THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Automated Traffic Light Detection for Day and Night Condition Using Geometric Moment Features

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Abstract:
This paper proposes a novel technique to detect traffic lights, based on Geometric moment features (GMF). First, a colour image is captured from the camera mounted on the vehicle. From the captured colour image candidate region of traffic lights are extracted by using morphological operations. The input image is converted to YcbCr colour. After candidate region selection, the required shape of candidate is selected using parameters such as length, area, area of boundary box, etc. Geometric moments based values between candidate region and adjacent region are used to improve the detection performance. Through this test, we show that the proposed method using GMF reaches up to 95 % of detection rate with computation time of average 82 s. The proposed method using GMF has got High detection rate and less computational time in comparison with other existing algorithms.

Key words*:Morphological transforms, YcbCr colour transform, GMF, Corr., ENL.*

1. Introduction

The traffic lights play an indispensable role in urban road safety. Arrow traffic lights are common at intersections of current urban scenes. Driver may have some troubles, when he or she could not recognize the situation of road environment. Up to seventy percent of road accident occurs in intersection. if driver handle an appropriate action before several second of accident, traffic accidents can reduce to less than 50% or turn a minor accident. Recognizing traffic lights are important for safety driving.[1]. Zixing Cai1,Yi Li2, Mingqin Gu3 proposed a method to detect real time traffic light recognition system.[2].There are two kinds of frameworks in the traffic light detection. The one uses colour information, but the other one do not use it. in the researches using colour information, Masako and Shinichiro proposed an algorithm to detect daytime traffic light detection. This algorithm uses normalized RGB to select as candidates of a traffic light. Then Hough transform is applied to detect an exact region.[3]. Park et al also proposed daytime traffic lights detection by judging the shape and size of an object, in which the arrow-shaped traffic light was not discussed.[4]. Chung adopted his model to recognize daytime and nighttime traffic lights, in which the road scene was simple and some interference problems such as vehicle lamps, street lamps were not considered.[5]. Moises et al proposed a technique to detect suspended traffic lights, based on colours and features such as black area of traffic lights or area of lighting lamps in the daytime.[6]. Additionally, the traffic light distance is estimated aiming at slowing down and stopping in the correct position, in case of red light. Cai et al proposed a algorithm to resolve the problems of detection and recognition of arrow traffic lights in the daytime.[7]. To get the regions of candidates of blackboards, the colour space conversion and morphology features filtering methods are performed. In the researches using non colour information as gray image, Raoul and Fawzi proposed a daytime traffic light recognition using spot detection and adaptive traffic lights templates. This algorithm is able to detect lights from a long distance.[8][9]. Recently, most of the researches have focused on daytime traffic light detection and recognition, but only few did on nighttime traffic light detection and recognition.[10].For this reason, we propose an effective night-time traffic light detection method for real time driving assistance system. This paper outline is as follows. A system overview is presented in section ii. in section iii, main steps of our detection method are detail.[11].

2. Proposed Method

The proposed algorithm is modified method of Zixing Cai Yi Li Mingqin Gu et al method[2].The proposed method uses GMF where as the previous algorithm uses Gabor wavelet features[2]. First a colour image is captured from a mounted camera and the image is then converted to Ycbcr colour. The required shape of candidate is selected using parameters such as length, area, area of boundary box, etc. Geometric moments based values between candidate region and adjacent region are used to improve the detection performance.

2.1. Candidate Region Selection

For valuable traffic light detection at night-time, it is important to find blobs with red colour and green colour lights. A simple thresholding on a colour channel image does not work well to extract candidates of traffic lights, since there are lots of noisy objects on urban road environments. There exist many noisy self-emitted lights which is similar colour to traffic lights. For examples, neon-sign with red and/or green colour, rear-lamp of other vehicles, street lamps, indoor light of building, and so on are included. Moreover, there are various reflectors such as traffic signs, fences, poles, and etc. In addition, blooming effects often appear on self-emitted lights. These noise and blooming effects make it difficult to detect real traffic lights. Clearly, it is very important to reduce such noisy blobs as many as possible in the first step, candidate region selection. In the proposed method, a dominant colour representation technique is used to effectively extract candidate blob of traffic lights with green and/or red colour. Blobs with dominant red and green colour are selected by using colour transform proposed by Ruta et al. For each pixel with RGB colours X = [XR, XG, XB] , red-dominant component f (x) R and green-dominant component f (x) G are obtained by respectively,

$$f_R(x) = \max(0, \min(X_R - X_G, X_R - X_B)/s)$$
$$f_G(x) = \max(0, \min(X_G - X_B, X_G - X_R)/S)$$

Where S =XR +XG +XB.

