Journal of Advanced Computing and Communication Technologies *(ISSN:* 2347 - 2804*)*
Volume No. 3 Issue No. 3, June 2015

License Plate Recognition: An Insight to the Proposed Approach for Plate Localization and Binarization Technique .

By
Swati Sinha, Brajesh K. Umrao
Research Scholar, United Institute of Technology, Allahabad, India
Assistant Professor, United Institute of Technology, Allahabad, India
swatisinhapune@gmail.com, umraoniec@gmail.com

ABSTRACT
License Plate Recognition (LPR) system for vehicles is an innovative and a very challenging area for research due to the innumerous plate formats and the nonuniform outdoor illumination conditions during which images are acquired. Thus, most approaches developed, work under certain restrictions such as fixed illumination, stationary background and limited speed. Algorithms developed for LPR systems are generally composed of three significant stages: 1] localization of the license plate from an entire scene image; 2] segmentation of the characters on the plate; 3] recognition of each of the segmented characters. A simple approach for preprocessing of the images, localization and extraction phase has been described in this paper. Numerous procedures have been developed for LPR systems and are assessed in this paper taking into consideration issues like processing time, computational power and recognition rate wherever available.

General Terms
Image Processing, Pattern Recognition, Security, LPR Algorithms.

Keywords
Image processing, license plate recognition (LPR), extraction of license plate, character recognition, character segmentation.

1. INTRODUCTION
As the public transportation system is promptly developing, the need for automatic identification of the vehicles has risen. Intelligent Transportation system (ITS) has made a huge impact in people's life as their main aim is to augment transportation safety and increase productivity using modern era's advanced technologies [4]. Nowadays, ITS is divided into intelligent infrastructure systems and intelligent vehicle systems [1]. License plate recognition (LPR) system caters to the needs of many commercial applications like electronic payment systems that include toll payment and fee parking payment. With increased security awareness, LPR can also be used for traffic surveillance and can be deployed as an access control system for allowing only authorized vehicles to enter restricted areas.

Every vehicle has a license plate which is the principal identifier of a vehicle although it can be consciously tampered with and be misused and replaced (e.g. with a stolen plate) [4]. Thus, the need for a robust LPR system arises. The LPR system is an image processing technology that is used to recognize the vehicles by identifying the content of their license plates. LPR algorithms usually consist of three major phases: 1] locating the license plate (LP) region from an entire image and extracting the correct LP candidate for further processing known as Extraction phase; 2] segmentation of the characters on the LP, known as Character segmentation phase; 3] recognizing the segmented characters accurately known as Character Recognition phase. The first two phases encompass image processing techniques on still images whose assessment relies on the true and error recognition rate [1]. Researchers have proposed many methods of locating and extracting the license plates, such as the edge detection method, line sensitive filters to extract the plate areas, the window method and the mathematics morphology method [6].

Papers that have ensued the three step framework are reviewed. Issues like performance, execution time, and platform for each method have been reported when available. In this paper a method for preprocessing of the image, locating and extracting the LP is proposed. A simple method that exploits the aspect ratio, texture property and color similarity feature is described. In the preprocessing phase, a binarization technique is applied first to the image to locate the LP. Thereafter a noise removal method is proposed before extraction of the LP from the image so as to reduce unnecessary data in the image.

The remainder of this paper is organized as follows. In Section 2, a description of the configuration of the Indian LP's is given. Section 3 gives a detailed review of the uses and applications of LPR. Section 4 discusses preprocessing and LP localization method proposed. .

2. DESCRIPTION OF THE INDIAN LICENSE PLATES

Figure 1 Sample Image of an Indian License Plate

Figure 2 Indian LP with numbers written in double rows and a border of the LP

Figure 3 LP of a public vehicle with yellow background

License plate localization methods are usually categorized into two broad categories: 1) based on the textures of the LP and 2) based on the colors of the LP [2]. Two types of LP's are used in India. For a public vehicle, a LP with a yellow background and black numbering is used as in Figure 3 whereas for a privately owned vehicle, a LP with a white background and black numbering is used as shown on Figure 1 and 2. The legal format of the LP is as shown in the above figure 1. The first two letters denote the state code in which the vehicle is registered, the next two digits represent the district code, and the following two letters denote the type of vehicle (Car, Two wheeler, Commercial) and the last four digits are the unique LP number. To recognize the state to which the vehicle belongs to a two letter state list is used as shown in Table 1 below that is referenced by the character recognition module.

