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Adaptive Automatic Number Plate Recognition (ANPR) and Extraction from Complex Images

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Abstract: ***Vehicle number plate recognition has attracted many researchers for intelligent transportation systems such as the payment of parking fee, controlling the traffic volume, traffic data collection, etc. We are presenting an enhanced license plate extraction methodology which includes edge statistics and the morphology. The proposed methodology includes vertical edge extraction, background curve and noise removing, edge statistical analysis and morphology-based license plate extraction.***

Keywords*:* intelligent transportation systems; license plate extraction; edge detection; morphology

1. Introduction

Invariably Intelligent Transportation System (ITS) technology is a vital research model that has attracted so much attention to itself. Automatic number Plate Recognition (ANPR) systems have many applications in ITSs, such as the payment of parking fee, controlling the traffic volume, traffic data collection, etc. Usually an LPR system consists of three components that are the license plate detection, character segmentation and character recognition. The first part is the most important and basic part which directly effects system's overall accuracy.

This part is primarily concerned in this paper. To detect the region of car license plate, many techniques have been used. In [4] a novel method called "N row distance" is implemented. This method scans an image with N row distance and counts the existent edges. If the number of the edges is greater than a threshold then the license plate is recognized, if not threshold have to be reduced and algorithm will be repeated. This method is fast and has good results for simple images. Disadvantage of this paper is that the edge based algorithms are sensitive to unwanted edges such as noise edges, and they fail when they are applied to complex images. Due to this problem, we use the algorithm which is mentioned in [2] to remove background and noise edges. In [5] first of all, edges are detected and then Hough transform is applied to detect the location of license plate.

This method requires too much computation and has difficulty in extracting license plate region when the boundary of the license plate is not clear or distorted or the images contain lots of vertical and horizontal edges. A wavelet transform-based algorithm is used in [6] for extraction of the important features to be used for license plate location. This method can locate more than one license plate in an image. Methods which are symmetry based are mentioned in [8]. Kim & Chien used symmetric regions to locate the license plate. This method is a little time consuming and does not work for rotated or distorted plates. Park et al. proposed neural networks to locate license plate [9]. Neural networks can be used as filters to analyze small windows of an image and to decide whether each window contains a license plate or not. Their inputs are HSI values and colors are changed under different illuminations and it makes some troubles. Fuzzy logic has been applied to the problem of locating license plate by Zimic et al. [7]. The authors made some intuitive rules to describe the license plate, and gave some membership functions for the fuzzy sets ‘‘bright’’, ‘‘dark’’ and ‘‘bright and dark sequence’’ to get the horizontal and vertical plate positions. From authors' point of view, by extending or changing the rules, the system can easily be adapted to locate other patterns.

In this paper first, we find the total vertical edges in the image, second we use the proposed algorithm in [2]. By using this algorithm we remove the noise and car edges. Then we use a new method to find a strip as a candidate. Afterwards, morphological operations are applied to detect the license plate. Finally, size of the plate is compared with the aspect ratio and if it is unacceptable the candidate strip will be deleted and the algorithm will be repeated. Fig. 1 shows the overview of the proposed system, which consists of four sections. In the next section, we describe the algorithm in detail. The experiment results are shown in section 3. Section 4 gives the conclusion.

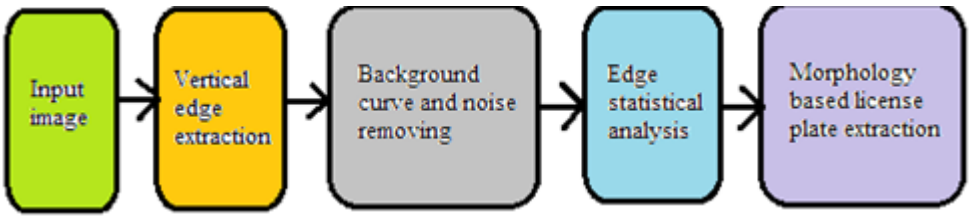


Figure 1: The system

- Vertical edge extraction
- Background curve and noise removing
- Edge statistical analysis
- Morphology-based license plate extraction

2. Automatic Number Plate Extraction

As shown in Fig. 1, the technique for the license plate detection consists of four sections. In the first section, we find the vertical edges. In the second section, we use an algorithm for Background curves and noise removing. Then we apply a new method to find the first strip as a candidate. Finally by morphological operations, the license plate will be detected. These steps will be described in detail in this section according to the processing order.