Each dominant colour image is transformed into binary image using pre-defined threshold and segmented bylabeling process

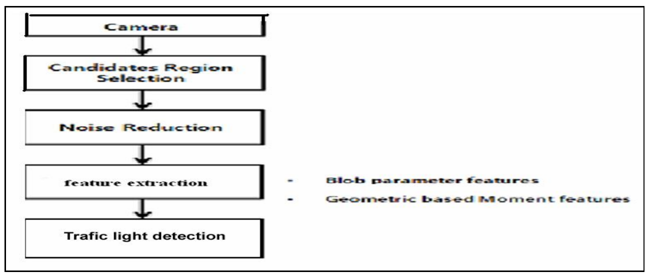

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Figure 1: System Overview for Traffic Light Detection

2.2. Noise Reduction Step

Scattered noisy blobs are filtered out and regions containing other types light such as street light, traffic sign, and vehicle lamps are detected. Assuming that the shape of traffic lights is circle type, we eliminate inconsistent blobs that can be regarded World Academy of Science, Engineering and Technology 76 2013 as noisy. The following criteria are used in this work. The blob of extracted spotlight is regarded as noisy:

- If width of the blob is smaller than 1.5 times of height, or if height is smaller than 1.5 times of width.
- If area of the blob is smaller than 1.5 times of the area of bounding box.

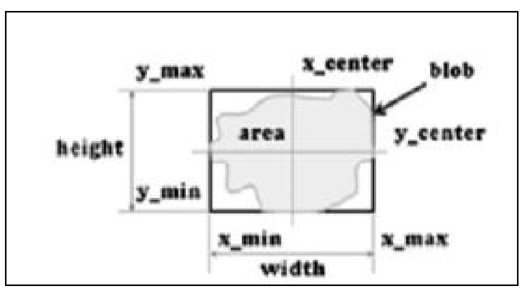

Figure 2: Shows Blob Parameters of Labeled Potential Traffic Lights

2.3. Feature Extraction Step

There are three ways to extract feature of the candidate accurately. They are

- BF (Basic parameter Feature)
- BMF (Brightness (or intensity) based Moment Feature) and
- GMF (Geometric based Moment Feature)

<u>2.3.1. Geometric Moment Features (GMF)</u>

Using the coordinates of blob, the following geometric (n-th, m-th order) moments are calculated and used as features. For more details of geometric moment, refer to

$$\Delta_{10} = \mu_x = E[X]$$
$$\Delta_{01} = \mu_Y = E[Y]$$
$$\Delta_{11} = \frac{E[(X-\mu_X)(Y-\mu_Y)]}{\sigma_X \sigma_Y}$$
$$\Delta_{20} = \sigma_X^2 = E[(X-\mu_X)^2]$$
$$\Delta_{02} = \sigma_Y^2 = E[(Y-\mu_Y)^2]$$
$$\Delta_{21} = \frac{E[(X-\mu_X)^2(Y-\mu_Y)]}{\sigma_X{}^2 \sigma_Y}$$

$$\Delta_{12} = \frac{E[(X-\mu_X)(Y-\mu_Y)^2]}{\sigma_X \sigma_Y{}^2}$$

Where, E means expectation and respectively means center of x and y coordinate of labeled object. Each means length of width and height of labeled object.

3. Algorithm

- Step 1: Colour Image is captured from the camera of size (MxN).
- Step 2: Colour image is converted to YcbCr image of size (MxN).
- Step 3: The required shape of the candidate is selected by using parameters like length, area, boundary of region e.t.c.
- Step 4: The noisy regions are eliminated using area, width and height of the candidate region.
- Step 5: The feature of the candidate is extracted using GMF.

