License Plate Detection Based on Rectangular Features and Multilevel Thresholding

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Abstract – *Rapid advancement of technology in artificial intelligence and computer science knowledge and then feel the need to search and secure automated systems are because of the appearance of intelligent systems based on image processing and spread this knowledge. One of these intelligent systems is license plate recognition (LPR) system. LPR plays an important role in intelligent transportation system; however, plate region extraction is the key step before the final recognition. In this paper, an effective license plate extraction algorithm is proposed based on geometrical features and multilevel thresholding to identify and segment the license plate from the image. Experimental results show that the technique achieved promising accuracy.*

Keywords: License Plate Detection, Image Processing, LPD, Object Detection.

1 Introduction

License plate recognition (LPR) has been adopted widely into numerous applications such as unattended parking, security control, and stolen vehicle verification. In the LPR system, license plate detection is the most crucial step. It is extremely difficult to detect license plate from a cluttered background efficiently because of the affection of varying illumination, perspective distortion, interference characters, etc. Most of the previous license plate detection algorithms are restricted to certain working conditions, such as fixed backgrounds, known the color, or fixed size of the license plates [1-4]. Therefore, detecting license plate under various complex environments is still a challenging problem.

Recently, LPR has become popular due to its practical importance in image processing applications. Several improvements are proposed in the literature [5, 6] which present efficient and accurate algorithms to detect license plate and identify the numbers and character on the license plate. The license plate localization is a technique to detect and isolate the plate in the image. Several methods have been developed for this purpose. This technology has been used in various intelligent applications, such as the access-control systems, automatic toll collection, intelligent parking systems [7, 8] and traffic analysis, vehicle tracking system, and identification of stolen vehicle can provide valuable information to police for searching the suspected vehicles.

License plate numbers uniquely identify a particular vehicle which varies from region to region because every country has their own license plate layout which differs in their sizes and colors. So there is a necessity for them to develop the LPR system suitable for the vehicle License Plate format. In general, the LPR system has the following parts: the acquisition of the image, the image preprocessing, detection of the license plate, segmentation and the character recognition [9]. The basic block diagram of the system is shown in Figure 1.

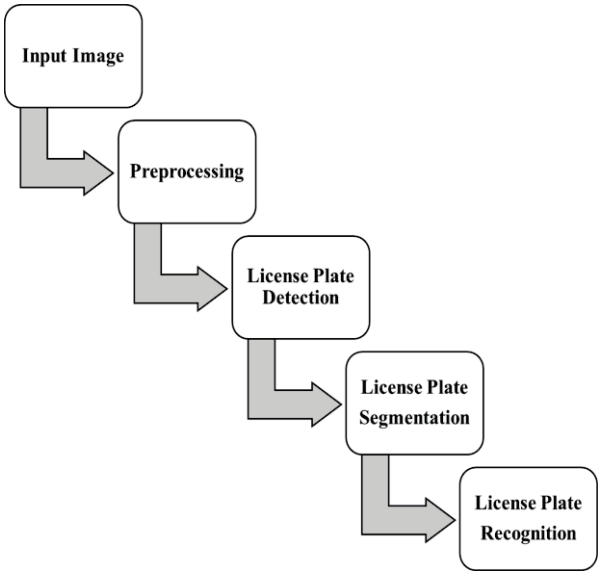

Fig. 1. The basic block diagram of the License Plate Recognition (LPR) System.

The detection steps have been focused in this work, in other words, the determination of the zone where the

license plates are located. The proposed algorithm is based on the extraction of plate region. The captured image is processed through the system to obtain the output. There are several detection methods such as [5-10] method and so on. However, in this paper, we focused on geometrical features and thresholding methods. In the literature, many techniques for this step have been reported. A segmentation method based on thresholds is proposed in [14]. In [11, 18] the finding of the plates is based on the analysis of connected components of four different binarization of the image. [5] And [12] discusses the edge detection of license plate using Sobel and canny edge detector respectively, Edge detection by means of gradient and morphological techniques are presented is [13]. The line detection using the Hough transformation is proposed in [14]. [15] proposed an algorithm in which vertical edges and edge density features are utilized to find candidate regions, the candidates are filtered out based on geometrical and textural properties. Learning techniques and Neural Networks have also been studied in this problem. In [16] the approach mainly based on Artificial Neural network while the steps proposed was (1) Plate Localization: - Canny Edge Detector used for the image localization purpose. (2) Character segmentation: - Histogram approach was taken into account for contrast extension while median filtering for noise reduction (3). Feature Extraction: Artificial Neural Network (ANN) was proposed in this process. Two separate ANN used one for character and the other for character extraction because confusion was high when combined approach was applied to both character and numbers so to increase the success rate separate ANN was implemented. (4) Character Recognition: - a Multi-layered perceptron (MLP) model of the ANN was used for the character recognition purpose. The research [17, 18] also describe the LP detection using neural networks. They proposed the methods for license plate detection problem which describe a strategy of multiple classifications based on an MLP.

