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Eye Fatigue Detection System Design and Implementation

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Abstract: This paper implements the detection and recognition of eye fatigue state based on artificial intelligence technology and computer vision. Through the detection and recognition of eye closure time, the system provides voice warning information to prompt the driver, so as to reduce the traffic accidents caused by fatigue driving. The system is connected to a night vision camera to achieve real-time face detection and recognition. On this basis, the system locates the driver's eye feature points and calculates the parameters corresponding to the eye feature state, which is used as the basis for eye fatigue detection. When the driver has closed eyes (non-blinking) driving, the system will issue voice warning and upload the image of fatigue state in real time using the cloud platform.

Keywords: Eye Features, Fatigue Detection, Voice Alert, Computer Vision.

1. Introduction

Traffic accidents have always been one of the serious social problems faced by all countries, and even become one of the seven major causes of human death. The number of people killed in traffic accidents worldwide in the 20th century reached 22.35 million, surpassing the total number of 15.37 million deaths in the First World War, and a large part of them were caused by human factors [1-3]. A statistical study by the Chinese Ministry of Transportation on the causes of traffic accidents shows that fatigue driving accounts for 26% of the causes of domestic traffic accidents, and fatigue driving is gradually becoming a major hazard in traffic accidents, resulting in economic losses of billions of dollars. According to the National Highway Traffic Safety Administration, fatigue driving causes about 100,000 traffic accidents in the United States every year, and fatigue driving has become a "killer" that threatens human lives.

In the case of sleep deprivation or prolonged driving, the driver's reduced judgment, slow reaction and operation errors are called fatigue driving state, whose distinctive features include constant blinking, constant yawning, dull eyes and constant nodding. The existing anti-fatigue driving system mainly judges the driver's state by judging the current vehicle trajectory, but such a way is affected by the driving road conditions, driving habits and other factors, and the detection error is extremely large. Although the 30s pedal used in high-speed rail can effectively avoid fatigue driving, it cannot be used in civilian vehicles and has great limitations. The use of human physiological data as the basis for detection means, subject to equipment limitations at the same time, will also produce a large error due to individual differences.

In recent years, computer vision and machine learning technology fatigue driving detection technology has gradually become a new direction of automotive safety-assisted driving, such technology can be combined with machine learning to reduce the error caused by individual differences, but also can effectively reduce the number of fatigue driving [6-8]. Therefore, such technology has important research value and practical application prospects.

This paper is a Raspberry Pi-based eye fatigue detection system that saves real-time eye status data for different people to prevent recognition bias caused by differences in appearance. The system external camera has night vision function, which is also effective for eye fatigue detection and recognition at night. The hardware platform uses Raspberry Pi 4B, which is small in size, easy to carry and install, and can be powered by car power. The software programming language uses Python programming to achieve uninterrupted detection of driver's eye closure, which can achieve a short period of time to sample different drivers' eye information, and the function of voice prompts to the driver when there is closed-eye driving, as well as uploading fatigue driving data and driver photos.

2. System design architecture

This paper is based on artificial intelligence technology and computer vision to complete the detection of driver's eye fatigue, in the first time to detect the driver's eye fatigue driving (manifested as eyes closed for a long time), while the voice prompts for fatigue drivers. The system uses Raspberry Pi 4B as the hardware platform to realize the overall control function, and uses the camera to collect the face image and complete the detection and recognition of the human eye state. The overall hardware structure is shown in Fig.1.

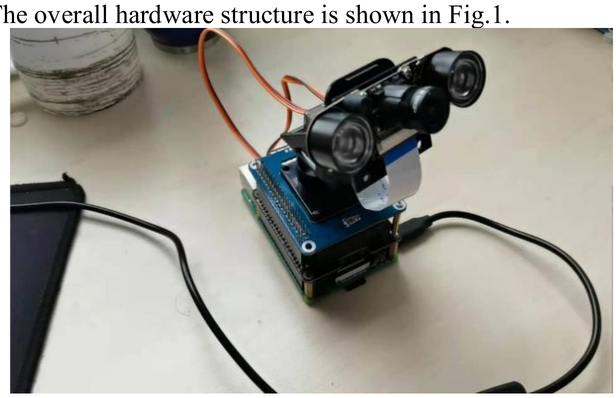

Fig.1 The system hardware structure

After the system starts, the first part is the feature data set part, which takes 1 minute to collect 50 groups of open and closed eye data of the detected object and save them to local, then the SVM data model generation part is executed, which uses the open and closed eye data saved in local to generate an SVM data model and save it, after the above is done, the formal detection part starts, the servo control, email sending part and detection The detection part reads the saved data model and compares it with the currently read real time data, if the eye midpoint coordinates are out of the specified range, it will trigger the gimbal control to rotate the camera, if there is a 3s long closed eye, it will trigger the mail sending part and the voice prompt part.

