

Vehicle License Plate Recognition Based on Hierarchical Approach

Dongwook Kim¹ and Liu Zheng²

^{1,2} Dept. of Inform. & Comm. Eng., Jeonju University, Jeonju, Republic of Korea,
¹dwkim@jj.ac.kr, ²liudalin@naver.com

Abstract

In order to accurately detect the various sizes of vehicle license plates which are included in input image, we introduce hierarchical approach and overlapped partitioning technique in this paper. The proposed approach firstly attempts the license plate detection for entire image. If detection is failed, the image is partitioned into 3 overlapped rectangular areas and the license plate detection is attempted again. If detection is failed again, the image is partitioned into 7 overlapped rectangular areas and license plate detection is attempted. The method to use for detecting license plate in each step is the edge-based projection technique.

Keywords: License plate, projection, edge detection

1. Introduction

Automatic vehicle license plate recognition is an important component of modern intelligent transportation systems (ITS). With the rapid development of computer vision and pattern recognition, vision-based technologies are increasingly applied in ITS to traffic control and management. Generally vehicle license plate recognition is divided into several steps including license plate extraction, image region which contains a license plate, character segmentation, and character recognition. In generally, in order to recognize a vehicle license plate, the region of the license plate should be extracted from a vehicle image [4][5]. Accurate detection of the plate region is essential process to go over to the step of character recognition. There are two major methods to extract license plate region, one is based on edge detection in grayscale image [1]. In other words, since the license plate generally has a rectangular shape with a known aspect ratio, it can be extracted by finding all possible rectangles in a vehicle image. Edge detection methods are commonly used to find these rectangles [3]. In detecting edge, several operators are used, such as Sobel operator [6-7]. In order to search rectangle candidates, a projection is used at horizontal direction or vertical direction. The other is based on the special color feature of the plate [2]. The image is changed from RGB model to HSI model. One problem of this approach occurs when the vehicle color and its plate color is similar. In this case, it is not easy to extract the license plate from the vehicle image.

The size of license plate in a vehicle image varies enormously depending on the acquisition condition of the image data. In other words, the farther you move from the camera the size of license plate gets smaller in the same image acquisition environment. Applying to the same method to extract license plates with different sizes can cause various problems. Especially, if the size of license plate of in vehicle image is small, license plate detection is easy to fail.

In this paper, we introduce hierarchical approach and overlapped partitioning technique to accurately detect the various sizes of vehicle license plates which are included in input image. The proposed approach firstly attempts the license plate detection for entire image. If detection is failed, the image is partitioned into 3 overlapped rectangular areas and license

plate detection is attempted. If detection is failed again, the image is partitioned into 7 overlapped rectangular areas and license plate detection is attempted. The method to use for detecting license plate in each step is the edge-based projection technique.

2. The Proposed Algorithm

Fig 1 shows the edge projection-based technique for detecting of car license plate. Our algorithm is based on this technique. In this paper, we would like to accurately detect the various sizes of vehicle license plates which are included in input image.

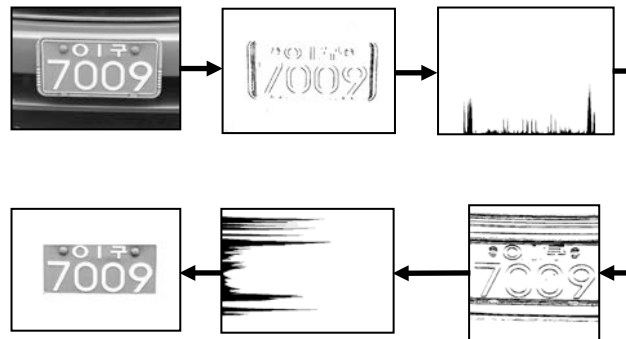


Figure 1 The Edge Projection-based Technique

The proposed algorithm has two primary steps including a hierarchical approach. The hierarchical approach consists of three parts: two parts of projection and one part of rectangle determination. The flow of this algorithm is roughly depicted in Fig. 2 and 3.

