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Cambodian Vehicle License Plate Localization

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Abstract: *Localization of the plate region is one of the critical tasks in the automatic vehicle license plate recognition (AVLPR) system. In this work, the algorithm for Cambodian license plate localization based on the mid-gray image removal combined with the connected component analysis (CCA) is proposed. We test our proposed technique with 70 images which are captured from some distances and viewpoints. As the result of the simulation, it shows the success rate of 98.57% for overall images in our image dataset.*

Keywords: License Plate Localization, Mid-Gray Image, Hough Transform, Connected Component Analysis

1. INTRODUCTION

There are many applications of vehicle license plate recognition system in many countries especially in developed countries, for example, traffic control to help monitor the movement and flow of vehicle around the road network, electronic toll collection, accessing to the restricted area, and more. In Cambodia, however, there are quite afew or no applications of such system.

In the AVLPR system, three most critical tasks, vehicle plate localization, character segmentation, and character recognition, are made up. The vehicle plate localization is one of those tasks which directly affect the accuracy of the AVLPR system. Various methods have been tested and implemented for the vehicle license plate (VLP) detection. Most of those algorithms are based on the edge detection and the morphological operations (Rafael, C. G. & Richard, E. W, 2002).

Lei, X.(2011) have proposed a new algorithm for license plate detection based on color and edge information of Lab space. This technique can deal with the situation of having the same color between the car and the plate.

Chirag, N. P. et alhave presented a novel multiple license plate extraction technique for complex background in Indian traffic condition. Firstly, the contrast enhancement based on the sigmoid function is employed to improve the quality of the images which are captured in different conditions. Then, edge detection is carried out based on sliding concentric window (SCW) adopted from Anagnostopoulos, C.N.E.et al (2006). Finally, the connected component analysis (CCA) and plate compatible filter technique are utilized to find the exact license plate. The authors have proved the performance of their algorithm with a large database consisting of 750 images with success rate of 99.2%.

Kaushik, D. et al (2009) have proposed a new edge detection method based on a sliding concentric window; horizontal and vertical sliding concentric window, for detecting horizontal and vertical edge, respectively. In the subsequent steps, connected component analysis is followed by a filtering technique of aspect ratio analysis to extract the plate regions.

The authors have tested their algorithm with 40 images which are captured from various distances (between 3 and 7 meters), in different weather, and from different viewpoints and they also have claimed the performance of detection rate of 82.5%.

A new binary method based on the improved Bernsen technique combined with the Gaussian filter which can remove the shadow from the detected license platehave been proposed by Y. Wen et al. (2011). The authors stated that their algorithm is robust to the variance of illumination, view angle, position,size, and color of the license plates when

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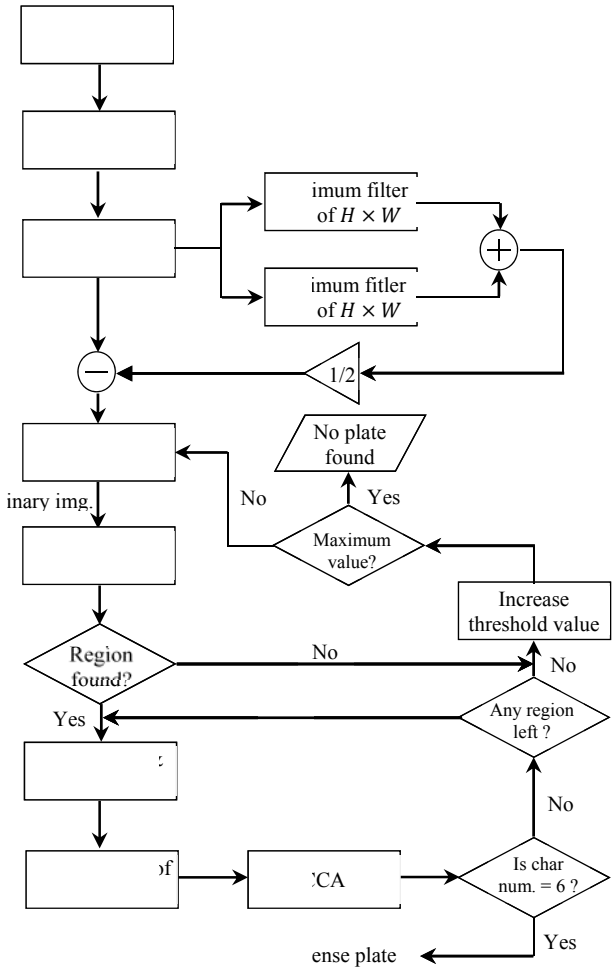
working in a complex environment by testing with 9026 images and can achieve the accuracy of 97.16% for the license plate localization.