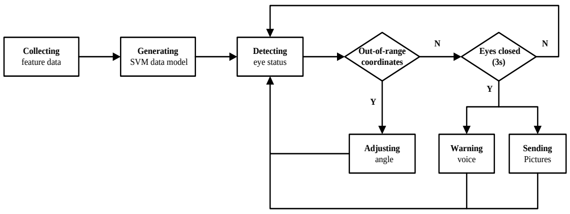

Fig.2 Flow chart of eye fatigue state detection algorithm

3. Verification and Testing

The tests of this design are all dynamic tests. All the modules are run separately and the results are recorded, and then all the modules are integrated for the overall run test. For the eye state detection part, the system outputs the opened eye result when the eye is open, the closed eye result when the eye is closed, and the closed eye three times when the closed eye length reaches 3s. As shown in Figure 3, the eye is marked with green line, when the eye is open, it will output open eye, close eye, and close eye three times after the eye is closed for 3s. For closed-eye voice warning, the system detects the closed-eye alarm part of the voice trigger once, normal playback. The system's gimbal is composed of two servos, so there is a separate control of the upper part of the upper part of the up and down with the lower part of the left and right rotation of the servo. Judgment is made every 1s to judge whether the current position of the midline coordinate point of the eye is within the middle zone of the image, and if not, the angle is adjusted, and the test results are shown in Figure 4 for each adjustment of 5°. When the system detects that the driver's eyes are closed, the system will send the real-time photos to the designated mailbox, and the test results are shown in Figure 5.

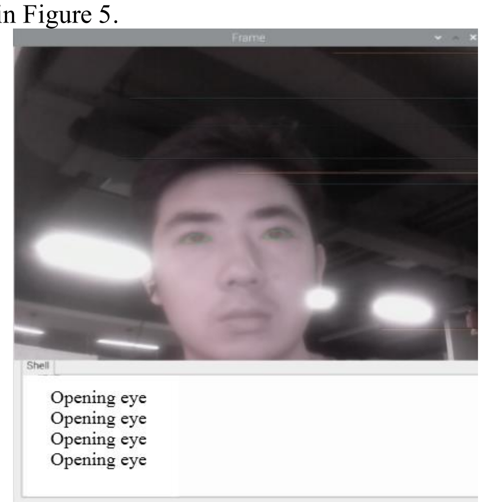

Fig. 3 (a) Opening eye test

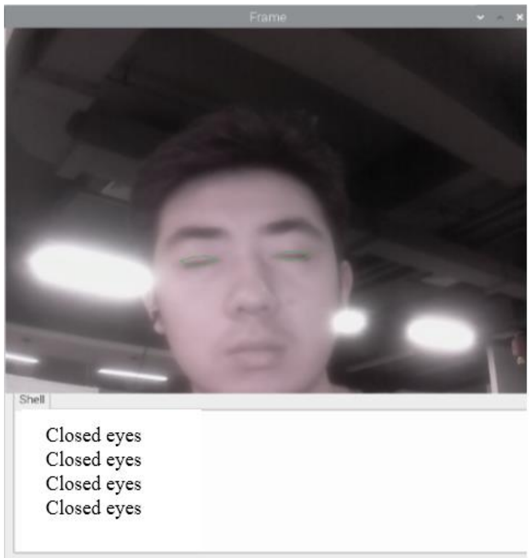

Fig.3 (b) Closed-eye test

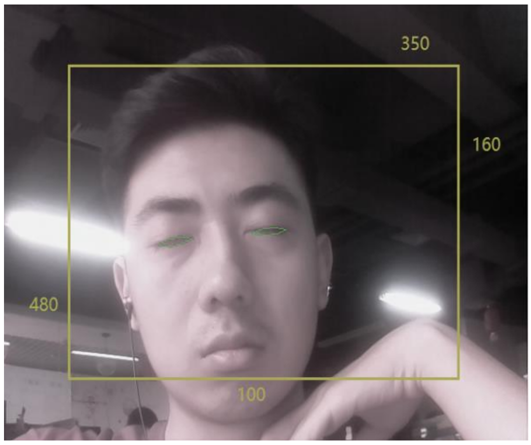

Fig.4 Cloud station testing

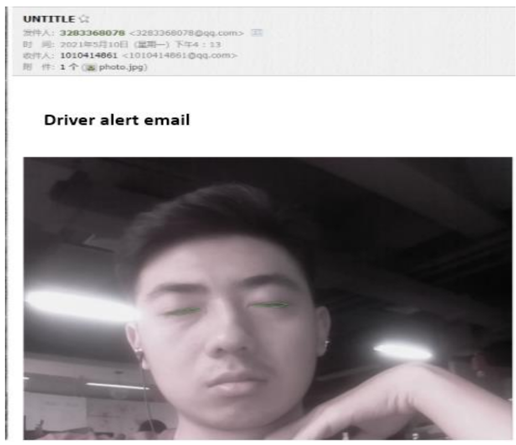

Fig.5 Fatigue state picture

4. Conclusion

This paper is based on artificial intelligence technology and computer vision to complete the detection of driver eye fatigue, in the first time through the detection of driver eye fatigue driving (manifested as eyes closed for a long time), and voice prompts to the driver, so as to reduce traffic accidents caused by fatigue driving. The product hardware platform is small in size, easy to carry and install, and can be powered by vehicle power. The detector is connected to a gimbal and a night vision camera, and uses software programming to achieve face detection and recognition, on the basis of which the driver's eye features are located, and the relevant algorithm is used to calculate the parameters corresponding to the state of eye features, as the basis for the detection of the driver's eye fatigue. The driver's eyes are closed (non-blinking) when the driver is driving, and the image of the fatigue state is uploaded in real time using the cloud platform.

Acknowledgments

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