Drowsiness Detection in Real Time Driving Conditions

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Abstract-

This paper presents a prototype to detect fatigue in drivers and helps in avoiding accidents. One of the reasons that accidents occur commonly is due to sleepiness during driving. This sleepiness or fatigue results in 30 to 40 % accident that usually occurs. It is estimated that the probability of meeting with an accident increases four to six times when the driver feels drowsy. Detection of fatigue is important to avoid accidents and thereby saving many lives everyday. This paper proposes a better fatigue or drowsiness detection system to that of existing system today. This method of drowsiness involves a minimum intrusive method of detection. Hence, the driver would experiences very less inconvenience. Once the detection is completed this prototype also alerts the driver, regulates the speed of the vehicle if fatigue is detected. Thus, avoiding the accidents due to fatigue and saving many lives.

Keywords: - Intelligent Transport Systems, Fatigue, drowsiness detection.

1. INTRODUCTION

The statistic of the past one decade shows that the total number of accidents had increased exponentially leading to loss of millions of people's lives. Motor vehicle accidents are very common and are a major problem all over the world. Apart from motor vehicle accidents, occupational vehicle accidents have also recorded an alarming increase in serious injury and death. These occupational vehicle accidents are more significant because it involves crashing of buses leading to loss of many lives. These incidents mostly happen due to human errors on the drivers' part (e.g. speeding, losing control over the vehicle, overtaking, fatigue, and drowsiness).

Driving fatigue is of such drivers' part error which causes most of the accidents. Diving fatigue is also described as a feeling of drowsiness due to extended driving period, monotonous road condition. The reasons for fatigue or drowsiness are long duration of driving, inadequate sleep and other cumulative factors caused the sleep deprived drivers to make higher number of right edge- line crossings and other errors. It was observed that reaction time of the driver was slowed by 18 percent while stopping distance increased by 7.6 percent in a sleep deprived individuals [1][2]. Hence, a convenient system is needed to avoid accidents due to drowsiness.

Today in the market there are few drowsiness detection equipments that help in detecting drowsiness. These equipments are generally categorized into four main categories. The first category includes methods based on biomedical signals. This involves monitoring biological parameters like EEG (Electro Encephalo Graphy), ECG(Electro Cardio Graphy), and heart beat. This calculation of the parameter is the best way to detect drowsiness because it use the biological and technical signals used for fatigue detection. EEG shows to be a reliable indicator of drowsiness. The amount of activity in different frequency bands can be measured to detect the stage of drowsiness or sleep. Here, the brain waves changes seem to be one of the most direct and fastest markers of the human vigilance level. The advantage of this technique is that it has faster dynamics i.e., even a small change in the human brain is detected. The disadvantage here is that they require electrodes attached to the body, which often causes inconvenience to the driver [5].

The second category includes methods based on driver performance, which evaluate variations in the lateral position of the vehicle, in the velocity, in the steering wheel angle and in other Controller-Area Network (CAN) signals. The advantage of these approaches is that the signal is meaningful and the signal acquisition is quite easy. On the other hand, these systems are subject to several limitations such as vehicle type, driver experience, geometric characteristics, condition of the road, etc. Then, these procedures require a considerable amount of time to analyze user behaviors' and therefore, they do not work with the so called micro-sleeps—when a drowsy driver falls asleep for a few seconds on a very straight road section without changing the vehicle signals [4].

The third category is based on visual assessment. Computer vision can be a natural and nonintrusive technique for monitoring driver's state from face images. These approaches are effective due to sleepiness is reflected through the face and eyes appearance. We take the face and eye into consideration because it helps us to effectively calculating the drowsiness of the driver. Earlier the face detection was only used to detect the drowsiness. There are different methods detect the face and the eyes. We get the different results based on the algorithm that is being used to detect the face [3].

The fourth category is based on the measurement of blinking. Increase in the blinking is often a gesture of feeling drowsiness, based on which drowsiness is detected. This requires some hardware unit to be placed around the drivers' eyes to count the blinks. But this technique is not quite efficient when compared to all the above techniques stated. The disadvantage is that the driver needs to wear a device that resembles spectacles which is quite heavy and causes uncomforting to the driver [7].

