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Traffic Conflict Identification Technology of Vehicle Intersection Based on Vehicle Video Trajectory Extraction

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Abstract

We do the establishment of the ground coordinate system by OPENCV software to obtain the actual coordinates, which is converted to vehicle coordinates in every pixel to get the parameters such as location and speed. MFC platform software which we exploited can directly output vehicle trajectory, speed and traffic conflict corresponding to the TTC time. There are different levels of colour marked in the map of the conflict distribution points. We use the cumulative frequency curve method to deal with the collected conflict samples, getting the TTC value which is used to define serious conflict and non-serious conflict. At the same time, we joined the car-following conflict, enriching our research content.

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Keywords: traffic conflict; TTC value; OPENCV software; road safety evaluation;

• 1 Background and Research at Home and Abroad

Most previous studies have relied on analyzing historic data to evaluate road trraffic safety, however the process of accident statistics collection is time-consuming and the data is lack of description of the accident prone points and the causes of the accident. This study employs the concept of TTC (Time to Collision) which is the expected time for two vehicles to collide if they remain at their present speed and on the same path as the quantitative indicator of intersection safety evaluation.

Recently, the research on traffic conflict problem of the video image also attracts scholars' attention. Tarek Sayed and Nicolas Saunier [1][2][3] developed automatic analysis system of the road intersection traffic conflict security based on video image processing. In 2008 Zhang Fangfang, made the first attempt in China to apply video detection technology into the intersection of traffic conflict detection [4]. However, the intersection video taken by aerial photography leads to low accuracy of the motor parameters estimation involved in the conflict and there is a considerable distance from the practical application of [5]. Another problem is that the existing research didn't have the description of the location of traffic conflict, but in fact the distribution of traffic conflicts in intersection is

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related to traffic facilities, traffic control and etc. To improve the safety of intersection, we should focus on the improvement of the location of serious traffic conflicts, through the traffic conflict heat map it can be more intuitive to reflect the serious position of conflicts in the intersection and then take the corresponding improvement measures. This study employs TTC indicator which is obtained through statistics and analysis of different types of intersection in Nanjing to qualify intersection safety. The software it developed can get the number and severity of traffic conflicts in the intersection and then make quantitative evaluation of intersection safety. This study also demonstrates the distribution of conflicts in the intersection visually in the form of heat map.

- **2 Traffic Algorithm of This Article**

2.1 Research Ideas

1. Recognize and segment vehicles with the help of OPENCV, using background difference method, morphological gradient method, feature point trajectory analysis, color segmentation and block morphological threshold judgment.
2. Collect videos of various forms of intersections, analyze the actual case to fit the data for the algorithm.
3. Establish the ground coordinate system, get the pixel coordinates of the vehicles in each frame and convert it to the actual coordinates, in order to get the parameters such as trajectories and speeds of the vehicles.
4. According to the speed and position of the vehicles, adjust the threshold of TTC algorithm, and add the traffic conflicts of the car-following situation, and write programs.
5. Use the TTC value corresponding to the 85 percent bit accumulated frequency as the cut-off value of the serious conflict and the non-serious conflict, and define the value by the frequency chart of traffic conflicts.
6. Build MFC platform, and implant the program into the software. Identify traffic conflicts synchronously, and output all the conflicts which has a TTC time value below 2 seconds and their according TTC time value.

2.2 Research on TTC Algorithm

Before determining the severity of a traffic confliction, the following parameters are required: the distance of the conflict, the initial speed of the conflicting vehicle, and the preliminary judgment of the observer on the severity of the conflict. According to the relevant contents in the data collection procedure, the acquisition of the collision distance and the initial speed of the conflict can be completed, and the TTC value is obtained indirectly. The difficulty of the data acquisition is the preliminary judgment of the severity of the conflict. The conflict is a serious conflict when the vehicle is experiencing an emergency braking, deceleration or a sudden turn. When these phenomena are relatively gentle, the conflict is a medium serious conflict. When they are small, the vehicle by the lateral interference is relatively minor and the conflict is a general conflict. According to the description above of the severity of the conflict, after the data collection is completed, the following indicators will be obtained: each conflicting sample corresponds to a TTC value and is divided into different conflict types including serious conflict, medium serious conflict and general conflict [6].

