ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 9, September 2017

An intelligent System to Detect the Drowsiness State of A person

Anil Kumar Shukla
Amity Institute of Telecom Engineering & Management, Amity University, U.P., NOIDA

Abstract: In this Paper we are planning to make a drowsy driver detector system using image processing technique with MATLAB. The result product will be a device that will monitor the behavior of the driver's eye and raise an alarm if the driver falls asleep or drowsy while driving. The sole purpose of this project is to prevent road accidents which are caused because of the driver falling asleep. This system will be built with imaging processing technique to detect eye movements. This device will come fully equipped with an effective alarm system. The microcontroller can be programmed in such a way that if the driver is found to be in a 'closed eye' state for a specific period of time, it will raise an alarm. This duration if wished can be adjusted. This can also be done by calculating eye-blinks using IR sensor

Keywords: Drowsiness detection, Image Processing, IR sensor, Lane monitoring, MATLAB

I. Introduction

Hundreds of people lose lives everyday due to vehicle accidents. And a significant number of these are due to drowsiness while driving. These accidents can be reduced by a great extent by implementing sleep detection mechanisms in vehicles

Considering the statistics, Nearly 1.3 million people die in road crashes each year. On an average it accounts to 3,287 deaths every day. According to stats released by Toyota[1], it can be seen that 20% of the total vehicle accidents are caused due to drowsy driving. Which means, around 700 people loses life every single day due to falling asleep or feeling drowsy while driving. This huge number of losses in life can be significantly reduced by making use of any kind of drowsy driving or sleep detection systems in vehicles like lane monitoring, learning steering behavior, alerting the driver etc.

According to another survey[2] conducted by Nation Sleep Foundation of US regarding drowsy driving, the annual death rate is found to be 1500 per year (in US alone). Drowsy driving also leads to an annual monetary loss of $12.5 billion every year.

Detection of drowsiness can be detected by several methods. Two of them (eye-blink sensing and image processing) technique will be discussed in the paper and one of them will be implemented based on comparative analysis of their advantages and disadvantages. The techniques used currently by different manufacturers also will be discussed

II. Systems In Use

Several different methods are adopted to detect sleepiness or fatigue of drivers in vehicles. Mostly, the driver will be indicated in case any drowsiness in detected suggesting to take a break or displaying coffee cup symbol in the display with buzzers.

Analyzing the driving behavior is done by manufacturers like BMW, Audi, Bosch, Ford, Mercedes-Benz, Mazda, Volvo and Volkswagen.Subaru uses Eyesight driver assist. Vigo makes use of Smart Bluetooth headset that detects signs of drowsiness through the eyes and head motion. The most common approaches are

A. Bosch Drowsiness Detection System

This is implemented in VW Passat Alltrack cars. In this system, the level of fatigue is determined based on information taken from the car steering-angle sensor. The basic concept is that when the driver tends to sleep, the steering will not be moved for a period of time. The lateral movement of steering will also be learned to make effective decision by the system. But this can be considered inefficient considering the fact that there are several other cases when steering won't be much used as in the cases of long drives which may include hundreds of kilometers on a single straight road.

B. Anti-sleep alarms

It uses accelerometer to measure the g-force. Such kinds of devices are very cheap and can be found in the internet. It can be worn around the ears and when the driver's head is titled to more than a critical angle, the alarm goes off and wakes the driver up. This is obviously inefficient due to several reasons. A person can sleep while driving leaning behind not varying the angle much to be noticed by the device. And drowsiness doesn't necessarily include tilting the head to some critical angles. This can also

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 9, September 2017

cause alarm in several other events which may not be related to sleepiness which involves tilting of the head.

C. Attention assist – Mercedes-Benz

This includes detection of driving patterns, steering behavior and driving conditions by which it helps to detect driver drowsiness. In case of detection and not getting responses from the driver, the car stops before getting too close to the next vehicle in front of it. Even though this can prevent many accidents, this system is inbuilt in the Mercedes E class which is therefore not made available to common drivers.