In this paper we propose an efficient technique or fifth category which is a combination of both fourth and third techniques which has a minimum intrusive approach for drowsiness detection, based on computer vision and some hardware which is put on to the driver. This approach helps in real time conditions and is also very precise as well as effective when compared to other techniques that were discussed before. Apart from being precise and effective the cost for installation and implementation is very less compared all the above techniques.

2. PROCESS OF DETECTING DROWSINESS

The systems architectural flow chart is as shown in the below figure1. When the vehicle is started the drowsiness detection system is initiated. Using IR sensor blink is detected. If the blinking is increased i.e, crosses 16 times in a minute, the system considers that the driver is feeling drowsy. If the blinking does not cross 16 times per minute the IR sensor continuously senses blink till 16 blinks is crossed. This consideration is done by the dual comparator, which alerts the micro controller when blinking count crosses 16 times per minute. The micro controller (here we are using ARM 7) in turn initiates the web cam which is installed on the dash board of the vehicle. The web cam takes the image of the driver; from the image acquired drowsiness is detected. If drowsiness is not detected in the image of the driver, the IR sensor value is set to zero and blinking is counted again. In case, drowsiness is detected in the image the micro controller alerts the driver using a buzzer. Along with alerting the speed of the vehicle is slowly reduced using H Bridge.

