Driver Behavior Monitoring

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Abstract- *In recent years driver fatigue is one of the major causes of vehicle accidents in the world. A direct way of measuring driver fatigue is measuring the state of the driver i.e. drowsiness. So it is very important to detect the drowsiness of the driver to save life and property. This project is aimed towards developing a prototype of drowsiness detection system. This system is a real time system which captures image continuously and measures the state of the eye according to the specified algorithm and gives warning if required. Though there are several methods for measuring the drowsiness but this approach is completely non-intrusive which does not affect the driver in any way, hence giving the exact condition of the driver. For detection of drowsiness the per closure value of eye is considered. So when the closure of eye exceeds a certain amount then the driver is identified to be sleepy. For implementing this system several OpenCv libraries are used including Haar-cascade. Also in order to improve the security and safety of the driver and also strictly monitor if the driver is following "do not drink and drive" rule. The alcohol is been sensed before the vehicle is started if at the the driver consumption of alcohol is detected by the driver the vehicle will not start. This avoids the driver to violate the rules and also to be safe at the same time.*

Keywords- Driver Drowsiness Detection, Face Detection, Eye Detection, Eye Tracking, Haar Classifier, Template Matching.

I. INTRODUCTION

The attention level of driver degrade because of less sleep,long continuous driving or any other medical condition like brain disorders etc. Several surveys on road accidents says that around 30 percent of accidents are caused by fatigue of the driver. When driver drives for more than normal period for human then excessive fatigue is caused and also results in tiredness which drives the driver to sleepy condition or loss of consciousness. Drowsiness is a complex phenomenon which states that there is a decrease in alerts and conscious levels of the driver. Though there is no direct measure to detect the drowsiness but several indirect methods can be used for this purpose. To detect alcohol consumption by driver, if the alcohol level sensed is above threshold the engine will not start and it will alert that the alcohol consumption is high.

Problem Statement:

The attention level of driver degrade because of less sleep, long continuous driving or any other medical condition like brain disorders etc. Several surveys on road accidents says that around 30 percent of accidents are caused by fatigue of the driver. When driver drives for more than normal period for human then excessive fatigue is caused and also results in tiredness which drives the driver to sleepy condition or loss of consciousness. Drowsiness is a complex phenomenon which states that there is a decrease in alerts and conscious levels of the driver. Though there is no direct measure to detect the drowsiness but several indirect methods can be used for this purpose. To detect alcohol consumption by driver, if the alcohol level sensed is above threshold the engine will not start and it will alert that the alcohol consumption is high.

Objectives:

Fatigue warning systems (FWS) have been proposed as specific counter measures to reduce the collisions associated with driver fatigue. These devices employ a variety of techniques for detecting driver drowsiness while operating a vehicle and gives signal to the driver when critical drowsiness level is reached. However, the detection of driver fatigue using valid, unobtrusive, and objective measures remains a significant challenge. Detection techniques may use lane departure, steering wheel activity, ocular or facial characteristics.

Along with this course, Drivers have a duty not to exceed speed limits, maximum work limits or breach minimum rest requirements. Complementing this, entities within the chain of responsibilities must take reasonable steps to prevent driver fatigue or situations that lead to drivers breaching speed limits. It provides extensive information on the alertness, driving performance, and physiological and subjective states of the drivers

II. THE LIETERATURE REVIEW

Driver drowsiness system helps in detecting the drowsy state of the driver such that it helps in avoiding the accidents and property damage. Several studies related to the Driver Drowsiness Detection System are as follows:

[1] Monitoring Physiological Characteristics:

Among these methods, the techniques that are best, based on accuracy are the ones based on human physiological phenomena [9]. This technique is implemented in two ways: measuring changes in physiological signals, such as brain waves, heart rate, and eye blinking; and measuring physical changes such as sagging posture, leaning of the driver's head and the open/closed states of the eyes [9]. The first technique, while most accurate, is not realistic, since sensing electrodes would have to be attached directly onto the driver's body, and hence be annoying and distracting to the driver. In addition, long time driving would result in perspiration on the sensors, diminishing their ability to monitor accurately. The second technique is well suited for real world driving conditions since it can be non-intrusive by using optical sensors of video cameras to detect changes

[2] A Dedicated System for Monitoring of Driver's Fatigue K.Subhashini Spurjeon, Yogesh Bahindwar:

Describe about the road accidents. The road accidents happen due to the lack of attention of the driver. In this paper author describes a real time system for analyzing video sequences of a driver and determining the level of attention. For this purpose, author uses the computation of percent of eyelid closure. The eye closure acts as an indicator to detect drowsiness. Driver's fatigue and drowsiness are the major causes of traffic accidents on road. It is very necessary to monitor the driver's vigilance level and to issuing an alert when he/she is not paying enough attention to the road is a promising way to reduce the accidents caused by driver factors. The fatigue monitoring can be starts with extracting visual parameters. This can be done via a computer vision system. In the purposed work, author purpose a real time robust method for eye tracking under variable lighting conditions and facial orientations. In this paper the latest technologies in pattern classification recognition and in object tracking are employed for eye detection. [4] The tracking is based on the eye appearance. Visual information is acquired using a specially designed solution combining a CCD video camera with an IR illumination system. The system is fully automatic and detects eye position and eye closure and recovers the gaze of eyes. Experimental results using real images demonstrate the accuracy and robustness of the proposed solution. This could become an important part in the development of the advanced safety vehicle.

[3] Drowsiness Warning System Using Artificial Intelligence, Nidhi Sharma, V. K. Banga:

In this paper author discuss about the various artificial intelligence methods for detecting the drowsiness of system. Driver's drowsiness is an important factor in motoring of vehicle from accidents. The driving performance deteriorates with increased drowsiness with resulting crashes constituting morel vehicle accidents. In recent years, there has been growing interest in intelligent vehicles. [5] The ongoing intelligent vehicle research will revolutionize the way vehicles and drivers interact in the future. The detection mechanism into vehicles may help prevent many accidents. There are various techniques used for analyzing driver exhaustion. Most of the published research on computer vision approaches to detection of fatigue has focused on the analysis of blinks and head movements. After long hours of driving or in absence of mental alert state, the attention of driver starts to loose and that creates risks of accidents. These are the typical reactions of fatigue, which are very dangerous. In image fatigue detection, correct and real time decision is very important. In this paper, author discusses the various artificial detection.

[4] A Yawning Measurement Method to Detect Driver Drowsiness, Behnoosh Hariri, et.al:

Describe that the drowsy is the major issue behind the road accidents. The use of assistive systems that monitor a driver's level of vigilance and alert the driver in case of drowsiness can be significant in the prevention of accidents.In this paper author purposed a new approach towards detection of drives drowsiness based on yawning measurement. [6] This involves several steps including the real time detection and tracking of driver's face, detection and tracking of the mouth contour and the detection of yawning based on measuring both the rate and the amount of changes in the mouth contour area. In this paper several techniques are used, that are applied several techniques to ensure the robust detection of yawning expression in the presence of variable lighting conditions and facial occlusions. Test results demonstrate that the proposed

system can efficiently measure the aforementioned parameters and detect the yawning state as a sign of driver's drowsiness.
[5] DEVELOPMENT OF A DROWSINESS WARNING SYSTEM USING NEURAL NETWORK, Itenderpal singh1, Prof. V.K.Banga:

Describe the facial image analysis. As due to the increase in the amount of automobile the problems created by accidents have become more complex. The transportation system is no longer sufficient. Hence the research upon the safety of the vehicles is the recent topic nowadays. In this paper author discuss about the safety warning systems. This system is active warning systems for preventing traffic accidents have been attracting much public attention. Safe driving is a major concern of today's societies. There are thousands of accidents are happen in a day. [7] Due to which many people get injured and many out of them got die. The aim of this paper is to develop a prototype drowsiness detection system. The main focus is on designing a system that are used for l accurately monitor the open or closed state of the driver's eyes in real time. By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident.

[6] 'Camerabased Drowsiness Reference for Driver State Classification under Real Driving Conditions'. In June, 2010, Bin Yang et. al. [16] described

They proposed that measures of the driver's eyes are capable to detect drowsiness under simulator or experiment conditions. The performance of the latest eye tracking based in-vehicle fatigue prediction measures are evaluated. These measures are assessed statistically and by a classification method based on a large dataset of 90 hours of real road drives. The results show that eye-tracking drowsiness detection works well for some drivers as long as the blinks detection works properly. Even with some proposed improvements, however, there are still problems with bad light conditions and for persons wearing glasses. As a summary, the camera-based sleepiness measures provide a valuable contribution for a drowsiness reference, but are not reliable enough to be the only reference.

[7] 'Visual Analysis of Eye State and Head Pose for Driver Alertness Monitoring'.

