Research on Vehicle Detection Method Based on Video in Color Low Illumination Environment

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ABSTRACT

In this paper, we study the method of video vehicle detection in color low illumination environment at night. At first, the low illumination image enhancement algorithm based on multi-scale Retinex used to process the original color image, and we make the open operation noise reduction processing after extracting moving object by frame difference method. Because of the extracted motion vehicle has tomography, this paper presents an effective solution to determine whether the moving target is the same vehicle. In this way we solve the problem of the faultage. The results of experiments show the proposed method in this paper has better performance. The method not only meets the requirement of real-time vehicle detection, but also solves the problem of detecting moving vehicles at night.

1. INTRODUCTION

Entering the intelligent transportation in the 21st century, the importance of highway transportation intelligent system stands out, and the vehicle detection method is the core of intelligent transportation system [1]. At present commonly used vehicle detection methods [2] include: Annular magnetic induction coil detection, ultrasonic testing, Microwave radar detection, infrared detection, Pneumatic tube detection, photoelectric detection, video-based vehicle detection, computerized pattern recognition, which through video cameras and computers to
etc. Video detection [3] is a technology of combining video images and simulate the function of human eyes. It becomes the hot spot of intelligent transportation and computer vision research in recent years.

Discernible information content of the vehicle itself in the video image is seldom, light illumination changes a lot, vehicle lights gradient information is not obvious, and has a clear halo. These factors cause target extraction difficult, making false detecting rate and false negative rate high. Especially in the low illumination environment, the quality of video image obtained is not high, that increased the difficulty for subsequent vehicle detection [4]. In order to solve the above problems better, this article will put forward the effective solution focus on in low ambient light conditions automatic video vehicle detection at night.

2. MOVING TARGET DETECTION AT NIGHT

Moving target detection and tracking, up to now, at home and abroad for its research is less under low illumination environment. For general vehicle detection system detection ability under low illumination environment, such as in the night has fallen sharply. On the premise of the camera fixed, mainly for outdoor video vehicle detection research under the low illumination environment.

2.1 Low Illumination Image Enhancement Processing

According to the environmental illumination at night, we divide the traffic scene into sufficient lighting and low illumination two cases. This article mainly aims in low illumination environment during the night. Retinex theory [5] is adopted to improve the low illumination image enhancement. Different from the traditional linear and nonlinear method that can only enhance one kind of image characteristics, Retinex can in dynamic range compression, edge enhancement, and color constancy three aspects equilibrium, so a variety of different types of images can be adaptive enhancement. In this paper, on the basis of single scale Retinex SSR (Single Scale Retinex) we use multi-scale Retinex MSR (Multi Scale Retinex) to process image enhancement [6]. MSR is developed on the basis of SSR, its advantage is can keep image high fidelity and dynamic range of image compression at the same time, and in some cases, MSR can realize color enhancement, color constancy, the local dynamic range compression, and the global dynamic range compression, it can also be used in X-ray image enhancement. Formula (1) (2) as follows:

\[ r(x, y) = \sum_{k} w_k [\log S(x, y) - \log [F_k(x, y) * S(x, y)]] \]  

(1)
In the formula, \( r(x,y) \) is for the output image, \( * \) as a convolution symbol, \( F(x,y) \) is a center around function, and the \( K \) in the formula is the number of Gaussian around the center function. When \( K=1 \), MSR degenerate into SSR. Generally speaking, guaranteeing with the advantages of high, medium and low three dimensions, the value of \( K \) is usually 3, and \( W_1 = W_2 = W_3 = 1/3 \), in addition, the experimental results show that taking 15, 80, 120 respectively can get good results. After dealing with the low illumination image enhancement for the original color video images, effect comparison is shown in figure 1 and figure 2:

![Figure 1. The original image in low illumination environment.](image1)

![Figure 2. The image after image enhancement processing.](image2)

### 2.2 Frame Difference Method To Extract Moving Targets

In the ideal situation that is noise free, the moving target detection is used to detect whether there are any changes between adjoining frames on the video sequence. If any change, it shows objects in change (movement), otherwise we think the object has not changed. The frame difference [7] is that the two gray values of the corresponding pixel point of the two frames before and after to do subtraction. If the gray level difference is very small, we can think that point without moving targets; otherwise, gray has changed a lot. We can think that there is a moving target. Firstly, we adopt the difference in value between two adjacent video frames to extract moving vehicle, then make the difference figure binary,
finally uses the open computing operations to remove noise. The formula (3) is the calculation method to extract ROI frame differential method, as the following:

\[ \Delta f = f_2(x, y) - f_1(x, y) \]  

(3)

In the formula, \( f_1(x, y) \) is the image frames at time \( t_1 \), \( f_2(x, y) \) is the image frames at time \( t_2 \).

After extracting the moving object, the image binary can be done. We set the image pixel gray value to 0 or 255, making the image present a clear black and white effect. Then combined with morphological noise reduction to process opening operation, thus image noise can be reduced [8]. The open operation makes the profile of objects smooth, breaks the narrow gap, and eliminates fine projections. The open operation is used to expand the difference binary images.

3. VEHICLE FLOW DETECTION AT NIGHT

After making low illumination image enhancement processing for the original color video images, we use frame differential to extract moving targets [9]. Then we use an effective method to estimate whether the extract moving object is a car.

3.1 Set The Interested Area To Virtual Coil Area

We set the interested region for virtual coil area (two lanes) to collect vehicle flow information. Considering the real-time requirements of vehicle detection system, we don’t deal with the whole image, only set a virtual coil of certain width and height. The selection of virtual coil position should fully consider the height, angle of camera installation and influence of field depth. Virtual coil is too big, it contains the information of front and following vehicle; virtual coil is too small, it contains so little vehicle information. Generally, it takes 20 rows height for the 768×576 images. This paper sets up two virtual coils: 20×160 and 20×140.

3.2 Vehicle Flow Detection

Due to the slices in extracted vehicles, we estimate whether the moving object through virtual coil is a car basing on the distance between vehicle slices is small and it between the vehicles is big. When the number of white points detected in virtual coil is more than 3, we begin to statistic; if white points fade and virtual coil inside becomes black, we count the number of frames until white points appear. The repeated experiments and previous experiences tell us that when the
frames of black area appearing between two white points detected less than 35, it means the black area is vehicle internal slice; otherwise it is the distance between vehicles. When determined to pass by a car, the virtual coil internal becomes white, a vehicle is counted. The experiment result is shown in figure 3.

![Figure 3. Vehicles through the detection area.](image)

4. CONCLUSION

Due to the interference caused by a lack of light under low illumination conditions during the night brings difficulty to vehicle flow detection and traffic information extraction. Making image enhancement preprocessing for color video images first before the moving objects detection, it can improve image quality and detection accuracy rate greatly. Frame difference is used to extract moving targets which suppressed vehicle light halo at night in real-time, and the vehicle contour information extracted by this method retained relatively complete. Then use the vehicle detection method proposed in this paper to make the effect better and improve the accuracy rate of the traffic violation detection in the night scene.

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