# Driver Alertness Ensuring System

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**Abstract:** About 10-20% of all world traffic accidents are due to the diminished level of attention of the driver. Drowsiness of driver is now identified as one of the key reasons behind fatal crashes caused by the drivers. Thus a drowsiness detection technique is discussed in this paper. This uses various images of the driver to detect drowsiness by monitoring the driver's eyes and yawning pattern. This paper also discusses the use of IOT techniques to send the location of the drowsy driver to the concerned authorities, who will approach the driver along with some help, if required. Thus a potential threat on the road is taken care off.

**Keywords**: Drowsiness detection, Viola Jones, IOT, GPS, SVM.

## Introduction

Current numbers estimate that annually 1,300 deaths and 75,000 injuries can be attributed to fatigue related accidents. National Highway Traffic Safety Administration (NHTSA) analysis data indicates that drowsiness while driving is a contributing factor for road accidents and it results in 4-6 times higher crash risk relative to alert drivers . Most of the fatal road accidents occur at speeds greater than 50 mph. The World Health Organization (WHO) has reported that India has the worst road conditions in the world resulting approximately two and a half lakh deaths in 2010 and 2011[1].

Driver fatigue not only impacts the alertness and response time of the driver but it also enhances the chances of being involved in car accidents. The sleepy drivers fail to take right actions prior to a collision. An important irony in driver's fatigue is that the driver may be too drained to comprehend his own level of drowsiness. This significant problem is often ignored by the driver. Consequently, the use of supporting systems that examine a driver's level of vigilance is necessary to avoid road accidents. These systems should then alert the driver in the case of sleepiness or inattention. Some warning signs that can be measured as indications of driver fatigue are: daydreaming while on the road, yawning, feeling impatient, and feeling stiff and heavy eyes.

The aim of this project is to develop a drowsiness detection system. The vision-based systems have been widely used because of its accuracy and non-intrusiveness. Visual cues such as eye states (i.e. whether they are open or closed) can typically reflect the driver's level of fatigue. Therefore, an automatic and robust approach to extract the eye states from input images is very important. The focus will be placed on designing a system that will accurately monitor the open or closed state of the driver's eyes. By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. Detection of fatigue involves a sequence of images of a face, and the observation of eye movements and blink patterns.

## Literature Survey

In the past few years drowsiness has been studied by various researchers. In [2] the authors have used the HOG SVM (Histogram of Oriented Gradients and Object Detection) approach for drowsiness detection and comparisons are made with that of a human retina. The popularity of HOG SVM lies with object detection and not with the eye blink detection. Further, comparisons with a human retina are highly unreliable as human decisions are prone to more errors than an automated one. In [3] the Authors have proposed a smart watch and a headband containing sensors to identify drowsiness. But this is limited by the choice of the driver who might not like to wear a headband and might wear a different watch. In [4] the authors used a supervised learning method which needed a highly reliable ground truth. The authors in [5] used PERCLOS (A Psychophysiological Measure of Alertness) features for eye status detection. All the human-defined eye features used in their research were calculated from eyelid movements. This means the features are a subset of information provided by eyelid movements. Hence, extracting and utilizing only those artificial features can lead to loss of some meaningful information. Researches in [6] have used speaking and smile detection as emotion detection parameters. In the absence of which a possible drowsiness condition can occur.Use of such a system can only make the algorithm more complex to identify drowsiness. In [7] the Authors have used deep learning and facial expression recognition. But, this approach has the shortcoming of requirement of a huge amount of data to train a neural network to work with a high level of accuracy. In [8] the Authors have considered only the iris status for drowsiness detection. They don't consider yawning detection or head lowering which could lead to a system with a much better accuracy. In [9]Authors have integrated an electrode within a steering wheel to monitor the heart rate and sound alarm in case of fatigue. The approach is still at a very nascent phase as stated in their paper. This paper presents a new method of drowsiness detection which monitors the status of eyes and mouth and does not require any sensors or wearable devices and works well under various illumination conditions.

