Automatic License Plate Detection System for Myanmar Vehicle License Plates

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Abstract

License Plate Detection is an intelligent system to find the exact license plate by analyzing image/video data for automatic license plate recognition (ALPR) system. The proposed system used image data. There is much early research has been done for ALPR purposes, however, it was still challenging tasks for accurately detect license plates in the open environment. The main difficulties lie in the diversity of plates such as language, font, color, and type of the number plates that differ across nations and conditional variations such as various background scenes and illumination when captured. The fundamental ALPR system consists of three processes: license plate detection, character segmentation, and character recognition. Proposed system focused on license plate detection based on image processing technology that is a crucial step for the whole ALPR system. A Myanmar License plate has a white boundary for every different color of plates, thus the proposed system applied an edge-based approach for any color of plates, and the plate region will remain because of its white boundary. After edge detection, morphological operation has been applied as it can add or remove pixels from/to the objects in an image. Thus the license plate can be extracted accurately. Finally, the bounding box technology was applied to extract only the number plate region properly.

Keywords- ALPR, license plate detection, character segmentation, diversity of plates, conditional variations

1. Introduction

Automatic License Plate Recognition (ALPR) is a technology to automatically recognize character string from number plate images attached to vehicles and it plays an essential trend in the field of the smart transportation system. There are many potential applications for the ALPR system such as security closed-circuit television (CCTV), vehicle parking, traffic management and toll enforcement, and also many other applications. For each country, the license plate structure is defined by the government of that country. In Myanmar, Vehicle registrations were started before 1996. The current Myanmar plates are defined with three-letter regional code (such as YGN for Yangon, MDY for Mandalay, etc.) followed by six alphanumeric characters with the height of 16.5 cm and width of 36.2 cm [4]. Moreover, Myanmar Vehicles Number Plates are not only the state/division specific but also color specific for different types of services, such as black for personal purposes, red for hire vehicles, yellow for religious, etc. Figure 1 shows some types of Myanmar License Plates.

Figure 1. Different types of Myanmar license plates

This study aims to obtain a specific and reliable license plate localization and recognition system for Myanmar's license plates, mainly for dedicated parking security.

Normally, the ALPR system has three processes: license plate detection, character segmentation, and character recognition. This work is only focused on license plate detection based on image processing technology and it is important step for the entire ALPR system.

License plate detection is the technology for localizing the region of interest from the given image/video only to extract the desired location, that is, given input in this step is vehicle image and the result will be extract number plate only. Although, a lot of research has been proposed during the past years, till now it is a challenging task to detect desired plate in the open situations such as blurring the given image/video, capturing dissimilar angle conditions, the different aspect ratio of plates across nations, etc. Overall plate detection algorithms can be classified into four different categories: character, texture, color, and edge based approaches [6].

Character-based method is based on finding the character like region in the image. Usually, in the vehicle body, there is only the license plate will be the character like region. However, nowadays most people used beauty stickers to decorate their vehicles. In such a case, Character-based method will have remarkable disadvantages.

Color-based method is applied by finding out the license plate colors that is normally different for each country. Also, this method focused on the color of the vehicle. In [1] license plate is extracted based on HSI color space model. This method can be applied to find the corrupted license plates. However, it is not suitable for the same color and same size structure as a license plate in the given input image and very sensitive for conditionally illumination changes in nature.

Texture-based method is the pixel-based approach. Compared with edge and color based methods it uses more discriminative characteristics, but it has computational complexity for output.

Proposed system applied an edge-based method. To find the license plate region in the given image edge-based method identified edge density, edge shape, boundary of the license plate, etc. This method is fast and simple. However, it requires finding the continuity of the edges. Thus the system applied morphological operations: dilation, image filling, and erosion to remove unnecessary edges and to extract connectivity of the objects. Lastly, the bounding box technology applied to extract only the number plate region properly.

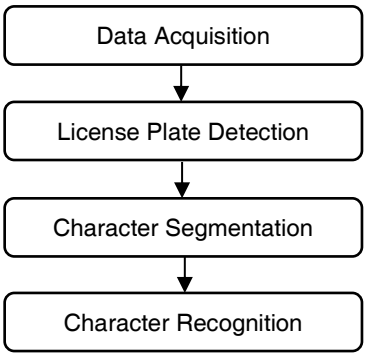

Figure 2. Fundamental processes for ALPR system

The rest of the paper is organized as follows: a brief description of related work, problem statements, proposed system, experimental results, conclusion and future research directions are elucidated in Section 2, 3, 4, 5 and 6, respectively.

