Scientific Journal of Impact Factor (SJIF): 4.72

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 8, August -2017

Traffic Light Signal Detection: A Study

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Abstract-*This project involves comparative analysis of detection of traffic light signals with the use of image processing.. This paper focuses on a product of usage of monocular video camera for the detection of traffic lights under different conditions i.e. adverse weather and low illumination, haze, fog etc. This paper provides a perception algorithm that works at real time with high apprehension rate while using closeout camera for traffic light signal detection. By the use of this algorithm credibility and immunity for UGV and drivers will step-up. The working of traffic light detection system is divided into in three parts i.e. a monocular or color camera, then acquisition of image by that camera and a PC is required to process the captured images. The RGB color space based algorithm helps to detect and extract the red, green and yellow objects in the images and then illuminating the disturbing colors present in the locale. The final objective is to verify the features and object identity and based on these the different types of traffic signals are examined. . The ideology is qualitatively computed in various conditions, including driving in the heavy rain, at night and in city roads with dense traffic, as well as their synergy. Quantitative computation on a publicly available manually commented database, scoring high apprehension rate is also implemented.*

Keywords-Traffic lights, light detection, RGB, ADAS,

I.*INTRODUCTION*

In the recent times the increment in the usage of car transport has induced to an upturn in traffic accidents. One of the most important causes of severe causality is drivers running red traffic lights at crossroads. In order to reduce these kinds of accidents, government have installed video cameras at crossroads to monitor the road and register the occurrence of car accidents. With the help of these systems, government can punish disorderly drivers, and manage the ongoing involuntary accidents. Yet, this approach does not provide mechanism for handling road- accidents. Also, this pursuit is upscale as installing a video camera at each crossroad of a city supposes a big expense for the governments, and does not give a true solution to the accidents themselves. One of a utopian approach is the usage of RF (Radio Frequency) system for security assured crossing. But this method is again expensive as the usage of RF system requires installment of RF receiver and sender at all the intersection or crossroads. Also, all the cars should have RF terminal. To start off all the intersections have to be changed. Vision system is economical than RF approach. Hence, vision detection system for signal lights detection should be developed. Also, signal light detection contributes to safety driving. A superlative system which helps and assists the driver in the driving process is Advanced Driver Assistance Systems, or ADAS. These systems have the best feature of being designed in such a way that they can be embedded in cars and can give ideas to the driver and at the same time are capable to correct some driving faults trying to avoid accidents without being interfering to the driver. Some of the examples of these systems are: adaptive curse control (ACC), lane departure warning system (LDWS), collision avoidance system (CAS), vehicle detection system, traffic sign and light detection system, blind spot detection system (BSD), etc.

Figure 1. General Traffic Light Signals

This paper deals with the traffic lights (TL) detection problem which is operated in the following steps: the basic step is to evaluate the current systems and public datasets in the field, and then introducing a system that digs some of the problems in the other systems. Distinctively, hanging and handle supported traffic lights will be dealt here along with a development of a system which will be able to recognize these ones at daytime. Pertaining to detection an on-board traffic recognition system is taken into consideration, which basically aims at automatic detecting of traffic lights that provides useful information to the driver, such as crossroad or crosswalk probability, dangerous area, etc. to the high level decision taking ADAS. These driving aids can be effectively.

used by perception system, but in many cases these system use alternative sensing modalities, such as radar or lidar, instead of vision. Traffic lights are a special perception problem. Attempts have been made to broadcast traffic light state over radio, but this stand in need of a convincing investment in infrastructure. One of the effective method is to use of a prior map that can be used to indicate when and where a vehicle should be able to see a traffic light, but vision is the only way to detect the state of the light, which may include detecting which sub-elements of the light are illuminated (Figure 2). The algorithms proposed came out to be really handy to reduce the traffic accidents and provides accuracy better than that of any system.

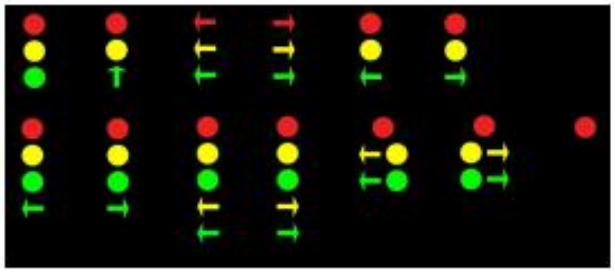

Figure 2. General Traffic Lights Detected by our system

II.*METHODOLOGY*

A.COLOR EXTRACTION-The proposed method uses different color spaces and detects and recognizes the traffic signals in a moving vehicle
Both in day as well as in night conditions

a) Candidates Detection: Detect possible candidates for traffic light using different color spaces such as HSV,RGB,YCbCr
b) Candidates Reduction :Application of morphological filters to remove noise and enhance the shape of traffic light
c) Recognition and Classification : Verification of false detected candidate based on statistical data
d) Decision Algorithm : Temporal correlation is the final step performed