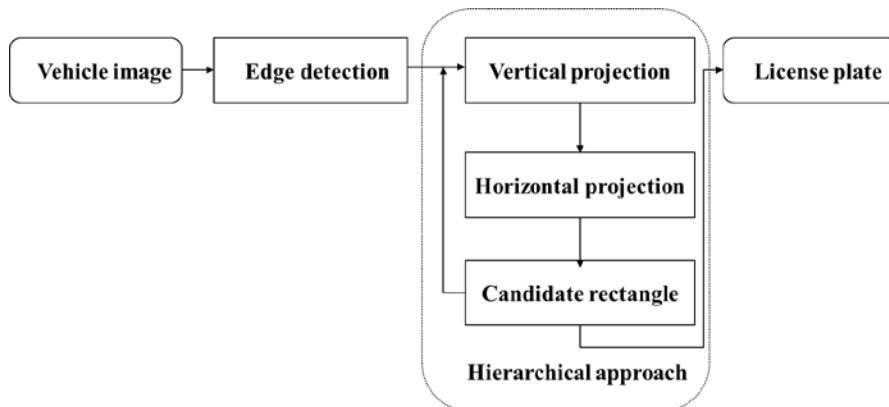


Figure 2. The Block Diagram of the Proposed Algorithm

2.1. Edge Detection

Edge detection is one of the key technologies in license plate extraction. The left and right sides in the license plate are generally vertical straight lines, respectively. The vertical straight line of the license plate is one of the key points for detecting the plate. This is why there are few vertical edges in car image, except for left and right side edges of license plate. Therefore, the vertical edges in car image can be important cues of evidence for detecting the license plate. In this step, vertical edges are detected for vertical projections in each level, first.

2.2. Hierarchical Approach

The hierarchical approach of the proposed algorithm is as follows. This aims to accurately detect the various sizes of vehicle license plates which are included in an input image. The following Figure represents flows for the hierarchical approach.

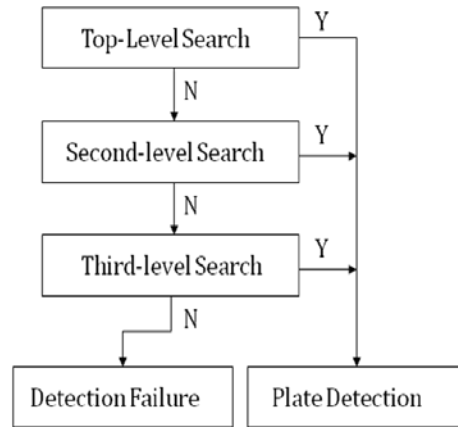


Figure 3. The Hierarchical Approach

● Top-Level Search

The top-level search is to detect the license plate for entire image as target region. This level is suitable for the detection of a relatively large license plate in a vehicle image. If the detection is failed in the level, the next level is performed.

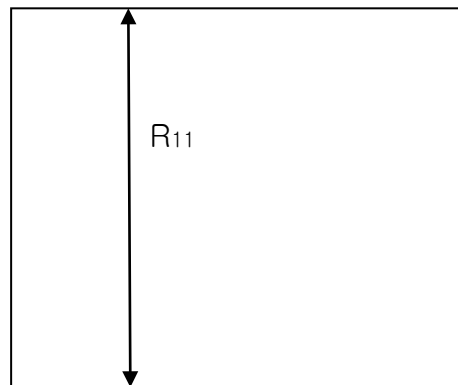


Figure 4. Top-level Search

● Second-Level Search

In the second-level search, the vehicle image is divided into three overlapped rectangular areas based on four areas as Figure 2. The overlapped partitioning is to prevent the plate straddling the boundary of two areas. In this level, several parameters to need extract license plate are readjusted so that it extracts the plate more efficiently.

