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Traffic Light Detection System for Different Weather Condition using Image Processing: A Review

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Abstract- *Image Processing is increases image property by transforming the input image into the digital form by doing some operations on it. Traffic Light Detection (TLD) via Image Processing provides accurate information to the intelligence system of autonomous vehicle about the traffic light scenario. Thus, traffic light problem for an unmanned vehicle can be solved. The challenge for autonomous vehicle is safety. Detection of traffic light is essential for autonomous vehicle. A camera will be installed alongside with the vehicle. Light is detected from the captured image. Traffic light detection for autonomous vehicle is important as a part of road safety. Many researchers proposed various algorithms for TLD. In this paper, we present the review of traffic light detection methods for different weather condition.*

Keywords- *Traffic light detection system, Weather Condition, Image processing, Autonomous vehicle.*

I. Introduction

In today's era growth of total number of vehicles around the world is increase exponentially. The development in many aspects of life traffic congestion is a challenge for all large and growing urban areas and becoming one of the daily concerns of all the individuals. Traffic lights have become an integral part of human's day-to-day life. The growth in traffic congestion has been recognized as a serious problem in many urban and suburban areas. It will effect on the accident risk, economy, pollution and discomfort for millions of road users. Now a day there is Intelligent Traffic Systems are introduced. In intelligent traffic control system there are unmanned traffic signals.

Traffic light detection is important for safe driving and will give useful information to help a driver to understand the road environment. And also useful for autonomous vehicle. However, detection and recognition a traffic light is not easy from image. The factors that affects: Night scene; have different illumination, the traffic light is very small compared to other objects, there are many objects of which colors are similar to one of the traffic light, the traffic light has complex shape.

Image Processing is increases image property by transforming the input image into the digital form by doing some operations on it. This image is useful in extracting some information from it. In image processing input is image or video frame and output may be image or characteristics related to image. Image processing is widely used in traffic light control system.

Most of the researcher tries to solve the problems related to traffic light detection and make the system able to find out or detects moving and stable vehicles in various weather conditions.

This paper focuses on the review of different methods for traffic light detection system. And also reviews on paper of traffic light detection system in different weather condition.

In paper, section 2 addresses the literature survey and section 3 presents conclusion.

II. Literature Survey

With the growing number of vehicles, traffic information increasingly becomes important for drivers. Many approaches have been proposed for tackling related problems in intelligent transportation system (ITS). In this section the literature survey on different paper is described.

When the traffic light is on, its corresponding color component is much bigger than other color in RGB color space. Proposed algorithm is work with RGB color space. According to this, red, green, and yellow color pixels of traffic lights can be extracted by subtraction between two color components. By using the object extraction in RGB color space and the rule verification, the traffic lights can be well extracted in the complex environment. The algorithm Rule-Based traffic light verification is used to detect the vehicle lamp from the other unwanted objects. Experiments show that the algorithm has the characteristics of stability and reliability [1].

Ms. Pallavi Choudekar et al. [2] propose a system for controlling the traffic light by image processing. The proposed system involves four steps which are Image acquisition, RGB to gray conversion, Image enhancement, Image matching using edge detection. In first level, image acquisition is done with the help of web camera. Image of the road is captured, when there is no traffic on the road this empty road's image is saved as reference image. In second step RGB to gray conversion is done on the reference image. From a few fundamental functions image enhancement step is done. so that result is more suitable than the original image for the specific application. In last step first edge is detected through Sobel, Prewitt and Laplacian operator's algorithms. And used gradient based Edge Detection method. In image matching any edge or its representation on one image is compared and evaluated against all the edges on the other image. This system gives good result.

An adaptive vehicle detection approach for complex environments is proposed for solving problems of vehicle detection in traffic jams and complex weather conditions like sunny days, rainy days, sunrise, sunset, cloudy days, fog, or at night. Use Histogram Extension (HE) for remove effect of weather and light impact. The gray-level differential value method (GDVM) is used to dynamically segment moving objects. Traffic parameters are evaluated from the proposed approach, like traffic flows, velocity, and vehicle classifications. System follows some steps the image frames taken from the video are, first normalized using the Histogram Extension (HE) technique. Then moving objects are dynamically segmented using GDVM. From the GDVM components R, G and B is used in this approach. The method has higher detection ratios and gathers more useful traffic parameters. In addition, the proposed system can easily be set up without being given any environment information in advance. Figure 1 shows system overview [3].

