

The significance of license plate location based on Lab color space

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Abstract—This paper proposes a significant license plate locating method based on Lab space. First of all, preprocess image, delete fog and uneven illumination areas. Then utilize a lookup table to accomplish the transformation from RGB to Lab, and use the characteristic of b component to extract the license plate area of blue and yellow. Finally use the significance of color and textures. The experimental results have proved that the license plate localization method is rapid and accurate.

Keywords-Lab; lookup table; significant; relative threshold; license plate location

I. INTRODUCTION

License plate location and recognition is one of the important research topics in computer vision and pattern recognition. The technology has a wide application such as: traffic monitoring, crossing monitor, security etc.. The potential market has a great value. It is able to generate huge social and economic benefits.

In the process of license plate recognition, the first step is license plate location. Due to the complex situation in real life, the vehicle and the environment are changing, it is difficult to locate a license plate. There are many methods about license plate location. The process of visual attention includes two parts: top-down and bottom-up and many scholars used bottom-up visual attention model^[1]. The most representative is the 9- layer Gauss Pyramid saliency map model from Itti^[2]. But the calculation is complex. Other researchers calculated each pixel's significant to its neighbors and used them to construct a saliency map^[3]. The calculation is still complicated. Hou proposed a method which constructed a spectral residual saliency map^[4]. It is simple and efficient, but the method only considered the brightness features and is not suitable for those images which haven't much contrast on brightness.

This paper presents a significant license plate location method based on Lab color space. The method is more flexible, and the mix of color characters and texture characters is more accurate and efficient, so the method is better.

II. COLOR SPACE

A. Lab Color space

Lab color space is a color mode published in 1976 by the CIE(international commission on illumination). It is a mathematical color mode based on human visual spectrum sensitivity. In Lab color space, visual distance between color and coordinates is proportional. So the color between two points is evenly distributed. Lab color model is the most wide color model. Any color in nature can be expressed in Lab space. Lab is a kind of device independent color space. It makes up for the RGB model which must be dependent on equipment characteristics.

The Lab color space is a color-opponent space with dimension L for lightness and a and b for the color-opponent dimensions. The three coordinates of CIELAB represent the lightness of the color (L=0 yields black and L=100 indicates diffuse white, specular white may be higher), its position between red/magenta and green(a, between -120 to 120, negative values indicate green while positive values indicate magenta) and its position between yellow and blue(b, between -120 to 120, negative values indicate blue and positive values indicate yellow).

B. Lookup Table

A XYZ color space is needed when transferring RGB to Lab. And if the input image is very big, the operation needs a large amount of calculation. To optimize calculation, here uses a Lookup Table based on the color space to accomplish the transformation. With the conversion formula we got the lookup table. And the input of the conversion formula is R, G, B(All value range from 0 to 255) while the output are 5 color categories (blue, yellow, red, white and black).

The formula of RGB to Lab is as follows:

$$\begin{cases} L = 0.2126007R + 0.7151947G + 0.0722046B; \\ a = 0.3258962R - 0.4992596G + 0.1733409B + 128; \\ b = 0.1218128R + 0.3785610G - 0.5003738B + 128; \end{cases}$$

Double multiplication has a higher precision, and a slower computing speed. Here rewrites the formula utilizing integer multiple and displacement instead of decimal operation. The accuracy is not very high, but the speed increases significantly.

$$\begin{cases} L = (222928R + 746082G + 75729B) \gg 20; \\ a = (341727R) \gg 20 - (523512G) \gg 20 + (181761B) \gg 20 + 128; \\ b = (127723R) \gg 20 + (396950G) \gg 20 - (524680B) \gg 20 + 128; \end{cases}$$

III. SIGNIFICANCE

To make the image segmentation results more in line with the human visual habits, the method based on visual significance is getting more and more people's attention^[5]. Visual significance takes advantage of human visual attention, computes the most significant part of a image and is expressed as significant figure^[6].

A. Color significance

Chinese license plates have four categories. They are white, black, yellow and red. According to the license background, the fuzzy position is obtained. It could easily and accurately get the license plate with an appropriate threshold, even when the color is similar between plate and car body. Then, calculate the color distances between a pixel and its neighbors. As a license plate has a fixed color combination, the difference is fixed too. It is easy to segment the area of license plate from an image^[7].

There is a salient region based on the color contrast. The size of an image is $M \times N$ pixels. Assume that each pixel represents a significant unit. The color contrast $C_{i,j}$ and the significant unit (i,j) is defined as:

$$C_{i,j} = \sum_{q \in \Theta} d(p_{i,j}, q)$$

According to the formula, $p_{i,j}$ ($i \in [0,m], j \in [0,n]$) is the significance unit marked (i,j) in an image, Θ is the adjacent area of $p_{i,j}$ and d is the color distance between $p_{i,j}$ and q .

The whole image is divided into several blocks. Set the color of each block as the average value of all pixels in it. Thus the amount of calculation is reduced for later processing. Then compute the value of each block in the image and record its adjacent block's value. At last, compare these two values.

Set a relative threshold which is the ratio of a region and its adjacent areas. The advantage of this operation is that in cases of fog, uneven illumination and dirty plate, all the pixels of the license plate region have the same degree of blur, darkness and pollution. Thus, the difference among colors in a license plate region is relative and setting a relative threshold can locate the license plate in a complex environment. When the difference value is greater than the threshold, then the block is significant.

There is an example of blue bottom license plate which can illustrate the color signification as follow. Firstly, normalize the image size for further blocks and transform the RGB image into a Lab image. Secondly, abstract the component of b in Lab and a gray image is got. Thirdly, divide the gray image into blocks and the gray level of each block is the average of all pixels in it. Then, create a slide window on the block image and

calculate the color difference between each block and its 8-direction adjacent blocks. When the difference is greater than the threshold, then a color significance is obtained. At last, set a threshold to fulfill the image binarization. Then a pixel's gray level is set 1 if its original level is greater than the threshold and 0 the reverse side.

