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# Effective Video Analysis for Red Light Violation Detection

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**ABSTRACT**

Red light Violation detection is one of the exigent branch of knowledge in modern intelligent transportation system, it is preferable to traditional detection methods in operation and maintenance aspect. According to the practice of crossroads and the characteristics of vehicles running red-light, this paper presents the methods of red light runners video detection algorithms sate the real time requirement as well as red-light violation detection with a high accuracy. In addition, they are also capable of tolerating a number of antagonistic but realistic situation such as pseudomotions due to shadows, poor contrast, minimum number of traffic light, pedestrian motions and turning vehicles. Purely from the video, the new methods firstly construct a traffic light sequence, and then detection region to detect moving vehicles and vehicles motions beyond the stop line while the light is red. Our methods are simple and effective, as while as can solve the problems of undetected and wrongly detected vehicles seen in existing algorithms.

**KEYWORDS**: Red-Light Runner, Vehicle Detection, Vehicle Tracking, Frame Difference, Region to Detect.

## 1. INTRODUCTION

One of the significant issues which reduces road safety is disobeying the traffic signals at signalized. Statistics from many countries showed that a high percentage of serious road accidents occurred at road junctions, and a high percentage of these are due to drivers disobeying or “running” the red light [1]. Aiming to deter red light running, it is very important to develop an efficient red light running detection system called the red light camera (RLC).

It uninterruptedly monitors the traffic in the crossroads and gets the evidence of vehicles running red-light without human inference. Compare to the traditional detection technology, such as induction coils, radar, ultrasonic, and police monitors the video detection method has got advantages of easy maintenance, long service life, high accuracy of detection, real-time detection, and would not require the demolition of pavements and roads.

Aiming to dissuade red light running, digital imaging, and sensor technologies have been developed and integrated for detecting the violation in action and taking photographic records of the accidents. This endeavor resulted in a class of systems called the red light camera (RLC), which operates in conjunction with the traffic light control circuit and inductive loop detectors (ILD) buried under the surface of the road at the [2], [3]. In essence, such system must be electronically connected to the traffic light control system and the ILD buried under the road surface, usually beyond the stop line. It is typically mounted on a post at some distance from the, with a recording camera viewing from continuously the traffic direction. The field of view (FOV) of the camera must include at least one traffic light (typically two), the and the vehicle’s license plate for later prosecution. The additional functions of the system are: 1) Handling signals from the traffic light and ILD; 2) Activating the camera; 3) Recording other relevant information of the offence scene. When the traffic light is red and the ILD sense the presence of vehicle(s) on either lane, the camera will be triggered to take two photographs of about 1 sec apart. The first photo depicts the vehicle entering the beyond the stop line, and the second photo shows the vehicle leaving the. Detailed information such as date, time, camera identity, lane number, red light duration, and detection identity will also be printed on the photographs for future reference.

At present, many RLC systems are gradually adopting digital technologies for recording, transmission, and pattern recognition. However, the RLC based on ILD have some deficiencies, such as demolition of road surface, inflexibility, and the high cost. Due to these disadvantages, the application of this kind of RLC is very difficult. To improve the effectiveness of deterring red light runners, the RLC principles must be redefined. One possible approach is to apply video technology and video analysis techniques appropriately, as video contains a large amount of spatial and temporal information that have not been fully exploited so far. Furthermore, video technology and video analysis theories are maturing rapidly. Therefore, it is our intention to study and exploit this possibility in this paper and propose several solutions and novel methods that performs automatic RLR detection on the traffic video without needing any signals from the traffic light system or the ILD.

At first method primarily [4] Nelson Yung and Andrew Lai tackle the problem at two stages:

1) It detects and constructs a traffic light sequence at the.
2) It estimates vehicle motions beyond the stop line, while the light is red.

The traffic light sequence detection firstly locates all the traffic lights in the FOV by searching all the red/yellow/green regions with an aspect ratio close to unity and similar sizes. The spatial relationship between the lights is utilized to eliminate other regions, while the light’s temporal relationship is used to improve the confidence of the former decision and to construct the light sequence. As there may be more than one traffic light under the FOV, the traffic light with the largest dimension, i.e., closest to the camera, is then chosen for all the subsequent analysis.

