Character Segmentation for License Plate Recognition by using Morphological Operation and Region Approach

Khine Thandar Nyunt Swe

***Abstract*— License Plate Recognition (LPR) plays an important role in Intelligent Transportation System (ITS). There are four main stages in License Plate Recognition: pre-processing, license plate localization and segmentation, character segmentation and character recognition. Pre-processing stage is the first stage after capturing and it is important to localize the region of license plate correctly. License plate localization and segmentation is the most challenging stage. In this paper, the license plate of captured vehicle image is detected and segmented. The character segmentation was also done successfully in this paper. Morphological operation and Connected Component Analysis (CCA) are used for license plate localization. Localized license plate is segmented by using the region-based approach. The segmented license plate is pre-processed. Euler Number and Bounding Box properties are measured for each connected component in the license plate image. Measured characters are segmented by using CCA. In this system, the vehicle images are tested and license plate characters are segmented successfully. Accuracy of license plate localization is 85%. Accuracy of character segmentation is over 90%. Distance between the camera and the vehicle, illumination and orientation are still the challenges for license plate recognition.**

***Index Terms*—Bounding Box, Connected Component Analysis, Character Segmentation, Euler Number, License plate localization, Morphological operation.**

1) INTRODUCTION

License Automatic Identification (LAI) is one of the key technologies that can realize modernization and intelligent traffic. At the same time, License plate recognition is the significant component of Intelligent Transform System (ITS). Today, traffic problems such as car theft, speeding, running red light, heavy traffic congestion increase significantly because the number of automobiles grow rapidly. Therefore, vehicle tracking and identification system has become a popular research topic in modern traffic control system. The existing technologies used for vehicle identification are Radio Frequency Identification (RFID), Infra-red, Microwave and image processing technology. Using RFID, Infra-red, and Microwave require to install transponders on the vehicle.

The fourth technology, license plate recognition, plays an important role in Intelligent Transportation System (ITS) and becomes more and more useful in many application areas such as toll payment system, traffic control system, parking fee payment system and others. License Plate Recognition (LPR) is known by various terms as Automatic Number Plate Recognition ANPR), Automatic Vehicle Identification (AVI), vehicle number plate recognition and others.

License Plate is the important symbol of the vehicle characteristics. Therefore, the research of the License Plate System has the important significance for realizing the modernization of traffic management. There are many applications for license plate recognition for example automated parking attendant, petrol station forecourt surveillance, speed enforcement, security, customer identification enabling personalized service, highway electronic toll collection, and traffic monitoring systems [1]. Some problems about images with license plates like poor image resolution, the plates that is too far away, low quality camera, poor lighting and low contrast due to overexposure, reflection or shadows, dirt on the plate can make localization process fail. Image enhancement technique is very crucial based on filters to remove noise and unwanted effects of the light in order to obtain clear and readable images.

License Plate Recognition (LPR) can be applied as an access control system for monitoring of unauthorized vehicles entering private areas. In License Plate Recognition, there are four main stages that are Pre-processing, License Plate Localization and segmentation, Character Segmentation and Character Recognition. In this system, Morphological operations and Connected Component Analysis (CCA) are used for license plate localization and segmentation. Segmented license plate was pre-processed again and the characters in the license plate were segmented by using region approach.

2) LITERATURE REVIEW

There are many research papers about license plate recognition. License Plate Detection using Harris Corner [2] addresses License Plate localization with the integrated segmentation approach. The crucial step in ALPR system is the precise confinement of number plate, Segmentation, Recognition. Harris corner algorithm is proposed in this paper which end up being robust in changing motion and illuminated lightning conditions. While the precision of License Plate restriction is fed forward to the Segmentation stage. The Segmentation is accomplished by a method of connected component analysis consolidated with Pixel count (PC), Aspect ratio (AR), and Height of characters.

After pre-processing, Harris corner algorithm is applied to extract the feature from the image. After extracting all the

Manuscript received May, 2019.

***Khine Thandar Nyunt Swe,**, Department of Electronic Engineering, Yangon Technological University, Yangon, Myanmar, +959976796003*

corner point, the sliding window (SW) approach is applied to find the most likely number plate region. Soft thresholding is taken as part of sliding window that works for the majority of pictures. Aspect ratio (AR) limit is set to find the License Plate (LP) viably subsequent to separating every single corner point and amid SW approach.

