Methods of Automatic License Plate Recognition: A Review

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ABSTRACT

Automatic vehicle number plate recognition is the most interesting and challenging research topic from past few years in India. In India, study indicates that the number of death toll in road accidents has gone up in recent past. Identification of vehicle and its owner who violates traffic rules has become very important. This is necessary in order to maintain traffic in control and to minimizing road accidents. Manually it is almost unmanageable to control this process. It is highly impossible to track the owner who are breaking the traffic rules and punish them. Thus by automating this process, we can catch the real owner of driven vehicle and with the help of computerized system we can handle the current activities and locate the license plate number using different image processing techniques. This automated system of recognizing and characterizing the license plate number of moving or still vehicle is called as a License Plate Recognition (LPR) system. This system consisting of four main phases such as image capturing, image preprocessing, character segmentation and character recognition. According to rules and regulations the license plate varies for country to country. It may vary in formats and color. According to rules and regulations each country has their own ANPR system. Right now this system is implemented in US, UK, Australia, Japan road conditions, but yet to be done real time work for Indian road conditions. In this paper our objective is to present the review of detailed processes and methods presented for LPR system. LPR system is based completely on real time image processing.

Keywords: License Plate Recognition, License Plate, Automatic Number Plate Recognition, Image capturing, Image preprocessing, Character Segmentation, Character Recognition.

1. INTRODUCTION

Intelligent transportation system (ITSs) are playing most important role in analyzing and handling the vehicles on the roads. India needs very intelligent traffic management system for handling the traffic on the roads day by day and in this ANPR is playing very important role in various real life applications such as parking lot payment, toll payment (access control) and law enforcement. Due to use of such automated system helps to reduce many overheads as compared to manual systems. The process of LPR is composed of three tasks such as image preprocessing, license plate detection, character segmentation and character recognition. The complexity increases when we are working with different view and angles i.e. when we are thinking of implementing the different tasks for making it very much application oriented. Many of the LPR system are minimizing the complexity by putting some constraints over the distance and position of camera or vehicle and its inclined angles. In our consideration of different angles and views of cameras, then the recognition rate is increased significantly and our overall system becomes stronger and in addition to it there are some other features such as illumination intensity and geometric background using which we can increase the accuracy of LPR system. In this paper we focused on how ANPR system works and explaining it’s very briefly and along with it we are discussing the different methods presented for each phase.

2. REVIEW OF LICENSE PLATE RECOGNITION METHODS

ANPR system is composed of following tasks or phases as shown in fig. We are explaining it one by one in brief and various methods incorporated for each phase by the various author.

![Fig 1: Architecture of License Plate Recognition.](image-url)
2.1 Image Capturing
The first task or phase of ANPR system to which we provide vehicle image as an input. These images are captured from the moving either from moving videos or still cameras. The qualities of images are depending upon the quality of cameras. The images are always in different sizes, different orientations and directions etc.

2.2 Image Preprocessing
The second phase of ANPR system is Image preprocessing in which vehicle image is improved by converting it into grey scale and transforming to binary, also smoothing and sharpening are carried out. In image preprocessing quality of image is improved by removing shadows and noise. In this various algorithms are used. In next section we are discussing preprocessing algorithms. In [1], Otsu binarization method is used for preprocessing. The image gets segmented into several sub-regions or parts for each part, type and maximum threshold value are calculated. In [4], preprocessing can be performed to locate the Region of Interest (ROI). This ROI can be helpful to detect the license plate in night or in ambient illumination conditions. By using image masking, binarization with Sauvola method. We can be able to detect RROI. For converting image from grey scale to binary we are adopting adaptive thresholding. For setting the threshold we have to think about range, variance and surface parameters. In the case of badly illuminated areas, calculated threshold value will be low. In [5], binarization can be done on the image for highlighting characters and suppressing background. By incorporating variable thresholding method, we can be able to reduce information loss from the images. This technique is proposed by Nakagawa and Rosenfeld [5]. In this technique, a local optimal threshold value is determined for each image pixel so as to avoid problem originating from non-uniform illumination. Locally adaptive thresholding method cannot completely able to remove information loss but it at least preserves the information that may be lost while we are using a simple binary binarization method. According to Anton Satria Prabuwono [6], a global threshold value should be set up. For preserving aspect ratio down sampling should be carried out. According to G. Sun et al. [7], preprocessing should be divided into luminance adjustment and image enhancement. These two tasks can be achieved by changing luminance curve and top-hat transform respectively. Hat transform helps to enhance hot region by suppressing the other regions. According to T. Duan et al. [9], by performing pre-processing we can enriching the edge features. For enriching this features various algorithms are used, they are graying i.e. converting the image from RGB to grey, normalizing and smoothing and histogram equalization. Histogram equalization helps to improve the contrast of image, which in turn improves results of edge detector. According to [13] preprocessing can be done with the help of sobel edge operator. According to Wenjing Jia [11], image de-noising helps to remove noises from the images. In this procedure, subtle fractures can be linked and tiny abrupt changes can be softened. By increasing the contrast between ROI and other regions, we can be able to prevent destruction of edges of images and its outline. In [10], improved Bernsen algorithm can be used for effectively removing the shadows from the image by converting it into a binary image. For converting it into binary we have to calculate two threshold values, they are original image threshold and gaussian filter image threshold. Each pixel of the original image is compared with these threshold values to convert it to a binary image.

