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Construction of a Driving Behavior Safety Monitoring Platform Based on Artificial Intelligence

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Abstract:
The existing driver driving behavior supervision platform is slightly insufficient in the overall control of fleet safety management. This is reflected in the lack of a clear definition of safety monitoring and the inability to implement timely intervention in case of bad driving behavior. Thus, the current fleet safety accident rate is still high. Based on this background, this paper proposes a safety management method for drivers on the way. This method combines the analytic hierarchy process to analyze the driver's driving behavior, identify the bad driving behavior on the way and push it to the team administrator in time. The team manager can intervene in time when facing the bad driving behavior of drivers. This can effectively prevent and control the occurrence of fleet safety accidents. Combined with this theory and method, this paper designs and implements a safety supervision platform based on driving behavior. The platform mainly includes six functional modules: data preprocessing, driving behavior calculation, safety value calculation, data storage and push, and real-time display. The test shows that the platform can reduce the human factors affecting vehicle driving safety.
KEYWORDS: Vehicle Driving Safety, Accident Prevention and Control, Behavior Identification, Human Factors.

1. INTRODUCTION

With the development of transportation industry, traffic accidents have become a serious problem faced by all countries. Fatigue driving is one of the important causes of malignant traffic accidents [1-2]. In 2019, the Chinese Medical Association and relevant transportation departments tested the alertness of 516 drivers, of which 24% felt tired driving that day, and 50% admitted to having been tired driving. According to the statistics of the World Health Organization, more than 1.2 million people die in traffic accidents and millions of people are injured or disabled every year [3]. The global economic losses caused by traffic accidents are as high as 518 billion US dollars every year, of which developing countries account for 100 billion US dollars. The death toll of traffic accidents in China has ranked first in the world for more than 10 consecutive years [4]. The number of people killed under the rolling wheels in China has increased from more than 50000 to more than 100000 every year in just over a decade, twice the number of traffic accident deaths in the second country in the world. According to the statistics of the traffic administration bureau of the Ministry of public security, in December 2005, there were 83334 traffic accidents across the country, resulting in 16582 deaths, including 381 deaths due to fatigue driving. For this reason, the development of driving safety detection method fully meets the trend of automotive technology development, and has important engineering and academic significance [5-7]. The research of driving safety detection technology is very important under this background. The vehicle driving safety detection technology is divided into two aspects in practical application: driver fatigue detection and danger detection outside the vehicle. This paper focuses on this problem.

2. RESEARCH ON FACE DETECTION METHOD

2.1. CURRENT SITUATION AND ANALYSIS OF FACE RECOGNITION AND TRACKING TECHNOLOGY

Since the late 1960s, the development of face recognition algorithm technology has experienced the following four stages [8](1) face recognition based on simple background: This is the primary stage of face recognition research. Since the late 1960s, the local features of human face organs are usually used to describe human face. However, because the facial organs have no significant edges and are vulnerable to expression. Therefore, it is limited to the recognition of frontal face (less deformation). (2) Face recognition stage based on multi pose and expression: This is the development stage of face recognition research. It began in the late 1970s. But it was not until the early 1990s that people really paid attention to it and carried out special research. (3) Dynamic tracking face recognition stage: This is the practical stage of face recognition research. It began in the late 1990s. In particular, the "9.11" event has promoted the rapid development of dynamic face tracking technology. (4) 3D face recognition stage: in order to obtain more feature information, it has also become a main research direction in this field to directly synthesize 3D face model using 2D face image for recognition.

2.2. ADABOOST ALGORITHM FOR FACE DETECTION

When AdaBoost is used for face detection, it extracts a large number of one-dimensional simple features from the face. These simple features have a certain distinction between face and non-human face. Finally, the system uses thousands of one-dimensional simple classifiers to achieve good classification results.

The training goal is to select t weak classifiers with the lowest classification error rate by analyzing the positive and negative samples, and finally optimize and combine them into a strong classifier.

The training methods are as follows:

Suppose the sample image $(x_1, y_1),..., (x_n, y_n)$, where for false samples and true samples, yi = 0,1, t is the number of weak classifiers included in the preset strong classifier of this layer.

For yi = 0,1, initialize the weights $w_{1,i} = 1 / 2m$ and 1 / 21 respectively, where m and 1 are the number of false samples and true samples respectively.