D. Lane monitoring

This technique uses lane monitoring cameras where the driver will be warned in cases where the car moves across the lanes unlike the way in normal lane changing scenario. Such unnatural ways of lane changing is also hard to predict whether it is an actual case of drowsiness and therefore might require complex algorithms to make decisions based on the vehicle speed, acceleration pattern, type of road etc. This technique will not be practical in coutries like India were traffic rules like following lanes are rarely practiced and therefore would only lead to un-necessary annoying alerts for the drivers

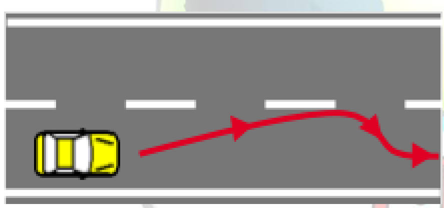


Fig. 1. Lane Monitoring. Show how the vehicle is re-routed on detection of abnormal lateral movements across the lane

III. MEASURING PHYSIOLOGICAL CHANGES

This way of sleep detection would more efficient as it is known that the physiological parameters rapidly changes during drowsy stage. This requires sensors for measuring parameters like muscle activity, skin conductance, heart rate and brain activity. As these sensors are needed to be in direct physical contact with the driver, it may cause discomfort which can be considered as one of its drawbacks. These will also be expensive as compared to other techniques which can be implemented. Some wrong judgements can also be expected as the similar changes in such parameters might also be a result of other activities which may not be related to drowsiness. Therefore it is best to combine this method with other techniques where both combined can help in an accurate judgement of whether the driver is drowsy or not.

A. Heart-rate monitoring

One of the approaches towards sleep detection is heart-rate monitoring to determine whether the driver is falling asleep as the heart rate decreases during sleep stage. There are four stages in sleep which are N.R.E.M stage 1, N.R.E.M stage 2, N.R.E.M stage 3 and R.E.M (Rapid Eye Movement). The first 2 stages constitute light sleep. 2,3 and 4 can be neglected for the case of this project as these are advanced stages of sleep. The first stage last to around 1-10 minutes and it is clear why later stages can be neglected.

During the first stage, which is the transition from being awake to falling asleep, heart beat rate becomes regular. It does not result in a significant decrease in heart beat rate. During the second stage, heart-rate decreases to a lower level than the normal value. But it will not help as the accident will obviously occur long before the driver enters this stage. But the rate reduces to lower than the normal rate during drowsy stage or when the driver is fatigued.

Heart-rate monitoring will not do much help in preventing an accident if not monitored with respect to normal heart-rate of the driver as the reference value. Considering the heart-beat rate of a healthy person, the system can be programmed with healthy rate boundary of 65-72 beats per second. But this will not be an accurate prediction.

The heart-beat rate is bound to change with respect to the emotion and physical condition of a person. Therefore it will not be possible to determine a valid healthy heart beat rate boundary which may lead to inaccurate system functioning. For example, heart-rate increases during fear, anxiousness and the average bps decreases/changes from person to person.

Change in heart rate during a short interval of time was monitored to observe the changes over time in different situations

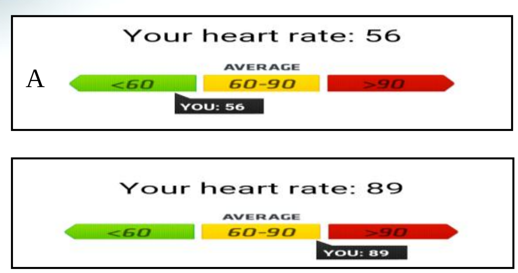


Fig. 2. Observation Heart rate of same person at two different times at A) normal and B) excited situation

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 9, September 2017

Comparing the results it is clear that the heart rate is to monitored at the initial stage of driving to get the normal rate or the average rate of the person is to be set so that the change can be monitored when the beats per minute reduces during fatigue or drowsy stage.

*B. **Detecting Brain activity***

Brain activity detection can be used to determine if the driver is drowsy. This is due to the fact that the waves show different patterns during different stages of sleep and drowsiness. Even though the rate (cycles) of brain waves decreases to a significant level during stage 3 of the sleep (delta range of 1-3 cycles per second), we will not be considering this case as we have done in the previous parameter as well, as it would not help in preventing any accidents. When a person first enters the sleep stage, brain waves slows down from beta (12-18 cycles per second) to alpha (8-12) and then to theta (4-8). At this stage, sleep begins.

The first stage of sleep lasts only a few minutes of light sleep. The person experiences a lowering of blood pressure and body temperature, relaxation of muscles, and a slowing of breathing and heart rate. Brain wave's low-voltage and slow. Since, the drowsy stage comes before the person actually enters the sleep stage, its pattern can be looked into, separately.

