Driver Drowsiness Detection System

Vikas Yadav, Deepa Makhija, Shruti Savant, Nilesh Dodani,
Prof. Dhananjay K. Theckedath,
TSEC, Mumbai University

ABSTRACT
Sleepiness or fatigue in drivers driving for long hours is the major cause of accidents on highways worldwide. The International statistics shows that a large number of road accidents are caused by driver fatigue. Therefore, a system that can detect oncoming driver fatigue and issue timely warning could help in preventing many accidents, and consequently save money and reduce personal suffering. The authors have made an attempt to design a system that uses video camera that points directly towards the driver's face in order to detect fatigue. If the fatigue is detected a warning signal is issued to alert the driver.
The authors have worked on the video files recorded by the camera. Video file is converted into frames.Once the eyes are located from each frame, by determining the energy value of each frame one can determine whether the eyes are open or close. A particular condition is set for the energy values of open and close eyes. If the average of the energy value for 5 consecutive frames falls in a given condition then the driver will be detected as drowsy and issues a warning signal. The algorithm is proposed, implemented, tested, and found working satisfactorily.

Keywords
driver drowsy detection, fatigue, eye detection, face detection, energy, sobel mask, sound alarm.

1. INTRODUCTION
Automobiles have revolutionized the human life in a significant way. People use vehicles for travelling off to various places for the purpose of work and for fun. With the rapid increase in the number of automobiles running over roads today, the danger of accidents is also increasing.
Road safety is a topic discussed almost every day in the papers and on our airwaves in this country and worldwide, unfortunately though this is usually because of the lack of safety and precaution taken by road users. While dangerous and drunken driving may be highly publicized a major contributing factor in many accidents on our roads is driver fatigue, according to the National Roads Authority, driving tired is as lethal as driving drunk.
"Up to 20% of fatal crashes may be linked to. They also say that driving when very tired is as dangerous as driving while over the drink drive limit. It also means that this silent killer could have been a contributory factor in almost 200 driver deaths in a recent five year period. Recent statistics estimate that annually 1,200 deaths and 76,000 injuries can be attributed to fatigue related crashes.
The critical points at which driver fatigue related collisions happen are between 2 am to 6 am and mid afternoon between 2pm to 4 pm when our "circadian rhythm" or body clock is at its lowest point. Males aged 18 to 30 are in the high risk category. If a driver persists in fighting sleep while driving the impairment level is the same as driving while over the drink drive limit.[23]

2. SYSTEM OVERVIEW
A flowchart of the major functions of The Drowsy Driver Detection System is shown in Figure.1. After acquiring the video file of the driver's image, it is converted into consecutive frames of images. The skin color based algorithm is applied to detect the face portion in the image. Since eyes lie in the upper half portion of the face, the lower half of the face is removed to narrow down the search area where the eyes exist. This reduces the amount of data in the image while retaining much of the critical information needed. Energy value of each frame is calculated and it is used to differentiate between the open and closed eyes .

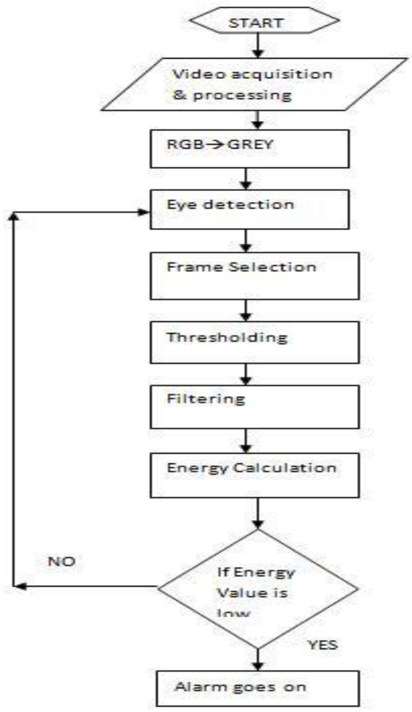


Figure 1. Flow Chart

3. FACE DETECTION
Human face localization and detection is often the first step in applications such as video surveillance, human computer interface, face recognition and / or facial expressions analysis, and image database management. A lot of research has been done in the area of human face detection. The face detection is performed in following steps.
Thresholding of an image is done from a grey scale image, it is used to create binary image which is used to distinguish between the obiect and the background. Thresholds are often determined based on surrounding lighting conditions, and the complexion of the driver To eliminate the noise left after thresholding, filtering is done by Sobel filter. The Sobel Edge

filter is use to detect edges based applying a horizontal and vertical filter in sequence.

