Detecting Driver Drowsiness as an Anomaly

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Abstract - *Driver's Drowsiness is one of the major causes of deadly road accidents, resulting in severe physical injuries and deaths. Drivers are more likely to work overtime when they have a heavy workload. They are exhausted from working continuously for more hours; this can lead the driver to feel drowsy while riding a vehicle. This also impacts a major threat to human life and to lives of passengers as well. To prevent deadly accidents or to warn the driver just in time, reliable drowsiness detection system is implemented, which would alert or warn the driver before anything undesired happens. There are three types of approaches for detecting drowsiness: behavioral, physiological, and vehicular-based methods. The suggested Haar cascade classifier makes use of the driver's "behavioral" measure, that is, it interprets the driver's visual signs. The driver's facial expressions are captured live in the webcam to accurately monitor the open or close state of eyes and mouth of driver's in real time.*

Key Words*: *Drowsiness Detection, Face Detection, Ear Aspect Ratio, Mouth Opening Ratio.

1. INTRODUCTION

Every year, a large number of people die as a result of major road accidents all over the world, and drowsiness is one of the key issues that threatens and affects road safety and causes severe injuries to human lives as well as economical growth. Fatigue or drowsiness is to be blamed for the majority of accidents. Because the motorist is unable to take preventative action, such as turning off the road, this presence while driving generally results in serious accidents. Drivers are more likely to work overtime when they have a heavy workload. They become tired after driving for long working hours and it makes them feel fatigue. The greatest sufferers of this overburden are truck drivers and bus drivers, who drive nonstop all day and night. This puts human life and lives of the passengers in great danger.

Neglecting responsibilities towards road safety has enabled hundreds of thousands of tragedies linked to wonderful invention every year. Maintaining the rules and regulations of the road safety seems most trivial thing to people. However, it is crucial. Because vehicle has more power on the road, and in the control of irresponsible drivers, it may even be dangerous for putting the lives of other road users at risk. Failure to admit when we are too tired to drive is one sort of carelessness.

In India more than 1,51,471 persons are killed in road accidents each and every year with a total of 4,64,910 cases occurring in 2018 as compared to a total of 4,64,910 in the year 2017. The death rate was increased about 2.37% in the period. Uttar Pradesh had the highest number (17,666) of road accidents, as per provisional police figures given by states, Maharashtra (13,212), and Karnataka (10,856). Sleep deprivation, insomnia, restlessness, drinking habits, a long rides, anxiety, drug addicts and extreme trauma can all contribute to a driver's drowsiness. Each one of these factors has the potential to result in a major catastrophe.

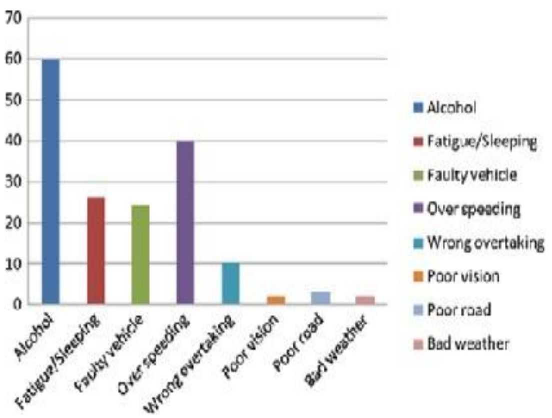


Figure 1: Causes of road accidents show in bar graph

In underdeveloped countries like India, fatigue combined with poor infrastructure is a cause for disaster. In contrast to alcohol and drugs, which has well distinct key factors and procedures, that are publicly available, drowsiness is harder to identify or notice generally. Growing awareness of drowsiness related disasters and motivating the drivers to admit drowsiness, when appropriate are likely the most effective ways to solve this problem. The former is complex and costly to get, whereas the latter is unachievable without such former since long journey travelling is extremely profitable.

The wages increases for the individuals if there is higher demand for jobs. This can include things like driving heavy commercial vehicles late at nights. Drivers are influenced by money to make poor decisions, hence drives tiredly during nights. This is primarily due to the fact that the drivers are unaware of the severe dangers of driving when drowsy. The number of hours a driver can drive at a stretch has been limited in some of the countries.

There are three types of approaches for detecting drowsiness: physiological, behavioral, and vehicle-based methods. Thus the suggested Haar-Cascade Classifier makes use of the driver's "behavioral" measure, that is, it interprets the driver's visual signs. Most of physiological procedures are aggressive, including heartbeat monitoring, sensors and ECG monitoring. Increased driver speed and steering actions are examples of vehicular-based methods. Behavioral approaches such as, eye closure, mouth opening, and others [10] were used. In this study, behavioral-based techniques are used, which have a non-intrusive personality.

