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Traffic Light Detection for Red Light Violation System

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ABSTRACT

The goal of Red Light Violation Detection System (RLVDS) is to track down vehicles that violated traffic regulations using surveillance cameras and image processing techniques. A complete automated red light runner detection algorithm that satisfies real time requirement and gives higher accuracy have been developed. The system detects simultaneously a traffic light sequence, stop line and detection region to detect moving vehicles and capture the vehicles beyond the stop line while the light is red and finally generates the red light running vehicle images with date and time information. In this paper, we propose a traffic light detection algorithm which is one of the processes of automated red light runner detection system. The proposed traffic light detection system includes four steps: color space conversion based on RGB color space, some regions are extracted as candidates of a traffic light and morphological operation is applied to eliminate disturbance in the environment that can interfere with the traffic light states. Then, the types of traffic signals are judged by calculating image moments and the results of experiment show that the system is stable and reliable.

Keywords: *Image Recognition, Red-light Runner, Traffic Lights Detection, Vehicle Driver Assistance System*

1. INTRODUCTION

The integrated automated traffic management systems (ITMS) are now being implemented across different major cities around the world.An automated Red Light Violation Detection System (RLVDS) is an integral part of the ITMS. In major cities, vehicle violation action becomes a serious problem by the rapid developing vehicles. People focus the negative aspects of rules rather than the positive. Simply, the consequences for not obeying traffic laws take place personal injury, death, and damage to your vehicle or other property. A high percentage of serious road accidents usually occur at the road crossing due to the drivers make red light violating according to the statistics from many countries. Red light running, speed violation, stop line violation and lane violation are all kinds of violation at a street intersection. Among these violation actions, red light violation is the most important cause of the accidents. The development of an automated Red Light Violation Detection System (RLVDS) may be considered as a key module of the overall Integrated Traffic Management System (ITMS).

The automated red light violation detection system is mainly composed of three modules: (i) traffic light detection (ii) stop line detection and (iii) moving vehicle detection as shown in figure 1. In this paper, traffic light detection process which is one part of the red light violation system is developed and it is important for safety driving, especially in autonomous vehicles and in advanced driver assistance system. Nowadays, in automatic traffic signaling system, red, yellow and green colored lights are used for interpretation of three types of signals for traffic controlling operations. Green light signals to start a stopped vehicle, yellow light signals a moving vehicle to slow down the speed and red light signals the vehicle to stop. In any crossing when traffic signal is red, the drivers rushing towards the crossing must stop immediately before stop line. The system regards the vehicles that make violation in situation where the vehicles are beyond the stop line only when the traffic light is red. The video files needed for making the current experiment are collected from MCDC (Mandalay City Development Committee). In proposed system, the detection procedures are performed based on the input images. The images have to be extracted from the testing input video files and the three modules are kept to continue as a next procedure. In moving vehicle detection process, a field of detection (FOD) is defined as the target area and the system only detects the vehicles in this region instead of detecting the vehicles in field of view of the camera so that the system not only can reduce the computational complexity but also can save time consuming. Finally, the system will detect the vehicles whether they are violated or not. If the vehicles make red light violation, then they are captured and recorded with date and time information.

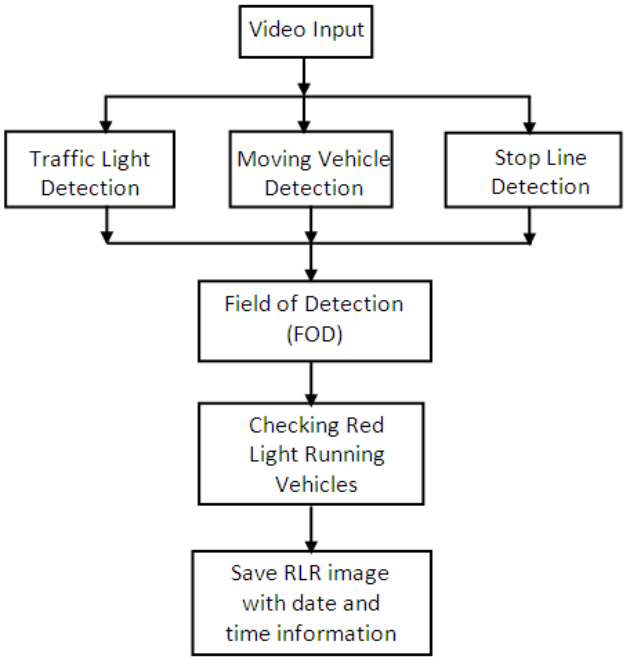

Figure1. Block Diagram of the automated red light violation detection system

2. Related Work

In the paper [1], it describes a new video detect and capture system based on surveillance cameras. Firstly, it fetches video flow from surveillance camera and detects violation vehicles by applying background generation algorithm based on Gaussian Distributions. Although the algorithm can adapt different weather and slowly change situation, it can't found object position if the object change status from moving to static. Therefore camera-shifting algorithm that can extract vehicle feature is adopted in this paper.