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This method is developed to replace the traffic light control signal. The detection of vehicle motion beyond the stop line is built on a direction-biased motion estimation algorithm. In this case, direction-biased three-step search algorithm is developed upon the concept of virtual loop detectors (VLD). The concept of VLD permits regions to be defined on the video that can emulate the function of the physical ILD. By defining these VLD beyond the stop line, their motions along the road direction may be estimated. In principle, motions objects such as pedestrians, turning vehicles and shadows may be differentiated according to their motion vectors. Based on this method, a prototype has been implemented and evaluated using a number of traffic videos taken under different outdoor conditions, including one with the video camera mounted on an existing RLC post. In all our evaluations, the method identified all the RLR correctly. Also it was observed that the new method is capable of tolerating a number of hostile but realistic situations: 1) minimum number of traffic light; 2) pseudomotions due to shadows; 3) poor contrast; 4) pedestrian motions; and 5) turning vehicles.

Second method is explained in the that many RLC systems based on video analysis techniques use virtual loop detectors (VLD) in the video picture instead of ILD under the road surface. The concept of VLD permits regions to be defined on the video, and can emulate the function of the physical ILD. In real world, if the setting of the VLD is not suitable, red light runners would be undetected, while it would wrongly detect right-turning vehicles as runners. In [5] Chen Yanyue and Yang Chenhui present a novel method that detects the red light runners by analyzing the tracks of vehicles. The method is on the basis of moving objects detection and tracking. After that, the moving points can be obtained. This method primarily tackles the problems in the existing VLD based on RLC such as: 1) undetected if the VLD can not cover the driving region of the vehicle(s) and 2) wrongly detected when the vehicle(s) go through the prohibited zoon but turning right.

In [6] Di Luo et al. explain that the main methods of video detection are feature line method, virtual coil technology, moving target tracking technology, and virtual coil technology cooperating with vehicle tracking technology. Feature line method greatly depends on lane condition and is easy to be affected by foot passenger, illumination, etc. There are three-hard problems in virtual coil technology and moving target tracking technology, which are hard to segment moving target from background accurately, hard to track moving target accurately and hard to give the right judgment for moving target behavior. Those problems result in high error detection rate and miss detection rate existing in red-light violation video detection system. Although virtual coil technology cooperating with vehicle tracking technology can improve detection rate, the algorithm is complex.Then is presented a vision vehicle detection algorithm based on region according to the practice of crossroads and the characteristics of vehicles running red -light.

In this paper, we study several red-light violation detection methods and then present a vision vehicle detection algorithm can eliminate the disturbance aroused by illumination, shadow, foot passenger, etc, therefore our method is simple and effective, and the experiment results show that this algorithm, satisfies the real time requirement and detects red-light violation incidents with a high accuracy.

The organization of this paper is as follows, section 2 we present full procedure for red light runners video detection, in this section we details the algorithms for red light runners video detection based on analysis of tracks of vehicles. In section 3 presents the results discussion the performance of the our methodology

**2. Full Procedure for Red Light Runners Video Detection Based on Analysis of Tracks of Vehicles**

With reference to Fig. 1, the traffic light detection and judgment is the first part of the system because of the future works need to be done only when the traffic light is red. Second, the input video is automatically analyzed by the vehicle motion estimation and tracking in the field of detection (FOD) which define as the zoon around stop line aiming to obtain moving points. Fit moving points so as to provide reference to analyze tracks of vehicles.