The most remarkable aspect of Detecting Driver Drowsiness as an Anomaly (D3A) is that there are no additional costs associated with the lack of use of sensors or external equipment. Eye Aspect Ratio (EAR) and Mouth Opening Ratio (MOR) are some of the parameters used in this system for detecting driver drowsiness. If the driver seems to be drowsy, the driver and the passengers will be alerted. This is how the remaining paper is presented in this manner. The literature Survey is described in Section [II]. The methodology is discussed in Section [III]. The results are stated in Section [IV], and the conclusion is presented in Section [V].

2. LITERATURE SURVEY

In this section, we look at the numerous approaches for detecting driver drowsiness which have already been developed by researchers in current years. Also each technique's strengths and flaws have been recognized.

Amna Rahman [1] et al in 2015 introduced an eye blinking monitoring algorithm that utilizes Haar-Cascade Classifier[15] detects if the eyes are in open state or close, using eye local features and triggers an alarm when the driver is tired. In addition, thorough research results are provided to demonstrate the technique's benefits and downsides. The proposed methodology has been found to be 94 percent accurate. When utilized in good lighting conditions and with a high-resolution camera, this technique produces extremely accurate results. This implies that it performed well under ideal conditions.

Fang Zhang [2] et al in 2017 proposed how to identify fatigue or drowsiness, a convolution neural network (CNN) based eye state recognition system was used, with the percentage of eyelid closure over the pupil over time (PERCLOS) and blink occurrence is being calculated. The result of the experiment shows that the proposed approach can correctly detect the drowsiness and also has the high acknowledgment accuracy for the status of eyes even while wearing glasses. They plan to add more fatigue factors to the system at some point, as well as adjust the parameters of the current model, in order to boost real-time performance and detection accuracy. The CNN algorithm doesn't really instruct the object's coordinates in its predictions, and therefore lacks the ability to be completely consistent to the input data.

Mkhuseli Ngxande [3] et al in 2017 proposed, In the area of drowsiness detection, machine learning techniques such as support vector machines (SVM) , convolution neural networks (CNN), and hidden Markov models (HMM) have been used. This study examines machine learning methods such as SVM, CNN, and HMM. Unfortunately, due to the scarcity of consistent datasets, comparing different methodologies is extremely challenging. A semantic was carried out to address this. This study demonstrated that CNNs outperform alternative strategies, but also addressed the need for larger datasets and consistent benchmarking standards for fatigue detection.

Anshul Pinto [4] et al in 2019 proposed, a Real-time approach for tracking driver concentration, and an extended approach based on Convolution Neural Networks. The system tracks the driver's eyes and feeds the information into a pre-trained model that estimates the condition of the eyes. The system's main factors after the prediction are a camera for real-time picture acquisition, and the processor for implementing algorithms to understand the collected image, as well as an alarm system to inform the driver when any symptoms are found, reducing unwanted disasters. The model's sensitive to movements and lighting conditions.

Wisaroot Tipprasert [5] et al in 2019 proposed a technique using an infrared camera, detecting the driver's eyes closing and yawning for drowsiness study. The four phases in this approach are face detection, eye detection, mouth detection, eyes detection and yawning detection. The performance of the suggested technique was evaluated using 3,760 photographs. Eye closure and yawning detection accuracy rates were 98% and 92.5% respectively. 1) face detection, 2) eyes detection, 3) mouth detection, and 4) eyes closure and yawning detection, had accuracy rates of 99.47%, 94.33%, 99.80%, and 92.5%. When a face is hidden by a hand, errors arise. When a face is obscured, by a hand, errors arise. Although the capture aspect of the camera varies in wide range, the procedure should be executed efficiently in future study.

Sanjay Dey [6] et al in 2019 proposed a pre-trained model that fetches the eyes, nose, and mouth position and analyses the eye aspect ratio (EAR), mouth opening ratio (MOR), and nose length ratio (NLR) using a histogram-oriented gradient (HOG) and a linear support vector machine (SVM). The main goal of this study was to develop a better, more inventive, cost-effective, and real-time technique for dealing with the problem of blinking, yawning, and head bending. The value threshold adapted from the sleeping or drowsy face models aspect ratio data set is then compared to these pieces of information. A Bayesian classifier and SVM were utilized in this study. FLDA and SVM have been demonstrated to lose to Bayesian classification. In the statistical measurement, the SVM and FLDA sensitivities are 0.948 and 0.896 respectively, while both specificities are 1.