Xiaoling Wang, in December 2013, proposed a video-based traffic violation detection system. It describes a variety of approaches to vehicle detection in video streams, including background difference, inter-frame difference, edge detection method, optical flow method, block matching method. The system consists of three modules, namely video loading, detection of violating vehicles, and violation evidence storage. A real-time adaptive background update algorithm is used to detect vehicle detection. The system can detect and track vehicles effectively and automatically save and display the information. [2]

For detecting general object from a scene image, a lot of techniques have been proposed. The template matching is one of the most fundamental methods. Given a template and an input image, a region that is the most similar to the template is selected with a criterion such as the normalized cross correlation or the sum of squared differences. However, the disadvantage of the template matching is the high computational complexity. [3] Swain and Ballard use color histogram method for detecting object because it is widely used for object detection. [4]

3. System Procedure For Traffic Light Detection

The traffic light detection is the first part of the automated RLVDS and it is very important because the system will be started only when the traffic light is red. The proposed traffic light detection system consists of five steps to perform that are presented in fig. 2.

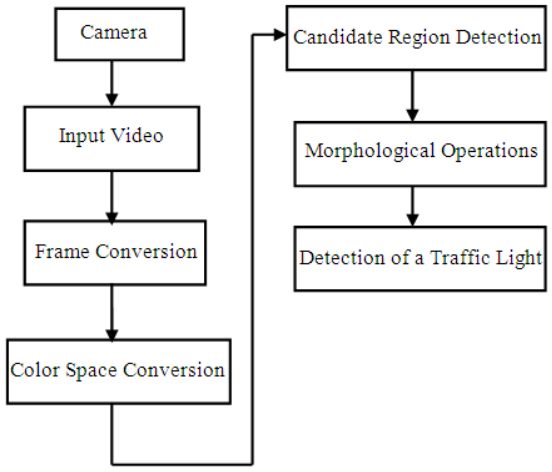

Figure2. Block Diagram of Traffic Light Detection

In proposed method, the image frame is firstly extracted from the input video streams. Traffic light image which is RGB components may be affected by different variations in scene illumination, optics drop-off, and variable distance. The image is converted from RGB to HSV color space because HSV color space can be used in situations where color description plays an important role. Then, the pixels of which colors are ones of the traffic lights are extracted as candidate regions for the lights. Morphological operations are applied to the image to remove the imperfections and noise in the structure of the image. Finally, the traffic light is detected by calculating image moments.

A. RGB to HSV Color Conversion

The colors of traffic light differ depending on the change in the lightning condition caused by weather, time and other factors. In order to eliminate the slight change in the color, we convert the color space. The HSV color space is invariant under the orientation of an object with respect to the illumination and camera direction and it can give better detection accuracy compared to RGB color space. Therefore, we convert the RGB image to HSV one.

$$H = \cos^{-1}\left\{\frac{\frac{1}{2}[(R-G)+(R-B)]}{\left[(R-G)^2+(R-B)(G-B)^{\frac{1}{2}}\right]}\right\} \quad (1)$$

$$S = 1-\left(\frac{3}{R+G+B}\right)\min(R,G,B) \quad (2)$$

$$V = \max(R,G,B) \quad (3)$$

where, H, S, V = Hue, Saturation and Value
R, G, B = Red, Green and Blue

B. Candidate Region Detection

From the HSV image, som rgions are extracted as candidates for a traffic light. The decision whether a pixel belongs to one of the candidate regions or not is done by the values of H, S and V. A pixel belongs to a candidate region if it is in the following condition:

For red traffic light, $20^0 \le H \le 30^0, 0 \le S \le 0.2, 0.9 \le V \le 1$

For green traffic light, $30^0 \le H \le 100^0, 0.4 \le S \le 1, V = 1$

Connected regions obtained by the selected pixels are the candidate regions of a traffic light.