Sliding Concentric Windows and Artificial Neural Network were used as a new approach. In that new approach, License Plate Localization was done by finding the vertical edges and horizontal edges. In this paper, initially, segmentation technique named as sliding concentric windows (SCW) on the basis of a novel adaptive image segmentation technique for detecting candidate region. HSI colour model was used for colour verification. Hue and intensity in HSI model verify green and yellow license plate and white license plate respectively. Tilt correction was done by using the least square fitting with perpendicular offsets (LSFPO). Firstly, rotation angle was estimated. Then the whole image is rotated for correcting tilt by this angle. Finally, a new algorithm based on artificial neural network (ANN) is used for recognition of Korean plate characters. Various LP images are used with a variety of conditions to test the proposed method and results are presented to prove its effectiveness [3].

Saqib Rasheed proposed a robust method of license plate detection and recognition based on Hough lines using Hough transformation and template matching for Islamabad standardized number plates cars. Before license plate detection, the input image is pre-processed. In pre-processing, Gaussian smoothing is a spatial filtering used as a pre-processing unit to remove adaptive noise present in the image. As it is used to blur the images, remove details and noise from the image. The sources of noise in digital images arise during image acquisition (digitization) and transmission. The Hough transform (HT), powerful global method for detecting edges, transforms between the Cartesian space and a parameter space in which a straight line (or other boundary formulation) can be defined. Therefore, using Hough transformation identified all the strong edges vertically and horizontally in the image. When all the strong edges are identified, vertical edges are differentiated from horizontal edges [4].

The existing license plate recognition system are presented. They have both advantages and disadvantages. Blurry image, different illumination condition, distance between the camera and vehicle, and execution time are still challenge for license plate recognition system.

3) METHODOLOGY

A license plate recognition (LPR) is a type of technology in which the software enables computer system to read automatically the license number plate of vehicle from digital pictures. Reading automatically the number plate means converting the pixel information of digital image into the ASCII text of the number plate. Fig.1 shows the block diagram of License Plate Recognition. In this paper, the results of each step are described. Segmented characters are shown in the test and result session. After this stage, the next one is to recognize segmented character. Characters need to be trained before character recognition stage. Character recognition can be done by using KNN or SVM or neural network.

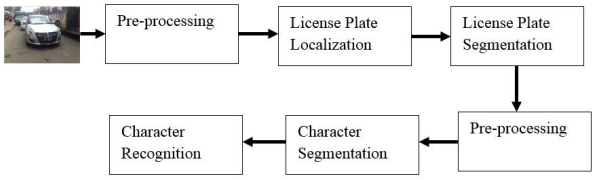

Fig. 1Block Diagram of License Plate Recognition

4) Pre-processing Stage

The pre-processing of License Plate Recognition (LPR) is the first step to remove the useless information from the input image. The input image captured is RGB image. Therefore, that image is converted to grayscale image. Gray image does not contain colour information, but contains only brightness information.

Histogram equalization is a process that attempts to spread out the gray levels in an image so that they are evenly distributed across their range. Histogram equalization reassigns the brightness values of pixels based on the image histogram. Contrast is defined as difference between lowest and highest intensity level. Histogram equalization is a method for spreading the histogram of pixel level more effectively. Adaptive histogram equalization shows better contrast than histogram equalization.

5) Top-hat Transform

Top-hat transform is an operation that extracts small elements and details from given images. The top-hat transform is defined as the difference between the input image and its opening by some structuring element. Top-hat transforms are used for various image processing tasks such as feature extraction, background equalization, image enhancement and others.

6) Binarization

The key of image binarization is threshold selection. An appropriate threshold cannot only greatly suppress the noise, but can clearly divide the image into the target and background, leading to reduce the computational time.

7) Morphological Operation

The basic step in recognition of car number plate is to detect the edges of the rectangular plate. In this system, mathematical morphology is used to detect the region. Mathematical morphology is a part of digital image processing concerned with image filtering and geometric analysis by using structuring elements (SE). The image which will be processed by mathematical morphology theory must be changed into set and represented as matrix. Structuring Elements are used in morphological which represented as matrices. Structuring element is a characteristic of certain structure and features to measure the shape of an image and is used to carry out image processing operations. The shape and size of the structuring element (SE) plays an important role in image processing. The basic mathematical morphological operations namely dilation, erosion, opening, closing are used for detecting, modifying, manipulating the features present in the image based on their shape. Morphological operations consist of a team of the morphology of the algebra operator, of which the basic two operations are imerode, imdilate. Dilation is a morphological transformation that combines two sets by

using vector addition of set structural element. Erosion can be obtained by dilating the complement of the black pixels and the taking the complement of the resulting point set. A structure element (SE) is chosen and the gray image is dilated with the structure element. Erosion on the image is made by the structure element. Dilation can enlarge the foreground pixels. Erosion reduces the number of pixels from the object boundary [5].