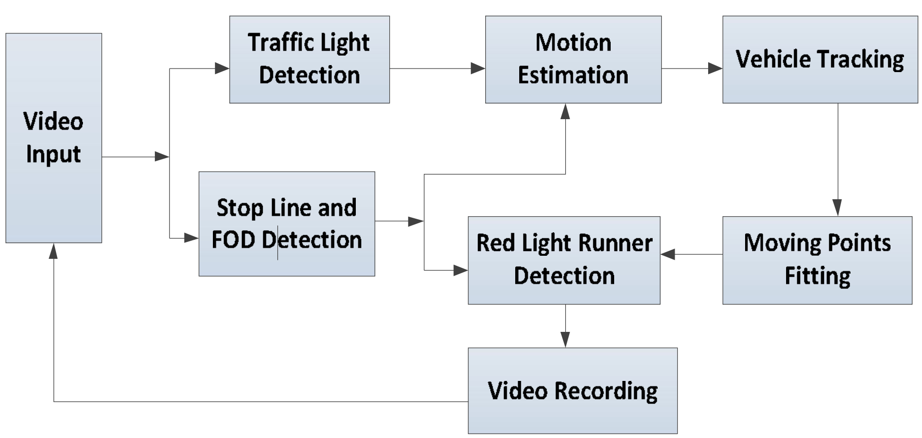


**Fig. 1.** Functional Block Diagram of The System

It should be noted that the stop line only needs to be detected once. As the camera parameters are fixed, the location of the stop line is fixed, which is used to define the location of the FOD and to detect the red light runners.

The prohibited zone can be weakly defined as the area between the entrance and the exit of a, bounded by the stop lines Fig. 2.

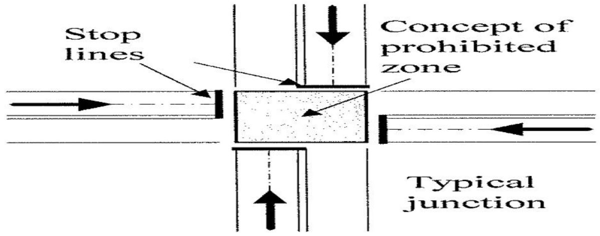


**Fig. 2.** Stop Lines and Prohibited Zone [4]

To detect the stop line, many detection and segmentation methods may be employed [7]. In general, a frame where the stop line is not obstructed must be obstructed must be obtained first. This usually would be a background frame obtained from background estimation methods. The stop line is detected using Hough transform in this method.

In general, a traffic light consists of three separate lights in red, yellow, and green spatially aligned vertically from top to bottom in this order. As it is likely that there will be similar red, yellow, and green objects in the FOV, the first task in detecting the traffic lights is to isolate the lights from a multitude of similar color regions. Of the three colors, it is observed that green is the most difficult to isolate because of its variation in shape, and the presence of similar green regions such as trees and bushes around a typical. Therefore, it would probably be more efficient if the detection starts with the red and yellow.

In addition to the spatial relationship as described, there is also a temporal relationship governing the traffic lights. The argument for utilizing this temporal relationship in the detection is that outdoor environment is hostile. For instance, any sudden change in the ambient light level may affect the brightness of the lights, especially the green light and may introduce ambiguity. Therefore, tracking the light sequence would probably provide a more stable and robust solution [8]

Our method uses frame-to-background differences in hue algorithm to judge whether detection region is covered by vehicle, the quality of subtraction result affects the accuracy of latter judgment directly. So how to construct "pure" background model is the key to improve veracity of detection. The background is constantly changing by the effect of time, light, weather conditions, etc, so it needs a kind of algorithm that it is able to conduct a background template automatically [9].

In Surendra background updating algorithms, the region which has moving objects is found by using frame subtraction, It updates background by remaining the background for the region which has moving objects and replacing the background with the current frame for the region which has no moving objects. After a period of time, all the background of interested region will be updated. In this paper, it will take a long time to capture the image which no moving object being on detection region owing to the length of detection region. So the detection region was divided into three parts and update background of each part dividually.

