© January 2016 | IJIRT | Volume 2 Issue 8 | ISSN: 2349-6002

Fatigue Detection based on Image Eye Tracking and Detection for avoiding accidents on Roads

Snehal B. Meshram, Prof. Sonali Bodkhe
Department of Computer Science and Engineering
Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur,India

Abstract- **This paper aims to provide reliable indications of driver drowsiness describe of detecting early signs of fatigue in drivers and provide method for more security and attention for driver safety problem and to investigate driver mental state related to driver safety.As soon as the driver is falling in symptons of fatigue immediate message will be given to driver.In addition of the advance technology of Surff feature extraction algorithm is also added in the system for correct detection of status of driver.The Fatigue is detected in the system by the image processing method of comparing the images(frames) in the video and by using the human features we are able to estimate the indirect way of detecting fatigue.The technique also focuses on modes of person when driving vehicle i.e awake, drowsy state or sleepy and sleep state.The system is very efficient to detect the fatigue and control the vehicle.**

Index Terms- **Face,Eye localization, Eye state recognition, Eye Pattern,Tracking Tasks**

I. INTRODUCTION

As the development of the transportation system and the increase of vehicle owners, traffic accidents happen more frequently recently. Thus more emphasis should be put on the preventive measures. 210812 traffic accidents happened on 2011 and 62387 people are killed in China [1]. Of all the reasons of traffic accidents, factors related to drivers themselves occupy a higher percentage. 20% of UK road accidents caused by fatigue [2], and the figure is closer to 40% in Australia [3]. Research on Driver Fatigue Detection System, which aims to ensure the safety of operations and reduce traffic accidents caused by artificial factors related to drivers, has been a research focus in the area of transportation safety abroad and at home.

Driver's behaviors such as visual delay, false determination on the environment and inappropriate handling of emergencies just before the accidents have close connection with the breakdown. Visual delay and mishandling of emergencies are common faults for high-speed train drivers, heavy rail freight locomotive drivers and car drivers. According to related materials, if the latent dangers could be warned to drivers several seconds before they become out of control, 90 percent of the traffic accidents could be avoided [2-3]. Actually, visual delay is the appearance of fatigue, so we should improve the early warning system for fatigue driving. In this way, a large number of traffic accidents will be reduced. It's important to realize the real-time monitoring of drivers and vehicles condition and send out warnings when abnormal cases happen.

Previous research on driver drowsiness detection has focused on medical science, people considered the fatigue driving from an aspect of medical science with the help of medical electroencephalograph (EEG), electrocardiograph (ECG) and electromyography (EMG) to detect a driver's EEG waveform, ECG waveform and EMG wave-form . In spite of the accuracy of medical methodology, it's complicated and need certain environment which made it hard to generalize. The method we'll discuss in this paper, fatigue driving based on image processing, is deemed as the most potential one. The research "An Evaluation on Various Vision-based Fatigue Driving Detection Methods" which was conducted in 1998 compared four methods and nine parameters fatigue driving results, and PRECLOS especially P80 detection method .

In order to avoid or reduce the traffic accidents, warnings to a fatigue driver should be accurate and prompt, thus made it impossible for a single algorithm and hard-ware to realize this function. In this paper, we use a distributed algorithm system combining the pipeline structure of its hardware implementation. Eyes localization, tracking and eyes state recognition are realized by using DSP. Eyes localization, tracking and eyes state recognition require immediate and accurate processing. Single recognition, tracking and location methods are not so useful any more, we need to merge different algorithms. The strong floating point arithmetic capacity of DSP satisfies our requirements. This part of research is crucial for the entire fatigue driving detection system.In the recent years many techniques and methods which can detect whether the driver is tired have been proposed by researchers and few of them have been implemented. But, due to a variety of factors, despite the success of existing systems and approaches for extracting characteristics of a driver using computer aided technologies, and other current efforts in this area, it is a challenging issue to develop a driver fatigue detection system.

II. LITERATURE REVIEW

2.1Existing Location applications based on Eye Tracking:

One of the main factor is the variety of eye moving speed of driver, external illumination interference and realistic lighting conditions. In the realistic lighting condition the eye motion is highly nonlinear. So the use of driver fatigue detection method that is based on linear movement of driver eye is very difficult in real scenario.