In 2013, G. Kong et. al. [19] described. They presented visual analysis of eye state and head pose (HP) for continuous monitoring of alertness of a vehicle driver. Most existing approaches to visual detection of non-alert driving patterns rely either on eye closure or head nodding angles to determine the driver drowsiness or distraction level. The proposed scheme uses visual features such as eye index (EI), pupil activity (PA), and HP to extract critical information on non-alertness of a vehicle driver. A support vector machine (SVM) classifies a sequence of video segments into alert or non-alert driving events. Experimental results show that the proposed scheme offers high classification accuracy with acceptably low errors and false alarms for people of various ethnicity and gender in real road driving conditions.

III. THE PROPOSED SYSTEM

This project can be executed in two ways: measuring changes in physiological signs, for example, brain waves, heart rate, and eye flickering; and measuring physical changes, for example, sagging posture, inclining of the driver's head and the open/shut conditions of the eyes [1]. In spite of the fact that this procedure is most precise, it is not reasonable, since detecting electrodes would need to be put straightforward onto the driver's body, and thus be irritating and diverting to the driver. Also, long time driving would bring about sweat on the sensors, reducing their capacity to screen precisely.

Hence this approach will be mostly focusing on amount of eye closure also called (PERCLOS) percentage of closure as it provides the most accurate information on drowsiness. It is also non-intrusive in nature, hence does not affect the state of the driver and also the driver feels totally comfortable with this system. Environmental factors like road condition does not affect this system. The case of micro nap is also detected according the given threshold value. The development of this system includes face identification and tracking, detection and location of the human eye, human eye tracking, eye state detection, and driver fatigue testing. The key parts of the detection framework fused the detection and location of human eyes and driver fatigue testing. The improved technique for measuring the PERCLOS estimation of the driver was to compute the proportion of the eyes being open and shut with the aggregate number of frames for a given period. And adding to it will be the Alcohol Sensor to detect the level of consumption of alcohol if the driver has consumed alcohol more than the threshold value the vehicle ignision is not enabled.

A. ALGORITHM STAGES:

The dataflow diagram makes us understand the detailed working procedures of the drowsiness detection system.

- **Image Capture:**

Utilizing a web camera introduced inside the automobile we can get the picture of the driver. Despite the fact that the camera creates a video clip, we have to apply the developed algorithm on each edge of the video stream. This paper is only focused on the applying the proposed mechanism only on single frame. The used camera is a low cost web camera with a frame rate of 30 fps in VGA mode. Pi Camera is used for this process.

- **Dividing into Frames:**

We are dealing with real time situation where video is recorded and has to be processed. But the processing or application of algorithm can be done only on an image. Hence the captured video has to be divided into frames for analyzing.

- **Face Detection**:

In this stage we detect the region containing the face of the driver. A specified algorithm is for detection of face in every frame. By face detection we means that locating the face in a frame or in other words finding location of facial characters through a type of technology with the use of computer. The frame may be any random frame. Only facial related structures or features are detected and all others types of objects like buildings, tree, bodies are ignored.

- **Eye Detection:**

After successful detection of face eye needs to be detected for further processing.

In our method eye is the decision parameter for finding the state of driver. Though detection of eye may be easier to locate, but it's really quite complicated. At this point it performs the detection of eye in the required particular region with the use of detection of several features. Generally Eigen approach is used for this process. It is a time taking process. When eye detection is done then the result is matched with the reference or threshold value for deciding the state of the driver.

- **State of eye:**

In this stage, we find the actual state of the eye that if it is closed or open or semi closed or open. The identification of eyes status is most important requirement. It is achieved by an algorithm which will be clarified in the later parts. We channelize a warning message if we obtain that the eyes are in open state or semi open state up to a particular threshold value. If the system detects that the eyes are open then the steps are repeated again and again until it finds a closed eye.

- **Alcohol level:**

A alcohol system will continuously monitor the alcohol level of the driver, If the alcohol level is above the threshold values where the driver will not be able to drive vehicle , the vehicle will be turned off.

