Extraction of License Plate Region in Automatic License Plate Recognition

Rajesh Kannan Megalingam, Prasanth Krishna, Pratheesh somarajan, Vishnu A Pillai, Reswan Ul Hakkim
Department of Electronics and Communication, Amrita Vishwa Vidyapeetham,
Kollam 690525, India
rajeshm@am.amrita.edu, jjprasanth@gmail.com,
pratheesh.sl@gmail.com, vishnuapillai@yahoo.com,
riswan451@gmail.com

***Abstract*: Automatic License Plate Recognition (LPR) is a technique involving image processing which is used to identify a vehicle by reading its license plate. In this paper we propose a system which is capable of extracting the license plate region from the vehicle's image taken from its rear end. The system consists of a digital camera, software to interface the camera with the software module and the software module which extracts and recognizes the license plate number. The camera captures the image of pre-defined resolution and passes it to the software module. The software module forms the heart of the entire system. It analyzes the input image, identifies the location of the license plate, segments the characters on it and recognizes the characters. The plate region is extracted by using the concept of connected components in the image (mathematical morphology). The characters in the license plate were segmented using digital image labeling and character recognition was done using template matching. The algorithm was implemented in MATLAB and the results obtained agreed with theoretical predictions. The first part of the paper discusses related works and areas of application. The later part of the paper shows experimental verification of the algorithm and test results.**

Keywords –License Plate Recognition, LPR, feature extraction,

I. INTRODUCTION

Automatic License Plate Recognition (LPR) system is used to identify a vehicle by reading its license plates. An efficient automatic license plate recognition process may become the core of fully computerized road traffic monitoring systems, parking systems etc. The License Plate Recognition system consists of three main processes:

- Plate region extraction
- Character segmentation
- Character recognition

There is a clear absence of standards for license plates in India [5]. However, license plates are characterized by high contrast in intensity between the characters and their uniform backgrounds. License plates may be made of different materials, composition and reflectivity. They come in a variety of colors. Character fonts, syntax, size, spacing and placement give rise to even more variability. Such diversity introduces a higher dimension of complexity in achieving successful automatic reading of license plates.

II. PROBLEM STATEMENT

LPR can be used in applications like parking lot management, access control to an entrance, automatic toll collection, surveillance etc. [9], [10]. The LPR system's significant advantage is that, it can keep an image record of the vehicle which is useful in order to fight crime and fraud.

In India and most developing countries, at present, there is no standard for license plates [5]. They come in different dimensions and hence methods which use a-priory knowledge of the dimensions of the license plate cannot be used effectively in such countries. The method we propose can extract license plate regions of any dimensions and hence is independent of the problem of lack of standardization of license plates.

III. RELATED WORKS

Automatic License Plate Recognition System is still in its infantry. The plate region extraction is the most challenging part of the entire system and only a few methods have been proposed for it. One such method includes the use of Hough transform [1], [2], [8]. Candidate rectangular regions are obtained by detecting horizontal and vertical lines (as the license plates are rectangular). From these candidate regions, the most suitable rectangular region is chosen using prior knowledge.

Another method involves spectral analysis [3], [8] of the image. The license plate region, which has its own characteristic frequency response, is filtered out from the rest of the image.

In our method we exclusively use the concept of connected elements [4] in the image. Since the characters used in the license plate have a unique size, it is possible to separate them from the rest of the image. We propose a method that exploits this feature of the license plate.

IV. BLOCK DIAGRAM

In Fig.1 the block diagram of the entire Automatic License Plate Recognition system is shown. It consists of a digital camera capable of capturing images at a resolution of 480x640 (low resolution improves processing speed).

Cameras with auto focusing, auto zooming and close up features yeild better results.

The captured image is passed from the camera to the software module. As mentioned in the introduction, the software module performs three processes: plate region extraction, character segmentation, character recognition.

