A Review on Efficient System for Driver Fatigue Recognition using Image Processing

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Abstract— Many systems are available nowadays that can guide the drivers to find the route such as navigation systems. Similarly intelligent warning alarm systems are also available which assist the driver. Driver's fatigue is a major problem which leads to many car accidents. Various techniques are there to detect driver's drowsiness. A study on various fatigue detection techniques using image processing has been done in this paper. Fatigue is detected based on eye's state whether eye is opened or closed and based upon yawning.

Key words: Driver Fatigue, Face Detection, Eye Detection, Yawning Detection

I. INTRODUCTION

With increase in no. of technologies and infrastructure, transportation by roads has increased. Nearly each and every person has his/her own car nowadays. But with increase in no.of vehicles, accidents are increased. One of the reasons for car accidents is driver's fatigue. We can know the behaviour of drowsy drivers through person fatigue expressions. Fatigue describes tiredness and/or a lack of energy level. These type of accidents takes place mainly during night. We can approximately considered timing during mid night and early morning. [1] mentions that drowsiness has caused 30% 0f all traffic accidents. Due to traffic accidents, peoples do not just have to suffer physically but also mentally as well as financially. Drivers and passengers may sometimes suffer from injuries and sometimes may result into death. This has inspired me a lot to choose this topic and to do study on various researches done uptil now on this topic.

According to the study carried out by Large Truck Crash Causation Study, 13% of crashes occur due to driver's tiredness [3]. U.S. National Highway Traffic Safety Administration reports that every year driver's fatigue and sleepiness causes approximately 60,000 traffic accident [4]. Driver distraction is another major concern besides driver's drowsiness for drivers and passengers safety [5][6]. Many researches and studies are carried out on human fatigue/drowsiness and they are trying to find out the level of fatigue [7][8][9]. Based on such studies, many active safety systems have been developed in which they monitor human drowsiness or fatigue [10].

II. DRIVER DROWSINESS DETECTION TECHNIQUES

Possible techniques for detecting drowsiness in drivers can be broadly divided into three major categories [18]: methods based on driver's state conditions, methods based on driver performance and methods based on combination of the driver's current state and driver performance.

A. Methods Based On Driver State Conditions

It includes intrusive techniques and non-intrusive techniques.

1) Intrusive Techniques

It measures physiological conditions, such as brain waves, heart rate (ECG) and pulse rate. Physiological signals measurements are very much annoying and difficult because of its intrusive and complex functions. Above mentioned first technique is not realistic since the sensing electrodes would have to be attached directly to the driver which will distract the driver. If they are used for a long time, it would result in perspiration on the sensors and so they won't be able to sense accurately.

2) Non-Intrusive Techniques

It measure visual behaviors such as, eye conditions (open or close), head tilting, eye blinking rate and also includes mouth and yawning analysis.

B. Methods Based On Driver Performance

It includes techniques based on monitoring of vehicles in road, vehicle speed etc. Studies on this method have mainly employed lane tracking alone or in combination with tracking of the distance between the driver's vehicle and the car in front. One problem is micro-sleeps: when a drowsy driver falls asleep for some seconds on a very straight road section without changing the lateral position of the vehicle. Such happenings would not be detectable by a system only based on lane-position measure [11].

C. Methods Based On Driver State And Performance

The approaches that combine driver state and driver performance will improve the sensibility and reliability in fatigue detection. [12] uses a range of measures to detect driver fatigue. They use eye-closure, lane tracking and changes in physiological state to predict fatigue-related crashes.

III. COMPARATIVE STUDY

Skin color model is used for face detection and after that eyes are detected by using Circular Hough transform, and then eye state is estimated by using developed distance logic. Designed system detected face as well as eyes with an accuracy of 80%. The system does not detect eyes and face properly during dark background [13].

Region of interest for eye is extracted from high-wide information of face. This extraction reduces computational complexity and improves system performance. Chrominance and luminance components are calculated to build eye map which indicates eye region. Actually the main difference is the area of the mouth during normal and yawning condition. In mouth area, red component dominates over blue colour. So that Cb component gives lower value than Cr component relative to other face region [14].

