International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 05 | May-2016 www.irjet.net p-ISSN: 2395-0072

An Automated Vehicle License Plate Recognition

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Abstract - *An exponential increase in number of vehicles necessitates the use of automated systems to maintain vehicle information. The information is highly required for both management of traffic as well as reduction of crime. Number plate recognition is an effective way for automatic vehicle identification. Vehicle Number Plate Detection (VNPD) is a mass surveillance system that captures the image of vehicles and recognizes their license number. Vehicle Number Plate Detection (VNPD) system is a type of intelligent transportation system (ITS).Some of the existing algorithms based on the principle of learning takes a lot of time and expertise before delivering satisfactory results but even then lacks in accuracy. In the proposed system an efficient method for recognition for Indian vehicle number plates has been devised. The algorithm aims at addressing the problems of scaling and recognition of position of characters with a good accuracy. The objective is to design an efficient automatic authorized vehicle identification system by using the Indian vehicle number plate such that the number plate of vehicle can be identified accurately and to implement it for various applications such as automatic toll tax collection, parking system, Border crossings, Traffic control, stolen cars etc In this proposed system , different phases such as number plate localization, character segmentation & recognition of the number plates are carried out. The system is mainly applicable for non standard Indian number plates by recognizing single & double line number plates under different varying illumination condition and works on multilingual, multi colour number plates according to Indian condition.*

Key Words: ***Neural Network; Template Matching; Sliding window; Normalized Cross Correlation***

1.INTRODUCTION

The population of India is increasing day by day, thus the number of private as well as public vehicles are also increasing with a great deal. This increase in number of vehicles is also serving a reason for increase in traffic and various crimes associated with it. Various cases of theft, hit and run, robbery, kidnapping, smuggling, on-road fatalities, etc. remain unsolved because the vehicles involved could not be recognized accurately [1]. It has various applications in toll payments, parking management, road-traffic monitoring, security, crime identification etc. [2]. These vehicle monitoring applications need to maintain a listing or detail of vehicles. Manual monitoring of vehicles is cumbersome and error prone because of weak and unreliable human memory. Thus, there is a need of a robust mechanism such as an automated vehicle recognition system to handle this task efficiently. Each vehicle is uniquely identified form its number plate. An Indian number plate contains the following ten characters in order. State code is a set of two alphabets. Followed by a state code there is a combination of two digits and alphabets for district information. At last a four digit actual registration number [3]. When a number from the number plate is correctly detected, the complete information about the vehicle and its owner can be retrieved. Lazrus et al. [4] proposed an algorithm for vehicle number plate detection and recognition using segmentation and feature extraction using template matching. Koval et al. [5] proposed a method for deblurring the number plate images and recognizing them using feed forward neural network technique. Ozbay and Ercelebi [6] proposed smearing and dilation technique for automatic vehicle identification. Shidore and Narote [7] devised histogram equalization followed by dilation and erosion for plate area extraction. The devised method used SVM classifiers were used for character recognition. Kumar et al. [8] proposed a method based on edge detection using Hough transform. Massoud et al. [9] devised a system using dilation, smoothing and erosion. Chen and Luo [10] and Du et al. [2] located license plate using improved prewitt operation. Khalil[11] suggested an approach based on moving window with template matching technique.

Vehicle Number Plate Detection (VNPD) System for vehicles contains three basic modules namely image preprocessing, candidate area extraction and character recognition [12]. In pre-processing, the image is being loaded and converted to gray or binary, followed by some denoising techniques. In candidate area extraction, detection of number plate area and segmentation of characters is carried out. In character recognition, template matching and retrieval of characters is performed. Character recognition can also be performed by

neural network but it needs periodical training for better efficiency. It also takes a lot of time and expertise for satisfactory results. In the method using neural networks [13] a perceptron is trained by providing a sample set and few intelligent rules. The problem with neural networks is that training a perceptron is quite difficult and it involves huge sample sets to train the network. If neural network is not trained in an appropriate manner, it may not address scale and orientation invariance. But training network with a rule that solves these problems is even more difficult. Template matching [11] on the other hand is an easier technique as compared to neural networks. Also, it does not require powerful hardware to perform its operations. But it is susceptible to the problems of scale [14] and orientation [15]. There are certain factors which make the number difficult to recognize from the number plate.

