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Driver Eye Blink Rate Detection and Alert System

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Abstract: ***Drowsy driving is as dangerous as drunk driving. Many people, especially youth, ignore this and still continue to drive in this state. Drowsiness is the one of the major causes of road accidents, especially at night. Eating certain kinds of food causes the blood sugar levels to plummet which make the driver energy deprived. Many drivers consume alcohol at night which causes dizziness that leads to fatal accidents. Many lives are lost due to accidents caused by drowsiness. There are many papers which studied and found out the exact blink rate for drowsiness detection, but in this paper we will first study the driver's blink rate, as it may vary from person to person, and then after learning, actions will be taken according to the driver's learnt blink rate. This paper describes the system that monitors the blinks of the driver which can be used to detect drowsiness and prevent such fatalities. After detecting the drowsiness, we aim to alert the driver about the drowsiness using certain alarm sounds.***

Keywords : Blink detection, Blink Rate, Drowsiness Detection, Dizziness,

I. INTRODUCTION

Monitoring human operator vigilance is an important issue which can be monitored by detecting eye blinks. Drowsiness alone causes many accidents every year around the world. 83,000 crashes and 1,000 deaths were recorded per year that is caused by drowsiness, in United States alone [1]. Drowsiness is caused by many reasons. One such reason is driving for a long duration of time without rest. There is an acute shortage of truck drivers in India. Low pay and unpredictable schedule has resulted in this shortage [2]. Due to ever increasing demand in the transport sector and the shortage of truck drivers has forced the drivers to work for long hours without taking rest. This leads to fatigue and drowsiness. There have been many instances when accidents have taken place due to driver falling asleep while driving. Another reason for drowsiness is consumption of alcohol. Alcohol results in decrease in alertness. Many accidents have been resulted due to drivers driving under the influence of alcohol.

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There is relation between the blink rates and the drowsiness [3]. When a person feels sleepy, the frequency of blinking decreases. This relationship can be used to detect when a person is feeling sleepy or when a person has slept. Drowsiness is one of the important factors for road accidents. Many methods have been developed to detect blink rates in video sequences which are based on motion estimation in the eye region.

A major drawback of all previous approaches is because of requirement of setup with respect to head orientation, resolution of images, image detection and its illumination

In this work we will devise an algorithm that uses this relationship to alert the driver.

II. LITERATURE REVIEW

Each year, around 1.5 lakh people die in road mishaps in India. Driver fatigue is a serious problem resulting in many thousands of road accidents each year. Exact number of sleep related accidents cannot be calculated but research shows that driver fatigue may be a contributory factor in up to 20% of road accidents, and up to one quarter of fatal and serious accidents. For detecting accurateness of drowsiness, various approaches have been proposed.

Methods used for eye blink detection can be active or passive. Active methods are expensive as it uses special hardware such as infrared cameras, portable devices, glasses with close cameras but these methods are reliable. Passive methods rely on remote cameras only.

Artificial Intelligence and visual information can be applied to automatically detect driver drowsiness. Algorithm is validated for different real vehicle image of drivers which is used to detect, track and examine face and eyes of drivers which works in different light condition. [6]

Key factor for increase in road accident is driver drowsiness and fatigue.

Video based approach is used to implement driver sleepiness. Support Vector Machine (SVM) is used to confirm analysis and categorization of vigilance state of the driver in [7]. In [7] to extract and investigate signals, band power and mode decomposition methods are used.

In [8], author detected drowsiness with 86% accuracy on the basis of correlations between micro adjustments and drowsiness According to [9], author claimed accuracy of over 90%. However, the main drawbacks of this method are its intrusiveness. It requires many sensors to be attached to the driver's body, which could be uncomfortable. On the other hand, non-intrusive methods for bio-signals are much less precise.

III. METHODOLOGY

To start with implementation of project, blink needs to be detected. Also their blinks, their rate and the time of blink is vital. For this, we first face to be detected and the points on the face to locate the eyes. The features of the face will be detected based on thresholding concept which is the difference of intensity values at a pair of pixels [4]. The paper [4] has two key elements detailed in their algorithm for identification of the face. The first key was involved in indexing the pixel intensity that is relative to the estimated shape of the face. The second key focuses on the prediction problem that estimates the shape of the face and its features. Author have used a large amount of data set for various angles of faces and identified the features of face where entire face is visible regardless of the alignment of the face. This algorithm is used for detection of eyes, which will be used in the proposed algorithm. This same algorithm is used by OpenCV (Open Source Computer Vision Library) in their implementation of locating faces in the frames.