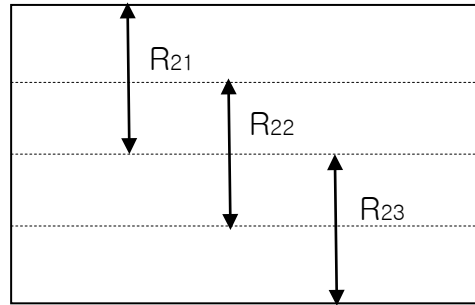


Figure 5. Second-level Search

● Third-Level Search

In the third, last-level search, the vehicle image is divided into seven overlapped rectangular areas based on eight partitions as Figure 3.

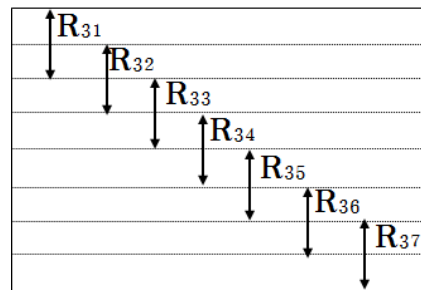
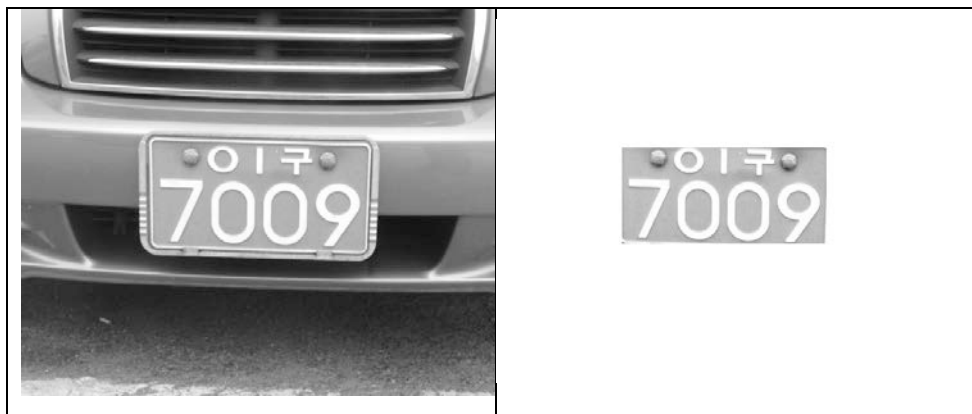


Figure. 6 Third-level Search

3. Simulation Results

Several experiments have been conducted on various images with different capture environments. Among the vehicle license plates of Korea, types of two, namely ‘Type-A’ and ‘Type-B’ were examined for evaluating the performance of our algorithm. Type-A is the old plate, Type-B is new. The width-height ratios of both have 2:1. Figure 7 and 8 show processes for license plates of ‘Type-A’ and ‘Type-B’, respectively.