i. Numbers are cluttered with other objects. It is difficult to tell which pieces go together as part.

ii. Parts of the number may be hidden behind other objects.

iii. The intensities of the pixels are determined much by lighting as opposed to the nature of the object. For instance black pixels on bright light will give much more intense pixels than the white surface in a gloomy light.

iv. Objects can be deformed in varieties of ways. There are wide varieties of different shapes that have the same name. For instance number '2' can be written in different ways.

v. Scaling is a huge problem in methods like template matching. The correlation differs vastly when the image is scaled [14].

vi. An image may be captured from various viewpoints. Changes in viewpoint cause changes in images thus the same information occurs in different pixels. This problem cannot cope up with standard machine learning approaches.

Scaling of characters in template matching may degrade the efficiency of character recognition. Characters with different sizes have different scales this is referred as scale variance. In order to handle such cases, a correlation is created for the templates. In this paper a new template matching model has been proposed to address scale variance.

2. Literature Survey

We have proposed a method of Automatic number plate recognition system based on image processing , the multiple peripheral interfaces and the high frequency execution of the ARM processors make them an attractive choice for real time embedded systems. DSPs are already widely used for applications such as audio and speech processing, image and video processing, and wireless signal processing. Practical applications include surveillance, video encoding and decoding, and object tracking and detection in images and video. The main goal of this work is to design and implement efficient and novel architectures for automatic number plate recognition (ANPR) system using image processing , which operates in high definition (HD) and in real time. Using otsu method and its optimization focused on real time image and video processing for license plate (LP) or number plate localization (NPL), LP character segmentation (NPS) and optical character recognition (OCR) in particular, which are the three key stages of the ANPR process. Its applications include identifying vehicles by their number plates for policing, control access and toll collection. The common guidelines suggest that, to read a number plate, the car should be 50% of the screen height. The height of the vehicle is assumed as 1.5 meters . The recognition will be performed in almost real time, watching cars passing at low –high speed in front of video recording device.

The OCR method This allows the user to choose an OCR engine which is suited to the particular application and to upgrade it easily in future. An alternative OCR engine is based on the constraint based decomposition (CBD) training architecture. The system has showed the following performance (on average) on real-world data successful plate location and segmentation is about 99%, successful character recognition is about 98% and successful recognition of complete registration number plates of about 80%. There are special designs issued for significant events such as the Sydney 2000 Olympic Games. Also, vehicle owners may place the plates inside glass covered frames or use plates made of non-standard materials. These issues compound the complexity of automatic number plate recognition, making existing approaches inadequate. System incorporates a novel combination of image processing and artificial neural network technologies to successfully locate and read vehicle number plates in digital images.

The proposed algorithm consists of three major parts : 1. Extraction of plate region, 2. Segmentation of characters 3. Recognition of plate characters. The main goal is to build a prototype system, which should be capable of recognizing a license plate number of standard format. The recognition should be performed in real time, watching cars passing at low-high speed in front of video recording device. Locating and detecting text in video is an interesting and real time research problem, which finds lot of applications in multimedia related area. This problem is nearer to the human perception as some of the strategies can be taken from human perception. In this work, a method is proposed to locate the vehicle number written in the front or back panel of the vehicle. The input is taken from a stationary

camera, which continuously takes the video of the passing vehicles through it. The problem of location involves lot of preprocessing activities like, normalization, skew detection and correction and segmentation. it is required to carry out preprocessing activities such as noise removal, edge detection, is done on the recorded video. Any standard OCR can be used at later stage to identify the text. Since the domain of the characters is very limited in the text of vehicle number, high recognition rate can be expected in the OCRs. Segmented characters are to be recognized. It was decided to use an algorithm, which must be as simple as possible, since the types of characters that appear on the number plates are limited.