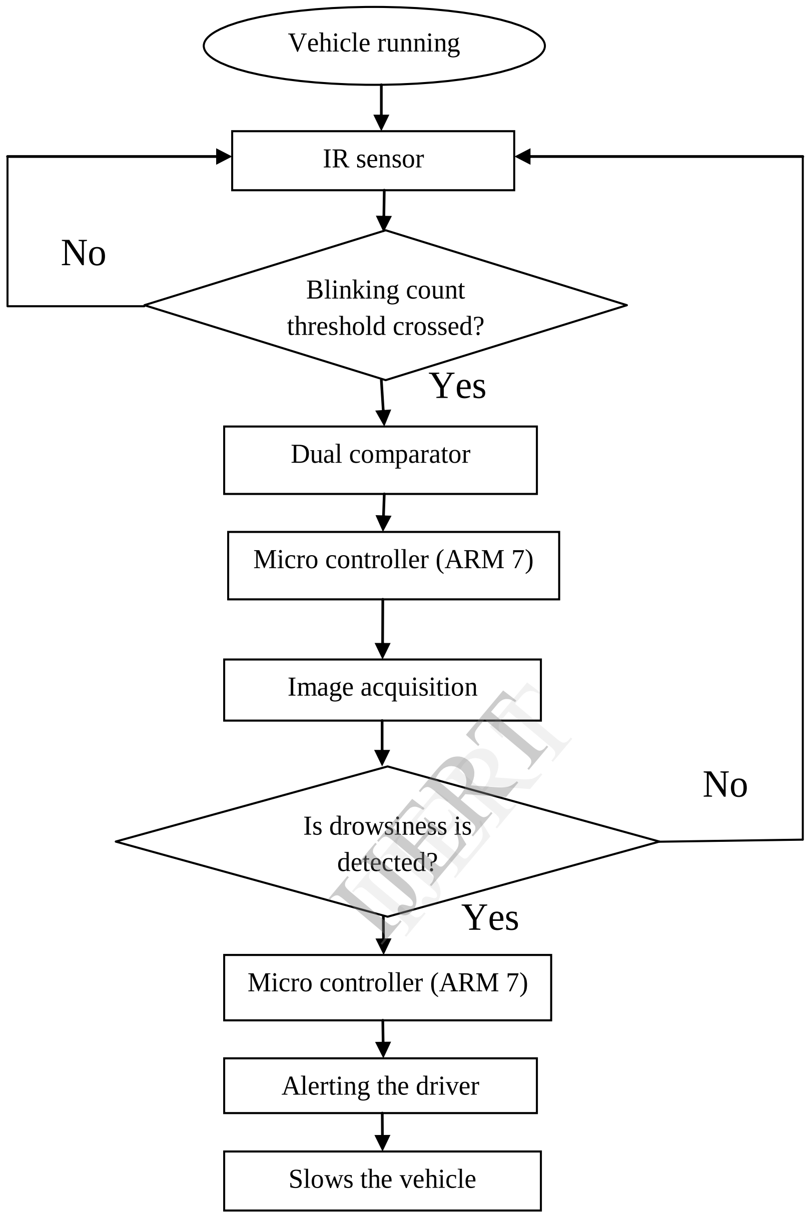

Fig 1 architectural flow chart

2.1 DROWSINESS AND BLINK

Blink in general is considered to be an indication for sleepiness so we take this parameter for drowsiness detection. But blinking is not the same in every person and some times due reasons like wind, lighting condition, dust, dryness in eye or due to etc, we tend to blink more often. Here in the paper blinking count is given as 16 because in normal active person the blinking per minute is around 10 – 11 (laboratory conditions). Thus, it shows the drowsiness. Blink can be detected by an IR sensor and an IR detector. When the driver blinks the eye lids obstructs the IR rays thus counting it to be a blink. Every time the driver blinks there is an obstruction between the IR transmitter and detector. Each time the comparator reads the counts of the IR and if a new count is detected the IR value in the comparator is increased. When the IR value reaches to 16 the comparator sends an interrupt to the microcontroller.

2.2 MICRO CONTROLLER

The micro controller used in this prototype is ARM7 LPC 2148 which is very versatile. Micro controller here the following tasks

1).Initiating the web cam when the blinking count is crossed.

2). Alerting the driver when drowsiness is detected and also regulating the speed of the vehicle.

The microcontroller receives an interrupt when drowsiness is detected by the drowsiness detecting algorithm. The reasons for selecting this particular micro controller for this system are its ability to operate on low voltages, higher processing speed, ability to accept many interrupts, more number of ports which would be useful for further extensions of this prototype and so on.

2.3 DROWSINESS DETECTING ALGORITHM

The drowsiness detecting algorithm involves face detection algorithm. To determine drowsiness the image of the driver is acquired and from that image we detect the face, eye. There are many face detection techniques that are available. The algorithm that is used here is based on fuzzy logic.

When the micro controller sends an interrupt the Matlab software is initialized. The web cam takes a frame from the video sequence, from which the drowsiness detection takes place. If drowsiness is not detected and interrupt is sent to micro controller that drowsiness is not detected.

The proposed technique in this paper is a unique and novel technique. Using segmentation of image technique this drowsiness detection is done. This method can effectively detect drowsiness compared to all existing method of drowsiness detection.

Face detection part is done by using face detector function available in the MATLAB 2012a software followed by resizing the obtained image to 512X512 image, from which we separate the eye part of the person image. This eye part is obtained by observing different images of driver, those values are taken, and according the eye part of the image is obtained. Hence we are able to get only the eye part from the total image.

The image is converted from RGB to grey levels, now only eye is considered, and using segmentation and distance between two pixels we detect drowsiness. Calculating distance between two pixels with that of the low intensity value helps in effectively knowing the pixels with high intensity and also low intensity. Final image contains only the eye with black and white pixels.

If there are more number of black pixels or pixels with low intensity levels then the driver is considered to be feeling drowsy. Low intensity values because when we close our eye we get more pixels with blacks values. Similarly when eyes are open we have more high intensity or white pixels. Using this logic drowsiness is detected.

Fig 2 Image obtained when eye is open

Fig 3 Image obtained when eye is closed

Fig 2 and fig 3 shows the image of the drivers' eye when opened and closed. Once drowsiness is detected the ARM is alerted and the vehicle speed is stepped down so that accidents could be prevented.

The fig 4 the flow chat gives the step by step process involved in detecting the drowsiness of the driver.