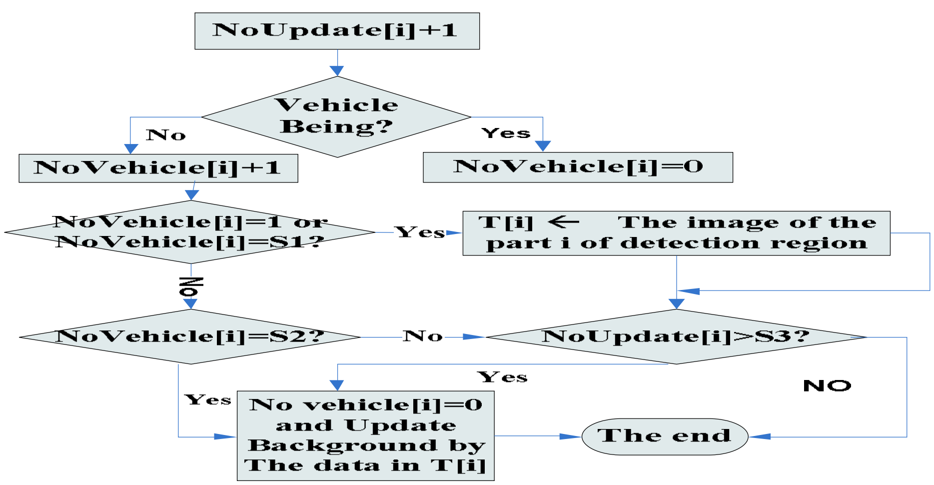


**Fig. 3.** Background Update Algorithm Flowchart for Part [5]

Fig. 3 is the background update algorithm for part i of detection region [10]. The algorithm detects efficaciously and can eliminate the disturbance aroused by illumination, shadow, foot passenger, etc, which satisfies the real time and accuracy requirement for traffic monitoring system. Considering the complex environment of crossroads and dense vehicles, the algorithm is not well to deal with the problem of hided vehicles.

The moving points of vehicle can be obtained by doing vehicle motion estimation and tracking [11]. Each moving point is the centroid of the vehicle which is the result of tracking.

If the moving points is mapped from background to the X-Y space Fig. 1, them can be defined as a sequence:

$$((x_1, y_1), (x_2, y_2), ...., (x_n, y_n)) \qquad (1)$$

where $n$ denotes the number of moving points and $x_i$ , $y_i$ respectively denotes value of the no. $i$ moving point in X-axis and Y-axis. To analyze the track of the vehicle, that for every $y_i$ there is a $x_i$ corresponding to it, that is the value of sequence (1) is continuous in Y-axis. Because the position points of the image are integer, was defined that $y_i = y_{i-1} + 1$ , $y_i \in [y_1, y_n]$ and $y_1$ is the value of Y-axis for the first point of the moving points and $y_n$ is the last one. That moving points are not continuous in Y-axis owing to choose of inter frame space and the change of vehicle speed. In a word, moving points fitting needs to be done before analyze tracks of vehicles. In this method, cubic splines interpolation was adopted to do the work [12].

The Y $(y_1, y_2, ..., y_n)$ is supposed as a given data, according to the relationship between $x_i$ and $y_i$, the cubic splines function S(x) can be obtained, where Y is independent variable and X is dependent variable all the vehicle which trough the red line during this period are red light violation, it includes three situation below:

1. When the vehicle goes to straight it is determined for a red light violation.
2. When the vehicle turns left it is determined for a red light violation like situation 1.
3. When the vehicle turns right it is not determined for a red light violation Fig. 4.


**Fig. 4.** Three Situation in The Cross Junction

The description of the algorithm as below:

1. To detect the vehicle L whether or not is a red light violation, the sequence of moving points is analysed of it:

$$\{(x_{L1}, y_{L1}), (x_{L2}, y_{L2}), ...., (x_{Ln}, y_{Ln})\} \quad (2)$$

If there being $y_m = y_{line}, m \in [1, n]$, the vehicle L would be a red light violation and go on to the step 2;

2. To analyze the sequence $\{(x_{L1}, y_{L1}), (x_{L2}, y_{L2}), ...., (x_{Ln}, y_{Ln})\}$ For every $y_i > y_m, i = (m+1, m+2, ..., n)$:

a) Along with the aggrandizement of value of Y-axis, the change of value of X-axis is abnormity and extent of change is less than T (the threshold value of change), it shows that the situation of the vehicle L is going to straight and it is a red light violation;

b) Along with the aggrandizement of value of Y-axis, the value of X-axis is increase and extent of increase is bigger than T, it shows that the vehicle turns left and it is a red light violation also;

c) Along with the aggrandizement of value of Y-axis, the value of X-axis is reduce and extent of reduce is bigger than T, it shows that the vehicle turns right and it isn't a red light violation.