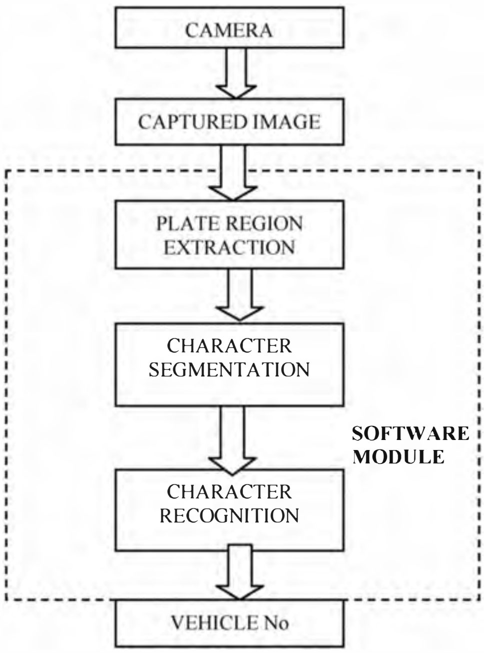


Fig.1 – Block diagram of LPR system

The software module first extracts the most probable license plate region. This is done by using the concept of connected components (continuos streches of 1's in binary image). The characters written on the license plate form connected components whose size falls in a known range. The length of the connected components varies with the distance from which the image is shot. The range of connected components was found by analysing different images shot from a distance of 2m to 5m and at different angles from the vertical (-20 degrees to +20 degrees frm the vertical). The range was found to fall between 250 and 30 (specific to MATLAB). From the image we filter all the components that falls in this range. The region thus extracted gives the most probable license plate region.

From the extracted license plate region, each character is then segmented and recognised. Segmentation of each character from the segmented license plate region and recognition of characters will be done as future work. Finally the identified license plate number is provided to make application specific decisions.

V. PLATE REGION EXTRACTION

The plate region is extracted by using the concept of connected components in the image (mathematical morphology [7], [8]). In Fig. 2 the block diagram of plate extraction module is shown. Captured RGB image is converted into a cropped gray scale image.

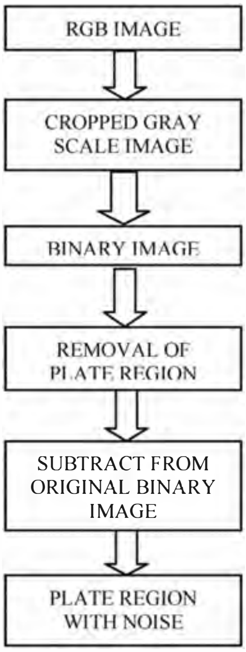


Fig. 2– Block diagram of plate extraction module

Cropping enables removal of unwanted boundary regions. The cropped image is then converted to gray scale image. This gray scale image is converted to its binary image. Through connected component analysis the plate region is removed from the binary image. Subtracting this from the original binary image gives an image with the plate region.

VI. EXPERIMENTAL ANALYSIS: EXTRACTING THE LICENSE PLATE REGION

The experimental analysis was done using MATLAB. Images of vehicles with different license plate dimensions were captured and tested. Due to space constraints we could include only two sample images. Steps A to K define the extraction of plate region from the captured image. Steps A to K were implemented in MATLAB.

A. The captured image is of size 480x640. Here two sample images Fig.3 and Fig.4 of resolution 480x640 are shown. They have some text written on it besides the characters in the number plate like the model of the car, makers tag etc. without using optical or digital zoom and with priority to close-up subjects.

Fig.3- rear view of car-1

Fig.4 – rear view of car-2

B. Step B is based on the assumption that the license plate region is located towards the centre of the image. The images are converted into their respective gray scale images. Then the images are cropped so that we remove the boundary regions from the captured image. Cropping was done by removing 60 rows and 180 columns from each side. The cropping also reduces the noise in the image. Thus we get a smaller image with lesser noise to work with. Fig.5 is obtained by cropping Fig.3 and Fig.6 is obtained by cropping Fig.4.

Fig.5 – grayscale image

Fig.6 – grayscale image

C. Once the image has been cropped, the gray scale image is converted into its binary image. As the license plate consists of characters written in black (as it is the case in India), we take the negation of the binary image. Thus the characters are displayed in white pixels. The negation is necessary as the characters are converted into connected white elements. Connected elements are continuous stretches of white pixels i.e. successive 1's row-wise or column-wise [6]. Fig.7 is the binary image of Fig.5 and Fig.8 is the binary image of Fig.6.

Fig.7 – binary image

Fig.8 – binary image

D. Now, we look for connected components of size less than or equal to the alpha-numeric character size used in the license plate and remove them from the binary image shown in Fig.7 and Fig.8. The alpha-numeric character size used in the license plates fall in a known range as explained in section IV. The result of this process is shown in Fig.9 and Fig.10.

Fig.9

Fig.10

Figures with license plate region removed

E. The next step is to subtract the binary image matrices of Fig.9 and Fig.10 from the binary image matrices of Fig.7 and Fig.8. This yields only those components which are less than or equal to the characters used in the license plate as shown in Fig.11 and Fig.12.