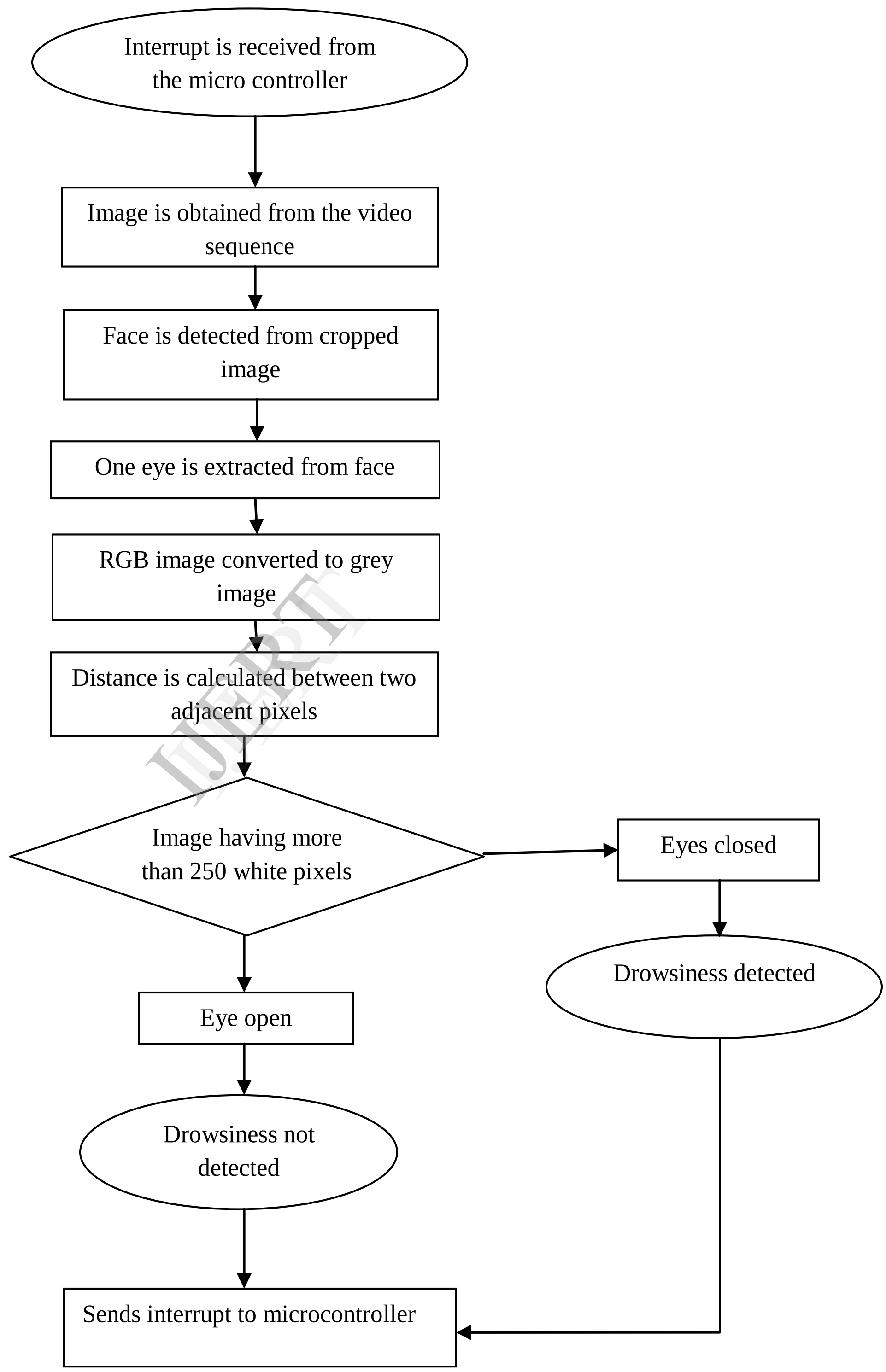

Fig 4 flow chart for drowsiness detection

2.4 RESULTS (drowsiness detection algorithm)

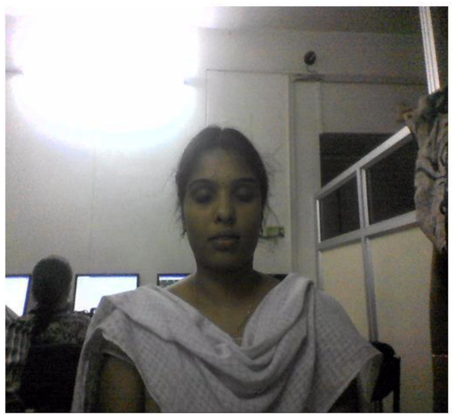

Fig 5 Original image captured

Fig 6 Face detected from image captured

Fig 7 Eye extracted from face

Fig 8 Grey image of eye when close

Fig 9 Original image captured

Fig 10 Face detected from image captured

Fig 11 Eye extracted from face

Fig 12 Grey image of eye when closed

Here two different samples are considered and there respective results are obtained using Matlab software.

3. TABLE

samples	Face detected	Eyes detected	Accuracy of drowsiness detected
Sample 1	100%	100%	100%
Sample 2	100%	95%	100%
Sample 3	95%	95%	100%
Sample 4	95%	95%	100%
Sample 5	65%	0%	0%
Total	91%	77%	80%

Five different volunteers' images with both eyes closed and open are tabulated in the above table. Among these samples sample 5 could not be predicted because of low lighting.

Accuracy = 1 - |total no. of blinks -no. of blinks detected| / total no. of blinks.

The same formula was used for calculating accuracy of drowsiness detection.

Here sample 5 is not taken into consideration then the system has an accuracy of nearly 100%. That said; the high amount of errors in sample 5 shows that the system is prone to error and has certain limitations which we will discuss in the next section. In sample 5 we did not use the backlight of the webcam. The resulting poor lighting conditions gave a highly erroneous output.

4. CONCLUSIONS & FUTURE SCOPE

The drowsiness detection proposed here is a minimum intrusive approach for monitoring driver drowsiness, based on computer vision techniques, installed on a real car, capable of dealing with real operation conditions. Results obtained with the system are similar or even better than other commercial ones being more flexible and open source. The commercial systems often require a non-trivial calibration procedure, to adjust the detection. This method is accurate up to 98% .This method of drowsiness detection takes less computational very less time. Hence, it is very advantages to use this technique in the real time applications.

Coming to future scope this system can be further extended to have security like only certain people can access the vehicle. In case of theft, the vehicle does not start and an mms of the burglar could be sent to the owner of the vehicle.