The experiment results show that the algorithm not only satisfies the real time requirement but also detects red-light runners with a high accuracy, and has been able to eliminate disturbing factors such as lighting and climate changes.

## 3. RESULTS DISCUSSION

A prototype was implemented based on the above methodology. The final result of vehicles motion estimation in Fig. 5. The rectangles are show the vehicles which are detected. The trail on vehicle motion estimation shows that the method we used in this paper is able to meet our requirements.

**Fig. 5.** Results of The Method

The red light runners detection algorithm proposed in this paper had been tested on video sequences of the crossroad junction, and the results of the trial showed that our method can tracks vehicles before the stop line, distinguishes from the situations in traffic, and detects red light runners correctly and easily.

**Conclusions**

In this study, we have presented a novel and effective methods for detecting red light runners in this paper. A number of method have been observed. Firstly, these methods offers a mobile, robust, and cost-effective solution, and the set up process was simple and fast. Secondly, the correct detection rate was acceptable and can solve the problem of undetected and wrongly detected runner in the traditional methods. Next, the video and the tracks of vehicles analysis can be further developed into a multifunctional architecture where other traffic parameters may be calculated or estimated.

## REFERENCES


1. Lum, K.M., Wong, Y.D., (1998): An overview of red-light surveillance cameras in Singapore, ITE J. Web, 1, 87–91.
2. Chin, H.C. (1989): Effect of automatic red light cameras on red-running, Traffic Eng. Contr., vol. 30(4), 175–179.
3. Thompson, S.J. and et al. (1989): Putting red-light violators in the picture, Traffic Eng. Contr., 30(3), 122–125.
4. Yung, N., Lai, A. (2001): An effective video analysis method for detecting red light runners, IEEE transaction on vehicular technology, 50(4), 1074-1084.
5. Yanyue, Chen and Chenhui, Yang, 2010, Vehicle red-light violation detection base on region, Computer Science and Information Technology (ICCSIT), 3rd IEEE International Conference, 9, Digital Object Identifier: 10.1109/ICCSIT.2010.5565080, 700– 703.
6. Luo, D. Huang, X., Qin, Li. (2008): The Research of Red Light Runners Video Detection Based on Analysis of Tracks of Vehicles, Computer Science and Information Technology, ICCSIT '08. International Conference, Digital Object Identifier: 10. 1109/ICCSIT, 83, 734 - 738.
7. Shan, Zhu., Kai-Kuang, Ma. (2002): A new diamond search algorithm for fast block-matching motion estimation, IEEE transaction on image processing, 9(2), 287- 289.
8. Lai, H.S., Yung, N.H.C. (1998): “A system architecture for visual traffic surveillance”, 5th World Congress Intelligent Transportation Systems, Seoul, Korea, paper 22.
9. armann, K., Brandt, A. (1990): “Moving object recognition using an adaptive background memory”, Time-varying Image Processing and Moving Object Recognition, Elsevier, Amsterdam, The Netherlands, Paper 2.
10. Chengzhong, Yu., Jun, Zhu., Xiaohui, Y. (2005): Video object detection based on background subtraction, Journal of Southeast University (Natural Science Edition), 35, paper 27.
11. Stauffer, C., Grimson, WEL. (1999): Adaptive background mixture models for real-time tracking, IEEE International Conference on Computer Vision and Pattern Recognition, 2, 246-252.
12. Coifman, B., Beymer, D., Malik, J. (1998): A real-time computer vision system for vehicle tracking and traffic surveillance, Transport. REs: Part C, 6(4), 271-288.