Research on Vehicle Speed Calculating Method of Traffic Accident Based on Reduplicated Video

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Abstract. With the wide application and product upgrading of monitoring equipment in China's road traffic management system, more and more traffic accidents are recorded in real time and intuitively, which plays an important supporting role in traffic accident handling. In view of the inconvenience of obtaining surveillance video from public security traffic management departments, this paper studies and proposes a method of calculating the speed of traffic accidents by using the remake video images. In this paper, the method of calculating vehicle speed by using remake video is studied by using real vehicle test method, the influence of the difference between the frame frequency of remake video and that of original video on the calculation result of vehicle speed is analysed, and the accuracy of this method in calculating vehicle speed is verified by real vehicle test, it has important practical value for speed identification of traffic accidents.

1. Introduction
Traffic accident technicians can't get the original video when traffic accident happens because of many objective factors, they can only use mobile phones or other video recorders to make video remake, because of the difference between the frame frequency of the remake equipment and the original video recording equipment, the frame frequency of the remake video is larger than or less than the frame frequency of the original video[1]. Because the recording process of the remake equipment can not be synchronized with the original video, there is a "Tow shadow" phenomenon in the remake video, so the accident appraiser can not directly use the remake video to analyze and calculate the vehicle speed.

In order to solve the above problems, the project team used the non-contact velocimeter to sample the speed of the test vehicle, and recorded the video of the test process with the camera; then the video of the test process was reproduced; the speed calculated by the original video and the reproduced video was compared and analyzed, and the accuracy of the speed calculation was discussed.

2. Basic Method of Vehicle Speed Calculation by Video
Both the original video and the remake video have their specific frame frequency information. Therefore, first determine the frame frequency of the remake video, then play the remake video frame by frame, determine the reference ruler and the feature points of the target vehicle in the video, establish the coordinate system, track the feature points of the target vehicle, finally derive the coordinate values of the feature points, determine the frame frequency of the original video, and calculate the driving speed of the target vehicle by using the kinematics formula[2-4].
Because of the "Tow shadow" phenomenon in the remake video, the key problem in calculating the vehicle speed by using the remake video analysis is to judge whether the feature points of the target vehicle are "real" or "virtual". Whether the recognition of target vehicle feature points is correct or not directly affects the correctness of the calculation results of vehicle speed. As shown in Figure 1, four tyres appear on the right side of the target vehicle.

![Figure 1. Tow shadow Phenomenon of Remake Video.](image1)

3. Real Vehicle Test Scheme
The non-contact velocimeter is mounted on the test vehicle, as shown in Figure 2. The driving process of the test vehicle was photographed by SONY camera at 30 frame/second frame frequency, and then the video captured by SONY was captured by Iphone at 25 frame/second frame frequency, then the test results of the non-contact velocimeter, the calculation results of the video captured by SONY camera and the calculation results of the video captured by Iphone were compared and analyzed, finally determined the speed of the vehicle.

![Figure 2. Non-contact Velocimeter on Test Vehicle.](image2)

4. Calculating Vehicle Speed Based on Video
4.1. Calculating Vehicle Speed Based on Reduplicated Video
4.1.1. Video Image Analysis
The frame frequency of the remake video is 25 frames/second and the length is 5 seconds. The whole video consists of 135 frames. In frame 73, the head of the test vehicle enters the video picture, and at the same time, the smear of vehicle’s head can be seen clearly; in frame 82, the test vehicle enters the video picture completely, at this time, the smear of the head and tail of the test vehicle can be seen in the video, the most obvious trailer is from frame 84 to frame 86, and it will be found that the position of the smear will change with the playing of the video; the 100th frame test vehicle is completely out of the video picture. The video image picture is shown in Figure 3.
4.1.2. Video Frame Loss Processing

The center of front and rear wheels of the test vehicle can be clearly seen in the video picture, it is known that the wheelbase of the vehicle is 2.71m, therefore, the wheelbase is used as the reference ruler, using motion tracking software to establish coordinate system, and the tracking point is set at the center of the front and rear wheels of the test vehicle to track frame by frame. The trajectory of the test vehicle is shown in Figure 4.

