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ISSN (Online) 2321-2004
ISSN (Print) 2321- 5526

International Journal of Innovative Research in
Electrical, Electronics, Instrumentation and Control Engineering

Vol. 6, Issue 8, August 2018

Design Simulation and Performance Analysis of Real Time Facial Features Monitoring for Drowsiness Detection Using Support Vector Machine

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Abstract: This article describes an effective method for performing drowsiness testing through three well-defined stages. These three stages are using Viola Jones for facial characterization, eye tracking and yawn detection. Once the face is detected, the system illumination is left unchanged by separately segmenting the skin portion and considering only the color components to reject most of the non-face image background based on the skin color. Eye tracking and yawn detection are accomplished by correlation coefficient template matching. Feature vectors from each of the above stages are connected, and a binary linear support vector machine classifier is used to classify successive frames into fatigue and non-fatigue states, and alerts the former if it is above a threshold time. Extensive real-time experiments have proven that the proposed method is very effective in finding sleepiness and warning

Keywords: Drowsiness, Alertness, FFT, ANN, SVM, Face Detection; Eye's State; Drowsiness

I. INTRODUCTION

In the past few decades, with the development of vehicle technology, the traffic accident rate has become higher. Driver drowsiness is considered an important factor. Many studies have shown that the danger of driving for a long time is equivalent to drunk driving. Therefore, the driver's sleepiness has become a hot topic. Therefore, many studies have investigated detection systems for unsafe driving.

Every year, thousands of people in India die from traffic accidents. The role of human factors plays a key role in the accident. In general, only driver fatigue accounts for about 25% of road traffic accidents, and up to 60% of road traffic accidents cause death or serious injury [1]. The main cause of fatigue is insomnia or insomnia. Therefore, the driver's Sleepiness is a major cause of serious traffic accidents, causing thousands of deaths each year. In recent years, the use of intelligent algorithms in automobiles has grown considerably. These systems use WSNs to monitor and transmit the condition of cars and drivers. Smart cars that use software technology to control engine speed, steering, transmissions, brakes, etc. significantly improve driving quality. The Ad hoc network was the first network to develop an automotive autopilot system. The obvious disadvantage of these systems is that they do not respond to environmental changes in real time. It is especially important in driving where time is a key factor in driver decision making. On the other hand, another way to check driver fatigue is to monitor the driver's physical condition and facial expressions, which the wireless sensor network cannot handle and transmit with sufficient accuracy and good recall. Therefore, it is very necessary to develop an effective drowsing detection system. Safe driving systems can be classified into two categories. One is a "vehicle-based" [1] [2] method that focuses on the state of the vehicle, such as the location of the vehicle on the road, the variability of speed, and the like. The other type is the “people-oriented” approach, which focuses on the state of the driver. The method analyzes the driver's facial image by image processing and/or pattern recognition, such as the frequency of blinking and the time of closing the eye [3].

Wu et al. [5] proposed a method of recognizing the state of the eye. They use the Haar-like feature and the Adaboost classifier [6] to find the face area. The LBP is considered to be a feature of the image and the features are trained by the SVM. The SVM is then used to identify the state of the eye. They demonstrated that the proposed method can effectively detect driver sleepiness by calculating PERCOLS (percentage of eye closure).

In this article, we present the identification of a sleepy eye. There is no drowsiness detection system during the training phase. A cascading Adaboost classifier with Haar-like features [7] and an active shape model (ASM) [8] was used to find the face position and eye area. Binary mode and edge detection are then used to extract eye features and determine the state of the eye. The experimental results will demonstrate comparative performance with other methods that have a training phase.

II. METHODOLOGIES

The proposed framework is shown in Figure 1. Initially, the camera gets a video of the driver. This video is then broken down into frames. The following sections describe the methods to follow after getting a frame.