In our work, the mid-gray image removal combining with the connected component analysis (CCA), as shown in Fig.1, have been proposed for the vehicle license plate localization. A difference between the input gray image and its corresponding mid-gray image is employed to remove all the pixels below the mid-gray values. Then, the CCA is applied to filter out the non-license-plate-like regions from the output binary image.This paper is organized as follows: the proposed technique is detailed in section 2. Next, the simulation results are illustrated in section 3. Finally, conclusions and discussion are given in section 4.

2. METHODOLOGY

The proposed algorithm have been separated into three main blocks, pre-processing, candidate region extraction and candidate region verification. Before explain each block, the decription of the Cambodian private car number plate is introduced.

There are currently two types of Cambodian private car number plate as show in Fig.2. For the type I, there are three rows. The first row is Khmer character (blue color) which is referred to the name of the province or city. The second row is the identity character which is random except the first numeral "2" (for 1–7 seats private automobile) which is referred to the class number. The last row (red color) is also referred to the name of province or city but in Latin. This description is the same for the type II but different format.

2.1 Pre-processing

In this stage, the input color image is resized to $M \times N$ pixels and is converted into a gray image. Then, its corresponding mid-gray image by the window size of $H \times W$ is removed. Finally, the binary image has been obtained by using the global technique with the threshold value T, which is expressed by Eq. (1).

$$T = \mu_G + k.\delta_G \quad (1)$$

where G is the gray image from removing its corresponding mid-gray image. μ_G and δ_G are the mean and the standard deviation of G, respectively. k is the parameter of the threshold value.

The parameters employed in the simulation are defined as follows: $M = 540$, $N = 720$, $H = W = 11$, and k varies from -1 to 1 with the increment 0.1. The example of the steps in the pre-processing is shown in Fig.3.

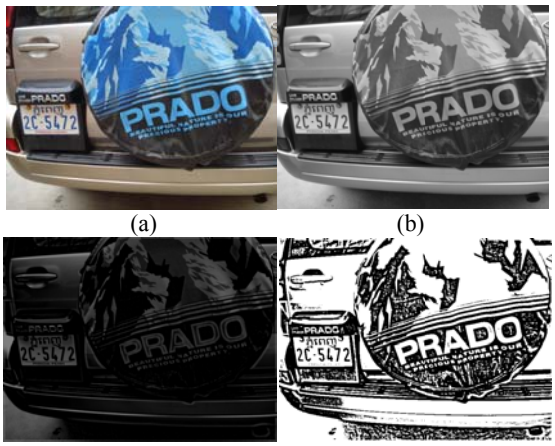
2.2 Candidate Region Extraction

After getting the binary image, the connected component analysis (CCA) is applied to find the LP-like regions. During the process, all regions labeled by CCA are filteredby the geometric properties of LP candidate such as aspect ratio (AR), height (H), width (W), area density (AD), area (A), and Euler number (EN).

Those regions, whose geometric properties fulfill the criteria as follows, are considered as the candidate plate regions and depicted in Fig.4.

(a) Type I (b) Type II

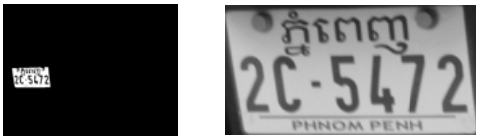
Fig.2.Cambodian private car number plates



(a) (b)

(c) (d)

Fig.3.Pre-processing (a) input color image, (b) gray image (c) image after removing a mid-gray image from (b), and (d) binary image of (c)



(a) (b)

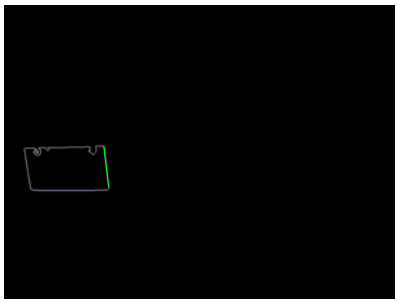
Fig.4.LP-like region extraction (a) region after filtered by CCA, and (b) extracted candidate regions

- Aspect ratio (AP) :$1.2 \leq AR \leq 4$
- Height (H) :$35 < H < 130$
- Width (W) :$80 < W < 280$
- Area density (AD) :$AD > 0.4$
- Area (A) :$1500 < A < 25000$
- Euler number (EN) :$EN \leq -5$

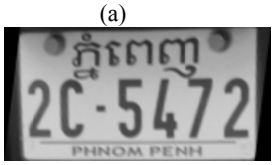
2.3 Candidate Region Verification

There might be more than one candidate regions are found as shown in Fig.5. In this stage, all found candidate plate regions are verified by counting the numbers of identity characters.If the numbers of the identity characters in the found candidate region is equal to six, it means that detected region is the license plate region.