3. PROPOSED SYSTEM

The proposed method is designed for Vehicle Number Plate Detection for Indian vehicles. In Fig. 1 the method for proposed VNPD System is depicted. VNPD System consists of the following modules:

A. Preprocessing

In this module firstly an input image is taken from an external source such as database or camera which is converted to grayscale. In this first phase, we capture the image of the vehicle and normalize to a standard dimension of 400 × 300 pixels. We then convert the RGB image into a grayscale one:

$$Agl = (3Ar+6Ag+Ab)/10$$

where *Agl* is converted gray-level image, and *Ar*, *Ag* and *Ab* are the RGB spectrum of the color image, respectively. Figure 1 shows original image, *Ar*, *Ag*, and *Ab*.

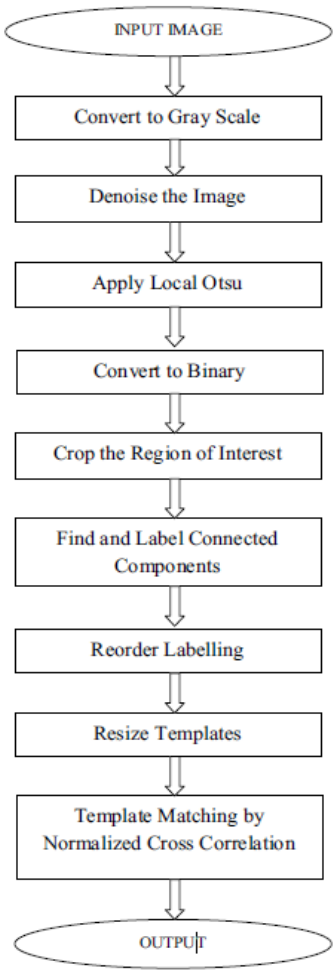


Fig. 1 Schematic flow of proposed method

Generally, the image obtained contains some irrelevant information or impurities such as holes, dirt particles and the background which must removed. The noise is removed using median filter.

Fig. 2 Input Image

Segmentation is performed using local Otsu's method. The initial threshold is set to zero. By calculating the size of input

image, *n* window frames of equal size were found representing the overall image. A window frame moves on the input image and its local threshold is being calculated, the task is carried out for *n* window frames. Finally the average of *n* threshold values is calculated. This weighted threshold value is used to convert the image to binary scale.

B. Candidate Area Extraction

In this module the number plate area of Indian vehicles is located and extracted. The exact number plate area is being located and cropped from the original image as shown in Fig. 3. Then the components are detected.

Fig. 3 Cropped Image with Region of Interest

Detection of components is done by starting with the top-left corner, the pixels are scanned from left to right in a top down fashion for any lower intensity pixels. If a lower intensity pixel is found, all the connected pixels of similar intensity are found and their information is stored in a set. Traversing along, if a pixel of higher intensity is encountered, the pixels are again scanned till a pixel of lower intensity is found. If the currently discovered pixel has already been recorded in the set, the scanning is continued without storing its information. The process is again continued until all the connected pixels forming different components have been recorded. The image is depicted in Fig.4