C. Morphological Operation

Morphological operations are performed to extract significant features from images that are useful in the

representation and description of region shapes. Morphological operations are well defined for binary images but are equally valid and are found useful for gray scale images also. It is mostly used in image segmentation and pattern recognition. The fundamental morphological operations are erosion and dilation which are especially applied for traffic light detection process. Here morphological operation is used to remove noise and to distinct the contour of traffic light.

D. Detection of a traffic light by Image Moment

Image moment is a certain particular weighted average of the image pixel's intensities and it is used to describe objects after segmentation. Simple properties of the image which are found via image moments include area, centroid, and information about its orientation. Here, we use image moment to find contours which are curves joining all continuous points along the boundary having same color or intensity and to detect traffic light.

$$M_{ij} = \sum_x \sum_y x^i y^j I(x,y) \quad (4)$$

where,

I(x,y) = pixel intensity value at (x,y) coordinate

M_{ij} = image moment

4. Tests And Results

The traffic light detection system proposed in this paper not only improves the detection accuracy but also the processing time. Moreover, we can predict the position of the traffic light because the position of the camera is fixed. The traffic lights are often set at the top of the image and therefore, only region that is greater than ¼ width of image and the region that is less than ¼ height of the image are considered in the system. By this way, it will be effective to improve the accuracy and to quicken the detection program. From the results of the detection, we can see that traffic lights were extracted accurately and the algorithm can give the correct types of traffic signal as well. The results of traffic light detection during day and night condition are described in the following according to the step by step procedure:

Figure3. The input color image

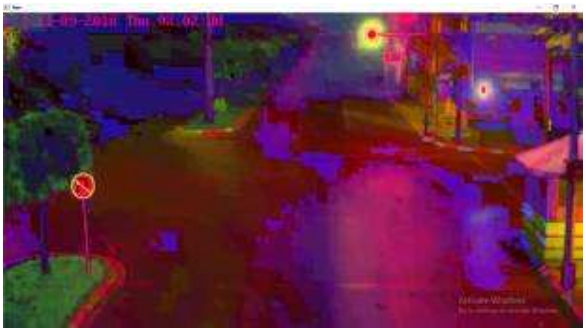

Figure4. The image with HSV color space

Fig. 3 is the input color image extracted from the input video file and the size of the image is big of 2160x4096 pixels that increase computation time because the resolution of the camera is high. Firstly, the frame is resized by multiplying with 0.3 factors to width and height of the frame to reduce computational complexity. The resized frame is converted into HSV color space which is more intuitively satisfying or more convenient than the RGB color cube as shown if fig 4.

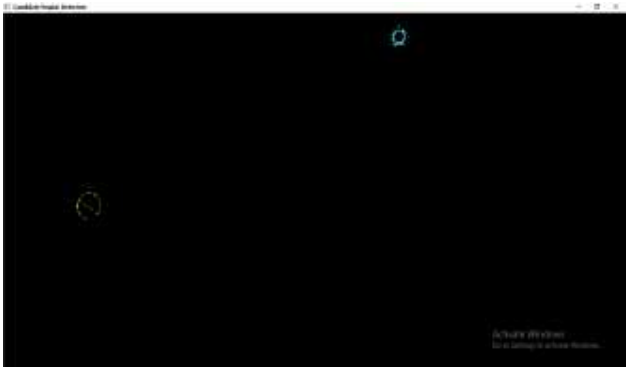

Figure5. Candidate regions

The candidate regions are extracted based on HSV color space and the pixels of the HSV image that are included the defined HSV color space are the isolate regions of traffic lights. Fig 5 is the image after making candidate region detection process.

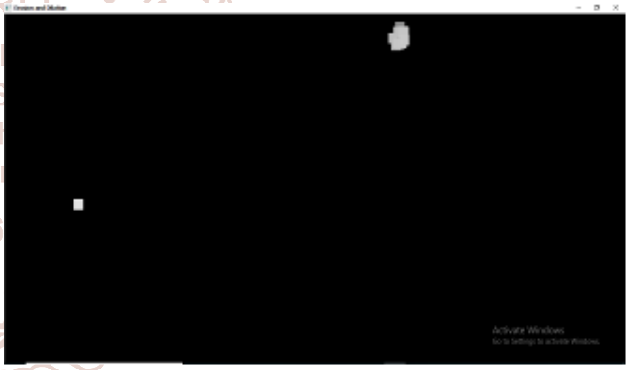

Figure6. Erosion and Dilation

After extracting candidate regions for traffic lights, the two fundamental morphological operations are applied to the image. It is obvious that the regions of interests are becoming more prominent by employing erosion and dilation process on the image as shown in fig 6. Finally, the traffic lights are detected by calculating moments and the results for green traffic light and red traffic light are shown in fi 7 and fig 8.