(1) Normalize the weights of all samples [9]:

$$w_{t,i} \leftarrow \frac{w_{t,i}}{\sum_{j=1}^{n} w_{t,j}} \qquad (1)$$

(2) For each feature, its weak classifier hj is trained, that is, the closed value is determined θj and bias Pj to minimize its objective function. The objective function is as follows:

$$e_j = \sum_i w_i \left| h_j(x_i) - y_i \right| \qquad (2)$$

Select the classifier h_t with the smallest e_t.

(3) Update the weight corresponding to each sample. The determination method is: if xi is correctly classified, ei = 0, otherwise ei = 1; and

$$\beta_j = \frac{e_t}{1 - e_t} \qquad (3)$$

The new weight is:

$$w_{t+1,i} = w_{t,i} \beta_t^{1-e_i} \qquad (4)$$

The final strong classifier is:

$$h(x) = \begin{cases} 1, \sum_{t=1}^{T} \alpha_t h_t(x) \geq \frac{1}{2} \sum_{t=1}^{T} \alpha_t \\ 0, otherwise \end{cases} \qquad (4)$$

Among: $\alpha_t = \log \frac{1}{\beta_t}$

The significance of the above training process can be expressed as: when the extracted classifier classifies correctly for some samples, reduce the weight of these samples. When the classification is wrong, increase the weight of these samples. In this way, the weak classifier extracted after training will strengthen the training of these classification error samples.

The above is the traditional AdaBoost learning algorithm, in which the value of weak classifier is not 0, that is, 1. Schapire proposed a new AdaBoost algorithm in a paper in 1999. The algorithm improves the traditional

AdaBoost algorithm from dealing with discrete binary decision rules to dealing with weak classifiers with continuous credibility output, that is, the value domain is the real number domain, so it can more accurately describe the classification boundary. The improved algorithm is called real AdaBoost algorithm.

The detector constructed based on AdaBoost face detection method is a cascade structure detector. Its basic principle is to combine multiple weak classifiers to form a strong classifier to form a multi-level structure detector composed of multiple strong classifiers in series. Among them, each weak classifier uses a rectangular feature, so its function is weak, but its structure is simple and easy to train. Although the function of each weak classifier is very weak, the function of strong classifier connected by multiple weak classifiers is really strong. Moreover, in the whole detection system, the more backward the strong classifier structure is, the more weak classifiers are included, the more powerful the function is, and the higher the accuracy is. Of course, the slower the calculation speed is, because the more to the back, the fewer the number of remaining sub windows, the greater the similarity between non face and face, and the greater the difficulty of separation.

2.3. EXPERIMENTAL RESULTS AND ANALYSIS

The face detection effect of AdaBoost algorithm is tested as follows. 5000 face samples and 200000 non face samples are used for training. Mit-cbcl face database is used for training samples, including face template and non face template. After face database training, the actual face image is detected. The test data includes the effect picture of the face rotating up, down, left and right within a certain angle.

From the experimental results, it can be found that AdaBoost algorithm has great advantages over other face detection algorithms. Firstly, the face offset in a certain range will not have a great impact on the detection effect. Through experimental measurement, the recognition accuracy range is 30 degrees up and down, 45 degrees left and right rotation and 30 degrees left and right tilt, which improves the stability and accuracy of detection. As a learning algorithm, in theory, as long as the learning use cases increase infinitely, the detection accuracy probability will be infinitely close to 100%, which has a relatively high guarantee in the detection accuracy. In addition, because the algorithm is separated from learning and detection, although the learning process will become very long with the increase of learning cases. However, the detection process is directly used with the learned data, so it can meet the real-time requirements of the system in practical application. Finally, because the algorithm adopts feature learning method, it is not sensitive to environmental light interference and other factors, and can maintain good stability in practical use.

3. RESEARCH ON HUMAN EYE RECOGNITION AND STATE DETERMINATION METHOD

3.1. HUMAN EYE RECOGNITION AND JUDGMENT METHOD BASED ON IRIS RECOGNITION

Iris is a very effective identification feature. At present, the more general iris boundary location algorithms mainly include the calculus circular edge detector method proposed by Joh Daugman, which uses the calculus operator to search the circular boundary and locate the inner and outer boundaries of iris; R. P. Wildes proposed a two-step localization algorithm using gray projection to roughly locate the pupil, and then use the circular gray gradient detection operator to accurately locate the outer edge of the pupil and iris.