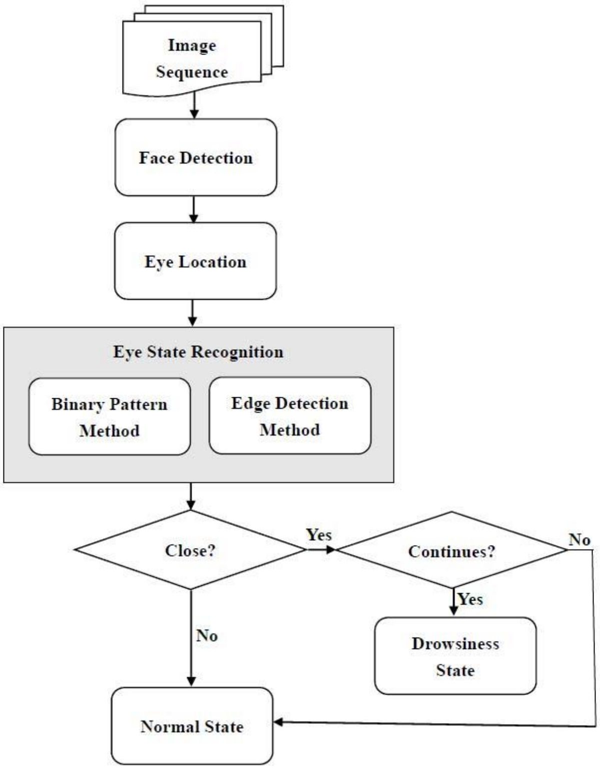

Fig.1. Flowchart of drowsiness detection system

Image preprocessing-Changes in brightness can affect the accuracy of the system. Therefore, the proposed method initially applies histogram equalization [9] to optical compensation. In this step, as shown in Fig. 2, we divide the color image into red, green, and blue components, and apply histogram equalization to each component separately. A compensation image is then obtained. After the light compensation, we reduce the resolution of the compensated image to improve the efficiency of the system.

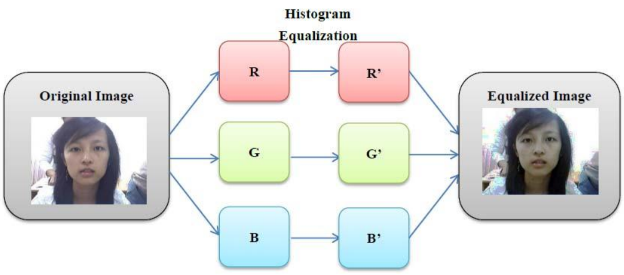

Fig.2. Image Pre Processing

Face detection -The main purpose of face detection is to minimize false detection of facial expression recognition. The importance of this part is to accurately position the eyes and mouth. Once the face is detected, skin segmentation is performed by converting the image to the YCbCr domain [11]. The biggest advantage of converting an image to the YCbCr domain is that the effect of brightness can be eliminated by considering only the chrominance components. In the RGB domain, each component of the image, namely red, green and blue, has a different brightness. However, in the YCbCr domain, all luminance information is given by the Y component because the Cb (blue) and Cr (red) components are completely independent of the luminance. Domain conversion is used to segment the RGB image into Y, Cb, and Cr

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Vol. 6, Issue 8, August 2018

components. Although the skin color varies from person to person and races gracefully, it is found that the color of [11] is still distributed in a very small area of the chromaticity plane. The method detects skin areas on the entire facial image and rejects most non-face images. Figure 2 shows the face and corresponding skin area detected using the YCbCr segmentation mentioned in [11].

Eye Location and Recognition-The most important factor that helps detect driver fatigue is the state of the eye, which is turned on or off. In the state when drowsiness, the eyelid muscles subconsciously tend to accelerate the process of falling asleep. Determine the position of the driver's eyes by using Viola Jones [10]. Then use edge detection and separate the two eyes according to the symmetry property[6] The center of the eye is determined [6]. At last the student was identified. If the eyes are open, they are considered normal and no alarm will be triggered during this time. If the eye is closed, it is considered to be the fatigue state of the alarm. Edge detection can be seen as the process of locating pixel intensity transitions. There are several edge detection methods, such as Sobel. This method has been proposed to detect transitions in an image. In the proposed work, Sobel is an edge detection method that is superior to other methods, such as Canny. Canny edges and other such algorithms solve these problems by first slightly blurring the image, followed by an algorithm that can effectively refine the edges into one pixel. This constitutes a slower process, so Sobel operators are strongly recommended over Canny in large-scale data communications, especially in image transmission. The Sobel detector convolves the image using a filter with small, separable and integer value functions in the horizontal and vertical directions. Therefore, it is a relatively inexpensive calculation method. Second, the gradient approximation produced by it is relatively rough, which is best suited for high frequency variations, such as blinking during fatigue.

