A vehicle license plate recognition algorithm in night based on HSV

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***Abstract*—In night, it is difficult to locate vehicle license plate for vehicle recognition .In this paper, the algorithm uses colorful component in HSV space depending on the character of vehicle images in night, can divide the vehicle- plate region and many noises including vehicle- lamp and it's reflection light and road- line, and can delete the region without similar color of vehicle plate but with higher saturation value.And the paper stresses the improvement on "maximum & minimum optimization of entropy thresholding method" as well as the prospects of regional character, the background distribution in the traditional character segmentation algorithm. The experimental result shows that the method is simple and fast, and it decreases the conglutination between the characters but also reduce the isolated noise point. The recognition quality of system is as good as what we expected.**

Keywords- nighttime image;Maximum & Minimum Segment; saturation component;hue component

I. INTRODUCTION

License Plate lights[4] of the key technologies include the acquisition of images, license plate of regional location, character segmentation and character recognition. To obtain images of vehicles at night as a targeting vehicle identification system object is a class of important research. Because of low visibility at night, even with fill light for lighting of compensation, access to low-contrast images there, the image itself is blurred, and the day to obtain a larger difference in image quality; the other hand, due to the need to open vehicles, night-time vehicle lamps, license plate lights by the side effects of blurred; the same time as a vehicle headlight of the exposure, the road ahead will have a strong reflected light, the road to various objects and decorative items, such as the zebra crossing and road lane lines, , all with great noise, the positioning of the target plates caused great impact. Is now often used algorithms are: 1. Using light compensation[2], the use of Sobel vertical edge of license plate location, 2. The use of video images adjacent two differential operation, and then use mathematical morphology operation to eliminate the impact of vehicle headlights, 3. the use of color and motion information for vehicle tracking positioning methods. Night-time conditions, to obtain images of vehicles, people can see a significant feature of the headlights as well as its projection beam, as well as street lamps and lane lines on the road, how to remove the noise impact is accurate targeting a major challenge. Among them, Method 1 is to require external hardware to set a higher situation, to obtain higher-quality images to the original, which is a research direction, but there are still certain difficulties to achieve them; Method 2, 3 is for the movement video image, but under normal circumstances, for target location and recognition of the original image to obtain a leaflet aimed at the image close-up of vehicles, not for the other frames with similar images for leaflets at night to obtain close-up images of vehicles license plate orientation, the elimination of all kinds of noise can not do anything. Based on the mount from the traffic of vehicles to obtain a variety of night-time images for testing, select the HSV color model, the saturation component of leaflets at night, close-up images can be effectively removed a result of various types of noise, lights, highlighting plate region; The color component H can be related with the license plate background color calibration out of the region, be able to highlight the part of the saturation of the image and the background color has nothing to do with the license plate area removed, accurate positioning plate target.

And in order to improve the system recognition rate, in the segmentation of the characters put forward improvements to the original max-min optimization of entropy thresholding method with the appropriate changes, combined with the prospect of regional distribution of license plate characters and background distribution, the prospects for the original background be weighted towards improving the treatment of the same. Experimental results show that reducing the adhesion between the individual character and isolated noise points, the system's recognition accuracy rate.

II. NIGHT-TIME VEHICLE LICENSE PLATE LOCATION ALGORITHM

Color search terms[3] as a simple and fast way to a wide range of applications. License plates of vehicles in the image area with a fixed character and background colors, color, full of features than other regions, even though the beam by the night lights[4] and road reflections greater impact, but the

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license plate to maintain good color characteristics of the region, still a very real performance targets can be used as a basis for separation of plates and noise.

A. The license plate using color-component S to the region

From the visual point of view, the color is hue (hue), saturation (saturation) and lightness (value) to describe. One color is a color different from the other colors of the most important features; color saturation reflects the purity; lightness and the brightness of the environment. RGB for display hardware, HSV apply to human visual characteristics. Select the RGB and HSV color images of various components of the vehicle at night to compare, which is characterized as shown in Figure 1.