Face is detected by AdaBoost algorithm then, it detects eyes and mouth. Then, two special algorithms PATECP and PATMIO are designed. Results can be made more accurate [15]. In [16], the system uses skin color

pixels detection and Viola Jones method for face detection. For accurate detection of yawning and eyes status, a threshold value is calculated dynamically and each coming frame is compared to the threshold value for drowsiness detection. The accuracy level of the whole system is increased due to the hybrid method. The system works in daytime only. It does not work during night time because VGA camera is used in image acquisition.

In this paper, the system is based on eyes closure, blinking rate of eye & yawning detection of the user. The system continuously captures the image of the subject on site and detects face region, then eyes and lips are detected. If eyes are found to be closed for 4-5 consecutive frames or blinking rate is found to be abnormal or lips are found to be open for long duration (yawning) for 3-4 consecutive frames then it is concluded that the subject is falling asleep or having state of drowsiness therefore fatigue is detected and a warning alarm issued. The system works in real time without requiring extra hardware. It also works with users wearing eye glasses [17].

In [18], this research has been made robust and efficient because of lane departure detection, head tilting along with facial expression detection. Skin color segmentation is used in face detection procedure that helps to avoid challenges due of face size, color and orientation. The proposed work uses region of interest for eye detection from detected face image. This extraction reduces computational complexity and improves system performance. Chrominance and luminance components are calculated from Eyemapc and EyemapL to build eye map which indicates eye region.

IV. PROPOSED WORK

1) Video Acquisition:
   Video has to be captured from the webcam. It is done using the code in MATLAB. The purpose of this stage is to obtain high quality video images of the driver's face and eye.
2) Conversion of video into frames.
3) Consider one frame. Detect face
4) Face detection:
   Skin color segmentation is used to detect face. One of the main use is for detecting the pixels indicating skin regions or areas and non-skin regions or areas. After pixels of skin region are detected, the next step is to group up pixels representing faces area and non-faces. Conversion of RGB to YCbCr is done. Each pixel of YCbCr is compared against the limits of Y, Cb and Cr to determine if the skin is present and if so, Use Skin color thresholding to identify and segment the face. Then, Erosion is done to reduce noise, Dilation to enhance the strength of the skin color and Binary image conversion to help image filling operation that fills unwanted holes in face region. Large area of face region is achieved through maximum connected area.
5) Eye detection
   Region of eye is used to extract eyes [18]. Then, Chrominance and luminance components are calculated from Eyemapc and EyemapL to build eye map which indicates eye region. Then, Erosion and dilation is done. Thresholding is done to eliminate other facial region. Then, it is converted into Binary image for indicating white region as eye. No. of detected eye determines whether eyes are opened or closed.

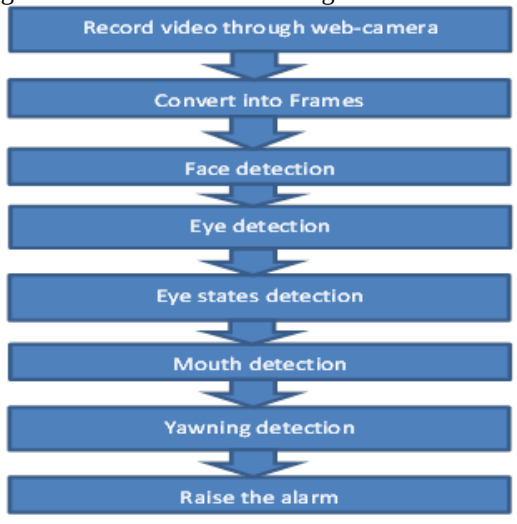

Fig. 1: Flow chart of the proposed work

Then, eye states whether eyes are opened or closed will be detected and then mouth and yawning will detected. If the eyes are found closed and if yawning is detected for 3 to 4 consecutive frames, then the system will generate alarm.