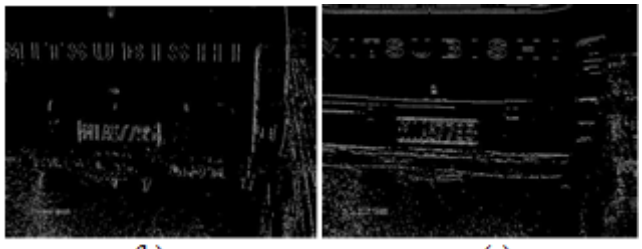
2.1. Vertical Edge detection and Extraction

In an image, ROIs are rectangular regions with white background and dark characters. The most important characteristic of these rectangles is the existence of lots of edges. In Fig. 2 we show the horizontal edge and vertical edge images. Based on this image, vertical edge images are better for next processing. There are many edge detectors such as Sobel, Canny and Prewitt. We use Sobel as an edge detector. This operator is shown in Fig. 3.

B. Noise Reduction

In this section we remove short and long edges by the proposed algorithm mentioned in [2]. Short edges are due to the noise, and long edges are due to the car and background. This algorithm only requires us to scan the edge image for three times. The first scan will record the edge lengths away from the top (or left) start points. And the second scan will record the edge lengths away from the bottom (or right) end points. And the last scan will add up the two kinds of lengths to denote the actual edge lengths.

(a)



(b) (c)

Figure 2: (a) Original image (b) Vertical edges image (c) Horizontal edges image

$$\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

Figure 3: The vertical Sobel operator

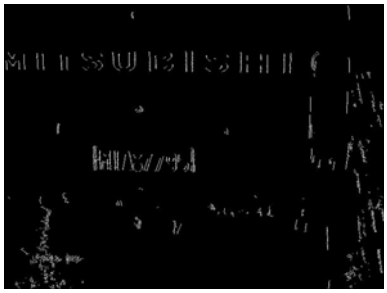


Figure 4: The image after applying the algorithm mentioned in [2]

In this algorithm we have two parameters as thresholds, Tlong and Tshort. Tlong is related to the estimated height of the license plate, and Tshort is shorter than most of the lengths of the plate edges. For our database Tlong=30 and Tshort=5. Fig. 4 shows the result of the algorithm. As it can be seen, lots of inutile edges are removed.

2.3 Edge Statistical Analysis

In this step, we are trying to find a strip that contains the license plate. First we divide the image into strips with height of '*L*' pixels. '*L*' is the maximum height of the license plate in the database. Then we count the edges in the strips. The result of these computations has been shown in Fig. 5. Now we find the strip with maximum edges and add the upper and lower strip to it. The result is shown in Fig. 6. After finding these 3 strips, we find the row '*r*' which contains maximum edges. Then let *lower_pointer=r+1* and *upper_pointer=r-1*. Now in a loop we will change pointers to the value which the license plate exists between two pointers. The algorithm for this loop mentioned in TABLE I.