2. Related works

A lot of the previous research has been done for license plate detection, character segmentation and character recognition from their different points of view and different types of challenges among researchers. Xiangjian He, Lihong Zheng [8] proposed vehicle plate extraction algorithm in which variable scanning window moved to the whole input image and then using the well-trained classifier to classify either true decision that is plate area or false decision that is not plate area. This work was the extension of P.Viola and M.J.Jones face detection algorithm. The plate detection accuracy rate was 96.4% and character segmentation was 98.82%. However, this work was not focused on skew correction of vehicle plates.

In [3], numbers from Myanmar License Plate were extracted by using neural network for Myanmar Vehicle Plate Recognition System. Plate localization is performed based on Euler number and aspect ratio, the resulted accuracy for localization is 99%. However, the character segmentation and recognition accuracy was 96% and 92%, respectively.

Jia Wang, Boris Bacic and Wei Qi Yan, 2017, proposed an effective method for plate number recognition. In this study license plate was localized by searching red light in HSV color space and then finding vertical edge of a plate. The accuracy for localization and recognition are 75% and 70%, respectively. This system was focused on only back side vehicles' plate and future work was described for both sides of vehicle plate's recognition system [2].

O. Khin and S. Choomchuay, 2017, studied on Myanmar license plate detection only for dissimilar angle vehicle plate. This research work totally 97% of number plates is well detected. However, this research work was failed for car body color and plate color are the same, and also for the license plate size is very small compared with the size of the vehicle [4]. Our system aims to propose a reliable vehicle plate detection method and the result indicated more than expected compared with the relevant contexts from our literature review.

3. Problem statements

Nowadays, due to the number of automobiles, monitoring vehicles for security purposes is consuming time, money and security officer to check the license plate of every vehicle. It is not viable to employ several officers to work as whole-time license plate investigators. The only solution for that is the Automatic License Plate Recognition (ALPR) system and it will reduce the workload and time for many security purposes.

The other three main factors why this problem was taken up as a research topic are the facts: such as diversity of plates, environment variations, and very little research work that has been performed over Myanmar License Plates. First, the diversity of plates means that the location and size of the license plate in each image frame are

different. In addition, plates may be tilted or obscured by dirt, stickers, screws and other objects. Moreover, license plate structure is a country-specific. Thus the font, language, color, and style of the license plates will differ across nations. Therefore, the license plate recognition system tends to be country-specific.

A second, conditional variation is depending on various illuminations and background scenes: such as input image/video may be captured at different lighting conditions as well as the vehicle lighting. This is also needed to be taken up into consideration. The intricate/complicated background in the license plate: such as plate-size advertisements, stickers, and other writing numbers on vehicles that often give the false alarm on the detection process.

In Myanmar, ALPR system is a current research topic. It was still challenging tasks to accurately detect the license plate in the open environment. Moreover, early research has not been focused on regional codes recognition: such as YGN, BGO, MDY, etc. Myanmar vehicle plates have two rows, one for regional code and one for vehicle identifier as shown in Figure 1. Besides the regional code, there has a round shape national seal and screws that look likes character O and number zero (0). It is also a challenge for the Myanmar license plate recognition system. In such a way, the ALPR system is currently an interesting topic for many experimenters.

4. Proposed System

4.1. Data acquisition

Data acquisition is the first step of the ALPR system. The outcome of the detection system also depends on the quality of the images. This system tested 40 images including both front and back sides of the vehicles. Most of these images are taken by using the phone camera from our University car parking. Images are taken from various colors of vehicles for the proposed system. They are saved with JPEG format since it is the default format of the phone camera. However, the system is working over other formats such as PNG, etc. Figure 3 shows some examples of collected images.

4.2. Automatic license plate detection system

To provide an efficient and reliable license plate detection method proposed system applied image preprocessing steps such as RGB to gray conversion, image binarization, image resizing. Then the system applied sobel edge detector followed by some morphological operations: erosion, dilation, and image filling. Lastly, the bounding box technology was applied to extract the license plate region accurately from the given input image. Figure 4 shows the architecture of the proposed system.