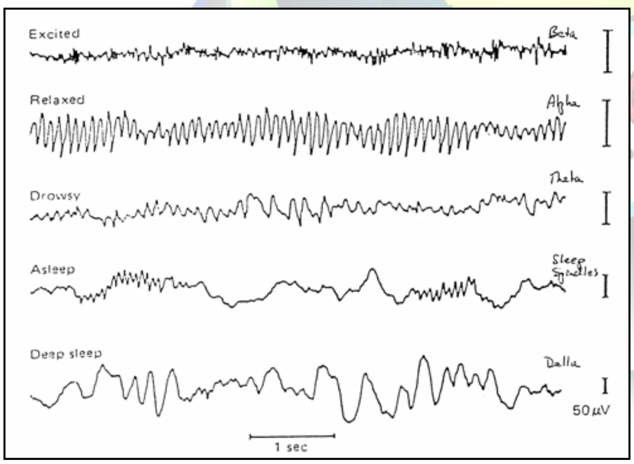


Fig. 3. Difference in brain activities. Drowsy stage can be seen as different from the activity of when the person is relaxed and awake

It can be clearly understood form the graph that during the drowsy stage, the brain waves decelerate to theta waves (4-8 cycles per second). Detecting this pattern from a driver with a sensor will help easily to identify if the driver is drowsy or not, to prevent an accident from occurring.

Even though detecting brain waves seems to be a good method to detect drowsiness, there are several disadvantages. Two of them are:

i) Physical discomfort for the driver as sensing device has to be worn by the driver when driving which can be irritating and most of the drivers may not choose to wear them where even seatbelts are neglected by many of the drivers

ii) Cost of the brain wave detecting sensor is very high and therefore most of the users may not prefer buying a sleep detection device of this kind.

Other parameters

Other physiological parameters include body temperature and muscle activity which are known to decrease during fatigue or drowsiness. For example, body temperature decreases constantly when a person becomes sleepy and enters the sleep stage. Average body temperature of humans is 37 degree Celsius or around 98 degree Fahrenheit. This can gradually reduce up to 96.5 degrees during sleep which is initiated at the sleepy stage or when the person is drowsy.

Even though the changes can be observed, they are slow and gradual. The temperature of a person may also differ according to the physical and health conditions. Therefore reference temperature of the driver's body is to be taken when he/she is not in a sleepy stage to be compared to different readings observed.

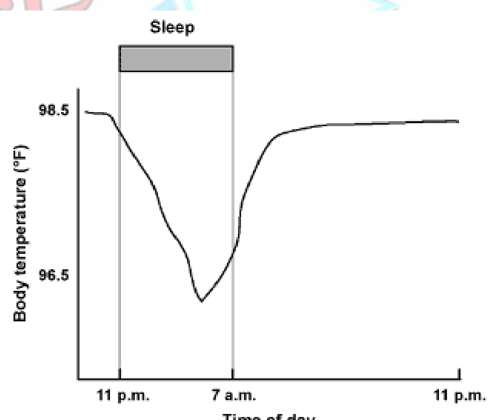


Fig. 4. Change in body temperature. When a person becomes sleepy, the changes in temperature that will take place can be understood form this figure

IV. IR SENSING

One of the methods by which drowsiness of the driver can be detected is by using the IR sensor as Eye-blink counter. If the number of eye blinks reduces to less than a

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 9, September 2017

threshold programmed, it can be considered as the driver is sleepy thereby alerting the driver with alarm.

The transmitter and receiver are kept on a straight line. If there is reflection back, it will be sensed by the receiver. In our case, the object can be considered as the eyelid. If the eyes are closed there will be more reflection received by the receiver and can be counted as "eye-closed" event. If it reduces to less than a limit in given span of time, the driver can be alerted.

The cases of "eye-closed" event mentioned is not the normal eye-blink event as it will be of higher duration which occurs in the case of drowsiness or fatigue which is to me calculated and not the usual eye-blink event which is much shorter in duration.

Infrared transmitter is used to emit infrared rays. Similarly, to receive the IR rays transmitted by the transmitter, IR Receiver is used. Both transmitter and receiver are kept in parallel to each other. When the signal is high, the I.R sensor is conducting and it passes the rays to the receiver. The receiver is connected to comparator. The comparator is then connected to an Op-Amp (operational amplifier). The reference voltage is given to inverting input of the op-amp and the Non-inverting input is connected to the receiver. When there is an interruption in the rays between the transmitter and receiver, the receiver becomes non-conducting. So the comparator non- inverting input terminal voltage is higher than inverting input. The comparator output is at the range of +5V. This is then given to microcontroller. When IR transmitter passes the Infra-red rays to receiver, the IR receiver becomes conducting due to non-inverting input voltage being lower than inverting input. [1]

This output is used to calculate the number of eye- .blinks. The calculation to determine if the driver is drowsy depends upon the number of eye-blinks counted. If it is less than a specific range, it means that the driver is sleepy and thus can give alert to the driver through an alarm which can be set to go off when the eye-blink reduces.

The working of the system can be summarized as: Eye-blink sensor is placed near the eye to sense the blink count and this information is transmitted to the Microcontroller (like Arduino board). It then uses this information to compare with the normal eye blink programmed in and if any abnormal situation arises, the indication is given to the driver to alert him.