Fig.11

Fig.12

License plate region with noise

F. Now we further reduce the noise from Fig.11 and Fig.12. This is done by removing very small connected white pixels from the image. Removing noise from Fig.11 gives Fig.13 and removing noise Fig.12 gives Fig.14

Fig.13

Fig.14

License plate region with reduced noise

G. Next, the row profile[4] of the image is found by taking the sum of elements in each row of the matrix of the binary image in Fig.13 and Fig.14. Row profile of Fig.13 is plotted in Fig.15 and row profile of Fig.14 is plotted in Fig.16.

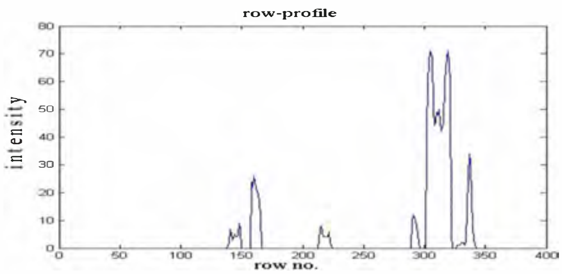


Fig.15 – row profile

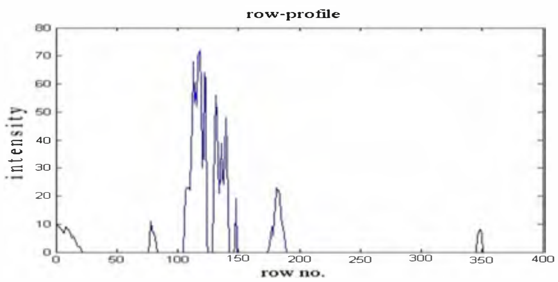


Fig.16 – row profile

H. The region corresponding to the rows of the license plate have characteristic high amplitude as seen in Fig.15 and Fig.16. The row-profile is passed through a threshold value. The threshold was set to 65% of the maximum. It was found by trial and error method. Analysing 50 images, it was found that maximum efficiency was obtained at the above mentioned threshold value. The result of thresholding the row profile shown in Fig.15 and Fig.16 are shown in Fig.17 and Fig.18.

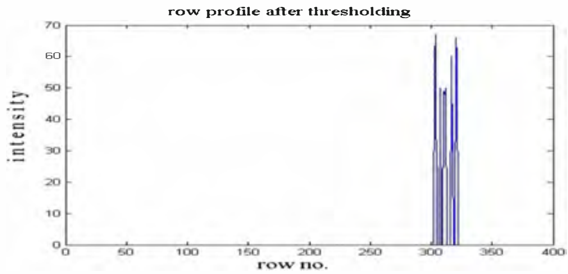


Fig.17 – threshold row profile

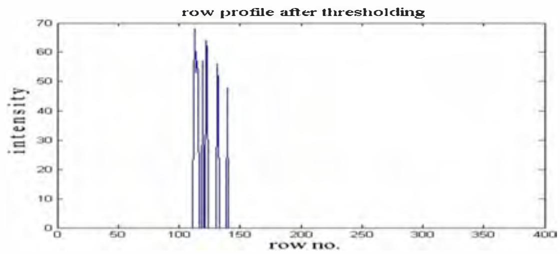


Fig.18 – threshold row profile

I. After step H we have the rows of the most probable license plate region. The next step is to analyze the columns corresponding to these rows. For that we plot the column profile[4] by taking the sum of elements in each column. Column profile corresponding to Fig.17 is plotted in Fig.19 and that corresponding to Fig.18 is plotted in Fig.20.

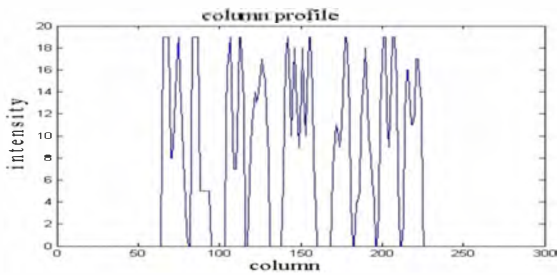


Fig.19 – column profile

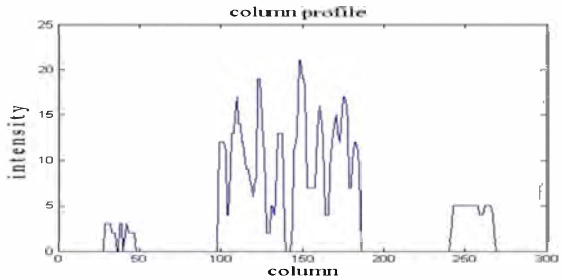


Fig.20 – column profile

J. The column profile is also passed through a threshold value 50% of maximum . The threshold was obtained in a similar way as explained in step H .