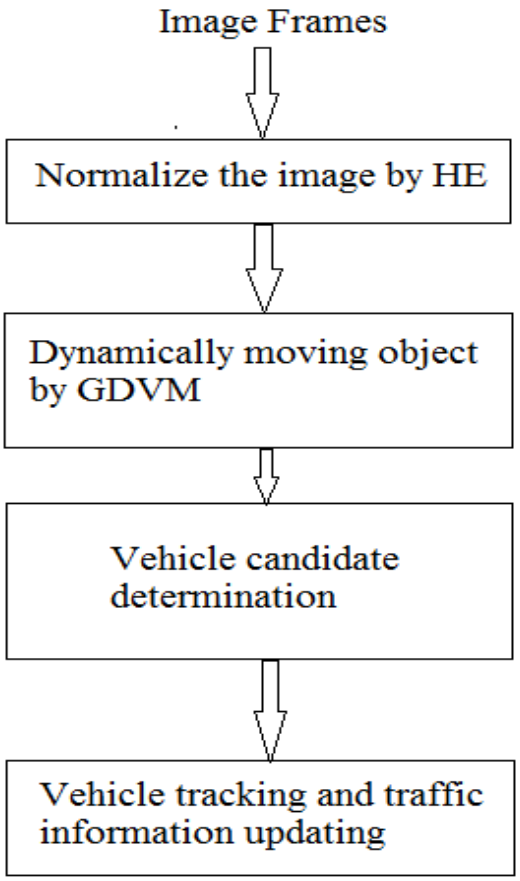

Figure1. System overview

The paper describes a color segmentation algorithm. In daylight the color of image is variant with the change of light. Due to the complex environment of roads the road sign become very difficult to detect. The colors of road signs are affected by sunlight and variations in daylight. Color segmentation algorithm is used to change the level of the RGB channels for each pixel. In this algorithm the image is separated in three images, each one is RGB channels. And then on each channel histogram equalization is done, and image is forward to color consistency algorithm to find the true color of road sign. Here the work area is part of Sweden. [4]
Advanced Driver Assistance Systems (ADAS) are new technologies which use monocular video camera for traffic lights detection, in different conditions, including complex weather [5]. The proposed system uses the monocular video camera for traffic light detection in different phases. The system uses a color pre-processing module to enhancement of red and green region of image, this handles the blooming effect. In addition the fast radial symmetry transform is used for the detection of traffic light. The system examines in various conditions including driving in the rain, at night and traffic of city road.

The survey paper presents the survey on crosswalk detection methods and traffic light detection methods. For traffic light detection and traffic sign detection the methods like Hidden Markov method, Color Segmentation method, Template Matching method, Color and edge information, Hough transform is surveyed. And for Crosswalk methods; Segmentation and projective invariant, Homography search approach, Vanishing line, two vanishing point, Projective geometry, Hough transform is considered. From comparison table given in the paper shows, for TLD the Hidden Markov Method is more accurate than other method. And HSV domain is accurate for Crosswalk Detection. [8]

Mark P. Philipsen et al. [6] highlighted some approaches of traffic light detection. From their survey they noticed that current research is evaluated based on local datasets with a limited number of traffic lights. They introduce a comprehensive traffic light dataset for common evaluation procedure. In the first approach the detector is relies on intensity from gray scale images. This has the advantage of being more robust to color distortion. The detector reaches a detection rate of more than 90%.In second approach top-hat spot light detection is used. It is relying on the assumption that TLs will only appear above the line. Then apply the white top-hat operation. This is done on the intensity channel V from the HSV color space. This system has accuracy of 85%. In next approach extracts candidate BLOBs from RGB images and using thresolding segmentation. This is followed by shape filtering to reduce noise using width/height ratio and the solidity of BLOBs. The solidity is calculated based on the ratio between the area of the BLOB and its bounding box. Here the detection rate is of 93%.An easy way of improving the segmentation is to reduce the search area. A popular and simplistic approach is to limit the search to the upper half of the input image. Here an off-line database containing prior knowledge of TL locations is used. The off-line database is created using the input image combined with accurate GPS measurements, and then manually hand-labeling of the areas with TLs on a pre-captured image sequences. With the use of their prior map their approach reaches a precision of 99% and a recall of 62%.

In [7] researcher presents the Traffic Light Solution for UGV (Unmanned Ground Vehicle) using Digital Image Processing Technique. This algorithm follows five steps Color Detection, Circle Detection, Camera Orientation, Co-ordinate Analysis, and Vehicle Density. In first step the pixels of the desired color are extracted from the image. In circle detection circle of traffic light signal is detected. Camera mounted on the vehicle. Co-ordinate analysis is analyzing the probability of traffic signal. Vehicle Density is considered in a situation where system keeps on detecting red signal indefinitely or traffic light system failure. This algorithm has a good detection rate and accuracy.