Figure 1 is the original image. B component in Lab is shown in figure2. Figure 3 is the block image. As color is susceptible to illumination, so b component is difficult to locate the license plate area^[8]. Here the result after a preliminary step is shown in figure 4.



Figure1. The original Figure2. B component map

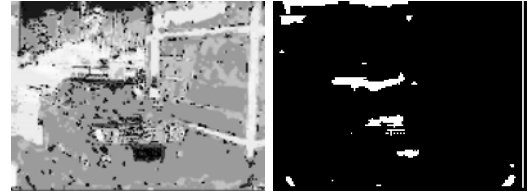


Figure3. block Figure4. color salient map

Since color feature is susceptible to illumination, so it's not accurate when the light intensity is very low. Thus texture significance is needed here to get better result.

B. Texture significance

Texture is represented by macro region while the structure of texture is caused by repeated basic pattern. Local property in a area such as local statistical characteristics and period changes in a image can be called texture.

Texture-based significant extraction, in fact, is to calculate the image edge significance. It extracts single object based on morphological filtering. There are many common methods and here uses Gabort template matching filter. The basic steps are as follows:

(1)Use Gabor method for edge distribution, and get independent edge areas as few as possible, through the choice of the threshold.

(2)Calculate the area of each individual area surrounded by the edge.

(3)Mark the edge of the largest independent area and use the method of filling to get ROI (Regions of Interest) area.

(4)Compute the area and the original image to get the ROI area of the original image. We can also directly select ROI area from the edge distribution and match it with the original image, to get the original ROI. The

problem lies in that the edge of the image always burrs and swells.

Using Gabor filter to extract the texture feature is an ideal choice. Gabor filter is similar to the feeling of the primary visual cortex cell field. It is closer to human visual perception. Gabor filter can gain image texture information through adjusting image with different directions and scales. In spite of wavelet transform achieving many good results in this field, in many cases, Gabor filter is better. Gabor transform is usually done by the Fourier transform, so it is a continuous method. Wavelet transform usually uses discrete wavelet, which leads to that using continuous Gabor transform better. Gabor filter can detect changing direction and scale. And the given statistics of microscopic characteristics in the area is often used to represent the texture characteristics. Define a two-dimension Gabor transform function as follows:

$$g(x, y) = \frac{1}{2\pi\delta_x\delta_y} \exp\left[-\frac{1}{2}\left(\frac{x^2}{\delta_x^2} + \frac{y^2}{\delta_y^2}\right) + 2\pi jWx\right]$$

$$G(u, v) = \exp\left[-\frac{1}{2}\left(\frac{(u-W)^2}{\delta_u^2} + \frac{v^2}{\delta_v^2}\right)\right]$$

The advantage of Gabor transform analysis method is that it can provide whole signal information and offer information about how much the signal changes in local space. Therefore, it accords with human visual characteristic most and obtains satisfactory results^[9].

In this paper, the method based on texture significance, using the characteristic of characters is linked closely on a license plate area. And the transverse edge character is especially obvious from which plate texture features are extracted. Gabor method has many direction templates, and here choose the horizontal gradient difference template for texture extraction in order to achieve a good effect. Results have shown that it can enhance strings where the boundary intensity is high, weaken the background region whose gray level changes little, and thus highlight the license plate area to achieve the correct license plate locating.

The following is the texture significant extraction process: first of all, apply Gabor filter to the b component of Lab image^[10] to extract the image edge. Then, divide the image into blocks, and calculate the number of texture within each block. Thirdly, use the gradient difference method to compare each block with its adjacent blocks. A block's text features are significant when its value is greater than a certain threshold.

Figure 5 is a texture saliency map. Figure 6 shows the result of color saliency and texture saliency, it is the result of the combination of the two binary images.

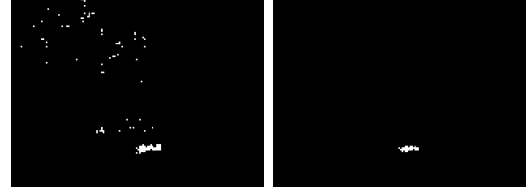


Figure5. Texture salient map Figure6. Merged figure

IV. ALGORITHM

The main process is as follow:

(1)Image preprocessing: choose a median filter, because it can filter out isolate short noises, and can keep the edge details.

(2)Color space conversion: convert RGB format into Lab format.

(3)Normalization of the image and blocking: adjust the image size to integer times of a block size, then block the image. Compute by block can reduce the processing time.

(4)Color significance: in Lab color space, use local color significance to fulfill the image binarization, then use filter to eliminate the small interference area.

(5)Texture significance: select a single component in Lab color space and use the strong texture significant of the characters on license plate in the gray image. Abstract the bigger difference edge from the gray image, binarize the image, and use filter to eliminate the small interference area.

(6)Combine the result of (4) and (5): apply and operation to these two gray scale images, then the white overlap area is the license plate area, and eliminate the interference through filtering.

V. CONCLUSION

License plate localization algorithm has developed a variety of technologies and related experiments and applications in recent years, but there are still many problems. This paper puts forward to a significance of license plate location based on Lab color space. Lab color space has a wider color gamut which conforms to the human eye perception. It doesn't rely on equipments. Visual significant is a new research area recently. Through 70 experiments, the accuracy of the results is higher than 95%. But in many serious conditions like uneven illumination and dense fog, selecting a single global threshold can't reach a high accuracy of the license plate locating. Further improvement is needed and necessary. This algorithm can be applied to the actual license plate recognition system. And it can also be used in other image retrieval applications.

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