An Approach of Locating Korean Vehicle License Plate Based on Mathematical Morphology and Geometrical Features

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***Abstract*— In a vehicle license plate identification system, plate region detection is the crucial step before the ultimate recognition. In most of the traffic-related applications such as searching of stolen vehicles, road traffic monitoring, airport gate monitoring, speed checking and parking access control. This paper is focused on license plate detection, license plate detection in this paper is based on mathematical morphology and considers features like license plate width, height, ratio, and angle. The advantage of the proposed system is that it works for all types of license plates which differ in size and shapes. The proposed system archived promising results.**

Keywords—license plate detection; morphology; lp localization; lpd

I. INTRODUCTION

Vehicles are a necessary part of our existing life. With the fast improvement of Intelligence transportation system, automatic identification of vehicles has played a vital role in many applications during the past two decades for examples, the identification system can be applied to management of parking services [1], controlling traffic flow[2], access-control systems, automatic toll collection[3], traffic analysis, vehicle tracking system[4], and [5] identification of stolen vehicle can deliver important information to police for searching the suspected vehicles and so on.

Conventionally, license plates are used for identification of every vehicle. License Plate Recognition (LPR) is the process of automatically locating and extracting license plate information. In the LPR system, license plate detection is the most critical step. It is exceptionally difficult to detect license plate from a cluttered background efficiently because of the varying brightness, 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[6-9]. Therefore, detecting license plate under various complex environments is still a challenging problem.

In recent years, LPR has become popular due to its practical significance in image processing applications. Numerous improvements are suggested in the literature [10, 11] which present effective and precise systems to detect license plate and recognize the numbers and character on the license plate in complex scenes which directly affects the system's overall performance. A large number of researches has been carried out for the development of this technology recently, and many techniques have been proposed, such as the methods base on edge extraction [12], Hough transform [13], color feature [14], and histogram analysis [15]. But most previous works have in some way limited their working environments, such as limiting them to indoor scenes, fixed background, fixed brightness, prescribed driveways or limited vehicle speeds.

License plate numbers uniquely identify a specific vehicle which varies in shape and formats, because every country has particular license plate layout which differs in their sizes and colors. So there is a requisite for the authorities to develop such LPR system which is suitable for the vehicle License Plate different format. In general, the LPR system has the following parts: the obtainment of the input image, the image preprocessing, detection of the license plate, segmentation and the character recognition [16]. The basic block diagram of the system is shown in Figure 1.

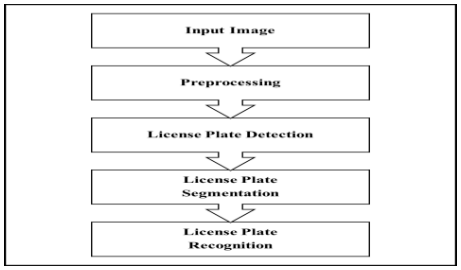

Fig. 1. The basic block diagram of the License Plate Recognition (LPR) System.

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The detection step has 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. In this paper, we focused on geometrical features and mathematical morphology methods to detect the license plate.

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

II. Background Challenges

In LPR System, we need to deal with a large variety of license plates, especially in South Korea, as shown in Fig. 2. In Korea, there exist various colors and sizes of license plates and different patterns and formats of numbers and characters which they include. There are three distinct sizes of license plates accessible in Korea, such as large size (52 cm × 11 cm), medium size (44 cm × 20 cm) and small size (33.5 cm × 17 cm or 15.5 cm).

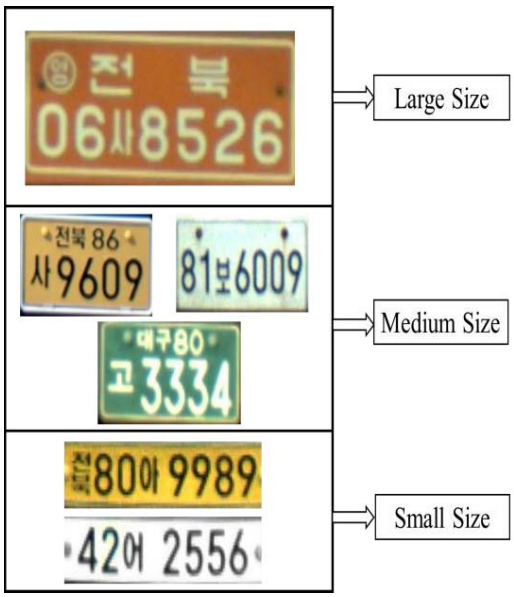


Figure. 2. Different types of Korean License plates

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. Which are briefly explain below.