The state of the eye is determined in each frame using a correlation coefficient template matching method. A specific area of the eye is obtained by fully considering the change in the connected pixels and the similarity to the eye pixels. The Sobel edge detection method is also used to detect precise and precise boundaries of the eye. The technique starts from the left and right sides and finds the eye so it can be detected separately. The detected eye is segmented from the image and used to generate an eye template, in this way a fairly stable eye template for state analysis can be obtained and the effect of light reflection is also reduced. Figure 3 shows the eye template generation process. In order to distinguish fatigue, the state of the eye should be accurately identified. Two factors that affect the size of the eye are described here. The size of the human eye is different. Second, the distance between the driver and the camera is different for each frame. It was therefore decided to normalize the eye template to a predetermined size of 12 x 30 and then extract the features. For each eye template, the area, average height, and aspect ratio are key features that determine the state of the eye, as shown in the table. I. Eye states can be divided into three categories: full open, half open and fully closed. As can be seen from Table I, eyes of different states have different characteristics. Most of the time does not distinguish between full-open and half-open different eye states and may result in more false alarms and variable movement of the driver's head may cause the driver's eye tracking to fail.

The characteristics of the eye are extracted to identify the state of the eye. Usually, the state of the left eye is equal to the right eye at the same time. Therefore, we only consider the state of one eye in one frame. This consideration is also useful for reducing computational complexity. In this step, two schemes are used: (1) binary mode and (2) Canny edge detection [11].

$$T = \frac{\sum_{i=1}^{n} x_i}{n} \text{-------------- (2.1)}$$

The eye image is converted to binary pattern based on the threshold value T. In(1),n is the number of pixels in the eye region and x_i is the pixel value of the position I in the region.

There are n pixels in the eye region. If the pixel value of P is greater than the threshold T, P will be set as white, 1.Otherwise P will be set as 0. Its definition is shown as (2).

$$P(X,Y) = \begin{cases} 1, \text{gray}(X,Y) \geq T \\ 0, \text{gray}(X,Y) < T \end{cases} \text{---------------(2.2)}$$

Fig. 3 shows some binary pattern of open eye and closed eye.
When the conversion of eye image is completed, the height of the eyelids is utilized to determine the eye's state.

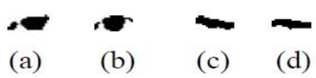

Fig.3. Binary pattern of open eye and closed eye

The Canny's edge detection algorithm is well known for its ability to generate continuous edge. First, the image is smoothed by Gaussian convolution.

$$g(X,Y) = I(X,Y) * G_{\emptyset}(X,Y) \text{---------------(2.3)}$$

$$G_{\emptyset}(X, Y) = \frac{1}{2\pi\emptyset^2} e^{\frac{(x^2+y^2)}{2\emptyset^2}} \text{---------------} (2.4)$$

where $\emptyset$ is a scale parameter. Then, the magnitude and orientation of the edge are calculated by the differential filter. The final edge image is obtained by edge information of multiple scale $\emptyset$. Finally, the numbers of edge points are summed for recognizing the eye's state.

III. RESULTS

A binary SVM classifier with a linear kernel is used for classification. Matlab 2017 has been used to get video frames using a 15fps 40M pixel camera. The proposed algorithm detects acceptable performance of the driver's facial fatigue signs while driving. To further verify the performance of the method, various tests were conducted in dim and bright light conditions. Table I gives the compilation of results.

Table I

Trial	Number of Frame	Detection Rate
1	90	93%
2	90	94.5%
3	90	96%
4	90	93.2%
5	90	94%
6	90	91.8%
7	90	93.2%
Average Accuracy		93.67%

IV. CONCLUSION

This paper describes a real-time implementation of sleep detection that is constant for illumination and performs well under a variety of lighting conditions. Correlation coefficient template matching provides an ultra-fast way to track eyes and mouth. The proposed system achieved a total accuracy of 93.67% in seven test cases,.High detection rate and reduced false positives ensure that the system can effectively reduce the number of deaths every year. More trials and harware implementation can be done to improve effectiveness of system.

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