Vehicle Brake Light Detection Using Hybrid Color Model

Siti Amaniah Mohd Chachuli[1, a], Khairul Anuar Ishak[2,b] and Norbayah Yusop[3,c]

[1]Faculty of Electronics & Computer Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

[2]Department of Electrical, Electronic and Systems Engineering, Faculty of Engineering, University Kebangsaan Malaysia, Bangi, Selangor, Malaysia

[a]sitiamaniah@utem.edu.my, [b]nuarscc@vlsi.eng.ukm.my, [c]norbayah@utem.edu.my

Keywords: brake, hybrid, HSI, otsu.

Abstract. This paper presents a method based on hybrid color model (HCM) to detect vehicle brake light during daytime. Five weathers during daytime have been considered in this work which are morning, noon, cloudy, rainy and evening. The hybrid color model (HCM) is developed by combination of red color from RGB color model and saturation and intensity values from HSI color model. Otsu method and HCM method have been applied in this work to find the adaptive threshold. Erosion and dilation techniques have been applied in morphology operations to enhance the detection results. The results have been verified by using Matlab software. From the analyses that have been carried out, this method able to detect vehicle brake light about 90.63% in 0.92 seconds. Comparison of HCM method with CBS method shows that detection by using HCM method produced better detections in a short time. This method also shows that HCM method can be applied on various weathers and situations on the road.

Introduction

Report by World Health Organization in 2013 stated that speed, drink-driving, helmets, seat-belts, child restraints and risk factors are six common causes of accidents in the world. Accidents not only involve with damaged vehicle but it also can cause injury and fatal accidents. Speed is one of major accident causes on the road that can cause bad injuries or fatal accidents if the speed is high and uncontrollable. Thus, detection of vehicle brake light plays as main role in road safety issues to avoid sudden collision from front and back vehicle. Though, the vehicles are driven by human, careless attitude while driving is always happened. Therefore, development of automatic detection of vehicle brake light is proposed in this work in order to prevent accidents and reduce careless attitude while driving.

Currently, the detection of vehicle can be divided into two categories which are based on temporal information and local features [1]. Detection based on temporal information able to track an object in a sequence of frames, despite noisy measurements [2] and track multiple vehicles [3]. Mean shift estimators, particle filters [4] and Kalman filters [5] have been widely used to track the moving objects. Meanwhile, local features only analyze the relevant features within a single frame. In this category, morphology method [6], finding on threshold value [7], and operating using alternative color spaces such as YCbCr [8], RGB [9] and HSV [5]. In this paper, we present a method based on local features which is using hybrid color model to detect vehicle brake light during daytime. Our main focus in this work is to develop an algorithm that able to detect the brake light with high percentage of detection with minimum consumption time.

Methodology

Fig. 1 shows the methodology flow of vehicle brake light detection. This system consists of three stages which are image processing, finding on threshold value and morphology operation. Each stage of operation will be discussed in detailed in the following section.

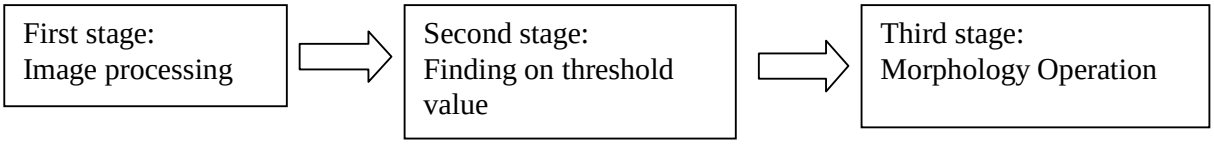


Fig. 1. Methodology of Vehicle Brake Light Detection

First Stage: Image Processing. The sample images were taken in RGB Color. Fig. 2 shows the sample image that captured in RGB color under noon weathers. In the first stage, the captured sample image will be cropped into 320 x 240 pixels from the bottom image. Next, the sample image will be converted to HSI image. The sample image in HSI color is shown in Fig. 3.

Fig. 2. Original sample image in RGB

Fig. 3. Sample image in HSI color

Second Stage: Threshold Value. Selections of threshold values are very important in detection of vehicle brake lights. Wrong objects or unwanted objects will be detected if non adaptive threshold values are used. At first, Otsu method is applied to find the threshold value in gray image. However, segmentation by using Otsu Method only unable to detect the vehicle brake light precisely. Thus, segmentation based on combination of Otsu Method with red color of RGB Color Model and HSI Color Space have been applied in finding of adaptive threshold values in this work.

Fig. 4 shows RGB color model for vehicle brake light in 3-dimension space. It showed that red color data in vehicle brake light has excellent dense in RGB color model. For analysis of HSI Color space, three spaces will be analyzed, and then only two spaces that produced highest dense color clusters in the space will be chosen in segmentation process. From the analysis, it is found that S-I space produced highest dense color clusters compared to the H-V space and H-I space as shown in Fig. 5. Thus, only saturation and intensity values in HSI color space will be used as threshold values in this work.