3. METHODOLOGY

This section illustrates how the drowsiness system detects the driver's condition along with considering all the facial features such as the state of the eyes and mouth, whether in closed or open state. The figure 2 depicted below shows the architectural design and the working of the system. Live video is fed to the system through webcam. The captured video is then processed at a rate of 21 fps (images are calculated in n number of frames per second), and the backend uses the Dlib library to extract facial landmarks. Hence the model detects the face with 68 specific points of eyes and mouth in the facial model. The face features such as, Eye Aspect Ratio, Mouth Open Ratio is calculated and decision is made on driver's drowsiness. Apparently the model consists of five modules, i.e. Acquisition of data, Face detection, Facial landmarking, and Driver's Drowsiness Detection.

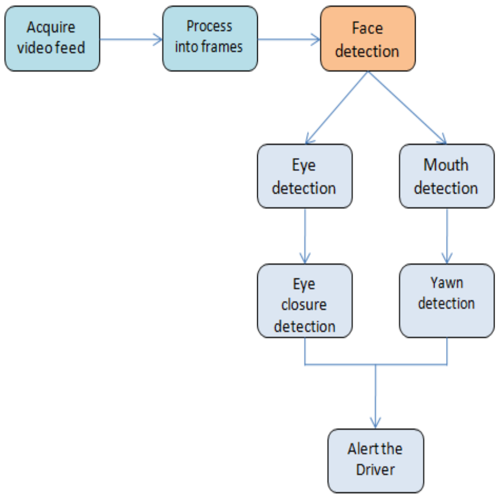


Figure 2: Block Diagram for Driver's Drowsiness System

A. Acquisition of data

Acquisition of data mainly concerns capturing the driver's live video feed. The data is collected via a camera mounted in front of the driver. This converts live video into a sequence of 21 fps, which are subsequently processed. Once the frames are extracted, Image Processing [7] strategies are used to get these 2D pictures. The volunteers are instructed to look at the camera with interrupted eyes blinking, pretending to sleep, and yawning as well.

B. Face Detection

The initial stage of the algorithm extracts the facial region of the input video frame. The Viola Jones Algorithm [8] was employed for this purpose. The world's first real-time face detector was introduced by Paul Viola and Michael Jones in 2001. The values of simple characteristics are used to classify photos in this algorithm. Real benefits are speed and accuracy, as it reaches detection rates comparable to the best models while being way faster than the most of them. The use of rectangular features rather than individual pixels is a main characteristic of this technique. To continue, the total of pixels is calculated using a rectangle box. Merging box sums creates features. Rectangular features are depicted in figure 3 in respect to the detection windows. Two rectangle features are shown in (A) and (B), while three and four rectangle features are shown in (C) and (D), appropriately.

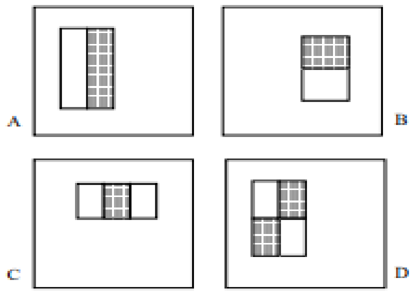


Figure 3: An illustration of rectangular feature in relation to the enclosing detection window

Paul Viola & Michael Jones proposed the integral image depiction of pictures to compute these rectangular features quickly and efficiently. They demonstrated how this input pattern can be used to compute any rectangular sum utilizing four array elements. The characteristics chosen by Adaboost [8] are used in the problem of creating a classifier to choose the best feature out of all the options Adaboost is a computational strategy that uses a weak learning algorithm to locate a single rectangle feature.

The weak learner determines for each feature, the optimum threshold classifier algorithm, resulting in the least amount of distortion examples. In a photograph, the non-face region takes up the majority of the space. As a result, if a region is not a face region, it is better to discard it and not analyze it again. This gives you more time to search for a possible face region. To carry out this procedure, Paul Viola & Michael Jones proposed the idea "Cascade of Classifiers."

In this procedure, the parameters are divided into several phases of the classifier. Instead of applying all 6000 features at once, each one is applied one at a time. When a window fails to reach the initial stage of features, then it will be discarded, with remaining features. If it succeeds, the procedure moves to the stage 2, which involves applying the technique on the window. The face region is chosen as its window that really completes all of these processes successfully. Face region can be detected from video using the Viola Jones methodology and algorithm.