4. Evaluation Metrics

4.1. Correlation Coefficient

The correlation coefficient is the measure of the closeness or similarity in small size structures between the original and the fused images. It can vary between -1 and +l Values closer to +1indicate that the reference and fused images are highly similar while the values closer to -1 indicate that the images are highly dissimilar.

$$CC = \frac{2c_{rf}}{c_r + c_f}$$

Where, $\mathbf{C_r}$ is the reference image and $\mathbf{C_f}$ is the fused image respectively.

$$c_r = \sum_{i=1}^{M} \sum_{j=1}^{N} I_r(i,j)^2$$
$$c_f = \sum_{i=1}^{M} \sum_{j=1}^{N} I_f(i,j)^2$$
$$c_{rf} = \sum_{i=1}^{M} \sum_{j=1}^{N} I_f(i,j) I_r(i,j)$$

4.2. Equivalent Number of Looks(ENL)

ENL is used to quantify the quality of the image. Higher the value of ENL higher the quality of the image. A simple, scalar definition of the ENL is the square of the mean pixel intensity divided by the variance.

ENL=[Mean of the image/Standard Deviance]^2

5. Experimental Results

The proposed algorithm is tested using various images of size (MxN) and results are shown for the two images of size (MxN).They are as Input Image 1 rural traffic area shown in figure 3 and Input Image 2 urban traffic area shown in figure 5.Evaluation metrics used are correlation coefficient and ENL.Table I describes the images used for the evaluation of the method.Table II describes performance results of the proposed method according to the Geometric moment featuresIt is observed that proposed algorithm performance is better in comparision with Zixing Cai, Yi Li, Mingqin Gu et al metod[2].

Image	File size	Width	Height	Bit depth
Input Image	8052	216	233	24

Table 1: Image Used for the Tests

Features	Image	Average computation time
GMF	95.53%	82s

Table 2: Results of the Frame Per Frame Matching and Computation Time

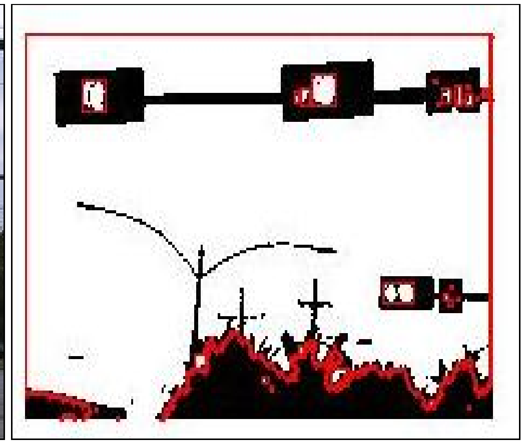

Figure 3: Input Image 1 Rural Traffic Area
Figure 4: Feature Detection Using Geometric Moment Features


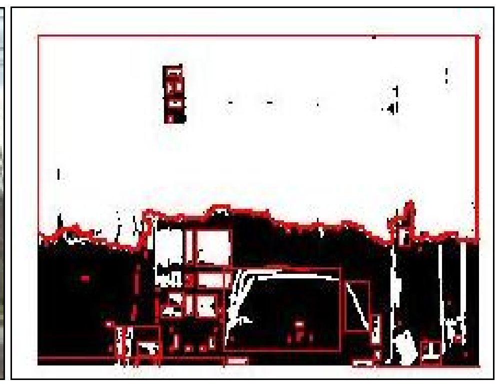

Figure 5: Input Image 2 Urban Traffic Area
Figure 6: Feature Detection Using Geometric Moment Features

Above figures shows the experimental results of the paper. The below given table explains the comparison of results for correlation coefficient and ENL using Gabor Wavelet and Geometric features.

Sl. No.	Image	Evaluation metrics	Gabor Wavlet Features	Geometric Moment Features
1	Input Image1	Correlation Coefficient	0.3502	0.4502
		ENL	2.7438	3.0174
2	Input Image2	Correlation Coefficient	0.1825	0.2825
		ENL	2.6797	3.0272

Table 3: Comparison of Results Using Gabor Wavelet Features and Geometric Moment Features

6. Conclusion

Arrow traffic lights are very popular in urban environment, and it is helpful for intelligent vehicle to make decision in the intersection. Since most algorithms focus on circular traffic lights, a novel method for detection and recognition of arrow traffic light including colour and direction is proposed in this paper. Here tremendous results are obtained when compared to the results obtained using Gabor Wavelet features. An Automated traffic light detection for day and night condition using Geometric features gives the better results. The proposed system is implemented on Intel Core CPU with 2.80GHz and 4GB RAM and tested with the urban and rural road videos. Through the test, we show that the proposed method using GMF reaches up to 95 % of detection rate with computation time of in average 82sec.

7. References

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