Volume 7, Issue 1, January 2017 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

A Survey on Automatic License Plate Extraction Methods

Bhadra M V*
Dept. of CSE, Thejus Engineering College,
Vellarakkad, Kerala, India

Shine P Xavier
Asst. Professor, Dept. of CSE, Thejus Engineering College,
Vellarakkad, Kerala, India

DOI: 10.23956/ijarcsse/V7I1/0119

Abstract— Automatic License Plate recognition (ALPR) system is the one which can automatically recognize the license number from the vehicle image. It can be used with or without the database depending on the applications such as electronic payment systems, freeway and specific road monitoring systems for traffic Surveillance etc. Recognition is done by means of four steps. They are Image enhancement, license plate extraction, character segmentation and character recognition. In these steps, plate extraction is the most crucial since the accuracy of entire system mainly depends on the results that get from this step. Hence the best extraction or detection of the license plate of the vehicle is necessary to get the high recognition rate in any ALPR system. This survey has been made in this field by considering different methods of plate extraction that have been used to detect the license plate from the vehicle images. All these methods are categorized based on the features that they have used. A comparison is done based on the advantages, drawbacks and performance metrics of all these methods.

Keywords— ALPR System, Edge Detection, Mathematical Morphology, Connected Component Analysis, SCW

I. INTRODUCTION

Automatic License Plate Recognition (ALPR) is a mass surveillance method that mainly uses optical character recognition on images to read the licence plates on vehicles. In 2006, systems can scan number plates at around one per second on cars travelling up to 100 mph. Those systems used existing closed-circuit television or road-rule enforcement cameras, or ones specifically designed for the task. various police forces and as a method of electronic toll collection on pay-per-use roads, and monitoring traffic had used it for their own special purposes.ALPR system can be used to store the images captured by the cameras as well as the text from the licence plate, with some configurable to store even a photograph of the driver. Systems commonly use the infrared lighting to allow the camera to take the pictures at any time of day. A powerful flash is also included in at least one version of the intersection-monitoring cameras, to both illuminate the picture and make the offender aware of his or her mistake. ALPR technology tends to be region conceptual resources. So there are various recognition techniques and number plate recognition systems that are used in various traffic and security applications, such as parking, access and border control, or tracking of stolen vehicles.

It has a wide range of real-life applications such as automatic toll collection, traffic law enforcement, and road traffic monitoring. Reading or locating the license number plate is the main and the first step in determining the identities of peoples involved in the traffic incidents. The common aim of these application is to reduce man power and facilitate to the automatic management. So the ALPR system should exhibit both high recognition rate and processing speed. For example, drivers normally have little patience when waiting for their vehicle to be recognized by a car parking system. It is also mass surveillance method that uses OCR on images to read vehicle registration plates. This technology is region-specific, owing to plate variation from place to place. An efficient license plate localization system thus can become the core of the fully computerized road traffic monitoring systems. Furthermore, an ALPR system can have two varieties: online ALPR system and off-line ALPR system. In an online ALPR system, the localization and interpretation of license plates take place instantaneously from the incoming video frames, enabling real-time tracking of moving vehicles through the surveillance camera. On the other hand, an offline ALPR system captures the vehicle images and stores them in a centralized data server for further processing, i.e. for interpretation of vehicle license plates. ALPRs are cameras mounted on stationary objects (telephone poles, the underside of bridges, etc.) or on patrol cars. The cameras snap a photograph of every license plate that passes them by capturing information on up to thousands of cars per minute.

Each countries use their own way of designing and allocating number plates formats to their country vehicles. That license number plate is then used by various government offices for their respective administrative task like- traffic police tracking those people violating the traffic rules, to identify the theft cars, in toll collection and parking allocation management etc. In India all vehicles are assigned unique numbers. These numbers are then assigned to the vehicles by district-level Regional Transport Office (RTO). In India the license plates are placed in both front and back of the vehicle. These plates in general are easily readable by human beings due to their high level of intelligence on the contrary. So it becomes an extremely difficult task for the computers to do the same. The attributes like illumination, blur, background colour, foreground colour etc. may pose a problem. Some standards have been given for numbering vehicles.