V. Image Processing

Another technique used to monitor the eye behavior is image processing suing MATLAB. Here, the face and eyes are identified by processing the image captured and the difference is calculated when the eyes are closed and open. This helps to identify drowsiness as images are processed in real-time.

The driver's face will be monitored in real-time by a camera from which the frames will be fed to the computer. These frames will be processed in MATLAB where the state of eye (whether it is opened or closed) will be calculated after a series of filtering and other processes with the help of image processing toolbox. If the eyes are closed for a few consecutive frames, the driver will be alerted by a buzzer. There are a lot of steps involved in the image processing from where the video is recorded in real-time to how drowsiness is detected. The first step would be frame grabbing.

Frame Grabbing

The image has to be taken continuously from the video being captured and that image is to be transmitted to the computer in appropriate format for further processing. This is called frame grabbing which is a crucial process in the system as the grabbing has to be in an acceptable rateto do processing in real-time. The common solution is a frame grabber board that attaches to a computer and provides the complete video signal to the computer.

Detecting the eye

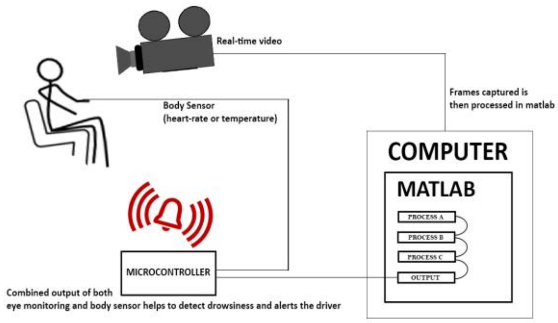
There are various algorithms which are used to identify eyes from an image which has pros and cons of their own. In some algorithms, the shape of eye, or the roundness is directly searched to separate it out. But this can be confused with other such patterns and most importantly, it will not help in detecting the difference between the open and closed stages of eyes. Accurate identification can be done my making use of image processing toolbox in MATLAB.

Binarization

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 9, September 2017

This is an important step in localizing the eye. Binarization is converting the image to a binary image. A binary image is an image in which each pixel assumes the value of only two discrete values. Say, 0 and 1, 0



representing black and 1 representing white. With the binary image it is easy to distinguish objects from the background. The greyscale image is converting to a binary image by thresholding where the contrast or the level is varied. The output binary image has values of 0 (black) for all pixels in the original image with luminance less than level and 1 (white) for all other pixels. This result will help in identifying the eye from the rest of the image. [2]

Fig. 5.Working of the system.The image captured is processed in MATLAB and if the driver is found drowsy, he will be alerted

Other processes or filtering in the procedure includes grey scaling, threshold etc.

Challenges

1) Real-time processing

Transferring the captured image from the video camera to the computer in real time for processing will be hard to achieve at the required rate

2) Variations for different people

Binarization of the image would give different results for different people as the threshold range varies. Therefore it will be impossible to determine an average range

E.g.:- Dark skinned people

3) Face edge detection

Face edge detection needs complex algorithms as several edges will be captured in a normal view of the camera

4) Difference in physical appearance

It will cause difference in the output result as the pattern and the algorithm used may not be applicable all of them

For example, a driver wearing spectacles

5) Background

The background should not contain any strong intensity changes as it would disrupt proper processing of the face image

VI. CONCLUSION

Although there are a few vehicle manufacturers like Mercedes and BMW who provides drowsy detection in their vehicles, majority of the drivers are still prone to accidents due to sleepiness or fatigue as these systems are not made available to other common vehicles. Implementing such a s system would help prevent thousands of accidents and save hundreds of lives.

REFERENCES

[1]. K.Srijayathi, M.Vedachary, (2013, September), Implementation of the Driver Drowsiness Detection System, International Journal of Science, Engineering and Technology Research (IJSETR) [online]

[2]. Available:http://ijsetr.org/wp-content/uploads/2013/09/IJSETR-VOL-2-ISSUE-9-1751-1754.pdf

[3]. Neeta Parmar, Drowsy Driver Detection System, Department of Electrical and Computer Engineering, Ryerson University. [online]

[4]. Available:http://www.ee.ryerson.ca/~phiscock/thesis/drowsy-detector/drowsy-detector.pdf

[5]. Rajasekar .R1, Vivek Bharat Pattni , S. Vanangamudi, Drowsy Driver Sleeping Device and Driver Alert System, Department of Automobile Engineering, BIST, Bharath University, Selaiyur, Chennai, TamilNadu, India [online].

[6]. Available:http://www.ijsr.net/archive/v3i4/MDIwMTMxNTY0.pdf