is assign and when that higher priority template is matched then lower priority will be discarded.

If X (i) is the input character, M(x, y) is the template , then the matching function r(d) will return a value indicating how accurate a template n matches the input character. The matching function used is Normalized Correlation given is given in equation (4) [1]:

$$r(d) = \frac{\sum_i [\{x(i)-mx\} * \{y(i-d)-my\}]}{\sqrt{\sum_i (x(i)-mx)^2} \sqrt{\sum_i (y(i-d)-my)^2}} \qquad (4)$$

The system uses the database of 33 alphanumeric (23 alphabets & 10 numerals) characters. The database is as shown in Fig.8:

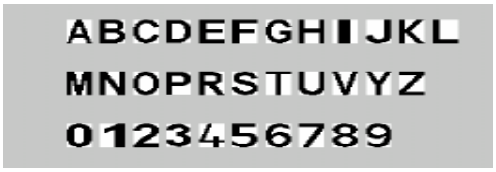

Fig.8. The database characters

B. Implementation:

The camera is attached to the laptop or system using USB port. Interfacing of camera is done through the MATLAB software. When a vehicle comes in front of system, camera will capture the image of number plate. Captured image is converted to grayscale and binary form. Localization of extracted characters is performed after conversion of RGB image into text. Image segmentation is performed and each character is separated out from each other. To recognize the characters, each character should be of same size and shape as that of database characters. By comparing these characters with templates stored in database, number plate is recognized.

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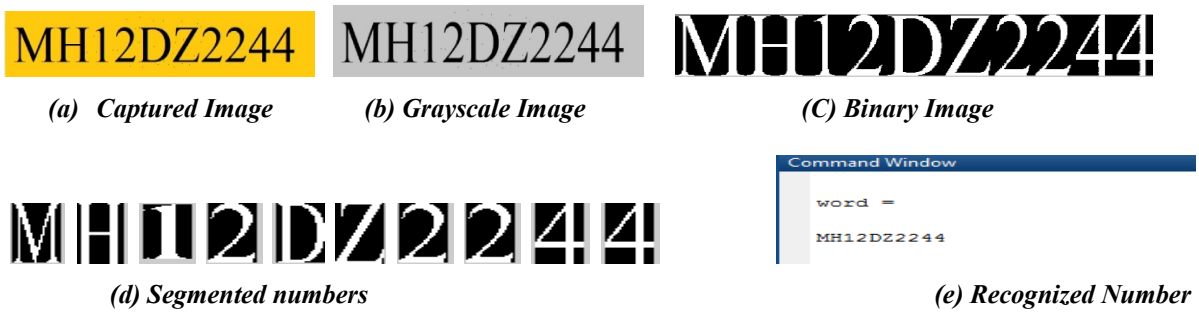
VII. EXPERIMENTAL RESULTS

In this section results of number plate recognition are shown. Experiments have been performed to test the proposed system and get the accuracy of system. Three types of fonts: Arial, Times New Roman & Verdana are considered for Number plates Recognition.

The experimental results for Times New Roman font are shown in Fig.9:



(a) Captured Image *(b) Grayscale Image* *(C) Binary Image*

(d) Segmented numbers *(e) Recognized Number*

Fig.9. Results of Times New Roman Font

The experimental results for Arial font are shown in Fig.10:

(a)Grayscale Image *(b) Binary Number* *(c) Recognized Number*

Fig.10. Results of Arial Font

The experimental results for Verdana font are shown in Fig.11:

(a)Captured Image *(b) Binary Image* *(c) Recognized Number*

Fig.11. Results of Verdana Font

VIII. CONCLUSION

In this paper, an efficient algorithm is used for recognizing the vehicle number plate. System captures the number plate image, extract it and convert it from RGB to binary, locate the characters in the image, segment them and identify the character as whole number plate of vehicle. Number plates of three types of fonts are used and achieved a good recognition rate like 84% for Arial, 82% for Times New Roman, 80% for Verdana font.

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