## Problem Statement

Driver drowsiness is a serious hazard in transportation systems. It has been identified as a direct or contributing cause of road accident. Driver drowsiness is one of the major causes of road accident. Drowsiness can seriously slow the reaction time, decrease awareness and impair a driver's judgment. It is concluded that driving while drowsy is similar to driving under the influence of alcohol or drugs. Hence to avoid road mishaps due to such condition of driver a very efficient and reliable drowsiness detection system must be developed.

### Objective

The objectives of the proposed work are:

a Capturing video either from a web camera or from the stored video from the computer
b Exploring various techniques for feature extraction and classification
c Identifying the state of drowsiness and comprehending the system performance through exhaustive testing process and alerting the driver through voice message or beep tone
d Informing the respective authority by sending the location of the vehicle through SMS (Short Message Service)
e Testing under various illumination conditions

## Implementation methodology

### Proposed Block Diagram

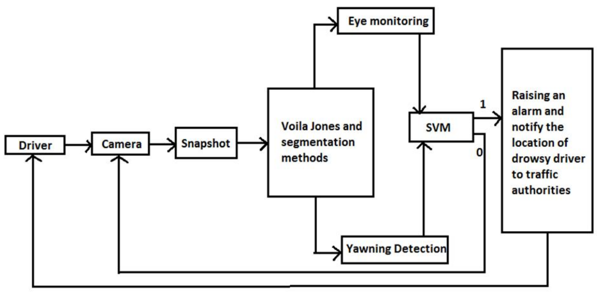


Figure 1. Block diagram

Figure 1 shows the block diagram for the proposed work. The system performs following tasks.

1. Face detection by voila-jones algorithm.
2. Eye state monitoring.
3. Yawning detection.
4. SVM Training.
5. Informing the authorities.

These are explained in next section

### Algorithm

The algorithm includes the following steps,

Step 1: Configure the webcam and assign the video properties.
Step 2: Obtain the live feed using the start function.
Step 3: Convert the video into individual frames.
Step 4: Detect the face using voila jones algorithm.
Step 5: Crop the image frames such that only the face is retained.
Step 6: Detect the eye region and using edge detection procedure, separate left and right eyes.
Step 7: Perform yawning detection using K means clustering.

Step 8: Measure correlation w.r.t. closed state of eyes and mouth to determine the closure of eyes and mouth.
Step 9: Send the location of drowsy driver to concerned authority through SMS.

**Face Detection**

The face detection is done by Viola Jones method [10]. The main aim of face detection is to minimize the false detections in identifying facial expressions. The importance of this part is to accurately locate the position of the eyes and the mouth. Once the face is detected, skin segmentation [11] is performed by converting the image to YCbCr domain. The biggest advantage of converting the image to the YCbCr domain is that, the influence of luminosity can be eliminated by considering only the chromatic components.

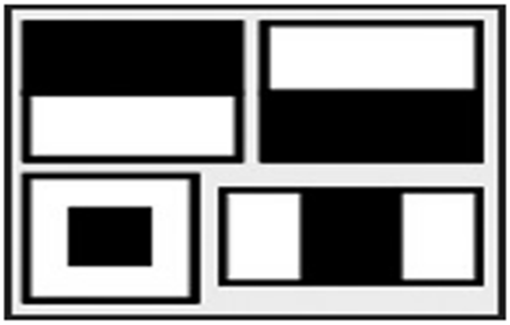

Figure 2:Haar features

In the viola Jones algorithm Haar like features are used in object recognition. Figure 2 shows the Haar features. Working with only image intensities i,e RGB pixel made the task of feature calculation computationally expensive .A Haar-like feature as shown in figure 2 considers adjacent rectangular regions at a specific location in a detection window ,sums up the pixel intensities in each region and calculates the difference between these sums. This difference is then used to categorize subsections of an image. It is given in equation(1)

**Value=(Pixels in black area)-(Pixels in white area)** (1)

We have an image database with human faces. It is a common observation that among all faces the region of the eyes is darker than the region of the cheeks. Therefore a common haar feature for face detection is a set of two adjacent rectangles that lie above the eye and the cheek region. The position of these rectangles is defined relative to a detection window that acts like a bounding box to the target object.