1	-2	-1
0	0	0
1	2	1

-1	0	1
-2	0	2
-1	0	1

Figure 2. Sobel Mask Filters

(a)Original image **(b) RGB to grey**

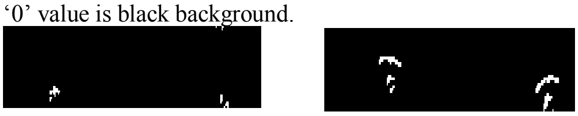
Figure 3. Face Detection

4. EYE DETECTION

The next step is to crop the frame obtained from video according to pixels having value '255' which represents the eye according to decided threshold value.

The first step after thresholding is to read the image for maximum number of '255' pixel value. It starts checking each pixel value in each column. After reading one column row value increases and cursor moves to next row and checks for the pixel value '255' in next column. This process continues till it detects the first column with pixel value '255' and the last column with pixel value '255'. The program breaks and comes out of loop after detecting the last column with pixel value '255'.

The next step is to crop the image on basis of first and last column. The region from first and last column with pixel value '255' contains the eyes. The new image now represents only the eye region with two gray level values '255' and '0'. The region with '255' values are eyes and the remaining with '0' value is black background.



(a.) Open eyes **(b.) Half Closed**

(c) Closed Eyes

Figure 4. Automatic Cropping

5. DROWSINESS DETECTION

The next step after eye detection is to calculate the energy of each cropped frame. The energy of each frame is represented by summation of square of each pixel value. The energy value changes according to opening and closing of eye. If eyes will be closed the image will have all black pixels and the value of energy calculated will be different than the value of energy calculated when eyes will be open. These energy values are then averaged for consecutive 5 frames. For every 5 frames average of energy values is calculated and stored.

The average energy value of 5 consecutive frames is compared with the given range. The average energy value range is decided on the basis of collected data base. If the average energy value falls into this range, it represents that the driver's eyes are closed, and the alarm is activated. Consecutive number of closed frames is needed to avoid false alarms due to eye blinking.

6. EXPERIMENTAL RESULTS

All the codes were written in MATLAB. The video recording of the driver's image is converted into consecutive frames. From each frame face is detected and lower half of the face is removed. In the upper half portion search has done for locating eyes. Once the eyes are located, the energy values of every frame are calculated (Table1 given below) by using these energy value variations the drowsiness is detected.

Table 1. The experimental results

Full open	Full close	Half close
84142350	10078875	58587525
88043850	11314350	52085025
91100025	9038475	49353975
88694100	10013850	47923425
87913800	9623700	50914575
92075400	12809925	45842625
79395525	11769525	53775675
77054625	13135050	47013075
77444775	12614850	34398225
69992910	10469025	34008075

Thus it can be seen that there is a huge energy difference between full open, full close, and half close eyes. The average energy values of 5 consecutive frames are then taken. Average range is given below:

Full open: 60000000 to 90000000

Full close: 9000000 to 14000000

Half close: 30000000 to 58000000

Thus if the average energy value of 5 consecutive frames falls into the Full close range then it represents that the driver is drowsy and an alarm is activated.

7. CONCLUSION

A non-invasive system to localize the eyes and monitor fatigue was developed. Information about the eyes position is obtained though various self-developed image processing algorithms. During the monitoring, the system is able to decide if the eyes are open or closed. When the eyes have been closed for too long, a warning signal is issued.

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