Hidden Markov Model (HMM) is detecting the traffic light and gives the state estimation, through the Viterbi algorithm. The image processing presents a problem regarding conditions for capturing scenes, and therefore, the traffic light detection is affected. This method helps to determine the current state of the traffic light detected, based on the obtained states by image processing. Aim is to obtain the best performance in the determination of the traffic light states. With the proposed method they obtained 90.55% of accuracy in the detection of the traffic light state, versus a 78.54% obtained using solely image processing. [9]

To detect suspended traffic light based on color and feature such as black area of traffic light or the area of traffic light lamp the novel approach is proposed [10]. This method detected suspended traffic lights located up to 80 meter distance. If the distance is up to 60 meters, then the car correctly detects the traffic light. This technique work based on assumption that the traffic light with black circle and only one traffic light bulb turned on and other bulbs are turned off.

In [11] presents the vision algorithm for real time signal light detection. System is basically for unmanned vehicle. Figure shows the steps of algorithm. This algorithm has high detection rate. Also, red and green signal lights are detected successfully. Low price camera can be used for this algorithm. Here the condition for weather is considered. All of computers and equipment's are built in real vehicle.

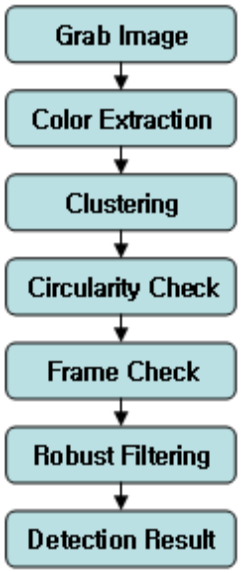

Figure2. Architecture for signal light detection

This system presents a real-time fog detection system using an on-board low cost b & w camera, for a driving application. This system is based on two clues: estimation of the visibility distance, which is calculated from the camera projection equations and the blurring due to the fog. Because of the water particles floating in the air, sky light gets diffuse and, focuses on the road zone, which is one of the darkest zones on the image. The apparent effect is that some part of the sky introduces in the road. Also in foggy scenes, the border strength is reduced in the upper part of the image. These two sources of information are used to make this system more robust. The final purpose of this system is to develop an automatic vision-based diagnostic system for warning ADAS of possible wrong working conditions. Some experimental results and the conclusions about this work are presented. [12]

The author proposed a defogging algorithm for single image based on dark channel priority which can make rapid defogging on foggy images. For the disadvantage of
HE algorithm, that is, much time is used to optimize transmission diagram, the paper applies a method combining adaptive median filtering and bilateral filtering to calculate dark channels, The dark channels are refined, and transmission diagram t estimated by the method is also refined without need to optimize, which reduces the complexity of algorithm significantly and overcomes the bottleneck of low speed for HE algorithm. The algorithm realizes rapid and high-quality defogging on single images in the condition of not influencing defogging effect. The improved algorithm has flexibility, practicability and effectiveness, and makes the reliability of outdoor visual system in foggy weather improve dramatically, so it has widely practical value. [13]

Wenbo Jin et al. [14] propose a novel algorithm to remove haze from a single image. A new dark channel estimation method is employed by subtracting three times variance from mean to approximate the minimum value, which is defined as the dark channel in a local area. To achieve anisotropic local mean and variance, a fast bilateral filter is introduced. Its complexity is a linear function of the size of the image, which makes real-time visibility restoration possible. Compared with existing algorithm based on dark channel prior, the proposed algorithm have better performance by reducing the halos introduced by large patches very well with less computational cost.

In [15], propose a simple but effective image prior—dark channel prior to remove haze from a single input image. The dark channel prior is a kind of statistics of outdoor haze-free images. It is based on a key observation—most local patches in outdoor haze-free images contain some pixels whose intensity is very low in at least one color channel. Using this prior with the haze imaging model, we can directly estimate the thickness of the haze and recover a high-quality haze-free image. Results on a variety of hazy images demonstrate the power of the proposed prior. Moreover, a high-quality depth map can also be obtained as a byproduct of haze removal.

III. Conclusion

This paper presents a review on methods for traffic light detection system – for traffic light and traffic light in diverse weather condition. From the literature review can say that image processing is best way to detect the traffic light for different weather conditions also. There are lots of techniques implemented for traffic light detection. But there is an issues related in detecting light for complex environment condition. So it can view as a future expansion.

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