B. Hardware and Software Requirements

Driver Drowsiness Detection is a very efficient system that helps in monitoring the drivers state of the eye and the alcohol consumptions if any will be detected by using this system. The components that are used to make this module are as follows:

Hardware Components

- Raspberry pi Pi camera
- Alcohol Sensor
- Buzzer
- DC Motor
- Relay
- display monitor
- Sprinkler
- Indicator Lights

Software Requirements:

- Raspbian OS
- open cv library

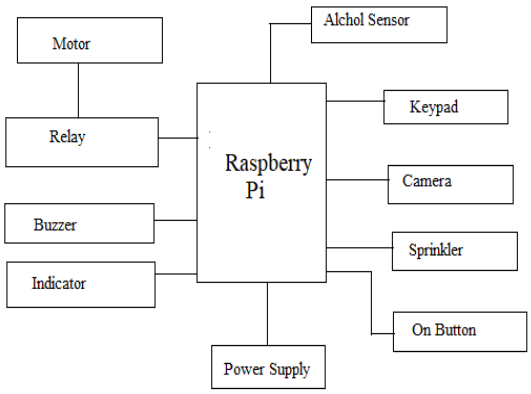


Fig 1. Block Diagram of Hardware Set-up

Software Requirements

- Raspbian OS
- python 3
- open cv library

IV. METHODOLOGY

A. Eye Detection:

Poor contrast of eyes generally creates a lot of problems in its detection. After successful detection of face eye needs to be detected for further processing. In our method eye is the decision parameter for finding the state of driver. Though detection of eye does not look complex but the actual process is quite hectic. In this case it performs the detection of eye in the specified region with the use of feature detection. Generally Eigen approach is used for this process. It is a time taking process. When eye detection is done then the result is matched with the reference or threshold value for deciding the state of the driver. Eye detection is divided into two categories: eye contour detection and eye position detection. Basically eyes are detected based on the assumption that they are darker than other part of the face. Hence Haar Features of similar type can be moved throughout the upper part of the face to match with the feature of eye leading to location of eye. We consider as potential eye areas, the non-skin locales inside face district. Clearly, eyes ought to be inside a face area and eyes are not distinguished as skin by the skin identifier. In this way, we need to discover eye-simple sets among a decreased number of potential eye regions. In recent years several eye detection methods have been developed.

Deformable template is one of the popular method in identifying the human eye. In this method, a model of eye is designed first and then eye position is obtained by recursive method. But this method strongly depends on initial position of the eye which should be near the actual position of eye. In the template matching aspect, the proposed algorithm is based on eigenfeatures and neural networks for the extraction of eyes using rectangular fitting from gray-level face images. This method does not need a large set of training images in its advantage and does by eigenfeatures and sliding window. But this algorithm fails if the user uses glasses or having beard. We know that using Haar features in AdaBoost results in increasing computational efficiency and accuracy than other methods for face detection. But Haar feature has a limitation i.e. discriminant capability. Although the Haar features vary with different patterns, sizes and positions, they can only represent the regular rectangular shapes. But for our case of eye detection eye and iris is of round shape.

Hence eyes can be represented by learning discriminate features to characterize eye patterns. So an approach towards probabilistic classifier to separate eyes and non-eyes are much better option for better accuracy and for robustness.

B. Alcohol Detection:

Alcohol is detected by the alcohol sensor, the values from the sensor is read by raspberry pi and only if the alcohol level is less than threshold value it switch on the relay which in turns on the ignition if the system.

C. Flow of the System:

The steps involved are:

- Authentication using Keyword(password)
- Alcohol Check (if Drink don't start car)
    - Once Ignition is on (Drowsiness detection)
- If driver Drowsy
- Step1: Alarm on (Buzzer)
- Step2: Sprinkler(water)
- Step3: ON Indicators and Switch off Ignition
- Step4:Mail with local Police and Authorised ID

V. RESULT AND DISCUSSION

The driver drowsiness can be measured using Eye Aspect Ratio(EAR). The ratio of the eye can vary for each and every person. Fig.4. the following case is tested for ten different set of people with two conditions. One is calculated for eye-opening condition and another one for eye closing condition. Fig.3. Eye closing rate is measured after every 0.5 seconds and if the value crosses already existed threshold value, then the raspberry pi 3 receives the alert signal from alarm connected to the GPIO pins of Pi 3 board. Fig 5.When the person closing his eyes for more than fixed threshold range then the alert signal is generated to wake up the driver from sleepy state and also through the cloud service the alert message is sent to the owner of the car along with the car plate numbers

VI.EXPERIMENTAL RESULTS

We have used Open CV as a platform to develop a code for eye detection in real time. The code is then implemented on system installed with Open CV software. To detect human eyes, face has to be detected initially. This is done by OpenCV face haar cascade classifier. Once the face is detected, the location of the eyes is estimated and eye detection is done using eye Haar-cascade classifier. Hence using the open CV, face and eyes are detected accurately and displayed on the monitor as shown in the Figure 5 (a). The

larger yellow square indicates the face while smallerred squares indicate the eyes