8) Connected Component Analysis

Connected Component Analysis is an important technique in binary image processing. It scans the binary image and labels its pixels into components based on pixel connectivity. Spatial measurements such as area and aspect ratio are commonly used for license plate extraction. CCA can detect and extract the license plate correctly.

The property 'Euler Number' is used to know the number of characters in the extracted license plate. Each character is extracted by using Bounding Box property. Before this step, extracted license plate is pre-processed again and binarized.

9) Pre-processing of Extracted License Plate

Median filtering is one kind of smoothing technique, as is linear Gaussian filtering. All smoothing techniques are effective at removing noise in smooth patches or smooth regions of a signal, but adversely affect edges.

Image Subtraction is used to find the changes between two images of the same scene. To assess the degree of change in an area, two dates of co-registered images can be used with the subtraction operation. Image subtraction can be used to remove certain features in the image.

10) TEST AND RESULT

The step by step tests and results for license plate localization and segmentation using Morphological operations are shown with respective diagrams. Original image is converted to gray-scale image to remove low edge intensity region. Step by step results from original image to extracted characters are shown from Fig. 2 to Fig. 17.

Fig. 2 Original Image

Fig. 3 Grayscale Image

Fig. 4 Image after Histogram Equalisation

Fig. 5 Image after Top-hat Transform

Fig. 6 Image after Dilation Operation

Fig. 7 Image after Filling Operation

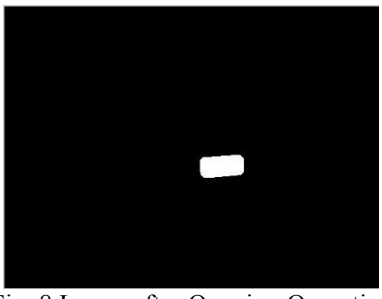

Fig. 8 Image after Opening Operation

Fig. 9 License Plate Localization Image

Fig. 10 Segmented License Plate

Fig. 11 Grayscale Image

Fig. 12 Median Filtered Image


Fig. 13 Image after opening

Fig. 14 Image after subtraction

Fig. 15 Binarized Image

Fig. 16 Image after removing border,dash and screws

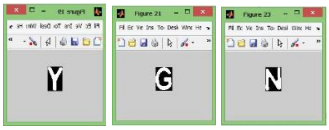

Fig. 17 Extracted Characters

11) CONCLUSION

License Plate Recognition (LPR) is an important task in various field. It can be used in parking fee payment system and electronic toll payment system. Top-hat operator is used for feature extraction. Holes in the image are removed by using Morphological operations. The connected components are labelled and Bounding Box method is used for license plate localization and segmentation. Fifty vehicle photos were tested for license plate localization and character segmentation. Accuracy of character segmentation is over 90%. The disadvantage of this system is that it is hard to detect license plate region in high illumination.

Morphological operations are used for license plate localization and the structuring elements are not fixed value. The characters in the upper line of Myanmar license plate have smaller font size. This case can be a problem for character recognition stage. Even in the character segmentation stage, some characters in the upper line of license plate were disappeared while implementing morphological operations. The distance between the camera and the vehicle should not be more than nine feet. License plate localization stage may fail in lighting condition. Filters can be used for lighting condition and motion blur.

ACKNOWLEDGMENT

Firstly, I would like to acknowledge my parents for allowing to continue my study at Yangon Technological University. I would wish to acknowledge my professors and colleagues of Yangon Technological University who have contributed to the development of this paper.

REFERENCES

[1] Wikipedia Website. No Date. *Automatic number plate recognition*. <http://www.wikipedia.org/>

[2] Panchala, T., Patela, H., and Panchalb, A. "License Plate Detection using Harris Corner and Character Segmentation by Integrated Approach from an Image".in Proc. 7th International Conference on Communication, Computing and Virtualization, 2016

[3] Deba, K., Khana, M.D., Sahaa, A., and Kang, H.J. "An Efficient Method of Vehicle License Plate Recognition Based on Sliding Concentric Windows and Artificial Neural Network". *Science Direct*, vol. 56: 812-819, 2012

[4] Rasheed, S., Naeem, A., and Ishaq,O. "Automated Number Plate Recognition Using Hough Lines and Template Matching". in Proc. the World Congress on Engineering and Computer Science, 2012

[5] Wikipedia Website. No Date. *Morphological operations*, January 2017 <http:// www.wikipedia.org/>