In face detection algorithm, location of the eyes and movement of eyes is one of the important features.For detecting sleepiness it is important to identify blinks and later rate of blinks and the number of frames for which the eyes are closed.

For detecting blink, reference is from [5]. In [5], author have suggested that each person has a different rate of closing of eyes and opening them. They gave the concept of eye aspect ratio (EAR) that will be calculated to detect the blink of the eyes, for each video frame. This aspect ratio is calculated ratio between the height and width of the eyes. This ratio was given in [5] by

$$EAR = \frac{\|p2 - p6\| + \|p3 - p5\|}{\|p1 - p4\|} \quad (1)$$

where p1, …. , p6 are the 2D landmark locations, depicted in Fig. 1.

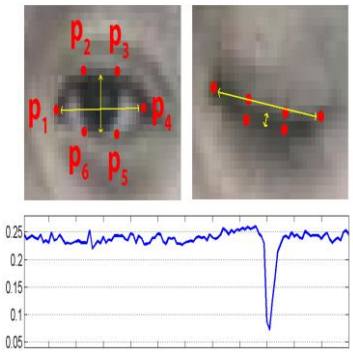

Fig1: Eye Blink Rate Detection

Fig1 is given by [5] where they detected the blink and have shown the use of EAR to detect blink with the help of the graph The algorithm for implementation is referred from [5] to detect blink and to estimate the drowsiness of the driver while he is driving.

IV. DESIGN

The module will consist of 2 parts.

- Camera: A camera will be placed on the dashboard of the vehicle.
- Raspberry pi: A raspberry pi will be required to process the images captured by the camera

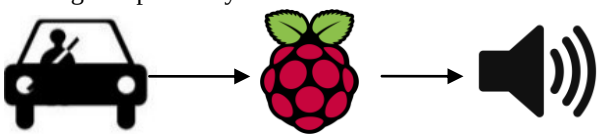

Fig 2: Pictorial representation of the flow of work, camera will capture video, raspberry pi will process and alarm will turn on if drowsiness is detected

A. Working

A on the dashboard will send the captured video to the raspberry pi module. The module will process the data and alert the driver accordingly by using the blink rate. Different people can have different blinking rates. So at first the average blinking rate for the driver will be calculated. To do so, values will be recorded for 2-3 days during the day time.

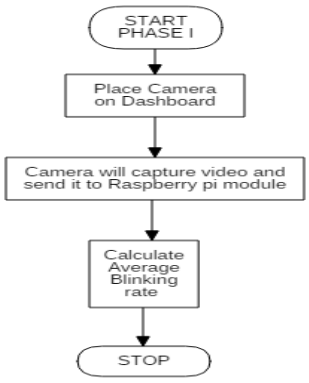

Fig3: Flowchart of phase I

After calculating the average blink rate for the driver, this value is used to detect the drowsiness. If the blink rate at any minute falls below a certain limit, an alarm will be played.

Also if the user keeps his/her eyes closes for particular number of frames, it can be inferred that the driver has slept. So an alarm will be played to wake the driver.

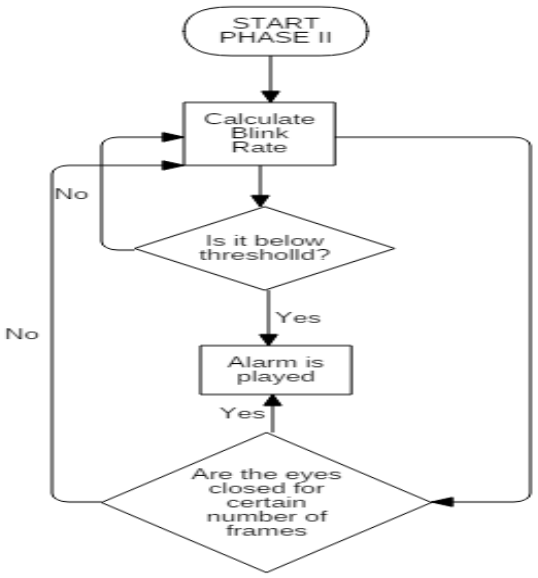

Fig 4: Flowchart of phase II

B. Algorithm

The project will have two phases. In the first phase the average blinking rate will be calculated. Each time the eye aspect ratio drops below the threshold value, the counter for the number of blinks will be incremented. At the end of the day we will get the average no of blinks per minute.