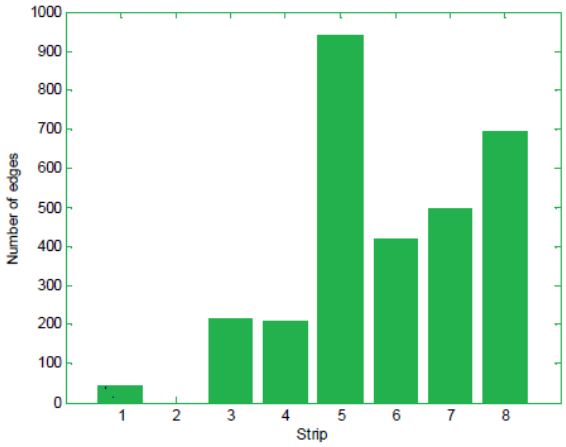


Figure 5: Number of the edges per each strip

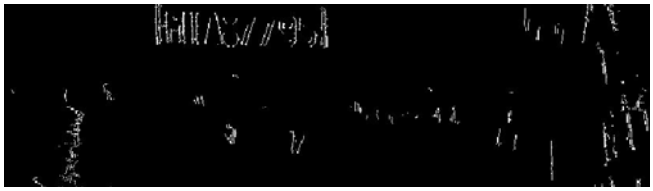


Figure 6: Three strips with maximum number of edges

Table 1: Strip Finding Pseudocode

```
Input= Vector ROW
_____________________________________
____
while (lower_pointer-upper_pointer != L)
{
T1= sum( ROW( upper_pointer-Tshort:upper_pointer ) );
T2= sum( ROW( lower_pointer:lower_pointer+Tshort ) );
if T1>=T2
upper_pointer= upper_pointer-1;
else
lower_pointer= lower_pointer+1;
}
```

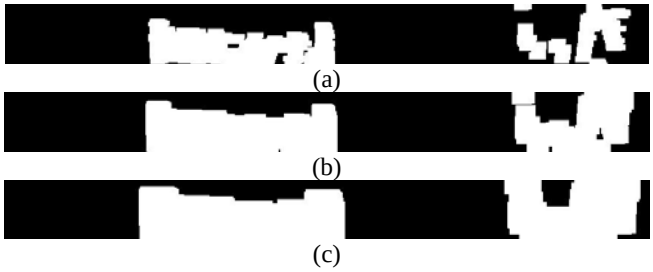
Where '*ROW*' is a vector which contains the number of the edges in each row of the strips. Length of the vector '*ROW*' is equal to 3×L. This loop continues till: *lower_pointer - upper_pointer = L;*

By this algorithm we find the strip which contains the license plate. The result is shown in Fig. 7.

Figure 7: The candidate strip

2.4 License Plate Extraction (Morphology based)

In this step we connect edges together by morphological operators and then we compare the candidate with the aspect ratio. We use dilation operator for three times. First a horizontal dilation, after that a vertical dilation and at last, again a horizontal dilation. By these operations we connect edges of existent license plate together. Result of these operations is shown in Fig. 8.Now we search for the biggest white strip in the region and set it as first candidate then, we compare it to the aspect ratio. If its dimensions are not close to aspect ratio, we delete this region from vertical edges image and repeat the above algorithm, if not, the first candidate is acceptable and the algorithm is finished. Final result is shown in Fig. 9.



(a)

(b)

(c)

Figure 8: (a) First horizontal dilation, (b) First vertical dilation, (c) Second horizontal dilation

Figure 9: The final result

3. Result

Our algorithm was tested with 310 natural color images of size 640×480 and 1792×1312 on Greek license plates. The images contain different complex background and ambient illumination. Also the distance between camera and license plate, and the angle of the license plate were different. The database is available on: http://www.medialab.ntua.gr/research/LPRdatabase.html

By our proposed algorithm, in 262 images of total 312 images, the license plate extraction leads to correct results. It means that the proposed algorithm can detect the license plate with about 84% accuracy. We implant our code on MATLAB software. Most of the mistakes happened because of the blur images and dirty cars. This method is a little time consuming. In Fig. 10 some experimental results are shown. Also, we note that the proposed method in this paper is used in [10] for license plate character recognition

Figure 10: Some experimental results

4. Conclusion

In this paper, Adaptive Automatic Number Plate Recognition (ANPR) and Extraction from complex Images
is explored via vertical edge extraction, background curve and noise removing, edge statistical analysis and morphology- based license plate extraction. Though Edge base detection is noise sensitive, we demonstrated an new methodology for reduction of noise scale in complex images a, future more experiments are needed to be done with consideration of database comparisons.

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