Every method gives the best results under some certain conditions, but every technique has its own limitations. The variations of the plate types or environments cause challenges in the detection and recognition of license plates. They are summarized as follows.

1) Plate variations:

a) Location: plates exist in different locations of an image;

b) Quantity: an image may contain no or many plates;

c) Size: plates may have different sizes due to the camera distance and the zoom factor;

d) Color: plates may have various characters and background colors due to different plate types or capturing devices.

2) Environment variations:

a) Illumination: input images may have different types of illumination, mainly due to environmental lighting and vehicle headlights

b) Background: the image background may contain patterns similar to plates, such as numbers stamped on a vehicle, bumper with vertical patterns, and textured floors.

The rest of the paper is organized as follows: Section 2 presents the proposed method for license plate detection, Section 3 demonstrates the experimental results and conclusions are drawn in Section 4.

2 Proposed Method

In this paper, we present a method for license plate as shown in Figure 2. The design is considered for the specific characteristics of Korean license plates. The vehicle images were obtained with different backgrounds, illumination, license plate angles, distance from the camera to a vehicle, light conditions and different size and type of LPs.

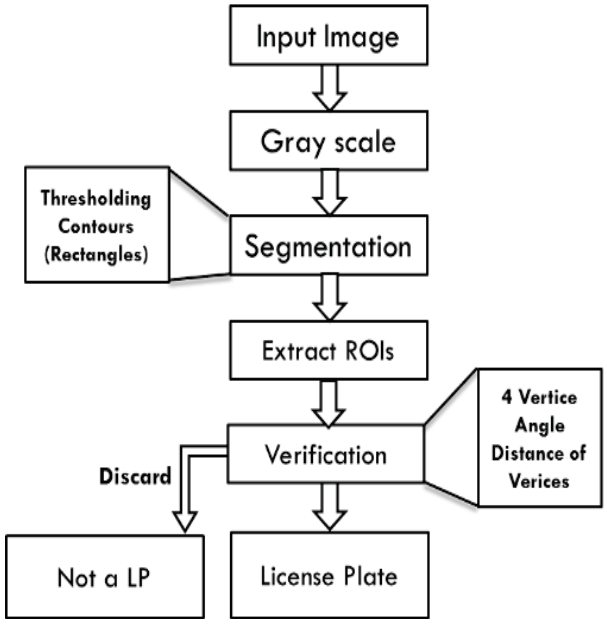

Fig. 2. Flowchart of the proposed method

2.1 Preprocessing

This section deals with the preprocessing procedure, Images taken from the camera were processed by the preprocessing module. The purpose of this module is to

enrich the edge features. This will improve the success rates of the license plate detection module. The algorithms sequentially used in this module are graying and noise removal. After having obtained a grey-scale image, we use the image pyramid to reduce the image noise. The resulted images are used as inputs for the license plate detection module.

2.2 License-Plates Detection Algorithm

In order to detect regions of the plate - candidate image, before applying contour algorithm we apply multi-threshold levels to the image. As adaptive thresholding typically takes a grayscale or color image as input and, in the simplest implementation, outputs a binary image representing the segmentation. For each pixel in the image, a threshold has to be calculated. If the pixel value is below the threshold it is set to the background value, otherwise, it assumes the foreground value. We use adaptive threshold instead of zero thresholds to catch possible plate region with gradient shading as shown in Figure 3 while for the rest of levels the system uses binary thresholding as shown in Figure 4.