In the RGB domain, each component of the image i.e. red, green and blue has a different brightness. But, in the YCbCr domain all the brightness information is given by the Y-component, since the Cb (blue) and Cr (red) components are completely independent of the luminosity. The domain conversions are used to segment the RGB image into Y, Cb, Cr components. Despite the fact that skin colors differ from person to person, and race to race, it was found that [11] the color remains distributed over a very tiny region in the chrominance plane. This method detects skin regions over the entire face image and rejects most of the non- face image. Fig. 4 shows mouth and eyes being detected, rejecting all insignificant features of face.

**Eye Tracing**

Monitoring the eyes is the most important task during the drowsiness detection i.e. eyes are open or not. During the state of drowsiness the eyes tend to close subconsciously.

The position of the eyes is found using Voila Jones algorithm. Once the eyes are spotted, both the left and right eyes are separated using Sobel edge detection. Here we use vertical and horizontal masks to perform the edge detection. The masks used are shown in figure 3.

| | | |
|---|---|---|
| -1 | 0 | 1 |
| -2 | 0 | 2 |
| -1 | 0 | 1 |

| | | |
|---|---|---|
| -1 | -2 | -1 |
| 0 | 0 | 0 |
| 1 | 2 | 1 |

Figure 3: Sobel mask for edge detection

The detected eyes are segmented from the image and are used to generate an eye template, by this means one can obtain a rather stable eye template for the status analyzing and also reduce the influence of light reflections. The different eye states of full open and half open are not well distinguished most of the time and can cause more false alarms and the variable movement of the drivers head can result in the driver's eyes tracking failure.

**Yawning Detection**

Yawning is another distinct sign of fatigue condition during driving. Yawning occurs when a person is tired and is about to fall asleep. Once the regions of mouth area are found using Viola Jones, the mouth region alone is segmented by K means [5] clustering and tracked using correlation coefficient template matching. K means partitions the objects into K no. of mutually exclusive clusters, so that objects in each cluster are closest to each other, and farthest from objects in other clusters. Each of the K clusters is characterized by its centroid, or center point. The function K-means performs K-Means clustering, by using an iterative algorithm that assigns objects to each clusters so that the sum of distances from each object to its corresponding cluster centroid, over all K clusters, is a minimum. The objective function aims to obtain the minimum distance between the classes, or basically between the image pixels. Using the templates generated with K = 2the exact position of the mouth is detected. The Minimum function is defined in equation (2) and (3)

$$X_K=(A_j|Min( ||A_j-A_k|| ) \quad (2)$$

$$Argmin\sum|| X_k-A_k|| \quad (3)$$

In equations (2) and (3) $A_j$ is $j^{th}$pixel, $A_k$ is the center of class k and $X_k$are pixels belonging to class j. Classification of image pixels is based on the brightness intensity.

Figure 4: Mouth and eyes detection

**SVM Training**

Image analysis is performed using SVM (Support Vector Machine). It is asupervised learning model with associated learning algorithms that analyze data used for classification and regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible.

Support vector machine classifier is the most popular learning model that analyses data and recognition pattern for supervised classification. However, SVM cannot deal with outliers and noises, i.e.its performance will decrease sharply when the data set either contains outliers or was contaminated by noises. Fuzzy SVM (FSVM) is an effective variant with the advantages of reducing the effect from outliers and noises. There are some other advanced variants of SVM, such as generalized Eigen value proximal SVM, twin SVM, least square SVM.

For training purpose 100 different templates are created for each type i.e. open and close. For each of the eye and the mouth their correlation is measured w.r.t to the completely closed ones. Hence the features extracted are Right eye closure, left eye closure and mouth closure. For better real time efficiency partially closed templates i.e. 30% - 50% closed are also trained and assigned the label of close.