II. LICENSE PLATE EXTRACTION METHODS

This section focuses on different methods that can be used to extract the license plate region from the captured vehicle image. Each method can be differentiated based on their features used for the process such as texture, edge etc.

A. Detection Of License Plate Using Edge Information

Edge detection is one of the basic tools used in image processing, basically for detection and extraction of features, which mainly aim to identify points in a digital image where brightness changes sharply and find discontinuities. The purpose of edge detection is to reduce the amount of data in an image and preserves the structural properties for further processing of the same image. In a grey level image the edge is a local feature that, with in a neighbourhood separates regions in each of which the gray level is more or less uniform with in different values on the two sides of the edge. In the case of noisy image, it is difficult to detect edges because both edge and noise contains high frequency contents which results in blurred and distorted output. Edge detection uses differential operators to detect changes in the gradients of the grey levels.

Initially the pre-processing is done using median filter. Median filter is a non-linear filter, that replaces the gray value of a pixel by the median of the gray values of its neighbours. Here, a 3x3 convolution mask is used . This operation removes salt-and- pepper noise from the image. In [6], Car images are taken from various positions outdoors. Because of the variations of angles between the car and camera, license plates have various locations and rotation angles in an image. In the number plate detection phase, the magnitude of the vertical gradients is used to detect candidate licence plate regions. These candidate regions are then evaluated based on three geometrical features. They are the ratio of width and height, the size and the orientation. The ratio of size and orientation is defined by the major axis. In the character recognition phase, we must detect character features that are non-sensitive to the rotation variations. Experimental results show that the license plates detection method can correctly extract all number plates from the given 102 car images taken outdoors and the rotation-free character recognition method can achieve an accuracy rate of 98.6%. In [7], the edges created by the characters within the license plate are extracted. Sobels edge operator is used for detection of edge gradients. The formula for getting vertical edge gradient is

$$gradV(y,x) = \sqrt{\left(\sum_{m=-1}^{+1}\sum_{n=-1}^{+1} Vmask(n,m)img(y+m,x+m)/4\right)^2}$$

where, img is the enhanced image over which the edge detection algorithm is operated upon, Vmask is the Sobel's mask for vertical edge detection as given below and gradV is the vertical edge gradient.

$$Vmask = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

Depending on the value of the gradV the edge image is binarized using the threshold and formed the edge image. Deciding the threshold value for binarization of edges is a key factor. After detecting the edges in the image, the required area is then evaluated based on the geometrical features such as the ratio of width and height, size and orientation. In [10] Mexican hat operator is used to detect the edges which perform smoothing before extracting edges. It is very easy and straightforward but accurate pre-processing is needed

B. Detection Of License Plate Using Mathematical Morphology

Morphology is the study of shape. Mathematical morphology mostly deals with the mathematical theory of describing shapes using sets. In Image processing, mathematical morphology is used to find out the interaction between an image and a certain chosen structuring element using the basic operations of erosion and dilation. Mathematical morphology stands somewhat apart from traditional linear image processing, since the basic morphology operations are non-linear in nature, and thus make use of a totally different type of algebra than the linear algebra. Morphological operations mainly describe the interaction of an image with a structuring element S. The structuring element is usually small relative to the image in the case of digital images.