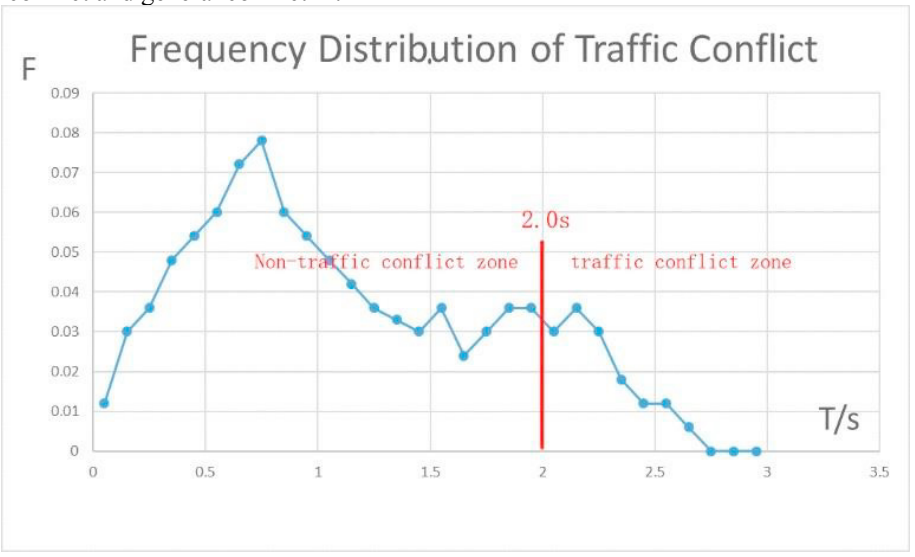

Fig.1. frequency distribution of TTC

We use the image processing procedures to get the traffic data including location, speed, speed direction, motion trajectory, etc.
In order to get the TTC values, the first step is to prolong the trajectories of the testing vehicle and find other vehicles that may conflict with it. The intersection of the trajectory can be the possible conflict point. According to car speed and distance to the conflict point, we can get the respective time with distances divided by speeds. The time to collision is obtained by subtracting their time to the conflict point.
The concrete formula is as follows:

$$\delta t = t_1 - t_2 = s_1 / v_1 - s_2 / v_2 \quad (1)$$

In the process of moving the car, the driver aware of the danger, to the reaction, braking or change direction, there is a process. In this process, because the two car driving direction and speed are changing, the time to conflict value is also changing, select the minimum value from these time difference and this is the most prone to conflict time. Generally, when it is the most dangerous, the time difference is that we need the time to conflict –TTC [7].

2.3 Conflict and its severity criteria

85% the cumulative frequency curve method is a common method in traffic engineering, such as determining the road speed limit value, usually according to the speed distribution of the measured cumulative frequency curve generation, road speed, and selected 85% cumulative frequency corresponding to the speed limit as the basis (i.e. under normal driving conditions, 85% vehicles do not exceed the speed) [9]. A similar analysis can be introduced to determine the severity of traffic conflict, based on the preliminary judgment of the observer, we can obtain the cumulative frequency curves of serious conflicts, moderate severe conflicts and general conflicts respectively. Then we can get the different severity of the definition of value conflict.

In this paper, we use the cumulative frequency curve method of collected samples of conflict processing, using 85 percent bit cumulative frequency corresponding TTC value as the boundary of serious conflicts and non-serious conflict value (moderate to severe conflict and general conflict are merged into non-serious conflict), the cumulative frequency distribution of two kinds of conflicts in figure:

The two kind of conflict have some overlap in the TTC index, when the 85 percent bit cumulative frequency curve method is used to calibrate the end value of the serious conflict, we also need to adopt the non-serious conflict of 15% cumulative frequency corresponding TTC value to verify the results. If in accordance with the results of the two methods, the difference is more obvious, we can think that the data acquisition or conflict classification is not reasonable.

With 0.1s as the minimum time interval, it can be seen from the figure that the TTC endpoint of serious conflict was 0.68 s, the value and non-serious conflict of 15% cumulative frequency corresponding to TTC are in good agreement, which indicate that it's reasonable to divide conflict into two categories of serious and non-serious conflict. In addition, it can be seen that when the TTC is greater than 2.0S, the number of conflicts observed has been very little, so 2.0S could be used as a standard to determine the time validity of the conflict, which TTC<2.0S, that this event do not constitute to a conflict. At this point, with TTC as the index, classification of the severity of traffic conflict has been clear division. When 0< TTC<0.68s, it's a serious conflict. When 0.68s <TTC, it's a non-serious conflict. When 2S <TTC, it's not a conflict.

• 3 coordinate and example analysis

3.1 Field coordinates and image coordinate transformation

The image coordinates represent the position of the target in the image, in pixels. The ground coordinate system is based on the ground plane of the intersection, and strictly speaking, the ground of the intersection is not a plane, but because of the small error, it is within the allowable range and therefore approximates it as a plane. The origin of the ground coordinate system can be arbitrarily determined according to the actual needs, because the absolute position of the vehicle in the intersection of the absolute position is insignificant, as long as the vehicle in each frame image relative position can be correct, so regardless of where the origin, distance, length and other physical Are consistent.