Fig. 4 Connected Components

The connected components by default are ordered using their left-top values, thus the numbers in the number plate do not occur in correct sequence. Though the correct sequence in the image should be 567 890 but since number 8 left is earlier than number 6. Hence number 8 is labeled before number 6. In order to minimize the layout of the numbers in the number plate the information stored in the set is used and the values of collected components are compared with other component in the set according to the bottom left values. The process is initiated by selecting any two components and reading the information of their bottom-left pixel coordinates and comparing them. The lowest value is used to rank the component. This process is continued till all the bottom-left values of the components have been matched. The rank found as a result of this process is used as a label to identify the order of the component in the image as in Fig. 5. Equation (1) represents the logical expression for the same where *G* is a connected graph with vertices *V* and edges *E*

$$\forall a, a \in \text{Connectivity}(G(V, E), x) \forall i N, \exists k \in N \{\text{Bottom}(a_k) < \text{Bottom}(a_i) \cap \text{Left}(a_k) < \text{Left}(a_i)\}$$

$$\forall i\, N, \exists k \in N \{ a_k\, \text{List}_j \Rightarrow \text{List}_j = \text{List}_{j-1}\} \quad (1)$$

Fig. 5 Labeled Connected Components

C. Character Recognition

In this module the labeled characters are retrieved and recognized. The templates loaded are resized to the size of recognized characters. Normalized cross correlation template matching is used to find the best match. Templates from an existing template set are selected and resized according to the size of the components discovered in the process. Resizing is done in such a way that the scale variance is minimized. In the proposed algorithm, the height and width of the template image is resized to the height and width of the characters of the processed image. Normalized Cross Correlation is performed between the components and the template image to find the degree of similarity between them. The value is obtained is compared to a given threshold. If the value of cross correlation is greater than the proposed threshold then the original threshold value is updated to the new one. If more than one correlation values

exceed the previous threshold then threshold is updated to the highest among these values for the best match. The matched characters are retrieved and the result is stored in a text file.

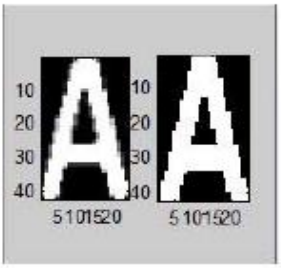


Fig. 6 Template Matching By Normalized Cross Correlation

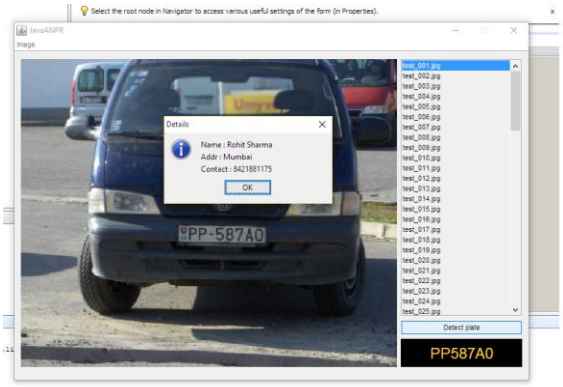
D. Extra of Linked Information and Processing

In this section, a database of information linked to the license plate number which may include the vehicle's owner information such as postal addresses, contact information, number of parking tickets etc. Also bank account information may be linked to debit fine amounts.

This linked information can be very beneficial for a proposed automated system wherein any traffic law broken can be immediately reported to the vehicle owner and his/her information may be reported to the officials for further processing.

4. EXPERIMENTAL RESULTS AND DISCUSSION

In order to evaluate the success of the proposed method 60 vehicle image samples were checked. Otsu's method for threshold partitioning was modified using the average of every window threshold. The bottom left pixel coordinates were used to find the sequence of characters and label them accordingly in the sample image. Maximum cross correlation was found using template matching for recognizing the characters. As a result 56 in 60 were correctly detected and 56 in 60 were correctly recognized by this system



5. CONCLUSION

This paper presents VNPD System algorithm based on template matching. The algorithm used modified Otsu's method for threshold partitioning. Scale variance between the characters was reduced by maximizing the correlation between the templates. An algorithm is proposed to cope with scale variance by using template matching with Normalized Cross Correlation. It obtained the accuracy of 98.07%. An automated reporting system using owner's linked fastracks the process of traffic law enforcement and motivates public to build a smart sense of driving.

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