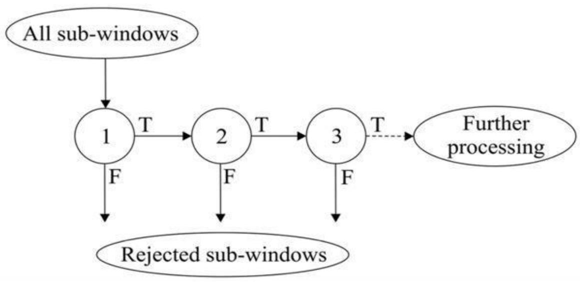


Figure 4: Cascade of Classifiers [8]

C. Facial Land marking

The Python Dlib module was used to extract 68 face landmark points [9] from an image recorded over the duration of the journey. The dlib library includes a face detector that has been pre-trained and utilizes a Cascade Classifier to identify objects. Between the co-ordinate points, the Euclidean distance is determined. A total of two parameters, namely EAR and MOR, have been considered. These parameters are fed into machine learning algorithms and artificial neural networks to determine whether or not a person is drowsy. Figure 5 shows a picture of "facial landmarking points" collected using the dlib library software, and explains the parameters to detect driver's drowsiness.

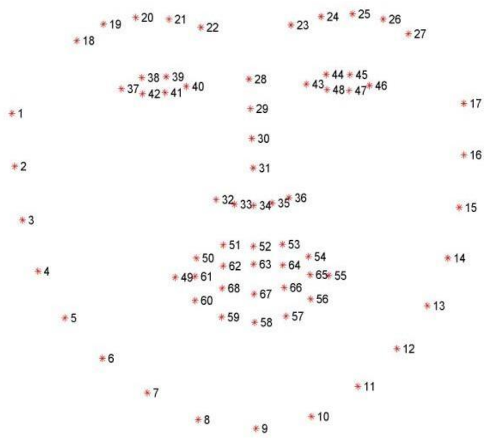


Figure 5: According to dlib library "Facial Landmarking Points"

D. Features Extraction

The features are computed after the facial landmarks have been detected, as stated below.

Eye Aspect Ratio (EAR):

It is defined as the ratio of the eye's height and width. The eyes detection function helps to determine the driver's eyes with appropriate facial land marking after the face detection function has detected the driver's face. This is accomplished by employing a series of pre-determined Haar-Cascade samples. Where pi is the distance between the points i and j in a facial landmark, and (Pi – Pj) is the distance between the points i and j. As a result, while the eyes are totally open, the EAR has a high value, and when the eyes are closed, EAR has a low value. As a result, slowly decreasing of EAR values indicate increasingly closing eyelids, with a value of almost zero indicating totally closed eyes. As a result, EAR levels determine the driver's drowsiness because drowsiness causes eye blinks.

$$EAR = \frac{(|p2 - p6| + |p3 - p5|)}{2 * |p1 - p4|}$$

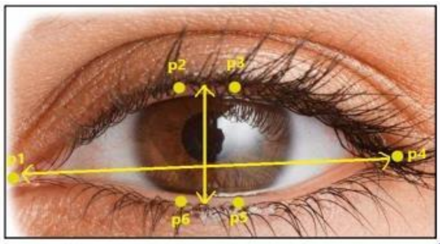


Figure 6: EAR landmarking in the eye

Mouth Opening Ratio

It is defined as the ratio of the extreme points of the mouth's height and the width. The same facial landmarks that are used to detect eye closures can also be used to detect mouth opening. When the mouth is open, the height refers to the space between vertical points. It rapidly increases when the mouth opens because of yawning, due to the yawn (stating that now the mouth is open), the value stays high for a while before swiftly dropping to zero [10].

$$MOR = \frac{(|C - D| + |G - H|)}{2 * |A - B|}$$

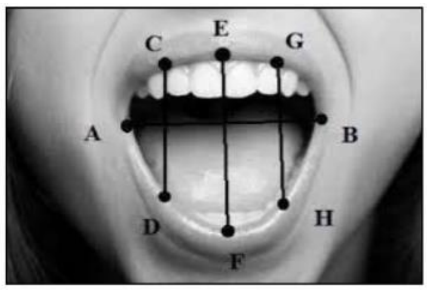


Figure 7: MOR landmarking in the mouth

E. Driver Drowsiness Detection

A region of interest is defined to avoid processing the entire image. By evaluating the region of interest (ROI), it is easy to limit the amount of process needed and speeds up the procedure, which is the major purpose of the proposed approach. Because the camera is focused on the driver, we can avoid processing the image at the corners for face detection, saving a lot of time.