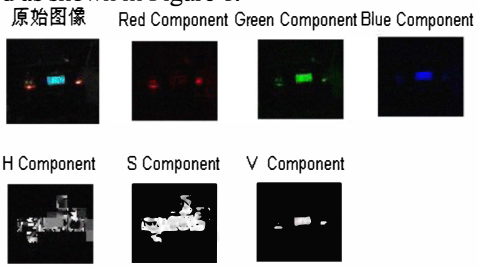

Figure 1. various components of RGB and HSV of the original night image

In the HSV space, S, H component is the representation of chroma components, V and color has nothing to do, in the three components, the right plate is the region most sensitive to the S component, Figure 1 can be seen, S component indicates that the license plate area prominent in other parts of the region and the characters jump frequently. Figure 1, S-component combination of light effects can be launched from, saturation component can be extracted with license plates have a certain color region, able to license plates with a large number of noise, including car headlights and reflected beams and the road lane lines and separation of other noise region are conducive to the extraction plate targets. H-component distribution is relatively lax, combined with Figure 1 can be extracted in line with the background color of part of the plate. H, S component of the license plate regions perform significantly better than RGB each component, so select the HSV color model is used to night-time vehicle license plate location.

Measured from the mount to obtain images for RGB model, first of all need to be converted into HSV model, conversion is expressed as:

$$R = R/255,\ G = G/255,\ \ B = B/255 \ \text{，则}$$

$$V = \max(R,G,B) \qquad (1)$$

$$\begin{cases} H = \dfrac{R-B}{\max(R,G,B)} & \text{if } \max(R,G,B) = R \\ H = \dfrac{1}{3} - \dfrac{B-R}{6\max(R,G,B)} & \max(R,G,B) = G \\ H = \dfrac{2}{3} - \dfrac{R-G}{6\max(R,G,B)} & \max(R,G,B) = B \end{cases} \qquad (2)$$

$$S = 1 - \frac{\min(R,G,B)}{\max(R,G,B)} \qquad (3)$$

B. The use of color component H to the region with the license plate color selection algorithm related to AOI

For the extract contains only a single vehicle headlights at night images, the use of saturation component can be extracted license plate region. But for containing the taillights of vehicles, as car taillights showing reddish color, and saturation, high color component can be separated with the license plate area. License plate region has a fixed colors. A total of four classes in our license plates: blue white text, yellow background with black lettering, white with black lettering, black white text. But at night, due to lighting effects, from the visually be able to clearly feel the license plate background color. The color will be blue, yellow, white and black as the four color classes and license plates. The probability of the size of their emergence into the blue, yellow, white, black, to appear in the other colors in the image has nothing to do with the license plate, if the rate of the entire original image to extract the four types the color area, then the license plates must be in terms which, its called the region of interest (AOI). Ways of using color quantization AOI in the same gray-scale image be expressed.

$C(x,y)$ Is assumed to be the midpoint (x,y) of the original image X in the HSV color model , $C_i(x,y)(i \in R, i \in [0,4])$ is the H, S, V-dimensional color sub-value of (x,y), in order to point to select the color of the H, S, V-dimensional color sub-value, select the color of blue $(i=4)$, yellow $(i=3)$, white $(i=2)$, black $(i=1)$, other $(i=0)$, if $\forall C(x,y) \in X,$ for $C_r(x,y) \in C(x,y)$.

Where T is to select the color tolerance, M for the gray-scale quantitative span, the results range. Note that only a certain saturation and brightness, the color makes sense, this article makes sense to take to ensure that the color values.

C. H and S components of the extracted license plate region and regional integration algorithm for AOI

Because the license plate lights at night in the region irradiated with a high degree of saturation and the colors remain the same characteristics, reflected in the HSV color

model in the S component of the higher, H component can be extracted together with the license plates of the region concerned, goals region with these two features will be integration of the two phase and the smallest results, using mathematical morphology to remove a small area, the results obtained shall be plate targets.