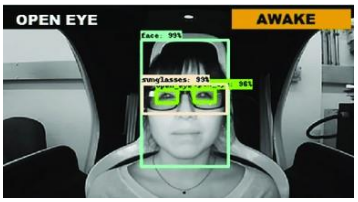
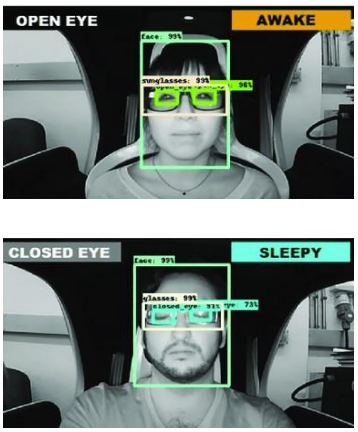


Figure 5 (a): Photograph showing the detected face and eyes

Once face and eyes are detected, it is checking status of eyes i. e. open or closed state of the eyes. If both eyes remain closed for successive frames, it indicates that the driver is drowsy and gives the warning signal as shown in figure 5 (b)

Figure 5 (b): When both eyes are closed gives warning signal.



ALERT!!!

Figure 5 (c): Photograph of combination of Haar classifier and Template matching method.

A fatigue detection system based on the above method was implemented by using Visual C++. At first, we fix a camera on a car in front of the driver. Then we capture some videos from 8 drivers in normal conditions. The whole input image format is 320×240 and they are in RGB color space. We have also found that the optimum distance from camera which obtained about 30cm-50cm that is very suitable for ourmethod

Table1, Table 2, Table 3 shows the experimental results for each method, where the accuracy is the number of frames of open eyes divided by the total number of frames multiplied by 100. The system proposed at the average of 15 frames per second. It surely met the needs of real time. For the proposed method, the correct ratio of open eyes is higher than that of eye close. The average accuracy of our combination method is 90.873%. Thus our eye detection method is robust and irrelevant with different sizes and more accurate. According to obtained results, our system can determine the eye states with a high rate of correct decision

Table 1: Eye state detection for Haar Classifier method

Videos	*HaarClassifer*		
	Total frames	*Open*	*Ratio (%)*
V1	189	158	83.598
V2	224	186	83.036
V3	182	150	82.410
V4	211	178	84.360
V5	252	206	81.746
V6	176	144	81.818
V7	192	157	81.771
V8	222	184	82.883

Table 2: Eye state detection for Template Matching

Videos	*Template Matching*		
	Total frames	*Close*	*Ratio (%)*
V1	277	28	89.892
V2	256	22	89.06
V3	204	25	87.741
V4	298	36	87.919
V5	348	44	87.35
V6	364	47	87.088
V7	312	30	90.385
V8	302	32	89.404

Table 3: Eye state detection for our combination method

Videos	*Combination of Haar and Template matching*			
	Total frames	*Open*	*Close*	*Ratio (%)*
V1	363	327	18	90.083
V2	405	369	27	91.111
V3	383	345	25	90.078
V4	412	378	29	91.748
V5	420	384	11	91.429
V6	392	353	20	90.051
V7	357	323	24	90.476
V8	375	345	20	92.017

For every test videos, the total frames are marked in the parentheses. The number of frames with eye open and close area also marked below. The correct ratio for open eyes is computed for every test videos

VII.FUTURE WORK

Our model is designed for detection of drowsy state of eye and give and alert signal or warning may be in the form

of audio or any other means. But the response of driver after being warned may not be sufficient enough to stop causing the accident meaning that if the driver is slow in responding towards the warning signal then accident may occur. Hence to avoid this we can design and fit a motor driven system and synchronize it with the warning signal so that the vehicle will slow down after getting the warning signal automatically. Also we can avoid the use of Raspberry Pi which is not so fast enough for video processing by choosing our own mobile phone as the hardware. This can be done by developing a proper mobile application which will perform the same work as Raspberry Pi and response will be faster and effective.

VIII.CONCLUSION

Implementation of drowsiness detection with Raspberry Pi was done which includes the following steps: Successful runtime capturing of video with camera and Successful detection of alcohol level.

Captured video was divided into frames and each frames were analysed. Successful detection of face followed by detection of eye. If closure of eye for successive frames were detected then it is classified as drowsy condition else it is regarded as normal blink and the loop of capturing image and analysing the state of driver is carried out again and again. In this implementation during the drowsy state the eye is not surrounded by circle or it is not detected and corresponding message is shown. If the driver is not drowsy and the alcohol level is less then on the vehicle ignition is started.

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