The feature vector is given inequation (4) which is normalized over the total number of frames.

**Feature = [LCRCMC TC] / TF** (4)

Where, LC= Left eye closure, RC=Right eye closure, MC=Mouth closure, TC=Total closure, TF=Total frames

**Informing the Authorities**

Here the traffic authorities are informed about the drowsy diver, so that they can take some actions and prevent any kind of mishap on the road.

*Alerting the Driver*

Here we are going to raise alarm inside the vehicle when driver is detected as drowsy or sleepy. This will help him to be alert. Even after the alarm if the driver continues to be drowsy, alarm will be repeated 2 to 3 times. If the driver fails to respond to the alarm, the system assumes that the driver needs some medical attention. In such cases the coordinates of the driver is sent to the server built to handle such situation.

*GPS Technology*

The Global Positioning System (GPS) is a space-based navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The NEO-6 module series is a family of stand-alone GPS receivers. Figure 4 shows the GPS module belonging to NEO-6 family.

Figure 4: Neo-6 module

These flexible and cost effective receivers offer numerous connectivity options in a miniature 16 x 12.2 x 2.4 mm package. Antenna continuously receives the signal from the satellite in an order to get the current position. Data received from satellite is encoded to give the latitude and longitude of position.

*ESP8266 WIFI-Module*

ESP8266 is a highly integrated chip designed for the needs of a new connected world. It offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to upload all Wi-Fi networking functions from another application processor.

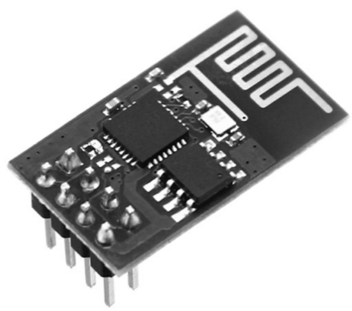

Figure 4.1: ESP8266 WIFI module

*Web Page*

The web page is created using HTML, CSS tools. Also PHP scripts are written to avail SMS, calletc. features in the webpage. Figure 6 and 5 shows the webpage developed for this system. Hence this webpage will act as a dedicated server in this entire system. The data is sent to the web server using the Wi-Fi module, which is thus received by the receiver script in the server. This information is processed and respective authorities are informed through text messages. The database contains the information of the drowsy driver and this can be used for withholding the driver's license till he recovers from the ailments which lead to drowsiness.


Figure 5: Web page

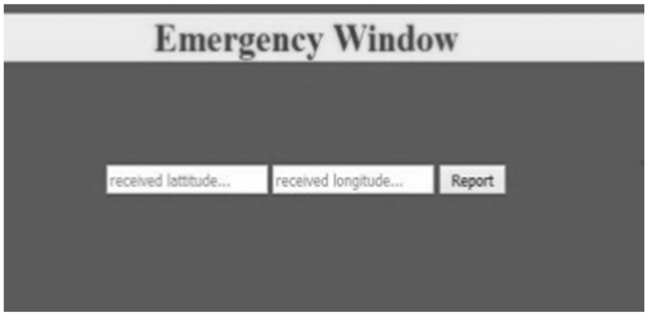


Figure 6: Emergency window page

## Results and Discussions

The condition of the driver is examined in real time and various results are obtained based on driver's behavior on the driving seat. His condition is shown on the console. Various cases are shown below,

**Under Ambient Light**

Case 1: Fatigue condition when eyes are closed
Figure 7 and 9 shows fatigue condition when eyes are closed

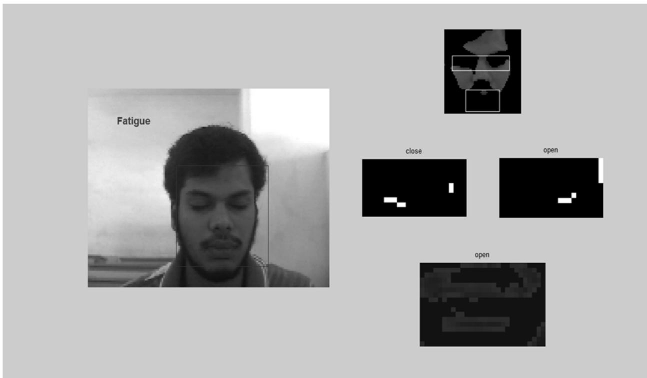


Figure 7:Fatigue condition when eyes are closed

Case 2: Non Fatigue condition when driver is alert
Figure 8 shows non fatigue condition