The human eye iris structure shown in the figure, and the overall flow of the human eye recognition method based on iris recognition is shown in Figure 1:

This method can accurately locate the human eye and obtain more detailed information. However, the algorithm has very high requirements for the quality of the human eye image, and needs a very clear human eye image and enough information to support the demand for knowledge in the algorithm, which is very restrictive in practical application.

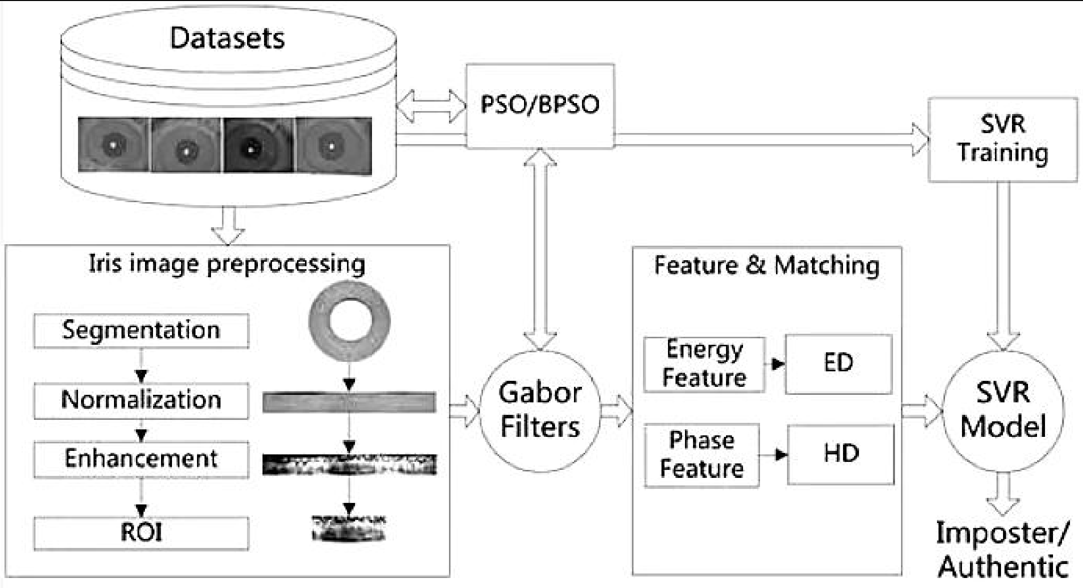

Fig. 1. Iris recognition process

3.2. HUMAN EYE RECOGNITION AND JUDGMENT METHOD BASED ON GRAY INTEGRATION AND TEMPLATE MATCHING

From the effect picture of edge detection, it can be seen that the gray of human eye area is obviously different from that of human face. The range of human eye area can be roughly obtained by using gray integration method. Before integration, the human eye search range can be further reduced according to experience, that is, the search range is roughly determined between 1 / 5 and 1 / 2 of the face part. In this way, the search range can be reduced again based on the face range, the amount of calculation can be reduced in the calculation process, the speed of calculation can be accelerated, and the real-time requirements can be met.

Due to the existence of white eye part and eyeball part, the gray change of human eye part is different from that of human face part under normal conditions. The gray value of white eye part tends to lighter gray. The gray level of other parts is dark. Due to this characteristic, the position with the maximum integral value can be selected as the transverse centerline of the eye by calculating the transverse gray level integral within the determined search range. From the rendering of edge detection, it can be seen that the upper edge of the human eye is the position of the eyebrow. After edge detection, the position of the eyebrow will also have a brighter effect relative to the surrounding. Reflected in the change of gray level, there is an area with large gray value, and there is a crest compared with the upper and lower parts, so it can be used as the boundary of the upper edge of human eyes.

There are many template matching methods. You can select standard face samples from the face database, manually calibrate the human eye template, normalize and train, and then search the matching position between topline and bottomline as the location of the human eye.