Figure7. Traffic light detection for green color

Figure8. Traffic light detection for red color

From fig 9 to fig14 are the step by step results of traffic lights detection for day condition.

Figure9. Original color image

Figure10. HSV color space

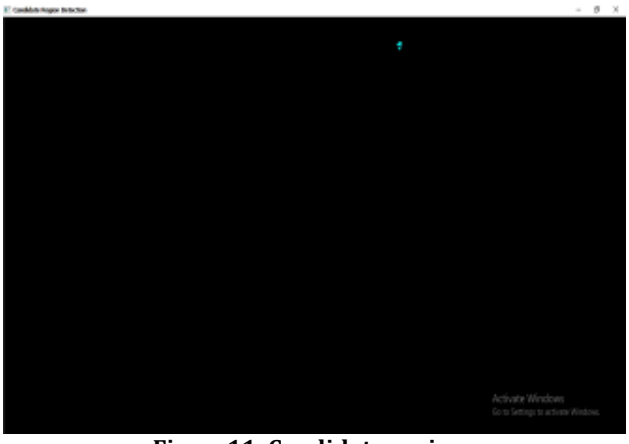

Figure11. Candidate regions

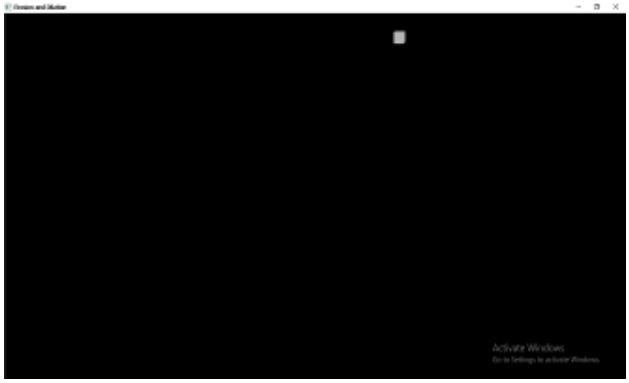

Figure12. Erosion and Dilation

Figure13.Traffic light detection for green color

Figure14.Traffic light detection for red color

Conclusion

The proposed system is developed by using surveillance cameras and effective image processing methods to detect the traffic lights. The system can detect the traffic lights even in the complex environment. The algorithms of traffic lights detection is widely used in vehicle driver assistance systems that can reduce the traffic accidents. The algorithm is designed for real time and the detection process is tested in both day and night conditions. From the results of the detection, we can see that the traffic lights were extracted accurately in a reasonable time. The colors of traffic lights are not the same during day and night condition and it is not easy to decide the traffic signal in night because the light radiates especially during night condition. However, the system can detect well the traffic lights because testing video files used by the system are captured by using high resolution cameras from MCDC. As a future work, the tracking algorithm will be taken into account to improve the accuracy because the system is aimed for real time condition.

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References

[1] Yu Wang, Xiaoxian Su, Mian Yang ,Li Xu,Chao Tang, "A Violations stop detect system Based on Surveillance Camera", School of Information Engineering Key Lab. of Broadband wireless communications and Sensor networks Wuhan University of Technology, WuHan,China.

[2] Xiaoling Wang, "A Video-based Traffic Violation Detection System", College of Information Engineering, Zhejiang University of Technology, Hangzhou 310023, China,DEC,2013.

[3] R. O. Duda and P. E. Hart, Pattern Classification and Scene Analysis, John Wiley & Sons, Inc., New York, 1973.

[4] M. J. Swain, and D. H. Ballard, "Color Indexing,"International Journal of Computer Vision, vol. 7, no. 9,pp.11–32, 1991.

[5] Maryam Heidari and S. Amirhassan Monadjemi, "Effective Video Analysis for Red Light Violation Detection", *J. Basic. Appl. Sci. Res.*, 3 (1s) 642-646, 2013.