Figure 8: Non Fatiguecondition

Case 3: Fatigue condition when driver is yawning


Figure 9: Fatigue condition when mouth are opened

**Under Poor Illumination Condition**
Case 1: Fatigue condition when eyes are closed


Figure 10: Fatigue condition when eyes are closed

Case 2: Non Fatigue condition when driver is alert

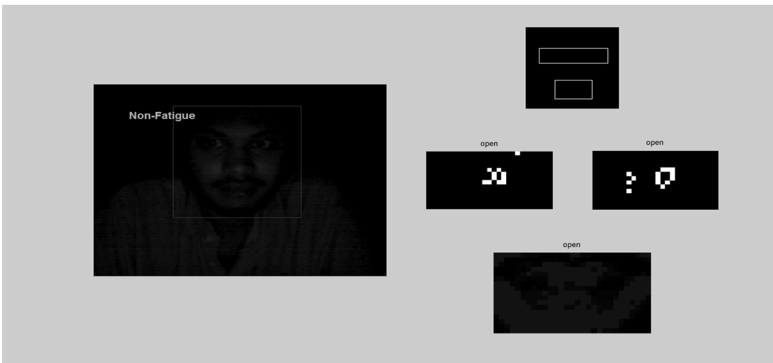


Figure 11: Non Fatigue condition when driver is alert

Figure 10 and 11 shows the drowsiness detection under low light conditions. Figure 12 shows the message received by the authority after detecting drowsy driver. NEXMO provides innovative communication SMS and voice API's that enables application and enterprises to easily connect to the customer.

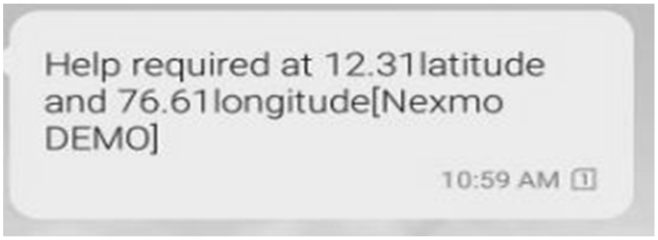


Figure 12: Text message sent by server

## Comparative Study

Table 1: Comparison between previous and proposed work on drowsiness detection

| Attributes | Previous work | Proposed work | Remarks |
|---|---|---|---|
| Voila Jones algorithm | Not all systems make use of this algorithm | Used for face, mouth and eye detection | It is most efficient approach for face detection |
| SVM classifier | Not used | Used | Very Efficient classifier with good average accuracy |
| Buzzer system | Most of them don’t use | Used | Marks the alarming system and hence necessary |
| Location update | Not used | Used | Drowsy driver could easily be found |
| IOT | Not used | Used | Interconnecting various distributed systems |

## Conclusion and Future work

The proposed system detects drowsiness of driver by continuously monitoring mouth area and eyes. This is a nonintrusive approach of detecting drowsiness of driver without interference in daytime with brightness controller.

However, there will be some false detection, where the results are not good when there is quick head-movement. At that time face detection is failed so, future work will be done based on drivers quick head-movement and make it feasible to detect driver’s drowsiness.

Future scopes related to this project are as follows:

- Smart phone application
  Our system can be further developed as a smart phone application that can be installed in the smart phones of the driver. The driver can start this application and place it in the position where camera needs to be placed for detection.
- Stand-alone product
  It can be developed as a stand-alone product with appropriate technology and can be installed in the vehicles to monitor the driver and detect drowsiness. Vehicular control could be implemented along with the system.

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