Generally, the human eye can be regarded as an elliptical shape, the inner knot circle is the position of the eyeball, and the rest is the position of the white eye. Through the ellipse and inner knot circle equations, we can determine the position of the current pixel. The following formula is shown:

Assume that the current pixel coordinates are (x, y):

When the pixel is in the eye range:

$$x^2 + y^2 < r^2 \quad (5)$$

Where r is the radius of the inner knot circle

When the current pixel is in the eye white range:

$$\frac{x^2}{R^2}+\frac{y^2}{r^2}<1, and x^2+y^2>r^2 \tag{6}$$

Where R is the length of the long half axis of the ellipse and r is the length of the short half axis of the ellipse, which is the same as the radius of the inner knot circle.

When the position of human eye and camera head is relatively fixed, we can choose the appropriate pixel width to define R and r through experiments.

4. RESEARCH ON VEHICLE DRIVING SAFETY JUDGMENT METHOD

4.1. DRIVER FATIGUE DETERMINATION METHOD BASED ON HUMAN EYE STATE

At present, PERCLOS method has been recognized as the most effective, on-board and real-time driving fatigue evaluation method. Walt Wierwille was the first person to study PERCLOS. He began to study the relationship between eye optical variables and fatigue in the University of Virginia in 1970s. Studies from 1980s to 1990s showed that fatigue was related to lack of sleep, pupil diameter, staring, Saccades, saccades, blinking and other factors. And it is found that PERCLOS is one of the most potential fatigue measurement methods, and its data can truly represent fatigue, which is the best method to evaluate and measure fatigue.

The principle of PERCLOS method is to take the percentage of human eye closure time in a period of time as the judgment standard of driver fatigue.

The formula is described as follows:

$$f=(t3-t2)/(t4-t1)\times 100\% \tag{7}$$

According to the previous experimental data, it is the best to take the human eye closure degree of more than 80% as the judgment basis of driver fatigue. Other researchers who use visual methods to detect the characteristics of eye state have also made progress: papanikolopoulos and others monitor the opening and closing state of the eyes through the CCD camera installed obliquely above the front of the driver, and put forward that if the eyes are closed for 2-3s, that is, microsleep (micro sleep) occurs, it is considered that the driver has fatigue symptoms. Horng of Tamkang University in Taiwan improved the algorithm of papanikolopoulos.

Based on the above theories, a fatigue judgment method based on human eye state is proposed. The significance of the algorithm is that for the left and right eye state tracking, if there is a continuous eye closure for a certain time, it will be judged as driver fatigue, otherwise it will be regarded as a safe state. Firstly, the algorithm uses a learning process to calculate the normal human eye state data through the data learning of N consecutive images, which avoids the contingency of single pair as the standard and improves the stability of the algorithm. In the process of continuous eye closure judgment, blinking and misjudgment due to interference may occur. In order to eliminate such interference, the counting process of lcount and rcount adopts that as long as a safety state image appears in the middle, it will be restored to the initialization state and counted again. In this way, eye closure due to occasional blinking interference will be eliminated in time. Through this method, the driver fatigue detection has a better effect.

According to this method, the fatigue degree can be determined simply by the driver's driving state, and a warning can be given in the case of driver fatigue driving, which is also the mainstream driver fatigue degree determination method at present. This method can basically meet the judgment of fatigue driving and give a warning in real time. However, the algorithm will also be affected by the external environment, such as the interference of shadow, the influence of colored glasses, and the driver's sitting posture. These problems need to be further solved.

4.2. DRIVING SAFETY JUDGMENT METHOD BASED ON ROAD CONDITION

With the decreasing cost of vision sensor and the rapid development of digital image processing algorithm, people pay more and more attention to the method based on machine vision for lane tracking and detection. The development of machine vision method is based on the following advantages: firstly, the price of equipment required is getting lower and lower with mass production, the price of various high-speed processors and memories is very low, and the camera equipment relied on by machine vision is becoming lighter and lighter in volume and lower in price. It provides a basis for extensive use in hardware. In addition, this method can not damage the original shape of the road, simple installation and convenient carrying. Images contain rich information and can provide enough information for decision-making. Image processing algorithms are becoming more and more mature, which provides necessary support for software development. Based on the above considerations, the lane line detection method can be used as a method to reflect the driving safety state.