1) Plate variations:

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

b) Quantity: there is many or no plates exist in the image;

c) Size: due to the camera distance and zoom factor the plate may vary in size;

d) Colors: in South Korea, there are different types of license plate which are different in colors and shapes as shown in the Fig. 2.

2) Environment variations:

a) Illumination: input images may have different types of brightness, mostly due to lighting in the environment and vehicle headlights

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

III. Proposed Method

A general block diagram of the proposed method is shown in Fig. 3. In this paper, we present a method for license plate localization. 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 license plates.

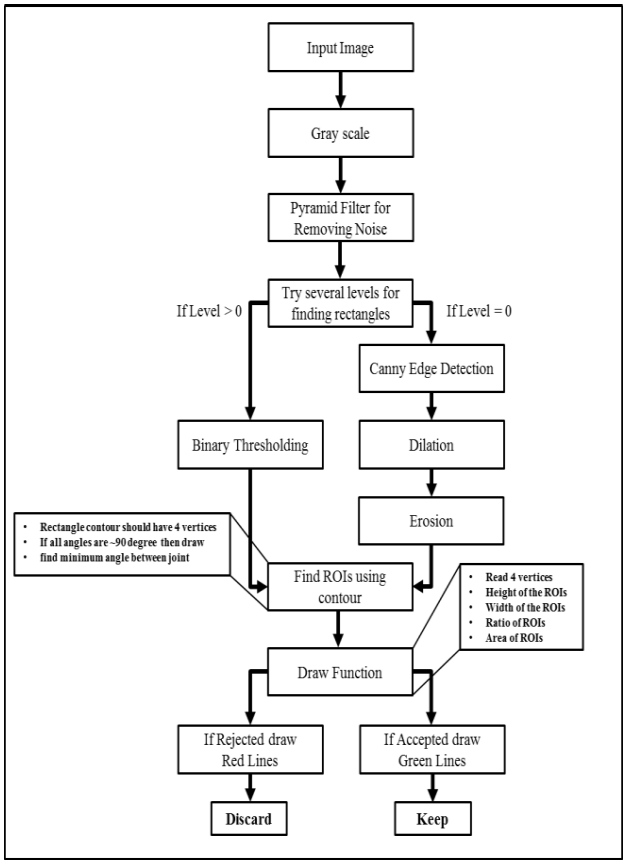


Figure. 3. Proposed method

A. Preprocessing

Pre-processing is applied to the image to improve the quality of the image which leads to the main processing becomes easier. This step involves image converting to grayscale and smoothing the images. Images taken from the camera were processed by the preprocessing section. 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 downscale and upscale the image to filter out the noise from the image. The resulted images are used as inputs for the license plate detection module.

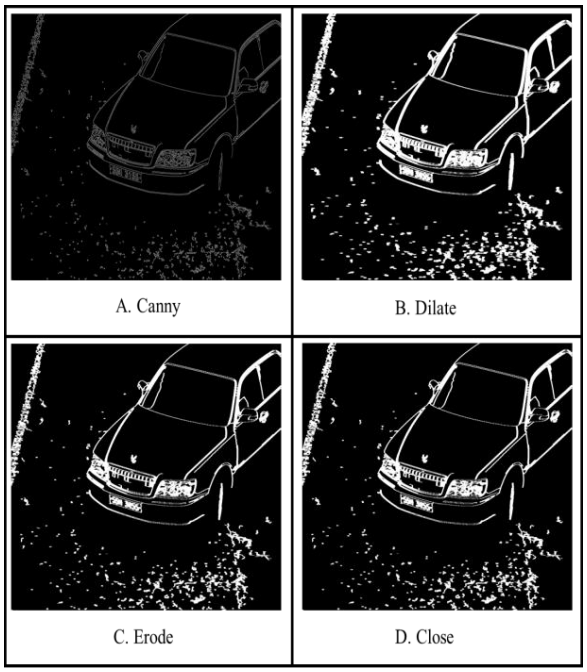
B. Korean License Plate Extraction Method

After the color input images is converted to grayscale and the noise is filter out with pyramid scale down and scale up, we passed this output of preprocessing to the another module to for finding the rectangles, but the system has set to some conditions for finding the rectangles, that the system will try several levels for finding the rectangles in the images, if level is zero the system will pass the image to the canny edge detector and convert it to the edge image as shown in Image A in Figure. 4.