[1]In references [3, 6], Qiang Ji et al. have made significant improvements of facial fatigue detection over existing techniques. However, their methods need infrared (IR) eye detector, or bright pupils and steady illumination. Their eye-tracking method that used Kalman filtering is a linear system estimation algorithm. In fatigue detection system, the eye motion has the high nonlinearity of the likelihood model that the standard Kalman filter is no longer optimal in realistic driving environments.

[2]To tackle some of those problems, in reference [1], ZHANGs have also proposed a new real-time eye tracking based on a nonlinear unscented Kalman filter for driver fatigue detection.

But these proposed systems/detectors works on IR image which is a problem.

To tackle this problem we have proposed a system that can be used without IR illuminator that illuminates a person’s face and use an IR-sensitive camera to acquire an image.

Drowsiness detection can be divided into three main categories (1) Vehicle based (2) Behavioural based (3) Physiological based. [4], the three different approaches for drowsiness detection. Drowsiness detection is based on these three parameters. A detailed review on these measures will provide insight on the present systems, issues associated with them and the enhancements that need to be done to make a robust system.

Vehicle based measures: A number of metrics, including deviations from lane position, movement of the steering wheel, pressure on the acceleration pedal, etc., are constantly monitored and any change in these that crosses a specified threshold indicates a significantly increased probability that the driver is drowsy. Behavioral based measures: The behavior of the driver, including yawning, eye closure, eye blinking, head pose, etc. is monitored through a camera and the driver is alerted if any of these drowsiness symptoms are detected.

Physiological based measures: The correlation between physiological signals ECG (Electrocardiogram) and EOG (Electrooculogram). Drowsiness is detected through pulse rate, heart beat and brain information.

Time of day is a key factor in tasks demanding vigilance such as driving, as highlighted by statistics on traffic accidents (Di Milia et al., 2011; Folkard, 1997). Specifically, traffic accidents occur most frequently when both body temperature and vigilance levels are at minimum, that is, around 3 to 5 am. Time of day effects in driving performance have also been demonstrated by laboratory experiments (Akerstedt et al., 2010; Baulk et al., 2008; Lenné et al., 1997).

However, most of these studies have not considered the negative impact that extending duration of prior wake exerts upon driving performance, which can be exacerbated at specific times of day when vigilance is low, for example at 4 am (Matthews et al., 2012).

III. EVALUATION AND DISCUSSION

Table.1 Represents the objectives and performance of various approaches along with techniques and features selection.

Sr.No.	Studies	Techniques Used	Advantage	Disadvantage
1.	Grace et. al	Special cameras.	Calculate different wavelength of Eyes.	Slow and long learning procedure.
2.	Ji and Yang	Infra-red illumination system.	Used light function between eyes.	Very high sensitivity change in illumination condition.
3.	Smith and D.Vitoria	Global motion and color statistic method.	Fast Eye color range.	Long training procedure.
4.	W.Rongben	Facial Feature Detection Method.	Fastly examine face features.	Slowly examine eye location.
5.	D'Orazio	Circle Hough Transform	Reliable and best match for eye position.	Slowly examine eye position.
6.	Valenti and Geverse	Isocentric Patterns	Reliable and very fast.	Misdetection of eye corners as the eye detection.
7.	Timm and Barth	Accurate eye centre localization	Very accurate in Eye centre detection.	Lower accuracy due to feature dependency chain.

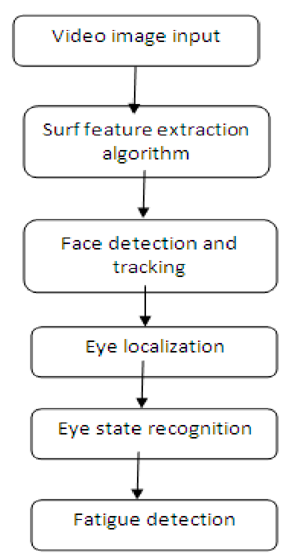
IV. METHODOLOGY

This paper includes four modules such as Face detection,Face Extraction,Edge Finding method ,SURFF feature extraction algorithm.