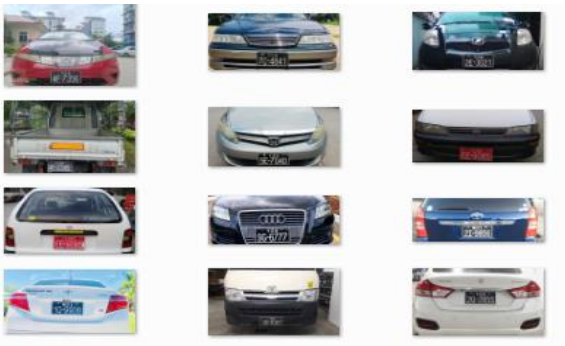

Figure 3. Collected images examples

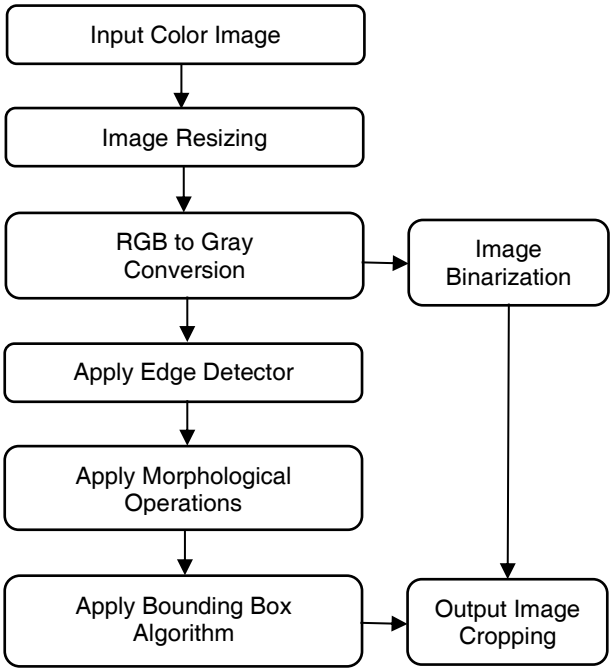

Figure 4. Architecture of proposed system

The difficulty of color visualization and the complexity of color codes is the main reason we need to convert color code in the image processing technique. The conversion will reduce the complexity of the image. Thus the system converts RGB to gray scale and as it is much better for license plate detection compared with RGB Image. Binarization is the next important process and it converts a pixel image to a binary image. Generally, background and characters must be different colors in every license plate, so theoretically both have opposite binary values. So, binary images are obviously easy to extract license plate from input image. *Imbinarize* function converts the grayscale image by replacing value 1s for all values that are above the globally determined

threshold and replacing all the remaining values to 0s. *Imbinarize* function uses 256-bin image histogram to compute Otsu's threshold and this method also compute by a specific method such as an adaptive method. Proposed system utilized the former function, which chooses the threshold value to minimize the intraclass variance of the thresholded black and white pixels.

As shown in Figure 1, Myanmar License Plate consists of white font with different color background and moreover, it has a white boundary on every plate. Thus plate region obviously will remain after edge detection for any colors of car and any color of plates as shown in Figure 5. Thus, the proposed system applied an edge-based approach for license plate detection.

Figure 5. Output of Sobel detector

There are lots of edge detection methods and that has been applied for different purposes. Prewitt operator does not emphasize the pixels that are closer to the center of the mask. Laplacian operator is very sensitive to noise and to filter the noise we need to apply Gaussian smoothing before the Laplacian filter. The canny edge detector is also the most common and it is a complex edge detecting method. In such a way, the system applied Sobel edge detector. The Sobel edge enhancement filter has the advantage of providing differentiating (which gives the edge response) and smoothing (which reduces noise) concurrently. Figure 5 shows the output of the Sobel operator.

Then, to know the exact place of the candidate license plate in the input image, the system applied morphological operations: dilation, erosion, and image filling methods. The experimental performance accuracy was much satisfied.

First, the system applied dilation to gradually enlarge the foreground boundary pixels (i.e. white pixels, typically) after the Sobel edge detector. Thus, the foreground regions grow in size while holes within those regions become smaller. Morphological dilation makes objects more visible and fills in small holes in objects as shown in Figure 6(a). Then the system made erosion to remove islands and small objects so that only substantial objects will remain as in Figure 6(b). After that, the system applied the bounding box to crop license plate effectively as this method proves isolation between the background and object as shown in Figure 6(c).

Result of each of the plate detection steps is shown in Figure 7 and it shows that the proposed method is good enough compared with the relevant contexts of the license plate detection system.

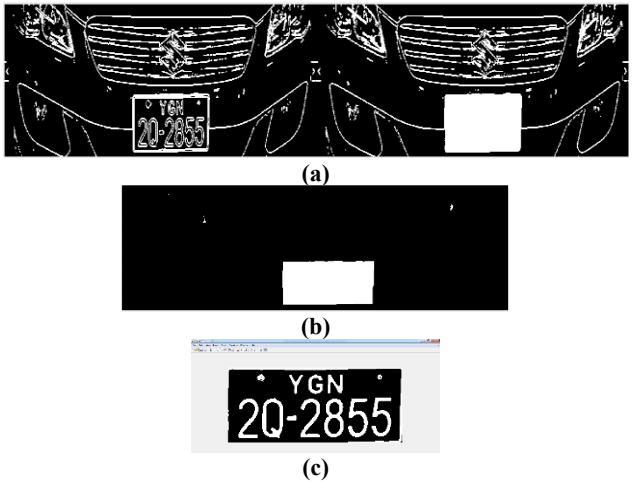

Figure 6. Morphological operation after edge detection (a) Dilation (b) Erosion after dilation (c) Plate extracted by bounding box