Table 1 Two Lettered State Code List of India

Code	State or Union Territory	Code	State or Union Territory
AN	Andaman and Nicobar Islands	LD	Lakshadweep
AP	Andhra Pradesh	MH	Maharashtra
AR	Arunachal Pradesh	ML	Meghalaya
AS	Assam	MN	Manipur
BR	Bihar	MP	Madhya Pradesh
CG	Chhattisgarh	MZ	Mizoram
CH	Chandigarh	NL	Nagaland
DD	Daman and Diu	OD[3]	Odisha
DL	Delhi	PB	Punjab
DN	Dadra and Nagar Haveli	PY	Puducherry
GA	Goa	RJ	Rajasthan
GJ	Gujarat	SK	Sikkim
HR	Haryana	TN	Tamil Nadu
HP	Himachal Pradesh	TR	Tripura
JH	Jharkhand	TS	Telangana
JK	Jammu and Kashmir	UK	Uttarakhand
KA	Karnataka	UP	Uttar Pradesh
KL	Kerala	WB	West Bengal

Few types of variations are also found in Indian LP's. Some possess a border or an outlining and in some plates the numbers are written in not a single row but double rows. Due to these variations, algorithms like multiple interlacing, transform edge detection cannot be applied to these plates since all LP's do not possess a border necessarily. In multiple interlacing method, the horizontal and vertical edge detection is performed on the input image. The detected edges images are then added to acquire the co-ordinates for the LP in the image. In Transform domain filtering, the high frequency region of the input image is acquired as a probable LP candidate. Then other features like aspect ratio are exploited to obtain the correct candidate. However, this method is also not suited for the Indian LP's due to presence of other characters on the plate.

Regarding the methods for locating the license plate in the image acquired, the method based on texture is exploited. In this method the main feature that is taken advantage of is the aspect ratio, the contrast variations and the uniform distribution of characters of the LP [2]. We have utilized the aspect ratio feature of the Indian LP for locating it and extracting it from the image. The legal requirements to be met by all of the Indian license plates are as follows: i) all LP's

should be 1mm thick Aluminum plates; ii) Registration number should be painted in black, stickers are prohibited. The aspect ratio (width/height ratio) of the LP of each type of vehicles is : a) Heavy weight/ light weight/ commercial vehicles – 340mmx200mm; b) Two and Three wheelers- 240mmx100mm; c) Passenger Cars- 500mmx120mm; d) Tractors- 285mmx45mm(Front), 200mmx100mm(Rear).

3. APPLICATIONS OF LPR

License plate recognition system can be exploited in a number of ways and it can be put to use in several ways as described below.

3.1 Ticket Issuing

One of the prime applications and motivation that led to development of a LPR system was to assist the human operators in issuing tickets in parking lots, toll booths. This is by far the easiest application. As a vehicle approaches the toll booth or the parking lot, it slows down before the check point. A triggering device (sensor/loop detector) detects the vehicle and signals the LPR system to start the image acquisition process. In the case of parking, when the vehicle exits, the LPR system compares the image with the one stored while entering the parking lot and the driver is charged for the duration. LPR systems can also be deployed at each of the toll lanes where a travel fee ticket would be issued or double checked to every vehicle entering a lane.

3.2 Traffic Surveillance

Over the past few decades, the issue of security has been taken to new heights. There is a need for a robust security system when it comes to the matters of security at the borders, government buildings, embassies, power plants and military camps, since illicit admittance to such prohibited areas may have serious consequences for homeland security [4]. Trespassing of vehicles is not allowed at the border. LPR systems can be deployed with an alarm system that would allow only authorized vehicles to enter the restricted areas and an alarm would be set off if any other vehicle approached. This would give better security options with less human intervention.

LPR systems could also be deployed as traffic monitoring devices that would keep a check on the speed of the vehicles on the highways and issue a violation fine if the speed of the vehicle crosses the permitted speed limit or if the vehicle has jumped the red light signal. Bus lane occupancy fines could also be issued by the LPR systems that are deployed on the highways.

3.3 Security

LPR system has another very useful application which is that it could detect if a vehicle was stolen and an alarm be set off as soon as a match occurs with a list of "stolen cars" that are pre archived into the database. As soon as the siren or display would be activated, the police officer would be notified that the black listed car has been detected which would help in reducing the crime rate as well.

4. LICENSE PLATE LOCALISATION – THE PROPOSED APPROACH

The major obstruction in locating the license plate in the image is due to the environmental conditions in which image is acquired. For example, outdoor parking lots face an added problem due to sunlight and varying illumination conditions than indoor parking spaces. Certain methods like histogram equalization have been devised to reduce the sunlight or low contrast problems [2]. Numerous methods have been reported in literature for LP detection and extraction. Although these algorithms can process the LP's location, they have their own daunting disadvantages such as sensitivity to brightness, longer processing time, and lack in adapting to the varying environment. The techniques based upon combination of edge statistics and mathematical morphology produced good results[3]. These methods rely on the fact that license plate regions are regions of high intensity and the brightness change is much more remarkable and more frequent than otherwise. Hence, the gradient magnitude and local variance in an image are computed. Then, regions with high magnitude and high variance are identified as possible LP candidates. Although this method is simple and fast the major disadvantage of it is that it is very sensitive to unwanted edges. Despite of this, when applied with morphological steps, it removes the unwanted edges and featured good results.

In this paper LP's with registration number written in a single row are considered and keeping in mind fixed illumination conditions. The algorithm implemented for the detection of the license plate is based on the fact that they are regions of highest intensity. Images undergo the preprocessing module according to the proposed approach shown in Figure 4 before being subjected to the extracting phase.