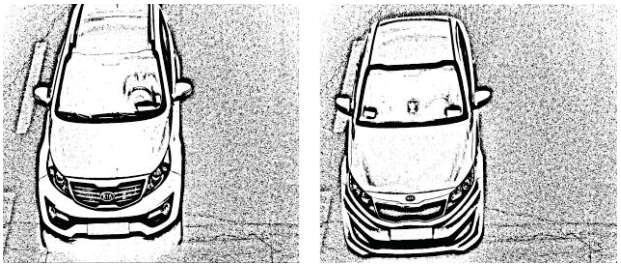

Fig. 3. Adaptive thresholding

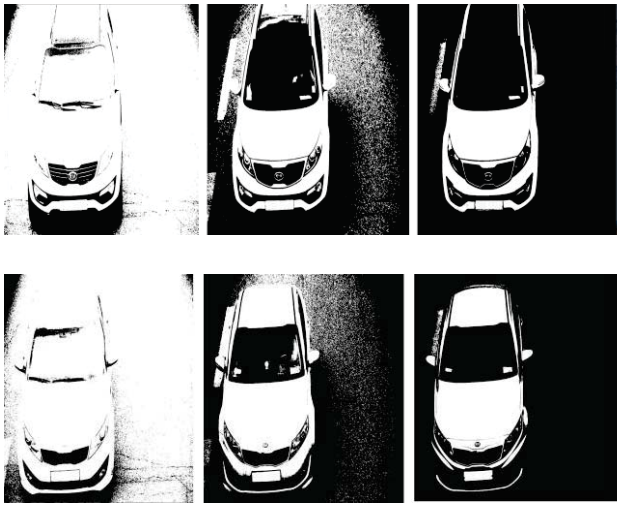

Fig. 4. Several levels of binary thresholding

Contour algorithm is applied to each threshold image which detects the polygons which have 4 vertices. A number of candidate evaluation algorithms are applied to contour images obtained from the contour algorithm to separate regions of interest which may contain license plate, however some false regions were also detected as plate-candidates. To reject such incorrect candidates, we implemented a module for evaluating whether a candidate is a plate or not before verifying the ROIs the algorithm de-skew the ROIs which can help to get good results in license plate recognition.

2.3 Verification of License Plate

As there are many ROIs received as a plate candidate, therefore, the system evaluates plate-candidates' algorithm based on three main steps, which are taken sequentially. The three steps are (1) evaluating the angle and set some parameter of angle, (2) ratio between height and width of candidates, and (3) area of plate candidate using Euclidian distance. After verification the license plate is segmented from the image and rectangle is drawn on the original images as shown in Figure 5.

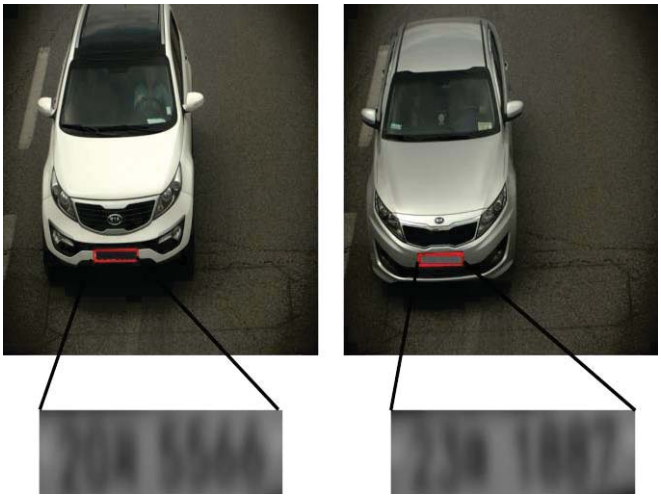

Fig. 5. License Plate Detection

3 Results

The system used in this work is built with Intel Core i5 3.6GHz CPU, 8GB RAM. In the experiments, we use 3000 dynamic images which contain images of different vehicles. These images were captured in different environmental conditions and with different angles. The results show 75% average accuracy while detecting the vehicle license plate (VLP). In the system, 6 different datasets of total size 500 were employed, which is shown in the bar graph with the accuracy of each dataset. In dataset 1 about 76% images were detected correctly, while in dataset 2 the accuracy is increased by 2%, in dataset 3 and 6 the accuracy is 74 %, the accuracy is increased by 1% compared to dataset 3 and 6, while the accuracy has drastically decreased to 73% due to some bad images or miss detection as shown in Figure 6. The overall accuracy

is 75%. The correctly detected license plates are shown in Figure 7.