1. Face Detection

Algorithms for face detection face many challenges; for example, facial expression, illumination condition and vibration. There are several mainstream methods for face detection, artificial neural network method, template matching method, skin color detection method, motion detection method and AdaBoost face detection algorithm.Skin color detection method is useful when it comes to multi-face detection and tracking.

Systems based on color can recognize human faces from different visual angles, but this method adapts to color image and cannot be used in night mode.Template matching method mainly recognizes human faces by the geometrical relationship within face structure. As for illumination and pose variation and covered partial human faces, this method shows its drawbacks. AdaBoost algorithm is adaptable to light variation, anti-shake and can localize human faces with all-weather conditions



Flow Diagram

First module description:

- Face detection method.
- Cascade object detector
- Advance face extraction method:Bounding rectangular box around only face.

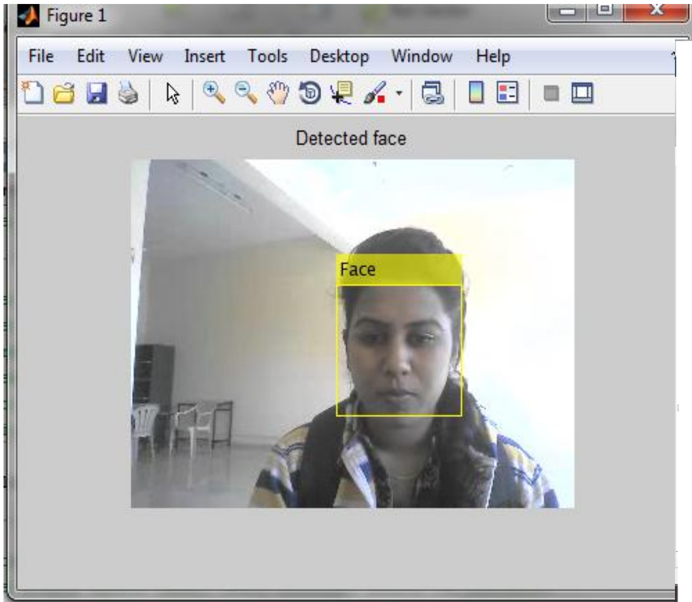


Fig: Face detection of an Image

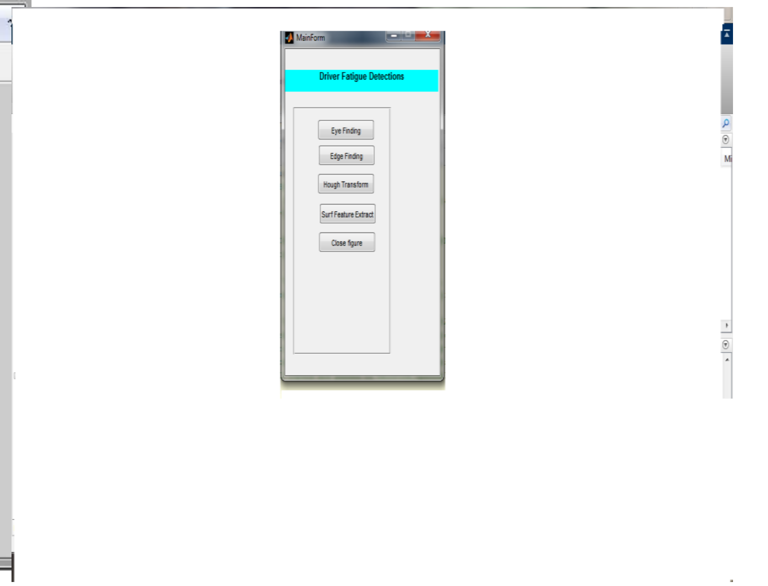
2nd Module Description:

Face Eye Localization and Eye State Recognition

In this paper, we concentrate on train drivers. After obtaining a large number of drivers' eyes pictures, we formed a general eye pattern for train drivers. Therefore, after detection human faces, sensitive eye areas are obtained through general eye pattern, then time difference method is applied to video image sequence and obtain eye difference image . Adding N eye difference images deduce frame differential accumulation figure, and then the eye position

- Input- image
- Detection- only eye region
- Create edges on eye region.
- Detect peak points on eye.
- place strong points on Eye