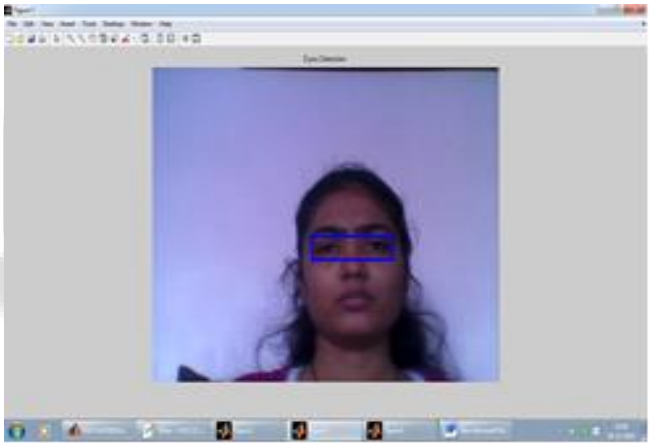

Fig. 2: Detected Eye

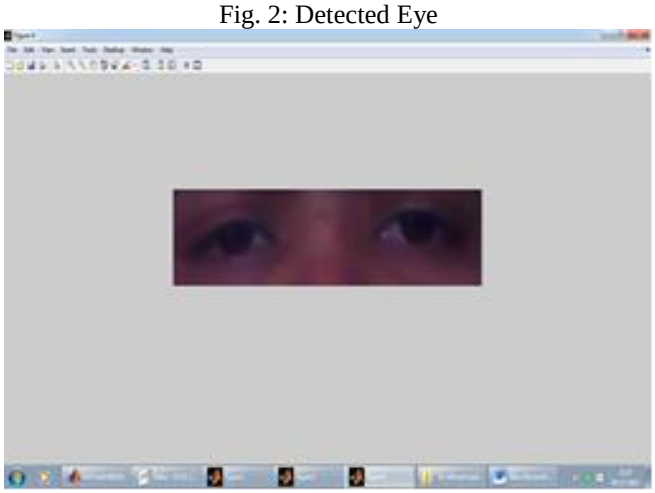

Fig. 3: Cropped Eye

Year	Methods	Advantage	Limitation	Accuracy
Oct 2012[15]	Adaboost algorith, PATECP, PATMIO	Adaboost is accurate.	sensitive to light glasses and direction.	Not specified
Mar 2014 [17]	Edge density of eye is calculate.	Works with eye glasses and under different illumination sources	Accuracy can be improved by using more reliable method	90%
May 2014. [18]	Region of Interest(ROI), Eye map is calculated.	Works in poor light intensity of camera,	Complexity increases as it considers lane detection and head tilting detection	84.5%
Dec 2015 [19]	Viola Jones, Haar cascade classifier, Grayscale Conversion, Harris Corner Detector	Simple, works in real time	Do not work with spectacles and under poor lighting conditions.	94%
Sept 2015 [20]	LBP Classifiers and Haar Cascade	Works with glasses	Do not work under poor lighting conditions	Medium-87.5% High-95.83%

Table 1: Recent Studies Done In Eye State Analysis

Year	Methods	Advantages	Limitation	Accuracy
May 2011 [14]	Non-skin Segmentation.	Improves detection efficiency, avoid false detection	Sensitive to skin types	Not given
May 2013 [21]	Viola Jones and back projection theory.	Good accuracy in face detection, real time	Do not detect eye states	60%
June 2013 [22]	Local binary pattern	low cost of computation, tested under different lighting conditions	Accuracy can be improved	90%
March 2014 [17]	Calculate Edge density in mouth	Works with eye glasses, under different illumination	Accuracy can be improved by using more reliable method.	90%
May 2014 [18]	Region of Interest(ROI), L*a*b* color space, Non Skin color segmentation	Works in poor light intensity of camera	Conditions to detect face region cannot be applied to all kind of skin texture	84.5%

Table 2: recent Studies Done In Mouth/Yawning Analysis

V. CONCLUSION

Review of various drowsiness detection techniques is presented. Here, approach to detect fatigue is shown using non-intrusive techniques. Non-intrusive techniques measures fatigue by measuring the fatigue symptoms such as eye closure or eye blinking rate and yawning. The main idea is to develop a fatigue detection system that can detect fatigue early enough so that driver can be alerted and accident can be avoided. Thus, the idea is to increase the transportation safety and lessen the personal sufferings which occurs due to the accidents occur due to fatigue

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