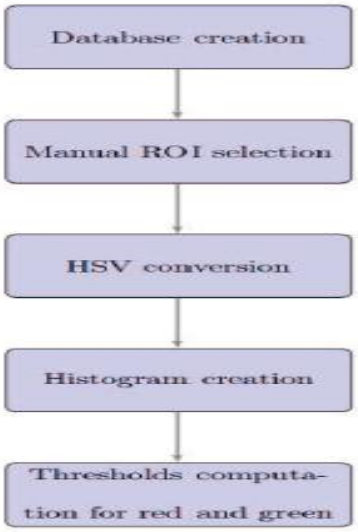

Figure 3. Steps used to find the thresholds in the color segmentation

B.Algorithm

a) Database Creation : A set of images representing the traffic light(red and green) in different conditions are taken
b) Threshold Computation : Gaussian Methodology is used as an accuracy measure to find the range for each HSV parameter for both red and green light
c) Dilation and Erosion : Morphological dilation is performed
d) Candidate Reduction : Support Vector Machine is applied to remove false detection

Figure 4. Original Image

Figure 5. Color Segmentation

Figure 6. After Dilation

Figure 2.5. After Erosion

e) Light Area :
$AreaMin = \pi * DiameterMin/4 = 176\ pixels$ (1)
$AreaMax = \pi * DiameterMax/4 = 11304\ pixels$ (2)

f) Convex Area : Area and Convex area compared are with the help of circularity and background checking

Figure 2.6. Candidates after basic properties check

A.Recognication and Classification

a) Feature Extraction : Features are extracted from the remaining candidate using LPB,HOG,Haar approach

b) Support Vector Machine : The purpose of the SVM is to differentiate traffic lights from other possible objects using features extraction

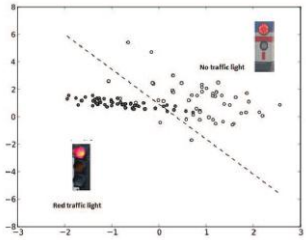

Figure 2.7. SVM Approach

B.Decision Algorithm :Verification of multiple detection and single candidate

III.*PROPOSED METHODOLOGY*

In this paper a robust method for traffic light detection have been proposed. The algorithm is competent enough to handle the detection of traffic light both at day and night. The algorithm exploits the color spaces for proper detection of traffic lights. Different techniques are used to detect traffic lights in day and night. As the color of the lights on camera sensor varies from day to night.Hence, the first step performed is to analyze the mode of detection which will decide whether it is day or night. Mean sky value approach is used for this purpose. The value will be high for the day time and it will be low for the night. Once it is decide, the second step is to decide the technique used to detect traffic light. For the day time we analyze the captured image in the YCbCr and HSV color space. For the detection of red color, Cr frame is selected and used as base image. The region of interest is selected for the removal of areas which can not contain the traffic light. For detecting green color in the day we use the HSV color space. Thresholding the HSV color image gives us the base image for green color detection. For the night time ,we analyze the captured image using greyscale frame of the colored image. The image is converted into black and white image and used as the base image for detection. Further the region of interest is selected. Lastly the detected candidates are checked through alignment and proportion. The resulted candidate is the color of traffic light.

IV.RESULT

The proposed algorithm has been tested in different environmental conditions and the result is consistent. Figure 4.1 is taken on a cloudy day. As apprehended, the tail light of the car resembles the traffic light but the detection was correct.

Figure 3.1. On a cloudy day

The next image, Figure 4.2 was captured at midday. Many variations of red light can be seen on the road, but the algorithm has detected the correct light.

Figure 3.2. At Midday

In Figure 4.3 the green colored light can be found near blue light, thus can create problem but by proper selecting of region of interest and color space ,the detection of light can be done.

Figure 3.3: At Night

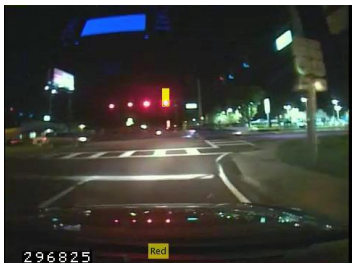

Figure 3.4:Detecting red light at night

The choice of different color space makes the detction of light at night easy because the whole surrounding sparkles at night. We have tested our algorithm on more than 10000 frames of video and have got results as in table below

TP	FP	FN	Precision	Recall
140	25	8	84.8	94.6

TABLE 1

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