3.2 Method used by software

We use the interframe difference method to deal with video, interframe difference method is a video image sequence by two adjacent frames for the differential operation to obtain the contour of the moving object method, it changes the number of moving objects and camera changes Have a good adaptability. When the object in the video area is abnormal, there will be a big change between the previous frame and the next frame. The difference between the two images is obtained by the difference between the two frames, and then the difference It is judged whether or not it is larger than the predetermined threshold value to analyse the motion of the object in the video image, and the difference between the video image and the moving image is obtained. Inter-frame difference method has the advantages of simple algorithm, easy realization of the program, the influence of the external environment is small, and it will not be affected by the tree and shadow. Adapt to the scope of a wide, good stability and so on. But there is a complete lack of moving objects can be extracted, only to obtain its boundary contours; moving objects and the inter-frame time interval there is a certain relationship [8].

3.3 Example Analysis

The following is the author of the Central Road in Nanjing and TONGJIA Lane UAV overlooking the intersection of the example, due to TONGJIA Lane and Central Road into the intersection of all the right turn all the vehicles are free from the signal control, so there is A large number of traffic conflicts, in which the largest number of conflicts for the left and left turn conflict.

After the image algorithm software on the video is not a long time after the identification, we get the final traffic conflict distribution points as follow:

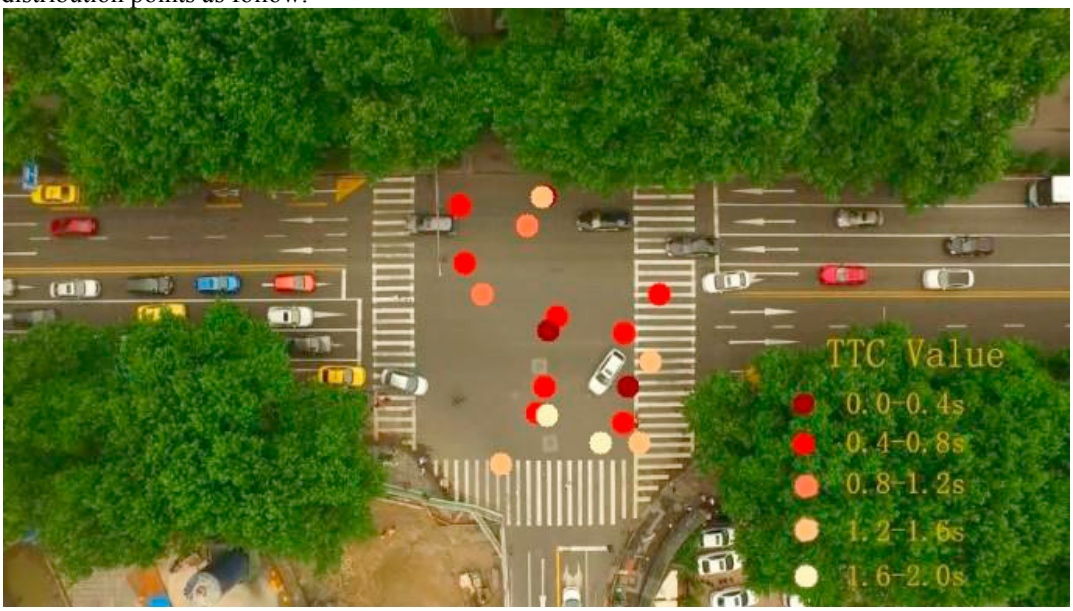

Fig. 2. traffic conflict distribution points made by software

Finally, after a long period of identification, we transfer it into the thermal map of the traffic conflict map as follow:

Fig.3. thermal map of the traffic conflict map

Using the same principle, we got the traffic distribution of the other two different types of intersections including crossroad and X intersection as follow:

Fig.4. thermal map of two types of traffic conflict map

- **4 innovative features**

Advantages of our image algorithm analysis method:

(1) comprehensiveness: the method of image algorithm analysis can be a comprehensive, no omission to determine the period of the entire intersection of the conflict, the exact location of the traffic conflict can be accurately described, if at least the same time at least one conflict The occurrence of the event, the ordinary manual conflict judgment is not well recognized, and we can through the software for any TTC value within the conflict threshold within the vehicle identification to determine.

(2) Intuition: We use five different degrees of distinction between the very obvious colour to characterize the degree of different levels of traffic conflict, through the TTC value to define the five levels, and then in the corresponding conflict location marked the corresponding colour, the formation of traffic conflict distribution Figure. In the figure we can visually see the concentration of serious conflict distribution position, is conducive to the future to improve the intersection, adjust the signal timing and so on.

(3) practical: our research has a very wide application of the market. However, our software to achieve the liberation of human resources, as long as the UAV aerial video, you can video into the program, the program analysis of the result is that we need the intersection of security evaluation, and software analysis of the universality, accuracy, quantification will be better than the artificial, which gives us the intersection of safety assessment work provides a great convenience. In addition, if the ground image processing and video capture connection, but also to achieve

real-time data processing, there is no delay, which increases the application of the software direction can be used for emergency, such as traffic accidents Live real-time analysis of road traffic conditions, which is much faster than manual surveys.

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