

- 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

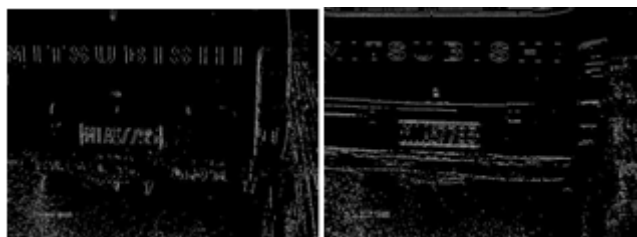
In an image, ROIs are rectangular regions with white background and dark characters. The most important characteristic of these rectangles is the existence of lots of edges. In Fig. 2 we show the horizontal edge and vertical edge images. Based on this image, vertical edge images are better for next processing. 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.

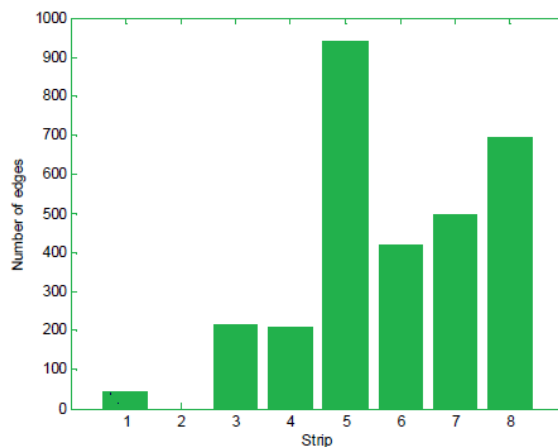


Figure 5: Number of the edges per each strip

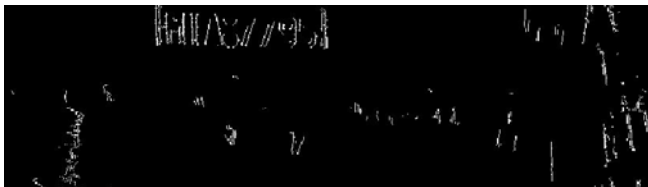


Figure 6: Three strips with maximum number of edges



Figure 9: The final result

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 $3 \times L$. 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.

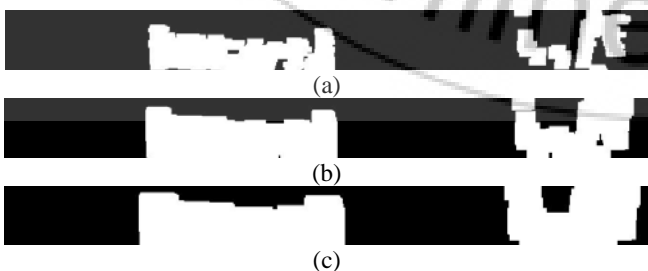


Figure 8: (a) First horizontal dilation, (b) First vertical dilation, (c) Second horizontal dilation

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

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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 a new methodology for reduction of noise scale in complex images a, future more experiments are needed to be done with consideration of database comparisons.

References

- [1] Feng Yang, Zheng Ma "Vehicle License Plate location Based on Histogramming and Mathematical Morphology", 2005
- [2] Wenjing Jia, Huaifeng Zhang, and Xiangjian He "Mean Shift for" Accurate Number Plate Detection", July 2005.
- [3] Moffa, Steven. (2010). License Plate Recognition Technology: Tips from the User Community. Fairfax County, VA: George Mason University. Located at: <http://gemini.gmu.edu/cebcp/LPR/for-lpr-deployment.html>
- [4] Satadal Saha¹, Subhadip Basu, Mita Nasipuri, Dipak Kumar Basu," License Plate Localization from Vehicle Images:An Edge Based Multi-stage Approach", International Journal of Recent Trends in Engineering, Vol 1,No. 1, May 2009
- [5] O. Martinsky, "Algorithmic and Mathematical Principles of Automatic Number Plate Recognition System", B. Sc. Thesis, BRNO University of Technology, 2007
- [6] C.T. Hsieh, Y.S Juan, and K.M. Hung, "Multiple license plate detection for complex background," in *Proc. Int. Conf. AINA*, vol. 2, pp. 389-392, 2005.
- [7] D.S. Kim and S.I. Chien, "Automatic car license plate extraction using modified generalized symmetry transform and image warping," in *Proc. ISIE*, pp. 2022-2027, 2001.
- [8] S.H. Park, K.I. Kim, and H.J. Kim, "Locating car license plate using neural networks," *Electron. Lett.*, vol. 35, no.17, pp. 1475- 1477, 2005 Fukunaga K.: Introduction to statistical pattern recognition, Academic Press, San Diego, USA, 1990.
- [9] V. Kasmat, and S. Ganesan, "An efficient implementation of the Hough transform for detecting vehicle license plates using DSP's," IEEE International Conference on Real-Time Technology and Application Symposium, Chicago, USA, pp. 58-59, 2005

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