Edge-detection is a basic tool that is widely used in image processing. It is applied practically in applications such as object determination, in which feature detection aims to sharply identify certain objects of an image as shown in the Fig. 4 below. Several edge-detection methods are widely used based on several possible optimization techniques. For example, error minimization, maximizing an object function, fuzzy logic, wavelet approach, morphology, genetic algorithms, neural network and Bayesian approach.

After converting the to the edge image we applied mathematical morphology to the image. Mathematical morphology is one of the branches of image processing that argues about shape and appearance of the object in images. The erosion, dilation, and close operators are basically operators of mathematical morphology that are used in this part to improve the edges of the image which include dilation, erosion and close morphology for appearance of object. We applied dilation to stronger the edges and complete the small gaps in between the lines as shown in the Fig. 4 in Image B, then the erosion is applied to the dilated image to remove the extra thickness from an edge image as shown in Image C in the Figure. 4 to make the edges distinguished from the unwanted edges which can affect the performance of the whole detection, then close morphology is applied to the image in order to fill holes in the regions while keeping region sizes as shown in Figure. 4.

Turning to the other side of the algorithm, if the level is greater than zero the system uses binary thresholding as shown in Image E, instead of canny operator and morphological operator to catch the possible plate region as shown in Figure. 4.



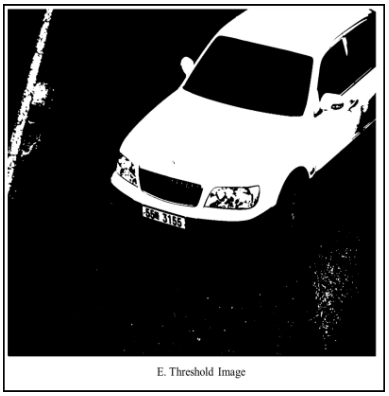


Figure. 4. Operations on input images

Contour algorithm is applied to each closed morphological and threshold image in order to detect the quadrilateral which has 4 vertices. The detected candidate evaluated more by the system which checks the angle which should be approximately equal to 90 degrees, to restrict the quadrilateral to be more accurate to rectangle 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.

C. Korean License Plate Verification

As there are many ROIs received as a plate candidate, therefore, the system evaluates plate-candidates' algorithm based on five main steps, which are taken sequentially. The three steps are (1) read the four vertices of an ROI, the system will check for the rest of conditions, (2) height of ROI, (3) width of the ROI, (4) ratio between height and

width of ROI, and (5) area of ROI. After applying the above condition we can get the license plate. After verification the license plate if any ROI satisfies all the condition the draw function draws a green line around the license plate otherwise, the red line is drawn by the draw function if any condition is not satisfied the system requirements as shown in Figure 5.