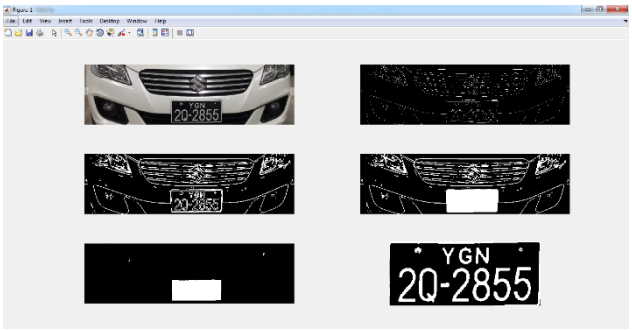

Figure 7. Overall plate detection steps

5. Experimental results

We experimented to verify the effectiveness of the proposed method. Proposed method is implemented on Matlab2017 and tested over-collected images by the digital camera and from another source such as online images to test different formats of images. Altogether there are 40 four-wheel vehicles images with JPEG and PNG formats. Almost all vehicle images are well-detected. Figure 8 shows some of the detected images.

Only 1 out of 40 vehicles could not be detected because of its degree orientation of the given input images. This false rate is (40-39)/440 = 0.025. Hence the accuracy rate is still high and gives optimal accuracy even taking this wrong detection of plate region. Although, the system is not well detected the oriented input image, it has still many advantages. The system was detected both sides of the vehicle plates that are front and back sides see in Figure 8. Also, it is well detected tilted or obscured plates by dirt, stickers, screws and other objects as shown in Figure 8. Moreover, the proposed system can be detected license plates that are captured at different

lighting conditions as shown in Figure 8(e) and Figure 8(f). Figure 8(e) was captured under the dark condition and Figure 8(f) was captured at heavy lighting conditions. The remaining result of Figure 8 is under normal lighting conditions.

Figure 8. Samples of detected images

6. Conclusion and future work

As the license plate structure is defined by the government of that country, it is not feasible to develop a universal ALPR system. This paper proposed an efficient and reliable license plate detection system for Myanmar Vehicle License Plates. This approach is well suited for the next step character segmentation that is in progression. Future work will include the next two steps of the ALPR system that are character segmentation and character recognition with deep neural network. According to the literature review, there is no previous research that has been focused on regional code recognition such as YGN, MDY. Thus, regional code segmentation and regional code recognition will focus in our future work.

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8. References

[1] K. Deb and K. Jo, “HSI color based vehicle license plate detection", International Conference on Control, Automation and Systems, 2008 in COEX, Seoul, Korea.

[2] J. Wang, B. Bacic and W. Yan, “An effective method for plate number recognition”, Multimed Tools Appl, Springer Science+Business Media New York, 2017.

[3] Myint Myint Htay, “Localization and Recognition of a Myanmar License Plate Based on Partially Cut Character Structure”, Fourteenth International Conference on ICT and Knowledge Engineering, 2016.

[4] O. Khin, M. Phothisonothai and S. Choomchuay, “License Plate Detection of Myanmar Vehicle Images from Dissimilar Angle Conditions”, ICSEC 2017, November 15-18, 2017.

[5] S. Du; M. Ibrahim; M. Shehata and W. Badawy “Automatic License Plate Recognition (ALPR): A State-of-the-Art Review”, IEEE Transactions On Circuits And Systems For Video Technology, Vol. 23, No. 2, 2013.

[6] S. Du, M. Ibrahim, M. Shehata, and W. Badawy, “Automatic license plate recognition (alpr): A state-of-the-art review," IEEE Trans. Circuits Syst. Video Technol., vol. 23, no. 2, pp. 311-325, 2013.

[7] W. Zhou, H. Li, Y. Lu, and Q. Tian, “Principal visual Word discovery for automatic license plate detection," IEEE Trans. Image Process., vol. 21, no. 9, p. 4269-4279, 2012.

[8] X. He, L. Zheng, Q. Wu, W. Jia, B. Samali and M. Palaniswami, “Segmentation of Characters on Car License Plates”, Multimedia Signal Processing (MMSP), 2008 IEEE.

[9] Hendry, R. Ching Chen “Automatic License Plate Recognition via sliding-window darknet-YOLO deep learning”, Image and Vision Computing Volume 87, July 2019, p. 47-56.