![Figure 4. Tracking Trajectory of Test Vehicle](image)

Tracking trajectory data is derived in the form of spreadsheet, by analyzing the inter-frame difference of the data in the spreadsheet, and found that some adjacent inter-frame differences have a large jump, in the Figure 5, such as the front-wheel pixel difference of serial number 5, the front-wheel and rear-wheel frame difference of serial number 11 and the rear-wheel frame difference of serial number 16. Because the difference between adjacent frames is almost the same in normal video images, it is judged that there exists "frame loss" in the remake video, the specific frame loss locations are between 5, 6 and 11, 12 of the front wheel and between f, g, k and L of the rear wheel as shown in Figure 6.

![Figure 5. Video Frame Differences](image)
4.1.3. Vehicle speed curve

The frame frequency of the original video captured by SONY camera is 30 frames/second, the coordinate values are filled in the space according to the difference between adjacent frames, then the time-velocity curve of the vehicle passing through the video screen is calculated according to the "time difference method", as shown in Figure 8.

4.2. Calculating Vehicle Speed Based on Original Video

Motion tracking software is used to track the front and rear wheel centers of the test vehicle in the video captured by SONY camera, establish coordinate system, derive the spreadsheet data, and the time-
velocity curve of the test vehicle passing through the video screen is calculated by the "time difference method", as shown in Figure 9.

![Time-velocity curve of test vehicle](image1)

Figure 8. Time-velocity curve of test vehicle

![Time-velocity curve of test vehicle](image2)

Figure 9. Time-velocity curve of test vehicle

5. Real Vehicle Testing Speed
Since the detection frequency of the non-contact velocimeter is to record a set of data every 0.1 seconds, and it cannot record a set of data every 0.033 seconds accurately, the data corresponding to four time points in the video can be obtained after comparison and correction with the video, and drawn the time-velocity curve, as shown in Figure 10.

![Real Vehicle Testing Speed](image3)

Figure 10. Real Vehicle Testing Speed

![Result Comparison](image4)

Figure 11. Result Comparison

6. Effectiveness Analysis of Vehicle Speed Calculating Method

6.1. Accuracy of Vehicle Speed Calculation
In summary, the results of the calculation of the remake video are basically the same as those of the original video, comparing with the results of the non-contact velocimeter, the range of difference is 1.8 km/h to 1.9 km/h, which is within the allowable error range. From the speed curve, the calculation accuracy of the remake video is much higher than that of the instrument and equipment, as shown in Figure 11.

![Result Comparison](image5)

Figure 11. Result Comparison

6.2. Video Frame Frequency Effect
In the real vehicle test, the frame frequency of the remake video device is less than that of the original video, so it is necessary to insert the corresponding frame number into the tracking trajectory data table. Similarly, if the frame frequency of the remake video device is larger than the frame frequency of the original video, the difference between two adjacent frames can be judged by using the frame difference. At this time, the difference between two adjacent frames can be found to be 0, which means that there are multiple frames phenomenon. Only the redundant frames need to be deleted, and then the speed of the vehicle can be calculated. If the frame frequency of the remake video device is the same as that of the original video, attention should be paid to whether the target vehicle feature point is "real" or "virtual", without increasing the number of frames or deleting the number of frames.
7. conclusion
Vehicle speed analysis and calculation based on remake video is an effective method to solve the current problem of vehicle speed identification. The results of a large number of real vehicle tests show that the calculation results of this method are basically consistent with those of the original video, and the calculation accuracy is higher than the current test values of instruments and equipment. This paper studies and solves the problem of calculating vehicle speed by replacing original video with remake video, which has important practical value for traffic accident speed identification.

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