Output of 2nd module will be shown as below:



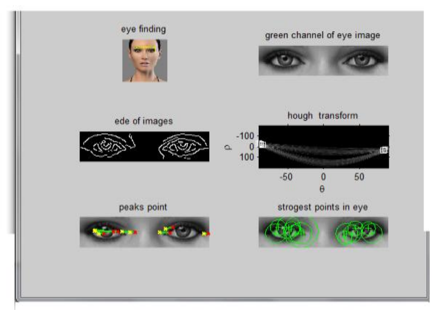


Fig:Detection of EYE

3.Edge Finding Method:

PRECLOS method is use as the criteria for fatigue judging. PRECLOS is recognized as the most effective vision-based fatigue evaluation method [15-17]. Eye state recognition should be conducted as soon as eye localization finishes. Eye position, open eye pattern and closed eye pattern of a detected person are obtained by frame differential accumulation figure. Then use closed and open eye pattern to determine whether this person is fatigue or not. Above is the template matching algorithm, where Pm,n (i,j) denotes the pixel value of eye coordinates i, j. T(i,j) denotes the pixel value of pattern coordinates i, j. S(m,n) denotes the correlation value between detected eye image and pattern image, $0 \le S(m,n) \le 1$.Threshold th is set. If $S(m,n) \ge th$, detected eye image and pattern image are considered match each other.

$$s(m,n)=\frac{\sum_{i=1}^{I}\sum_{j=1}^{J}P^{m,n}(i,j)\bullet T(i,j)}{\sum_{i=1}^{I}\sum_{j=1}^{J}\left[P^{m,n}(i,j)\right]^2}$$

Modified histogram equalization algorithm introduced by Jiang Duan and Guo Ping Qiu [11] is used to eliminate light effect. This algorithm uses floating-point numbers to represent the gray value of a RGB image.

$$P_r(r_r)=n_k/n$$

Where $0 \le rk \le 1$, k=0,1,2…L-1 nk denotes the number of certain gray value in an image, and n denotes the total number of pixels, L is the gray value. It's convincible that the image contains the most information when its histogram distributed evenly. The histogram conceived in this paper is:

$$H[k]=P_r\left[Lu(i,j)\right]=K$$

Project the gray values to dynamic [0, 255] g

$$Lu(i,j)=0.299\times R(i,j)+0.587\times G(i,$$

where R(i,j),G(i,j) , B(i,j) denote the red, green, blue pixel values of eye coordinates i, j separately. Find an a0 and make it satisfies:

$$\sum_{k=0}^{a_0}H[k]=\sum_{k=a_0}^{255}H[k]$$

Then divide gray level into $[0, c_0]$ and $[c_0, 255]$.

$$c_0=(255+0)/2+b(a_0-(255+0)/2$$

where b is the control parameter. Find a_1 from [0, c

$$\sum_{k=0}^{a_1}H[k]=\sum_{k=a_1}^{c_0}H[k]$$

Third Module Description:

- Input- video file
- Detection- only eye region (2)
- Create edges on eye region. Output screen shot will be given as below:

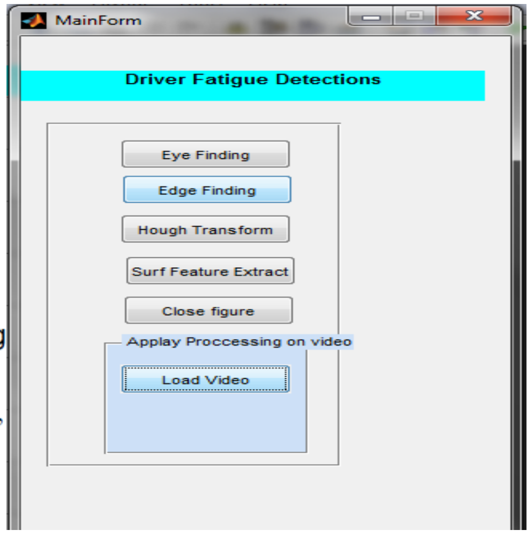


Fig: Mainform of Module

Fig: eye pair detection

After detecting eye pair the strong points will be plot on eye region as shown below:

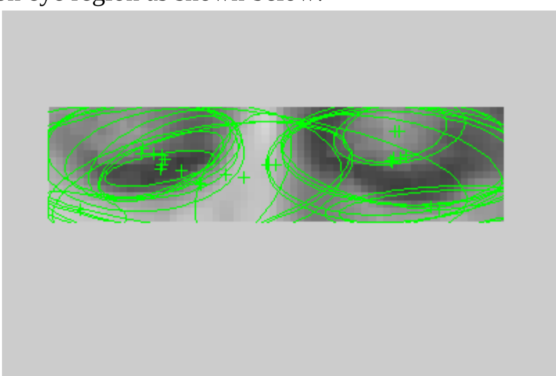


Fig: strong point on eye

4.SURFF Feature Extraction Algorithm:

After detecting eye location and edge of eye,surff feature extraction algorithm is apply which plot strong points on eye and detect the state of a person's eye.

4th Module Description:

In this module it will show negative and positive database from which we can get the exact position of eye.

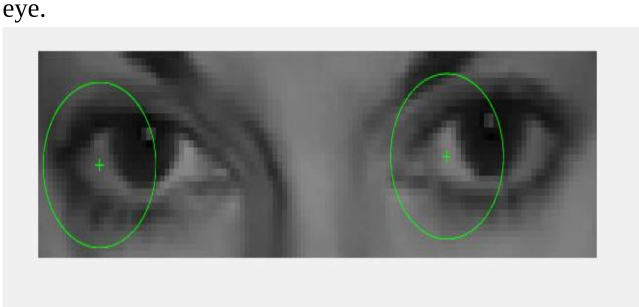


Fig:Strong Point Detection

5.Comparative graph between the images and surff feature and template matching :