Fig.5.Two candidate region are found without the region verification



(a)

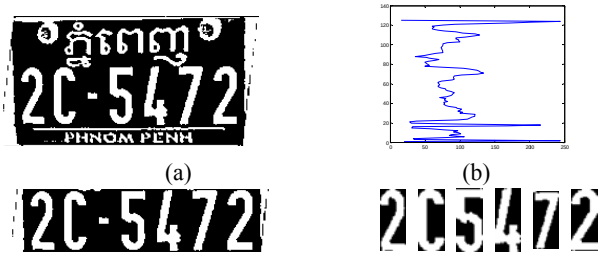


(b)

Fig.6.Orientation correction (a) the longest horizontal and verticallines detected by Hough transform, (b) the candidate plate after the orientation correction

(a) (b)

Fig.7.Image enhancement (a) unsharp masking image from Fig.6(b), and (b) gray image equilibrium of (a)



(a) (b)

(c) (d)

Fig.8.Character segmentation (a) binary image from Fig.7(b), (b) vertical projection, (c) identity character region, and (d) extracted characters

Fig.9. Sample images are employed for simulation

Fig.10. Some results of the plate localization with the region verification.

If all six characters could not be found at the corresponding threshold value, this thresholdvalue will be increased for the imagebinarization, searching for the candidate plate regions, and finding identity character numbers again. If still not verified, repeat until the maximum threshold value. When it reaches its maximum threshold value, still not verified, it will show the message "license plate not found".

Prior to character segmentation, some processes are required including orientation (horizontal and vertical) corrections and image enhancement.

a. Orientation Corrections

Several techniques for the orientation corrections have been implemented in the license plate recognition system.

In our approach, we adopt Hough transform for detecting the longest horizontal (blue color) and vertical (green color) lines of the candidate plate regions as shown inFig.6(a). Firstly, the binary image in Fig.4(a) is filled with all holes and then Prewitt edge detector method is used to detect the edge. Next, Hough transform is applied on the edge image to detect those lines. Finally, the candidate plate region in Fig.6(b) is corrected from Fig.4(b) with the direction angles of both lines.

b. Image Enhancement

Because some candidate plate regions are not clear, this can affect the results of the character segmentation. Thus, their qualities are improved by the image enhancement techniques, those are unsharp masking (Rafael, C.G. & Richard, E.W., 2002) and image gray equilibrium (Y. Wen et al., 2011),which are applied to the candidate plate region after orientation correction as depicted in Fig.7. As the results, it shows that the characters in image of Fig.7(b) are clearer than those in image of Fig.6(b).

c. Character Segmentation

After enhancing the image; it is converted into binary image as shown in Fig.8(a). As seen in this figure., the character "C" and the numeral "7" are almost connected to Khmer characters above them. And some cases those identity characters are connected to the line below them. This is the issues when directly extracting the identity characters based on the connected component analysis (CCA). Thus, the identity characters region must be cut out based on the valley detection of the vertical projection as shown in Fig.8(b). Then, CCA is examined onto the region in Fig.8(c) to get the extracted characters as depicted in Fig.8(d).

3. SIMULATION AND RESULTS

The evaluation of the implemented algorithm is done on PC and tested under MATLAB R2012a environment. In the simulation, 70 images are employed. The sample of the tested images areshown in Fig.9.All of these images arecaptured by the digital camera Sony Cyber-Shot DSC W55 from some distances and viewpoints.

Fig.10 shows some results of candidate plate regions detected (from front and rear views). Based on our technique, the simulation results show that the performance can be achieved 98.57%(69 out of 70 images) of plate localization.

4. CONCLUSIONS AND DISCUSSION

In this work, the algorithm for automatic Cambodian license plate localization based on the mid-gray image removal combined with the connected component analysis (CCA) is proposed. As the simulation results, the performance of our algorithm can be achieved 98.57% on overall images in our image dataset.

However, some parameters used in this algorithm are not invariant to the size of image such as width, height, and area.This means that if we change the system with a new camera and capture with different size of image, we have to configure.these parameters again.

For the future work, we will use color searching techiques instead for finding the plate location, and study deeply some criteria such as various distances of the vehicle from the camera, different viewpoints from camera, light intensity variation in image, and the dirty vehicle license plates.

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