A Morphology based method is proposed in [11] in which license plate extraction is done by means of five processes(image enhancement, morphological transformation, morphological gradient, combination of resultant image from morphological transformation, and plate region confirmation) as depicted in fig 1

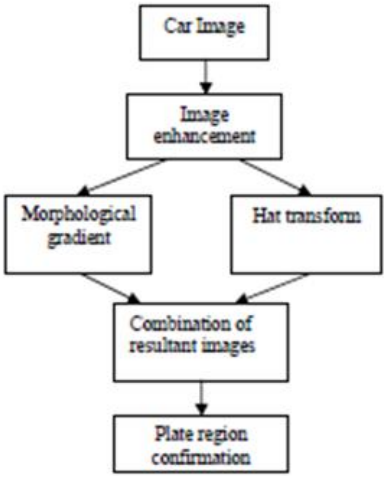

Fig.1 Proposed system based on mathematical morphology

Image enhancement is done as pre-processing step in which the image is enhanced so as to improve the quality of image. Here intensity and contrast enhancement is taken as pre-processing step. The technique used for intensity adjustment is known as histogram equalization. After the preprocessing,two processes namely morphology gradient calculation and hat transformation is done parrallelly.Hat transformations can be used for contrast enhancement. The two hat operations are known as the top hat and bottom hat transformations . Top-hat transformation is applied after enhancement whose aim is to suppress the dark background and highlights the foreground objects. Top-hat operation is actually the result of subtraction of an opened image from the original one. On the other hand in the case of bottom hat operation, it is defined as the closing of the image minus the image.

The structuring element selection is based on the application and is not fixed. The available structuring elements are of shape square, rectangle, diamond and disk. Here the structuring element of disk shape is used. In order to measure the local gray level variation in the image morphological gradient operation is performed. There are several morphological operations but we use only dilation and erosion for the purpose of number plate extraction It is the subtraction of an eroded image from its dilated version.

The system proposed in this paper used the morphological gradient for the detection of plate designated area. First the image was eroded by a disk shaped structuring element. Then the original image is again eroded using the same structuring element that used before. After that the eroded image was subtracted from the dilated version. This produces an image with very less designated areas for the probable vehicle plate. After this step the resulting image changed into binary [12] and all the noise components were removed. Next the plate region should be confirmed based on the properties of the plate like aspect ratio, area of the plate etc. This method gives success rate of 96% with the images acquired from the highways, toll gates with different conditions. It is easy to implement but there is a chance of getting deformed boundaries

C. Detection Of License Plate Using Sliding Concentric Windows(SCW)

Edges are usually displayed irregularities in intensity or colour of the image. It is supposed that, if there are abrupt changes in such local characteristics of the image , it provides evidence for presence of a possible edge. So we can assume that, no edges should be present without irregularities in intensity or colour in the local region. On the basis of this observation, an algorithm has been developed which aims to describe the local irregularities in the texture of the image. This idea is transferred to software steps where the standard deviation of a processing block must vary with the standard deviation value in the neighbouring blocks in the case of presence of an edge in the image.

Three stages used for license plate area detection described in [13] are a novel adaptive segmentation, colour verification and histogram. Initially two concentric windows, A and B are taken to scan the entire image. The scanning is done from left to right and top to bottom. Then calculate statistical measurements(such as mean and standard deviation) for both windows A and B.If the ratio of those measurements exceeds a threshold then set the corresponding value (x,y) as 1 and it is considered to be in ROI(Region Of Interest),otherwise it is assigned with value 0 and it is considered as not in ROI.

$$I(x,y) = \begin{cases} 0, if \dfrac{Mb}{Ma} \leq T \\ 1, if \dfrac{Mb}{Ma} > T \end{cases}$$

Here M is the statistical measurement and T is the value of threshold. Next colour verification for candidate region.HSI model separates all the colour information described by hue and saturation from intensity component. HSI (hue, saturation, intensity) model verifies green, yellow and white LP respectively. The transformation from RGB to HSI is done by the following given formula for H. Finally, candidate LP region is extracted based on the vertical and horizontal position histogram. After SCWs, morphology can also be applied instead of using colour model. Dilation and erosion are the two morphological operations applied to get the right candidate plate region.The man advantage of this method is that it produces good results with different illumination. The main drawback is that it is sensitive toangle of view and physical appearance

D. Detection Of License Plate Using Connected Component Analysis

Connected component analysis can be used to locate the license plate region from the vehicle image. In which the steps follows are given in [16].