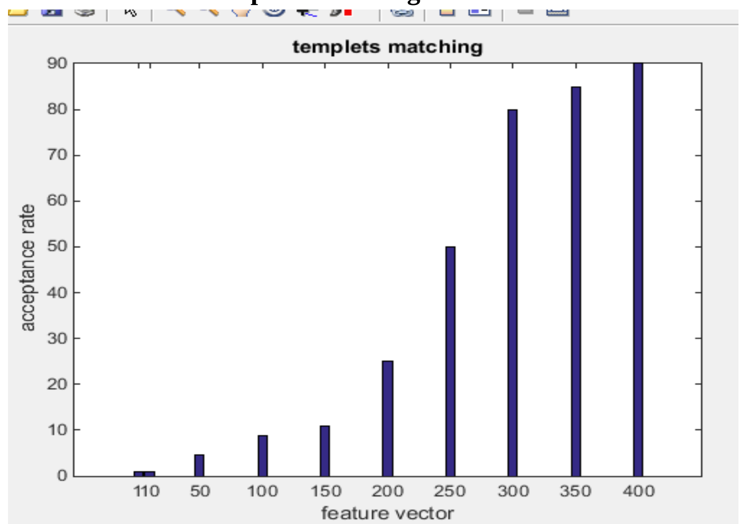


Fig:Comparative graph between template and feature techniques

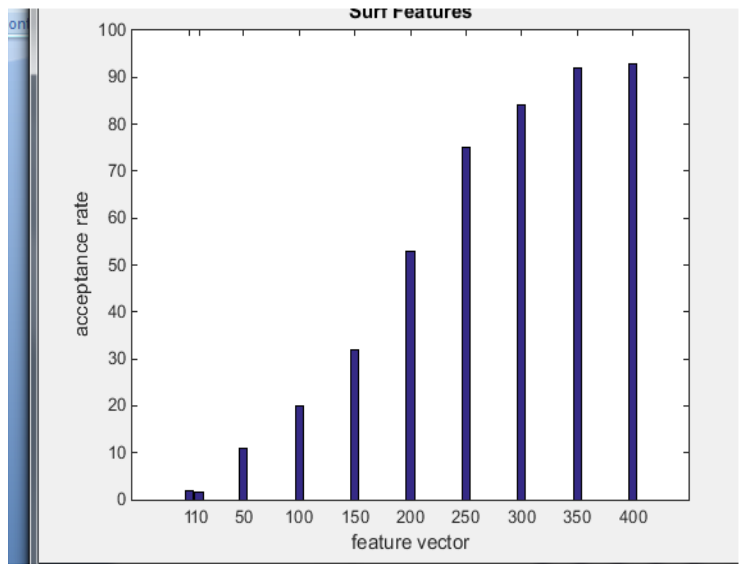


Fig:Comparative graph of Surff feature extraction algorithm

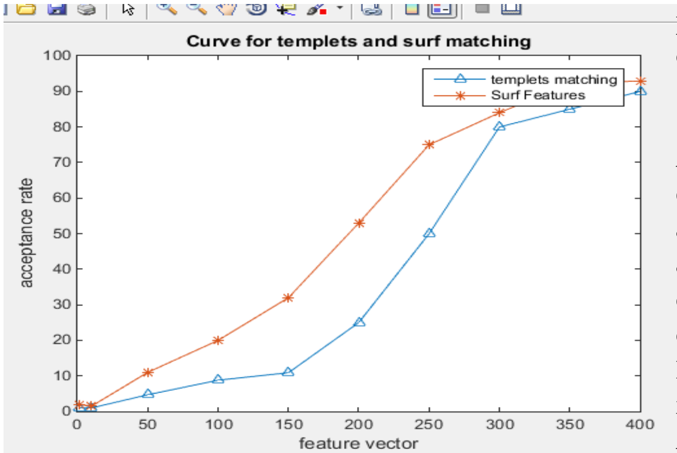


Fig:Final Curve between surff and template

V. RESULT & DISCUSSION

The proposed driver fatigue detection system use Videos with images to capture driver's images.

The system was tested under the environment of Pentium 4 with 512 MB RAM. The format of input video is 320 240 true color. After starting the system, it took less than 40 milliseconds for initial face location and eye detection. Once the eye templates were found, eye tracking could achieve more than 30 frames per second. Recall that in this system, if the driver closes his/her eyes over 5 consecutive frames, then the driver is regarded as dozing off.

The first four videos were captured under different illumination conditions with different people and backgrounds. The last video 5, was captured when driving around a parking lot at nightfall with large illumination change. The field Total Frames means the total number of frames in each video.

Tracking Failure is the count of eye tracking failure. Correct Rate of eye eye tracking in which is the ratio of (Total Frames – Tracking Failure) to Total Frames.We can see that the correct rate of eye tracking is higher than 98.3% in the first four videos, and it still can reach 80.0% in the very strict environment of video 5. The average correct rate achieves 96.0% in the proposed system on these test videos.

The proposed system could still correctly detect and track the driver's eyes. In spite of this kind of interference and illumination changes, the average precision rate for fatigue detection for all videos could still achieve 89.3% in the proposed system.

VI. CONCLUSION

As describe throughout the paper, many technologies exists to detect driver fatigue. This paper tries to look at the emerging technologies and determine the best approaches in trying to prevent the number one cause of fatal vehicle crashes. To overcome such problem our system is using new method SURF Feature Extraction Algorithm specially for eye tracking to improve matching accuracy and also Fast Search Algorithm in eye tracking to improve search efficiency. Also through these methods the particular attention has been paid to accuracy in feature detection and ability to operate in real time system.

VII. FUTURE SCOPE

This paper use vision-based real-time driver fatigue detection system for driving safety. The system uses camera to capture the driver's images, which makes the method more practical.

Tested on a notebook of Pentium M 1.4G CPU with 512 MB RAM, the system could reach 96.0% of average correct rate of eye detection on five videos of various illumination conditions, and could achieve 100% of correct rate of fatigue detection with our present rate 89.3%. The speed of this system could reach more than 30 frames per second for eye tracking, with each color frame of size 320 240. In summary, the proposed driver fatigue detection system could cope with the illumination change problem and could be suitable for real-time applications to improve driving safety.

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AUTHORS BIOGRAPHY

Name:Miss.Snehal B. Meshram has completed B.E in Computer Science and Engineering from Nagpur University in 2013 and now pursuing M.Tech(4th sem) from G.H.Raisoni College of Engineering,Nagpur, Nagpur University.

Name:Prof.Sonali Bodkhe Department of Computer Science and Engineering, G.H.Raisoni College Of Engineering Nagpur.