III. CHARACTER SEGMENTATION AND INDIVIDUAL CHARACTER SEGMENTATION MODULE FUNCTION DESIGN

The system uses the max-min optimization of entropy to carry out the principle of image segmentation, and make some improvements. Gray set up a series of gray-scale image L, f_i is the number of pixels with gray value i, the total number of pixels is $M \times N$, $P_i = f_i / (M \times N)$ is the gray value of pixels account for the proportion of the whole image. S threshold the image is divided into two types (object and background), that is C_0 ={1 , 2 , … , S} and C_1={S+1,S+2,…,L}. Then, the information entropy of C_0 and C_1 is defined as:

$$H_0(S) = -\sum_{i=1}^{S} \frac{P_i}{P_0(s)} \ln\left[\frac{P_i}{P_0(s)}\right]$$

$$= -\frac{1}{P_0(s)} \sum_{i=1}^{S} P_i [\ln P_i - \ln P_0(S)] \quad (4)$$

$$= \ln P_0(S) + H(S)/P_0(S)$$

Where $P_0(S) = \sum_{i=1}^{S} P_i$, $H(S) = -\sum_{i=1}^{S} P_i \ln P_i$ 。

$$H_1(S) = -\sum_{i=S+1}^{L} \frac{1}{P_1(s)} \ln\left[\frac{P_i}{P_1(S)}\right]$$

$$= -\sum_{i=S+1}^{L} \frac{P_i}{1-P_0(S)} \ln\left[\frac{P_i}{1-P_0(S)}\right] \quad (5)$$

$$= \ln[1-P_0(S)] + [H(L) - H(S)]/[1-P_0(S)]$$

When a gray-scale value for each calculated $H_0(S)$ and $H_1(S)$, you can use the following ways to seek the greatest possible value of the minimum threshold value:

$$\psi_1(S) = \min_{1 \le S \le L} \{H_0(S), H_1(S)\} \quad (6)$$

The final optimal threshold is calculated as follows:

$$\psi_1(S') = \max_{1 \le S \le L} \{\psi_1(S)\} \quad (7)$$

Thus obtained the optimal threshold value between OTSU threshold and maximum entropy thresholds, indicating the greatest effect of the minimum threshold segmentation is better than the maximum entropy thresholding. Max-min optimization of entropy thresholding by the foreground and background of the impact of the distribution is relatively large. The above algorithm under the assumption that foreground and background have a similar distribution (both normal), but mean different. This license plate character segmentation is clearly inappropriate and, therefore, need to make the corresponding coefficients adjusted accordingly. Adjustment is based on the license plate characters in the statistical distribution of pixel gray-scale features and a large number of experiments based on the. But for License Plate Character Segmentation for this coefficient is just about right. Adjusted formula for calculating entropy, respectively type reference (8) and type (9).

$$H_0(S) = 2\ln\left(\sum_{i=1}^{S} P_i\right) - \ln\left[\sum_{i=1}^{S} P_i^2\right] \quad (8)$$

$$H_1(S) = 2\ln\left(1 - \sum_{i=1}^{S} P_i\right) - \ln\left(\sum_{i=1}^{L} P_i^2\right) \quad (9)$$

Other subsequent calculations are still using equation (6) and equation (7). Experimental results show that segmentation is not only good part out of character, but also effectively reduce the adhesion of the impact of character and isolated points. Character segmentation is completed, the system horizontal projection method to complete a single character segmentation. At the same time, use the connectivity to determine whether the method to determine whether it is character. And then sent to character recognition module for recognition.

IV. EXPERIMENTAL RESULTS

Tsting machine (PIV, cpu 2.0G, 1G memory), using matlab software using the 1000 images were tested, respectively, tested the accuracy of license plate location, character segmentation accuracy and character recognition accuracy. Test results in Table 1, in which a picture of the running effect diagram in Figure 2.

TABLE I. SYSTEM TEST DATA SHEET

Algrorithm	The number of images	The number of License plate accurate positioning	the number of exact characters Segmentation	The number of Exact character recognition	The average running time
Traditional Algrorithm	1000	867	924	913	3.4673
This Algrorithm	1000	992	996	994	2.3654

Figure 2. One image of night license plate recognition diagram

V. CONCLUSION

Vehicles through the night image saturation and color component of the license plate contribution of targeting select the degree of saturation component to remove the noise due to a large number of lights caused by the impact; color components excluding a higher degree of saturation but does not meet the license plate background color of the region, is mainly the impact of car taillights; the use of two-phase integration of a variety of characteristic information can be vehicles of different gestures at night to complete the image targeting. The method is applied to the measured night-time image tests show that the method has a high engineering practicability. And, in connection with license plate character segmentation of foreground and background of the regional distribution of the maximum entropy to determine the evolution of the max-min partition has been modified to make it more suitable for binary license plate region, effectively reducing the adhesion of characters and isolated point of impact.

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