First the image is thresholded so that the license plate characters in the image look different from the background. The elements present in this picture are identified in the labelling process to take part in a set of eliminating and grouping operations. A special filter having the aim of selecting areas of the picture in which the contrast between neighbouring points exceeds certain threshold is used. If the contrast exceeds the threshold for a given input, it means that there was an edge between character and background. This point is marked. On the otherhand,if the given point is too small then only threshold operation is performed.

After labelling the black and white spots the elimination process is done. The main aim of this stage is to leave in the picture only these spots which are mostly likely to be license plate characters. The spot is eliminated if it satisfies any of the conditions specified as in [16]. Further processing stages are directly connected with identifying fragments of the image which may contain number plates. It is done by special grouping of spots in sets resembling sets of characters on license plate. The neighbourhood of each spot in the image is analysed and if there is another spot of the same size in this neighbourhood the spots are grouped. The grouped spots are called a segment. After grouping segments, again

segments which contain incorrect number of spots are eliminated. Finally all segments remained in the image are treated as license plate candidates. This method is simple and independent of the position of the plate. But the drawback is that it may generate broken objects.

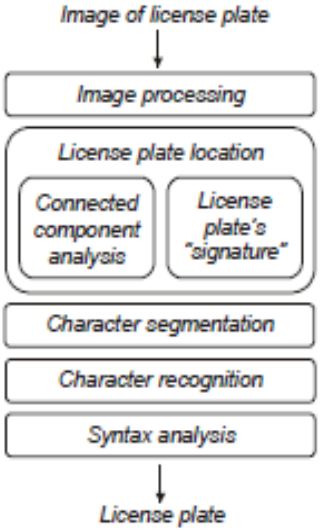

Fig 2 : Diagram of the proposed license plate recognition method

E. Detection Of License Plate Using Texture Features

By this method, the process of extraction of license plate area from an image is done based on the number of edge points, the length of license plate area and the number of each line of edge points. This concept is given in [20].As in the previous methods, image is pre-processed or enhanced by using median filter and thereafter edges are formed by the method of sobel edge detection.Binarization of the resultant image is done to reduce the unwanted portions in the image. The ratio of number of edge points and length of plate area should be from 3.9 to 13. The approximate localization was done based on the minimum and maximum edge points. As this was not a required region, to get the accurate region aspect ratio taken into consideration.

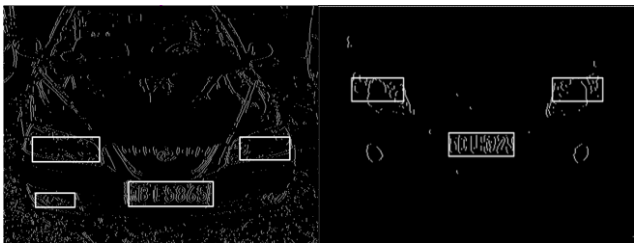

Fig 2 : Diagram of the proposed license plate recognition method

III. COMPARISON

This section compare each method based on their performance metrices.The metrics considering are average success rate, processing time and whether it can be applied in real time or not. Table I shows methods and its performance matrices

Table I Performance Metrics

Method	**Average Success Rate (In Percentage)**	**Processing Time**	**Real Time**
Edge Detection	95	100 ms	Yes
Mathematical Morphology	96	100 ms	Yes
SCW	82.5	276 ms	Yes
Connected Component Analysis	89	30 ms	Yes
Texture Feature	92	220 ms	No

IV. CONCLUSIONS

The In this study various methods for license plate localization of vehicle images is presented. With rapid development of transportation technology, monitoring of vehicles is necessary for various purposes. The main step in any recognition system of this field is localization or detection of number plate of vehicle images hence the overall correctness of the system depends on it. Due to various environmental conditions and independent standards among the

countries, localization of the number plate is a challenging problem in the world.So the overall system effiency mainly depend on the result of plate localization in ALPR. From the comparative study it is clear that mathematical morphology can be chosen as best method of plate localization. If we can combine different methods together the accuracy and efficiency of the result may get improved.

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