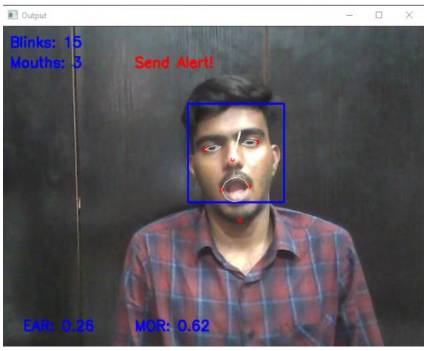
A webcam interface is utilized to check the visual features of the driver, while driving for drowsiness detection [11]. The web cam output will be shown on the screen, and the detection will be done in real time. The system and the driver will have direct connection. If the driver is been identified to be drowsy or fatigued, an alert will be issued, which will be delivered by an inbuilt alarm.

4. RESULTS

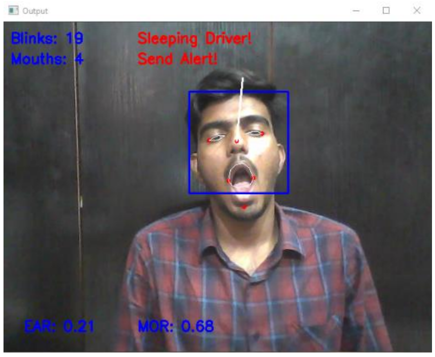
The system was implemented and tested. In order to detect drowsiness, we used it in good lightening condition and stable sitting posture. This work has 4 experiments i.e. Face detection, Eyes detection, Mouth detection, Eyes blinking and yawn detection. A webcam connected with laptop will record all the actions such as, randomly blinking of eyes, yawning. Subsequently, the feature values are stored. Frame from awakened to sleepy state has been exhibited in below figures. Where the threshold values for

EAR = 0.28 MOR = 0.3

Snap 1: This is normal/Ideal condition where the face of person is detected with the specified features, EAR (0.31) is greater than the threshold value (0.28) and MOR (0.26) is less than threshold value (0.3) hence no alarm.

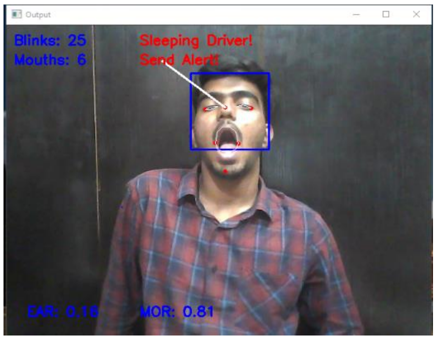


Snap 2: Here person seems to be yawning for 3 counts, hence alert is sent.



Snap 3: Drowsiness detected due to yawn and eyes closure, hence alarm is raised.

Snap 4: Drowsiness detected due to sleep, EAR value is very low, and hence alarm is raised.



Snap 5: Due is high decrease in EAR value and high increase in MOR value, alert is sent and alarm is raised.

Table I illustrates the different states of driver's compared with the different parameter values. Three states have considered in the table that is, Normal state, Eyes-closed state and Yawning state. Hence for each state the alarm is specified with Yes or No.

Status	EAR	MOR	Alarm
Ideal	0.31	0.26	No
Eye Closed	0.10	0.26	Yes
Yawning	0.16	0.61	Yes

5. CONCLUSION

In this paper a survey is carried out for Detecting Driver Drowsiness as an Anomaly. Drowsiness threatens and affects road safety and causes severe injuries to human life as well as to economical growth. To overcome this problem, a drowsiness system is developed using Haar-Cascade Classifier. According to studies done by researchers, driver drowsiness is the primary cause of road accidents. The model can detect drowsiness in driver based on their facial features and expressions. No external equipments or sensors are attached to the driver's body. From the webcam facial features eye aspect ratio (EAR) and mouth opening ratio (MOR) has calculated. If vulnerability is observed like closing of eyes and yawning for a period of time than driver is alerted and alarm is being raised. For the time being threshold value method is created to detect driver's drowsiness in real time, hence the system has performed well and correctly with the artificial data provided. This model works in good lightening conditions and in stable sitting posture. Cab-hiring services like Uber and Ola can be incorporated with the proposed system, which will lower the number of deaths and tragedies.

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