2.3 Detection of License Plate Candidate
After first phase of the preprocessing step, the next is to detect the edges of license plate with the help of horizontal and vertical projections. We can also locate license plate through search window. If above method fails then original image is inverted and bottom of the license plate should be scanned. For this scanning projection histograms are used. The LPs are located at the bottom. On this the horizontal segmentation and vertical projection are carried out. According to You-Shyang Chen and Ching-Hsue Cheng [2], dense vertical edges region can be segmented as a candidate plate which is also known as RROI (Region of Interest). In the location procedure, vertical Sobel edge features are primarily extracted. Then skeleton extraction algorithm is performed. There is a possibility that dense pixels are arête region and isolated edge pixels are often noises. So density-based region growing method is used to locate candidate LP regions. To extract license plate characters in Indian road condition Ch. Jaya Lakshmi et al. [12] proposed an approach based on texture characteristics and wavelets [13]. In this paper morphological operation [14] for better performance in complicated background is used. License plate character extraction for video is discussed. As per Yuntao and Cui, localization means finding text in the images. The authors considering license plate with light background and characters with dark background. For localization, spatial variance method is used for finding text regions and non-text regions are found out by high variance. To detect license plate from moving video or from CCTV footage, ‘ConnectedComponent Labelling (CCL)’ is used for license plate detection [3], [4]. CCL is used for scanning the image and labelling it according to the pixel connectivity. There exist two types of connectivity: 4 and 8 connectivity. In [3], a feature extraction algorithm is used to count the similar label and distinguishing assigned region. Then region with maximum area is considered as possible license plate region and this region is forwarded to the segmentation process. But according to Fikriye Öztürk and Figen Özen [10], two different detection methods can be carried out in which first task is identification of white frame and second is black character identification. For this CCL technique is used, as it is insensitive to the edges. For determining the candidate frame aspect ratio, width of characters and height of characters should be considered. Further, the penetration times for LP are also calculated. In [4], after the successful CCL on the image, measurements such as orientation, aspect ratio, Euler number for every binary object in the image should be taken into consideration. Criteria such as orientation, aspect ratio and Euler number are
considered as candidate plate regions in [4]. But this method fails in dark background In [5], for locating the LP, fuzzy logic is used. For this fuzzy functions and vertical plate positions rules. But it is very sensitive to the color and brightness and takes longer processing time compared to conventional methods. In [6], For locating the edges of LP vertical edge detection method is very useful. In this very many changes in intensity should be considered as a plate zone. Image pixels are convolved with the horizontally oriented filter. The last step of plate localizing is horizontal projection. In [11], after applying the Sobel edge detection method, finding the column range and detecting row range. After these steps, license plate candidate will be obtained. In [9], Hough transform and counter algorithm is applied to detect the LP candidate region. Counter algorithm is applied to detect the closed boundaries of objects which next can be applied to though coordinate for finding intersected parallel lines. To filter out the candidate plates, the aspect ratio of the LP and the horizontal cross cuts are reused. Skew Correction Method: While we are taking the pictures it is highly impossible to avoid tilt while clicking it. When we are expecting the highest successful recognition rate, for this tilt correction should be carried out. In [6], Random Transform (RT) can be carried out for removal of skew or tilt in image. But this RT method has a large computation cost. For reducing the cost, RT should be replaced by faster Hough transform. In [10], the horizontal and vertical correction is done.