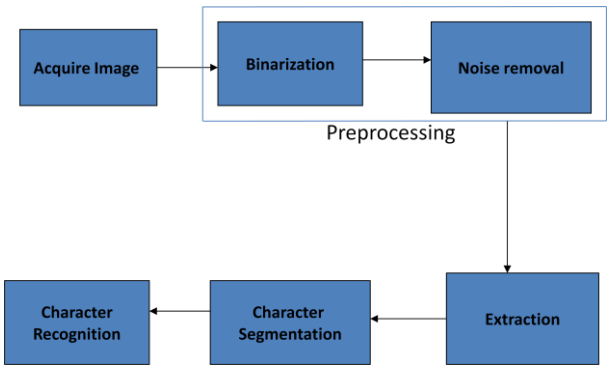

Figure 4 Proposed Approach for LPR system

4.1 Preprocessing

The key function of preprocessing module is to improve the image in ways that would increase the chances of success of other modules. Preprocessing is used to augment the processing speed, and reduce the noise caused due to environmental conditions or by the equipment used. It consists of two steps:

i) Binarization **–** It is the process of converting a colored image into a binary image. The colored image is made up lots of little dots called pixels. Each pixel is represented as three bytes – one for red, one for green and one for blue. Each byte is interpreted as a number, which is how much of that color is used to make the final color of the pixel. A binary image as known has two colours, black with intensity 0 and white with intensity 255. The coloured image before being converted to a binary image undergoes grey scale conversion. Grey scale images are monochromatic, denoting absence of any chromatic variation. The greyscale intensity is stored as an 8 bit integer giving 256 possible different shades of grey from black to white. The method used for Binarization is that of Single threshold value. Threshold value was set to 158. The mean value of RGB intensities is calculated for each pixel and if it greater than 158, it is converted to white else black as shown in figure 5.

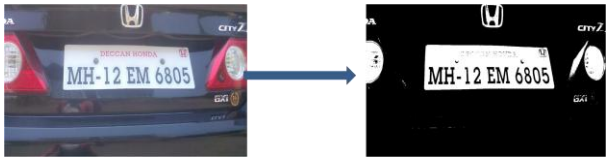

Figure 5 Binarization of an image

ii) Noise Removal – Noise is referred to as darker dots and disturbances in the image. As seen in figure 5, after the colored image is converted into binary, the screws on the plate, the headlights and the emblem of the car they are nothing but noise. These need to be removed in order to get faster processing time and better efficiency. The use of noise removal suppresses the risk of detecting the rear or front lights and other bright items as they too are high intensity areas and can be detected as LP can. The method used here is that of erosion. The binary image is scanned horizontally and keeping in with the aspect ratio of the LP, any row containing white pixels greater than threshold value the row is eroded and turned to black, as it contributes to nothing but noise.

4.2 Extraction

Once preprocessing is performed on the image, the binary noise free image is input to the next phase – extraction. To facilitate accurate identification of the correct LP candidate a horizontal and vertical scan is again performed on the binary image. The correct candidate is obtained by once again exploiting the aspect ratio of Indian LP which ranges normally in the range 2.5 to 3.0.

4.2.1Horizontal scanning

In this method, a row wise scan of the image is performed. Rows with highest intensities of white pixels or yellow pixels are marked. This marks the beginning of the LP. After 15 rows when they are scanned again the highest intensity pixel rows are marked which denote the end of the LP region. These 15 rows are nothing but the height of the LP. If after the specified height the high intensity pixels are not found then the threshold is reduced, co-ordinates are reset and the next portion of the image is scanned. In this the radiator grilles or the rear and front headlights are discarded. A horizontal scan thus provides for the horizontal coordinates for the LP candidate so that it can be extracted from the entire image.

4.2.2 Vertical Scanning

In vertical scan, however, a column wise scan of the image is performed. Columns with highest intensities of white pixels or yellow pixels are marked. This marks the beginning of the LP. After the specified threshold, again a column with highest intensity is marked. This denotes the end of the LP region.

According to the co-ordinates that are acquired by horizontal and vertical scan, these are passed to the extract function which extracts the correct LP from the entire image.

To get better processing times, the area above and below the number region on the LP needs to be removed so we have only the area covered by the registration number. Hence this area is cropped.

5. CONCLUSION

Although significant growth has been made in the last decade there is still work to be done as a robust LPR system should efficiently work for a variety of environmental, illumination, plate types/ conditions as well as acquisition parameters.

Increased mobility and internationalization set the challenge of developing an effective LPR system that can handle plates from various countries with different characters sets and formats. Till date this matter is yet to be significantly addressed in the literature as the recognition systems developed are usually country specific.

In addition, assuming that LP regions are evident even in very low resolution, and open topic for future research is the readability improvement of LP text using image processing techniques. Lately, a lot of research has been ongoing for improving degraded plates which has been directed to super resolution methods for video sequences or too blurred images with promising results.

6. REFERENCES

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