5. LIMITATIONS

The limitations of the system are as follows.

1. Dependence on ambient light: - With poor lighting conditions even though face is easily detected, sometimes the system is unable to detect the eyes. So it gives an erroneous result which must be taken care of. In real time scenario infrared backlights should be used to avoid poor lighting conditions.

2. Optimum range required: - when the distance between face and webcam is not at optimum range then certain problems are arising. When face is too close to webcam(less than 30 cm), the system is unable to detect the face from the image. When face is away from the web cam (more than 70cm) then the backlight is insufficient to illuminate the face properly. So eyes are not detected with high accuracy which shows error in detection of drowsiness. This issue is not seriously taken into account as in real time scenario the distance between drivers face and webcam doesn't exceed 50cm. so the problem never arises. Considering the above difficulties, the optimum distance range for drowsiness detection is set to 40-70 cm

3. Hardware requirements: - The system was run in a PC with a configuration of 1.6GHz and 1GB RAM Pentium dual core processor. Though the system runs fine on higher configurations, when a system has an inferior configuration, the system may not be smooth and drowsiness detection will be slow. The problem was resolved by using dedicated hardware in real time applications, so there are no issues of frame buffering or slower detection.

4. Orientation of face: - when the face is tilted to a certain extent it can be detected, but beyond this system fails to detect the face. So when the face is not detected, eyes are also not detected. This problem is resolved by using tracking functions which track any movement and rotation of the objects in an image.

5. Poor detection with spectacles: - When the driver wears glasses the system fails to detect eyes which are the most significant drawback of our system. This issue has not yet been resolved and is a challenge for almost all eye detection systems designed so far.

6. Problem with multiple faces: - If more than one face is detected by the webcam, then our system gives an erroneous result. This problem is not important as we want to detect the drowsiness of a single driver.

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