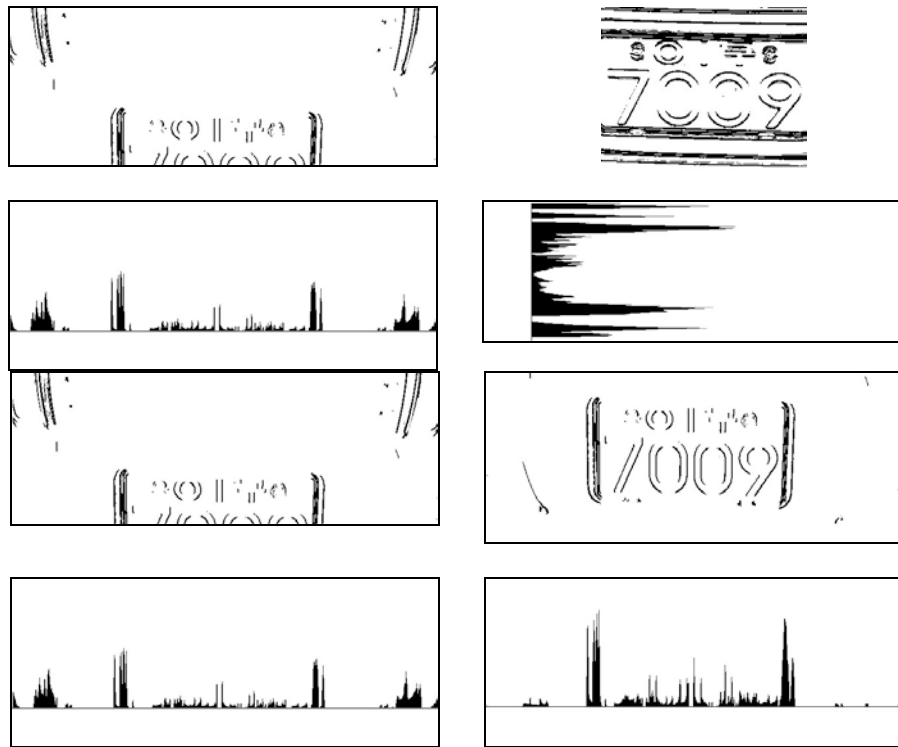
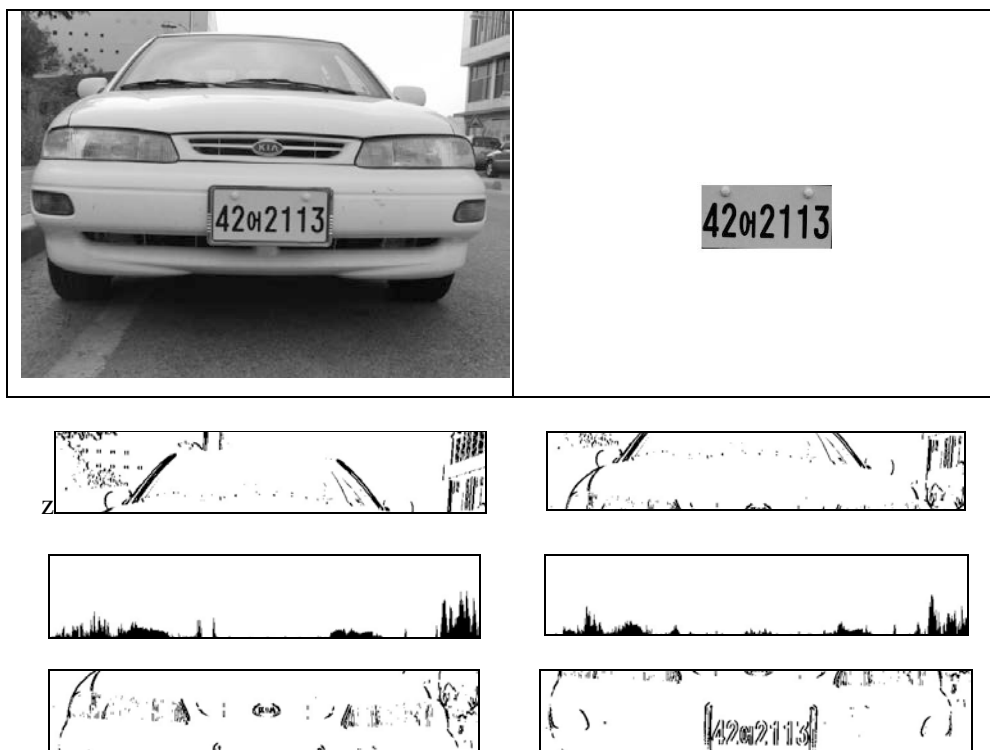


Figure 7. The Simulation Results for 'Type-A'