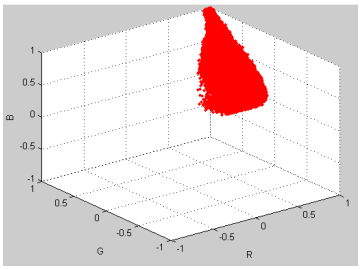


Fig. 4. Brake light color of RGB Color Model in 3-dimensions

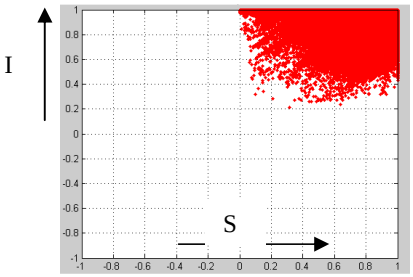


Fig. 5. Brake light color of HSI Color Model in S-I space

The obtained threshold value from S-I space are s_min = 0.2371, v_min = 0.7638, s_max = 0.9847 and v_max =1.0878. The threshold value will be compared with each pixel value in the sample image. The pixels image that have value greater than the threshold value will be set to 1, which it will be white color, while lower value of pixel image will be set to 0, which is black color.

From the analysis, it is found that combination of Otsu method with red color of RGB Color Model and HSI Color Space able to produce better segmentation and detection compared to the Otsu method only. These comparisons of segmentation result are shown in Fig. 6 and Fig. 7. It showed that small noises have been eliminated by using HCM method.

Fig. 6. Segmentation by using Otsu method only

Fig. 7. Segmentation by using Otsu Method and red color from RGB Color Model

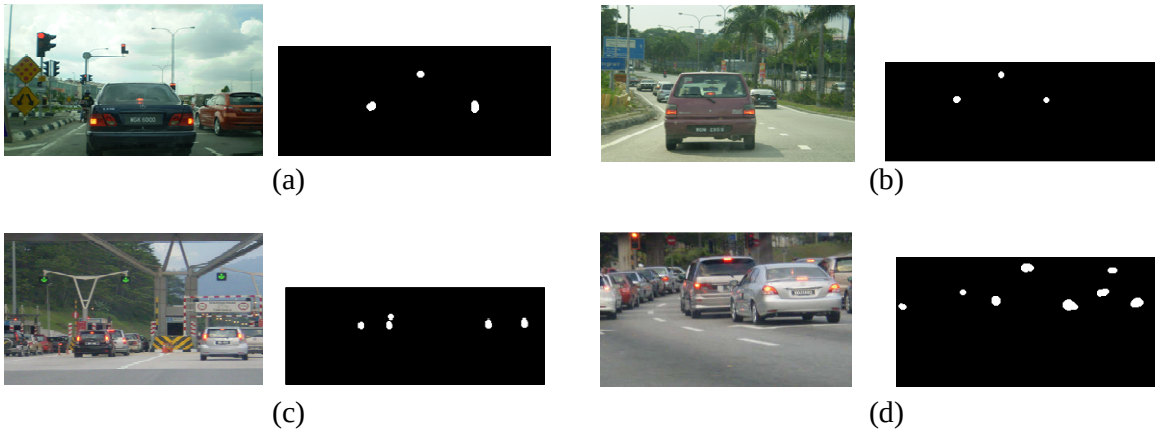
Third Stage: Morphology Operations. After binary image has been produced, two processes in morphology operation will be carried out which are erosion and dilation process. These techniques are applied to obtain better result in detection of vehicle brake light. Fig. 8 shows the binary image before and after the morphology operations. From the operations, we can see that unwanted object or small noises in the image have been eliminated by using erosion technique. Better detection image has been produced after morphology operations as shown in Fig. 8(b).

(a) (b)

Fig. 8. Sample image in binary image (a) before morphology operation (b) after morphology operation

Results and Discussion

Fig. 9 shows the detection of vehicle brake light under various weathers. From this work, it showed that this method able to detect vehicle brake light under various weathers and situations. This is due to the characteristics of brake light that has high intensity of red color compared to the other red colors on the road such as traffic light color and vehicle with red colors.



(a) (b)

(c) (d)

Fig. 9. Original image and produced results (a) common road (b) red color car (c) toll environment (d) congested traffic

This work has been compared with developed Color Base Scheme (CBS) method. The comparison of both methods is shown in Table 1. From Table 1, we can see that HCM method able to detect up to 90.63% and CBS method able to detect about 89.45%. It showed that Hybrid Color Model (HCM) method able to detect the vehicle brake light in short time and produced better detection rather than CBS method. Though, the difference percentages between HCM and CBS method are not large, this method shows that HSI Color Model is one of color model that able to detect better object in sample images compared to the RGB Color Model.

Table 1. Mean of Percentage of Detection and Time Detection of Vehicle Brake Light

Method	**HCM**	**CBS**
Percentage of Detection (%)	90.63	89.45
Time Detection (s)	0.92	0.97

Conclusion

By using HCM method, detection of vehicle brake lights able to produce better detection results compared to the CBS method. The analyses showed that the percentage of detection by using HCM method is 90.63% and 0.92 second is consumed to detect the vehicle brake light. From observation, it showed that HSI Color Model able to detect objects better than RGB Color Model. Besides, this method also can be applied in any field of color detection.

Acknowledgment

This work has been funded by Universiti Teknikal Malaysia Melaka under Short Term Grant.

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