2.4 Segmentation of Character

After detection license plate localization, the next phase of process is segmentation of characters. Character segmentation is the procedure of extracting the characters from the license plate image. In [1], [3] and [10] horizontal and vertical projection are used to segment the characters. In [8], vertical and horizontal scanning is used to detect the characters. Width between the first and last columns of the character is separated from the plate background and stored in separate arrays. Subsequently, the horizontal and vertical scanning is performed. Horizontal scanning can be performed erodatively to detect the extra upper and lower region from the image. In [2], different methods are used for character segmentation. First task is a gray-level quantization and morphology analysis is performed. The candidate characters are selected. Operator chosen was (1, 0.2-H) pixels in X and Y orientations where H represents the height of ROI. To improve the results of segmentation procedure, above methods should be combined with binarization method.

2.5 Recognition of Character

Character recognition helps in identifying and converting image text into readable text. Almost all LPR systems are using different types of Artificial Neural Network (ANN), neural networks based on organized feature maps which are implemented in [5]. After recognizing an unknown character and the classified character is performed in the neural network literature. Anastasopoulos et al. [4] introduced Probabilistic Neural Networks (PNNs) comparisons. There are two PNNs, i.e., one for alphabet recognition and the other for number recognition. The recognition rates reported in the literature are very encouraging when PNNs are trained and tested in noisy, tilted, and degraded environments. The Optical Character Recognition (OCR) system is at a workstation. The character is recognized using neural network (BPNN) for recognizing characters. The 26 vertical projections and 50 horizontal projections of the normalized 26×50 pixel license plate image. It should now feed into 76 input nodes of BPNN. BPNN is very efficient for recognizing the characters. In [10], Support Vector Machine (SVM) is mostly used for character recognition. Local-Density Distribution (L-DCD) and Global-Density Distribution (G-DCD) are used for extracting features before training and testing data sets. In [8], the template matching method is used for character recognition. It can be also used for detection of objects generally in face detection or face image processing and medical image processing. It is divided in two parts. They are featuring based matching and template based matching. Feature-based approach is useful in case of template image has strong features otherwise template based approach can be useful. Each character is matched with the stored template character. Priority is assigned for each template so that exact character is found as a result. To differentiate the similar characters from character pairs such as (8, B) and (O, D) the authors predefined a set containing the characters 0, 8, B and D and each template. After the unknown character is classified as one of the characters in the ambiguity set, a minor comparison between the unknown character and the classified character is performed. Each segmented character is matched with the stored template. While matching the characters the priority should be assigned to highest level than the lowest one. Number templates are assigned higher priorities because chances of occurrences of alphabets are less than numbers. In [3], SOM neural network is used to identify the characters. An ordinary SOM consists of two layers, i.e., an input layer and a computation layer. The computation layer has its own processing units and hardware designed to calculate the hamming distance between a neuron and the input image character. The recognition rate is 90.93%. In [6], two types of template matrix are extracted. They are Object Thinned Representation (OTR) and Characteristics Background Spots (CBS). OTR represents the character shape while CBS reflects the image background.
3. CONCLUSION AND FUTURE WORK

In this review paper we presented the detail LPR system, which is composed of four tasks. ANPR can be further extended as multilingual ANPR to identify the language of characters. It can provide various benefits like traffic safety enforcement, security in case of suspicious activity by vehicle, immediate information availability as compared to searching vehicle owner registration details manually. It should be cost-effective and easy to use. It can be used by any developing and developed country. Another point that should be considered i.e. it should be application oriented that at the same time we can use it for the access control, traffic law enforcement and road patrolling. While we are thinking of its much application oriented we also thinking of the quality of resulting image it should be more and more clearer. Different rotation angles, tilt, and pan should also be considered.

REFERENCES


