Traffic Light Signal Detection: A Study

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Abstract

This paper presents a study on the use of a monocular video camera for traffic lights detection, in a variety of conditions, including adverse weather and illumination. The study emphasizes on the system incorporating a color pre-processing module to enhance the discrimination of red and green regions in the image and handle the "blooming effect" that is often observed in such scenes. The study also illustrates that the fast radial symmetry transform is utilized for the detection of traffic light candidates and finally false positive results are minimized using spatiotemporal persistency verification over many years.
Keywords: Traffic Signal, Computer Vision, ADAS, Automatic Detection, Image Processing

I. INTRODUCTION

Car driving itself without human is a dream of people. There are many studies about Intelligent Transport System (ITS) and Unmanned Ground Vehicle (UGV). Interest on unmanned vehicle is increasing. One of important issue in UGV is detection of signal light. Which is necessary when car is on the crossroads and intersection? RF(Radio Frequency) system is a perfect system for safety crossing, but, for using RF system, all of the intersection or crossroads must have RF receiver and sender, and all the cars should have RF terminal. All of intersection should be changed. This method requires lots of cost.

Vision system is cheaper than RF approach. Therefore, vision detection system for signal lights detection should be developed. Also, signal light detection provides help to safety driving. There are many accidents in crossroads and crosswalk. Such accidents are caused by careless drivers. Signal light detection system can support driver to notice about signal light. In this paper we present a new vision algorithm for signal light detection which has real time processing with high detection rate while using low price camera. Using this algorithm, reliability and safety for UGV and drivers will be increasing.

In the last years the increasing use of car transport has led to a rising number in traffic accidents. One of most important causes of severe accidents is drivers running red traffic lights at crossroads. In order to reduce those kinds of accidents some governments have installed video cameras in crossroads to monitor the road and log the occurrence of car accidents. These systems enable to the government to punish undisciplined drivers, and treating in the same way with unintentionally accidents. However, this approach does not provide tools for dealing with accidents. In addition, installing a video camera in each crossroad of a city supposes a big expense for the governments, and does not give a true solution to the accidents themselves.

Traffic lights are widely available in city environment. The autonomous detection of traffic lights helps intersection safety warning, V2V and bridging the infrastructure-vehicle gap, red-light warning etc. Traffic lights usually locate at intersections of the roads and provide rich information about the location of the intelligent vehicle. They also guide the motion of the intelligent vehicle in the next step. So the detection of the existence and the status of the traffic lights is an important part for the autonomous mobility in urban environment. Video camera can provide appearance information about the environment. As we all know, traffic lights usually have different colors and brightness compared with the scene near them. So we can detect traffic lights with the help of video camera.

Advanced Driver Assistance Systems, or ADAS, are systems designed to help the driver in the driving process. These systems are designed to be embedded in cars in order to give hints to the driver and at the same time be able to correct some driving errors trying to avoid accidents without being intrusive to the driver. There are many examples of these systems: 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.

II. BACKGROUND

The traffic signal light detection step provides position on an image and color information for traffic lights. Color based segmentation is commonly used to detect red, yellow, and green traffic light bulbs [1-8]. Alternative color spaces [12-15] (including HSV, HIS, and Normalized RGB) are employed for color space transformation since RGB color space is easily affected by various -illumination conditions. Based on the color spaces, a color threshold method is applied to classify color into red, yellow, or green [1-5, 7-9]. Various traffic light samples analyze the color distribution to determine several threshold values for each color. Otherwise, a Gaussian based color model is proposed [6]. The authors obtain a means and covariance of the color model from just few training images and apply the color model to classify traffic light colors. Monochromatic images obtained from the color threshold method may contain noise; therefore, morphological filters (including erosion and dilation) are employed to remove noise and emphasize traffic light regions [1-4, 6, 7]. Furthermore, some methods use the shape of the traffic light bulb (in terms of aspect ratio and pixel density) to filter out residual noise [2, 3, 6, 8-11]. The color based segmentation method has a common trade-off problem: an increased false positive rate due to the wide color threshold region (required to cover various illumination conditions) or a decreased detection rate due to a narrow color threshold region. The detection performance is highly dependent on the results of the color based segmentation; consequently, a robust color segmentation method is required that considers various illumination conditions.

Fig. 1(a): traffic signal light detection

Fig. 1(b): traffic signal light detection

The recognition pipeline based on visual systems can be implemented in several ways but generally the algorithm can be divided in few main steps that are described in the following.

III. METHODOLOGY FOR THE EXISTING APPROACH

The proposed method uses different color spaces and detects and recognizes the traffic signals in a moving vehicle. The method is efficient enough to detect traffic signals in day as well as in night conditions. The method is robust enough to detect traffic signal lights in low resolution videos and also in different lighting and atmospheric conditions even including rain.

We divide the whole method into two cases namely day and night. For detecting the scene belongs to day or night we consider the mean intensity value of the scene. The procedure of detecting traffic signal is different for day and night scenes are different. In either case we select a region of interest which is above the horizon as traffic lights are always at a height above the ground. In the night scene we use RGB color space to detect traffic signal. We extract the objects in the scene which are of similar size as of the traffic signal and hence we get our candidate objects. We analyze each candidate object for traffic light and see if it is red or green and compare it to its outer area.

When we have iterated through all the candidate objects we check for collinear traffic signals detected to reject the traffic signal looking outliers. Finally we check for the rightmost signal among the selected signals. In the day scene we use Cr frame of YCbCr color space for detecting the red traffic signal and HSV in addition to YCbCr color space for detecting green traffic signal. The overall process remains the same just the color space used for the traffic signal detection varies in night scenes and, red and green traffic light detection in the day.

IV. CONCLUSION AND FUTURE SCOPE

Furthermore, this work can be extended to better accuracy than the existing approach and can also be implemented on hardware to be applied in the real time. The approach can be revolutionized by integrating to the driveless systems. The study explains the importance in the driver assistance systems.

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