Algorithm: Calculating average blinking rate

1. Initialize:
   no_of_blinks = 0
2. Start the timer
3. for each frame
   a. if EAR < blink_threshold
      i. no_of_blinks++
4. average_no_of_blinks_per_minute = (no_of_blinks)/ (Time elapsed in minutes)

From the first phase the average blinking rate will be calculated. In the second phase this value will be used to detect drowsiness. There will be 2 types of alarms, one when the driver is feeling drowsy and one when driver has already slept. If the driver keeps the eyes closed for certain number of frames, it means that the driver has slept and an alarm will be played. Also if at the end of each minute if no of blinks is less than the drowsiness threshold then an alarm will be played.

Algorithm: Alerting Drowsy Drivers

1. Initialize:
   drowsiness_threshold = average_no_of_blinks_per_minute-c where c is a constant
2. Start the timer
3. For each frame
   a. if EAR < blink_threshold
      i. no_of_blinks++
      ii. counter++
4. if counter > frame_threshold // user has slept
   a. Play the sound to awake the user
5. Else
   a. counter=0
6. At the end of each minute
   a. if no_of_blinks<drowsiness_threshold //user feeling drowsy
      i. Play the sound to alert the driver
   b. The no_of_blinks will be set to 0 after every minute

V. EXPERIMENTAL RESULTS

This section present results for eye blink rate detection and drowsiness detection. The camera can detect the eye blink rate of the driver.

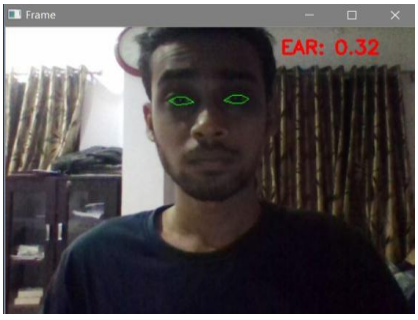

Fig 5: Normal Eyes without drowsiness

In Fig 5, user's eyes is in normal state and eye blink rate is as per the standard expectations set in eye aspect ratio hence it will not trigger alarm to the user.

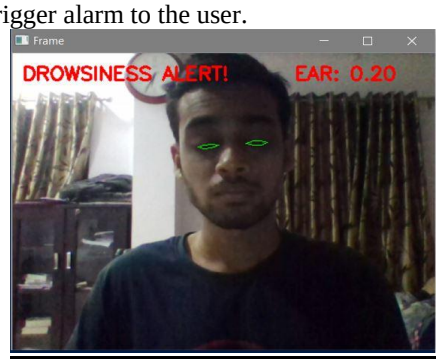

Fig 6: Drowsiness Alert

In Fig 6, drowsiness alert is raised as eyes of the user are closed for more than the standard frames threshold set as per the eye aspect ratio. This will now give alert to the user indicating that some measures to be taken in order to avoid drowsiness and thereby reduces the chances of road accidents.

A. Eye Blink Detection under Normal Light Condition

Table 1: Eye Blink Rate Detection accuracy matrix

Test Condition	Number of Observations	Number of	Accuracy
Sunlight	90	74	82.22%
Indoor Light	90	72	80%
Dark	60	12	20%

The proposed approach provides high accuracy of results under sunlight and indoor light condition with measured accuracy as 82% and 78% respectively.

Whereas, in dark test condition, it is found that accuracy is very low which can be improved by installing infra-red cameras in the vehicles.

B. Eye Blink Detection matrix with spectacles

Table 2: Eye Blink Rate Detection accuracy matrix with Special condition

Test Condition	Number of Observations	Number of Hits	Accuracy
With Spectacles	150	118	78.66%
Without Spectacles	150	116	77.33%

The proposed approach is tested under special environment by trying spectacles to the user and provides good accuracy results in both the scenarios.

VI. CONCLUSION & APPLICATIONS

In this paper, Computations are minimized and tried to make the algorithm as simple as possible by only focusing on the detection of blink and its rates. The system first study the person's average blink rate and then it actually starts its algorithm to detect the drowsiness of the driver. The algorithm can practically implemented as the IR cameras also work at night with great efficiency and we need to only find the outlines of the features of eyes for this algorithm.

The proposed methodology will help in avoiding road accidents due to drowsy driving which is achieved through eye blink rate detection.

A complete implementation of the proposed method will help in averting road accidents which will save precious human life and it will be acting as boom in automobile industry.

The proposed approach can be implemented in buses, trucks and cars in order to detect driver's eye blink rate and fire alarm based on its drowsiness condition as proposed in the algorithms. In India 20% of road accidents are due to driver drowsiness. The implementation of this work will help in saving precious human life.

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