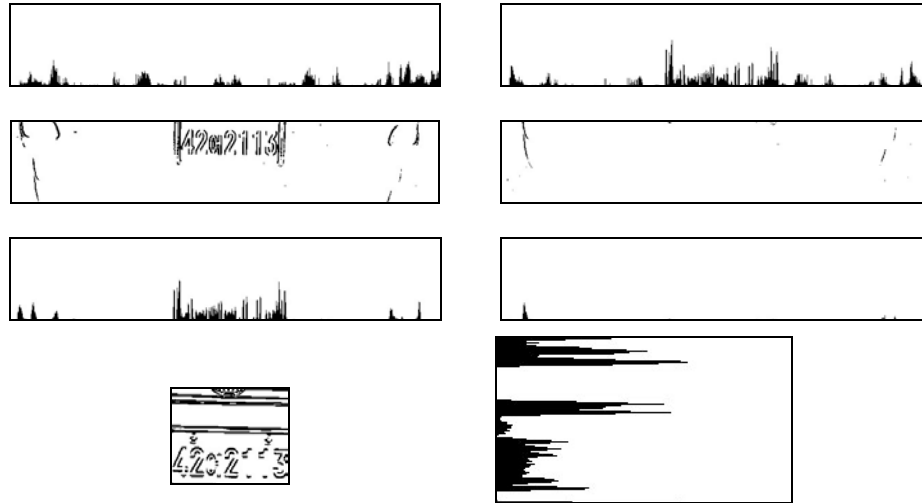


Figure 8. The Simulation Results for 'Type-B'

For confirming performance of the proposed algorithm, simulations were done for 108 license plate images. The results are listed in the Table 1.

Table 1. The Percentage of each Level

Level	Type-A, B
Top-Level	30%
Second-Level	51%
Third-Level	16%
Total(Success)	97%

Simulation results show that the proposed algorithm can detect accurately different sizes of license plates on average about 97%. This results show that our approach can solve the plate detection failure problems caused by a small size plate in vehicle image using the hierarchical approach and overlapped partitioning technique.

4. Conclusions

We proposed a new algorithm to detect the various sizes of vehicle license plates accurately. The main idea is hierarchical approach and overlapped partitioning technique. Based on this approach, the plate detection failure problems caused by a small size plate in vehicle image can be solved efficiently.

References

- [1] S. Kranthi, K. Pranathi and A. Srisaila, "Automatic number plate recognition", Int. J. Adv. Tech., vol. 2, no. 3, (2011), pp. 408-422.
- [2] C.-N. E. Anagnostopoulos, I. E. Anagnostopoulos, I. D. Psoroulas, V. Loumos and E. Kayafas, "License plate recognition from still images and video sequences: A survey", IEEE Trans. Intell. Transp. Syst., vol. 9, no. 3, (2008), pp. 377-391.
- [3] S. Du, "Automatic License Plate Recognition (ALPR): A State-of-the-Art Review", IEEE Trans. on Circuits and Systems for video technology, vol. 23, no. 2, (2013), pp. 311-325.
- [4] C. Nelson Kennedy Babu and K. Nallaperumal, "An efficient geometric feature based license plate ocalization and recognition", Int. J. Imaging Sci. Eng., vol. 2, no. 2, pp. 189-194.
- [5] H. Bai and C. Liu, "A hybrid license plate extraction method based on edge statistics and Morphology", Proc. Int. Conf. Pattern Recognit., vol. 2, (2004), pp. 831-834.
- [6] D. Zheng, Y. Zhao and J. Wang, "An efficient method of license plate location", Pattern Recognit. Lett., vol. 26, no. 15, (2005), pp. 2431-2438.
- [7] S. Wang and H. Lee, "Detection and recognition of license plate characters with different appearances", Proc. Int. Conf. Intell. Transp. Syst., 2, pp. 979-984 (2003).

Authors



Dongwook Kim received the B.S. degree in electronic engineering from electronic engineering from Sungkyunkwan University, in 1983, the M.S. and the Ph. D. degrees in electronic engineering from Chungang University, Seoul Korea, in 1992 and 1996, respectively. He is currently a Professor with the Department of Information & Communication engineering, Jeonju University, Jeonju, Seoul Korea.



Liu Zheng received the B.S. degree in Information & Communication Engineering from Jeonju University, in 2011. He is working towards a master's degree in Jeonju University, Joenju, Seoul Korea.