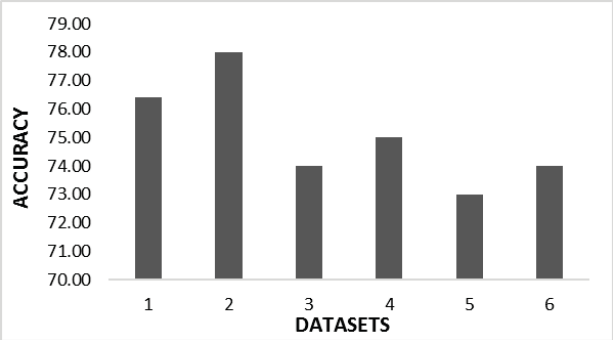

Fig. 6. License plate detection accuracy

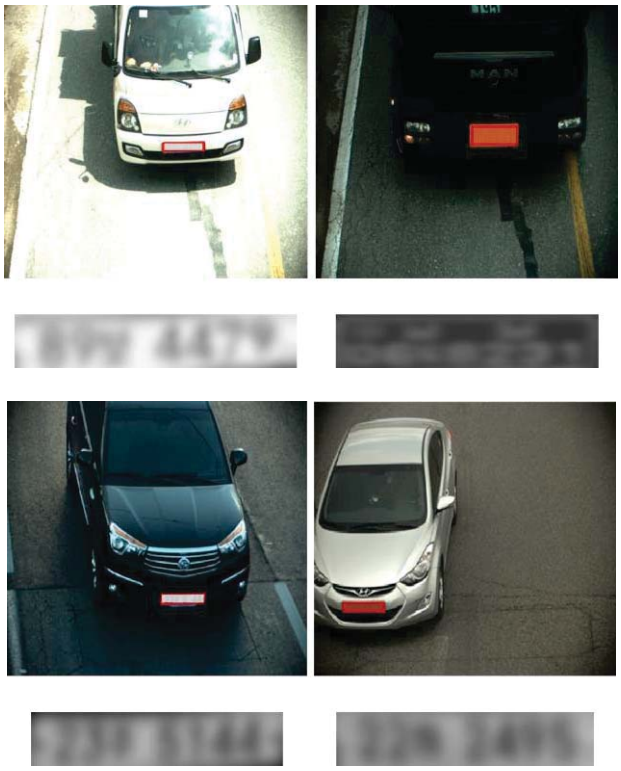

Fig. 7. License plate detection

The rest of the images were either missed or wrongly detected as shown in Figure 8. In image A, there are more than one ROIs because sometimes more than one geometrical object fulfills the rules which are set in the algorithm, in Image B the detection is failing due to the unclear and dusty plate. In Image C in Figure 8 the license plate is not distinguished because of the damage LP region. It is also noted that light intensity and angle variation can also cause miss detection.

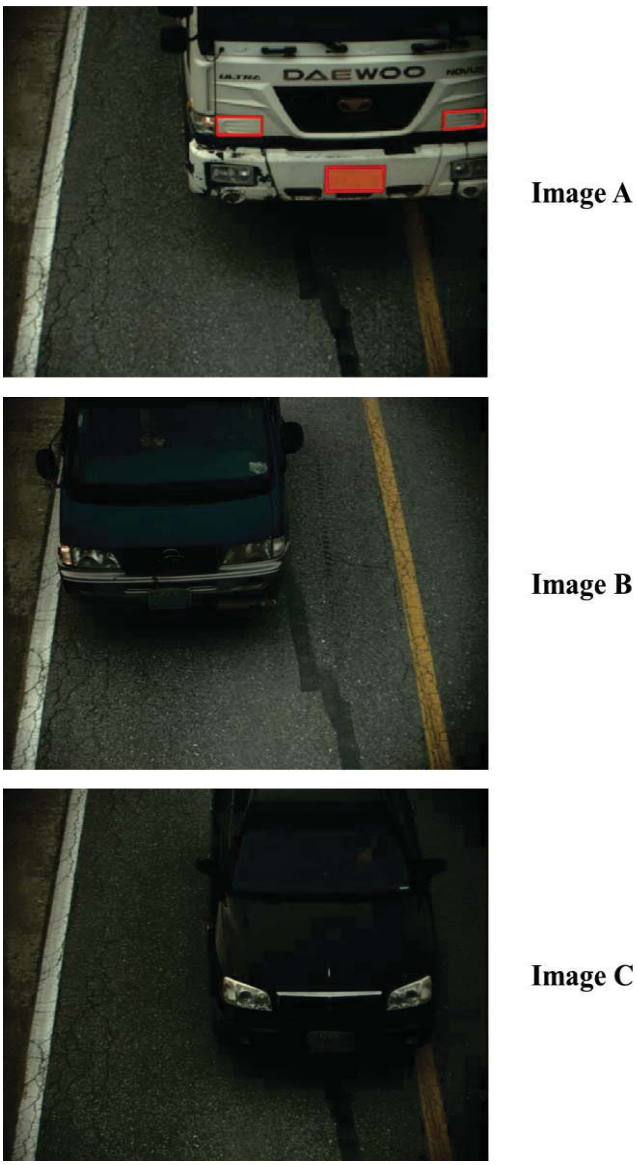

Fig. 8. Wrong and Missed Detection

4 Conclusions

This algorithm detects the license plate using the geometrical feature and multilevel thresholding to identify and segment the license plate from the image. This algorithm performs well on various types of LP images. However, it still has some challenges for example when dealing with bad quality and damaged plates. We are working on a number of algorithms in the preprocessing module. The purpose is to detect regions that are likely plate regions first and thus to reduce the computation cost of the VLP detection algorithm. In addition, we intend to combine a number of texture· based approaches, and machine learning methods to evaluate plate-candidates'. We believe these will improve the accuracy of the algorithm furthermore.

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