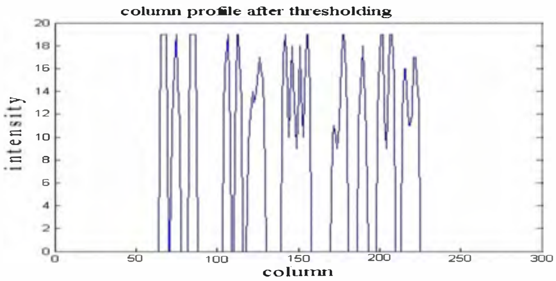


Fig.21 – threshold column profile

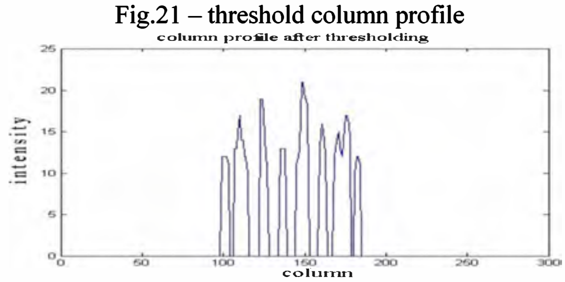


Fig.22 – threshold column profile

K. Now we have both the row range and the column range of the most probable number plate region and we extract it from the image. Fig.23 is the extracted license plate region of Fig.3 and Fig.24 is the extracted license plate region of Fig.4.

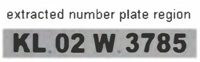


Fig.23- extracted plate - 1 of car-1

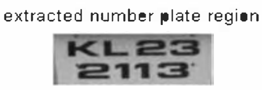
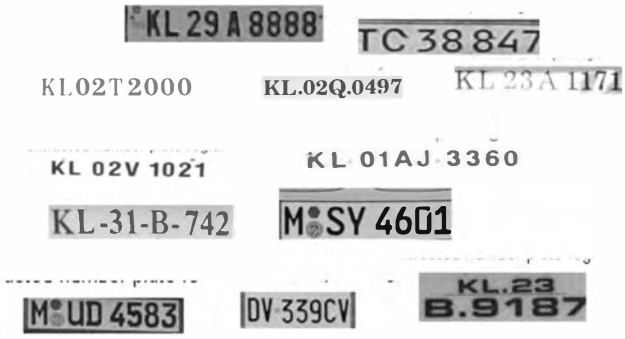


Fig.24- extracted plate - 2 of car-2

VI. Some Extracted License Plates



VII. Conclusion

In this report, the software module for extracting the license plate region from the captured image, segmenting the characters and recognizing them was discussed in detail. The plate extraction succeeds in 91% of the test images and this is a very high success rate. The extraction fails in only 6 of the images. This is acceptable, since the extraction works in more than 90% of the images, thereby fulfilling the criteria of this task. We have successfully designed and implemented the key element of the system, the actual recognition of the license plate region. The main theme of the project was gathering and description of information and the goal is to collect physical data, represent these symbolically, and demonstrate processing techniques for this data. This goal has been accomplished in this project.

Acknowledgment

We gratefully acknowledge the Almighty GOD who gave us the strength and health to successfully move forward in this venture. The authors also wish to thank Amrita Vishwa Vidyapeetham, in particular the Digital library, for access to their research facilities.

References

[1] "Automatic car registration plate recognition using fast hough transform", Security Technolog. 1997. Proceedings. The Instituteof Electrical and Electronics Engineers 31st Annual 1997 International Carnahan Conference on, pp. 209-218, 1997.

[2] Y. Yanamura, M. Goto, D. Nishiyama, M.Soga, H. akatani, and H. Saji, "Extractionand tracking of the license plate using houghtransform and voted block matching",Intelligent Vehicles Symsposium, 2003.Proceedings. IEEE, pp. 243-246, 2003.

[3] Digital Image Processing by Rafael C.Gonzalez and Richard E.Woods

[4] An edge based approach for video text extraction. Paper appears in computer technology and development, 2009. ICCTD '09. IEEE, pp. 331-335.2009

[5] www.carazoo.com/article/0911200902/Facts-on-Car-Licence-Plates

[6] MATLAB documentation

[7] http://en.wikipedia.org/wiki/mathematical_morphology

Digital Image Processing using MATLAB by Rafael C Gonzalez and Richard E.Woods.

[9] An efficient method of license plate location in natural scene image. paper appears in fuzzy systems and knowledge discovery, 2008 by Haiqi huang, ming gu, hong yang chao-. IEEE,pp.15-19.2008

[10] Automatic license plate recognition by Shyang Lih Chang, Li Shien Chen, yun Chang Chang. IEEE,pp 42-53.2004.