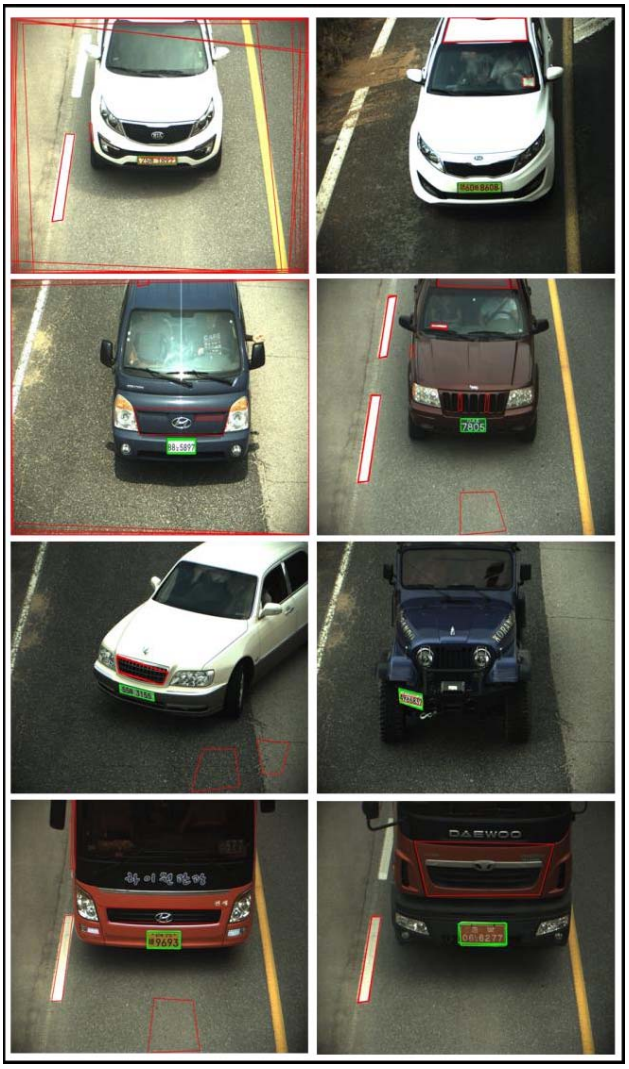


Figure. 5. Rejected and accepted ROIs

IV. Results

The system used in this work is built with Intel Core i5 3.6GHz CPU, 8GB RAM. In the experiments, we use 1580 dynamic images which contain images of different vehicles. These images were captured in different environmental conditions and with different angles. In general, there are three classes for a Korean VLP that summarized in Figure. 2 and a sample of every license plate are also shown in Figure. 2. Although each class uses a different size and has a different plate color. In this paper we will consider Korean license plate detection although we believe that our proposed algorithm can be used for foreign vehicles as well. The results show 78% average accuracy while detecting the Korean vehicle license plate. Some license plate. We tested our system with 1580 dynamic images in 1233 images the license plates are correctly identified as some of the examples are shown in Figure. 6 while the rest of 347 images are either detected wrong or miss detected due to the unclear and dusty plate and sometimes license plate cannot be distinguished because of damage license plate region. It is also noted that light intensity and angle variation can also cause miss detection.

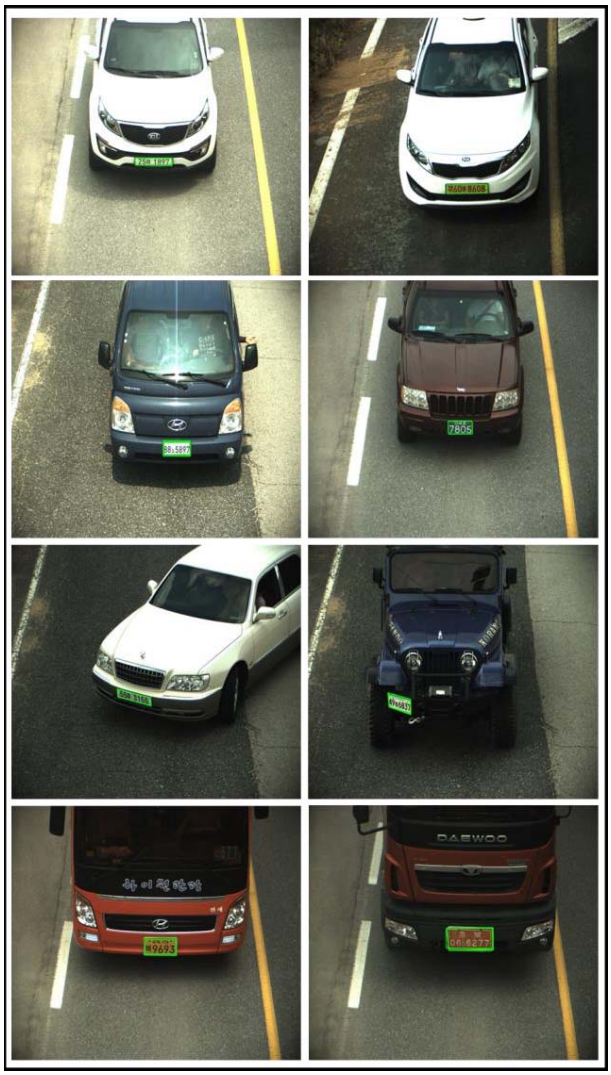


Figure. 6. License plate detected

V. Conclusion

In this paper, we proposed a method for finding license plate location. Images we used in our system are complex and differ in size, background, camera angle, distance etc. Considering all of these, the proposed method has the correct location rate of 78%. Moreover, the license plates consist of characters of variable size. The algorithm is based on mathematical operator and considers features like angles,

license plate width, height, and ratio. The advantage of the proposed system is that it works for all types of license plates which differ in size and shapes. Although our proposed algorithm is efficient in detecting any Korean license plate, we also believe that it can be used for foreign vehicle plates as well.

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