The detection of lane mainly depends on the houtransform method. Due to the inherent morphological characteristics of lane, it presents a straight line shape reflected in the image. The houtransform algorithm can be used to calculate the longest straight line in the image to find the white lane. On the basis of rough detection, the center line can be finally integrated from the detected line cluster by line clustering method as the final lane detection result.

The determination method can be determined according to the abscissa position of the vanishing point in the image. When the abscissa of the vanishing point is in the middle of the image, we can think that the vehicle is in the middle of the lane and in a safe driving state. In case of danger, the vehicle will deviate from the lane, and the degree of danger depends on the degree of deviation. The closer the vanishing point is to the middle in the image, the safer the vehicle is. Otherwise, the closer it is to the left and right ends, the more likely danger is. The vanishing point is shown in Figure 2. This is the principle of using the vanishing point to determine the driving state of the driver. In the specific process, we can use the position of the vanishing point to calculate the probability of danger. Assuming that when the vanishing point is located in the center of the image, the risk probability is 0, then when the vanishing point moves left or right, the risk probability increases as the vanishing point is farther and farther away from the center of the image.

Using this method, the danger probability of driving can be determined only by the external conditions, the driver's fatigue can be reflected from the side, and a warning can be given in case of danger. However, this method also has some problems. How to select the curve equation in the hazard probability judgment function is more in line with the actual situation, which needs to be judged according to the actual requirements, so it has certain uncertainty.

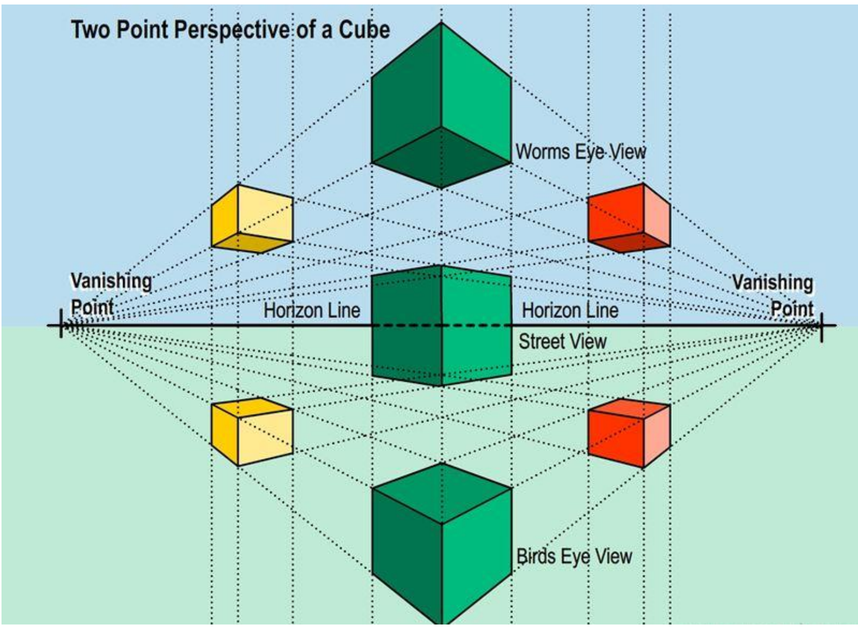

Fig. 2. The vanishing point

5. CONCLUSIONS

Based on the classical algorithm, this paper tries to improve the human eye detection, and puts forward a new algorithm to eliminate the specular reflection. The new algorithm can not only eliminate the interference caused by wearing glasses, but also eliminate the interference similar to the specular reflection. Through the experimental comparison with the previous algorithm, the new algorithm can eliminate most of the specular reflection interference and improve the recognition rate. At the same time, the detection effect of the new algorithm without glasses also reaches a good level and has good universality. Moreover, the similar specular reflection of human face caused by the influence of external light can also be well excluded without eyes. In the driving safety judgment method, firstly, the method based on driver fatigue detection is tried and improved. In this method, PERCLOS method and continuous eye closure detection method are combined, and a relatively stable detection algorithm is proposed. On this basis, a new criterion is proposed, which is based on the double standard of human eye state and lane detection. Different from the previous judgment methods that only rely on human eye state or lane line, the new method integrates the information provided by the two and carries out weight distribution. The weight distribution method also provides flexible operability for users, so that the algorithm can be more suitable for different environments.

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