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Drowsiness Detection System Using Haar Classifiers

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Abstract
The image processing algorithm is used to create a non-intrusive device that can detect any human being's exhaustion and that can provide a timely alert. Studies by the expert show that about one-fifth of all serious motorway incidents are due to tired drivers in need of rest, which suggests that drowsiness causes more road accidents than drunk driving. Using a camera, this device can track driver eyes and, by creating an algorithm, we can predict driver’s fatigue symptoms early enough to prevent the person from sleeping. Right now, consider certain parameters like the discovery of the face, the position of the head and the flickering of the eye. Picture Processing Algorithms are utilized to guarantee legitimate identification of tiredness to keep away from mishaps. So, this project will help detect driver fatigue in advance and will offer alarm and pop-up warming performance.

Keywords: *Drowsiness, Face detection, Flickering of an eye.*

1. Introduction

Drowsiness is a psychological disorder no one takes to heart. This characteristic, however, can have serious and fatal consequences if it is not considered and behaves when driving on roads. Drowsiness is defined as a state of unconsciousness. Real-Time Drowsiness behaviors that are sleepy are in the form of eye closing, head shaking or brain activity. A human being requires at least 6-hour sleep a day to function properly and carry out his / her day — activities. When this factor is ignored and for whatever reason, a person does not get enough sleep it contributes directly to a state of drowsiness. Therefore, we can either assess changes in physiological signals such as brain waves, heart rate and eye blinking to track drowsiness or we can find physical adjustments such as loosening stance, driver's head leaning and eye open/closed state. Driver somnolence detection is a device that guarantees the safety of the vehicle, which can in effect help avoid mishap such as accidents when the driver feels asleep. Several other factors can cause car accidents such as road conditions, atmospheric conditions, and mechanical error/fault of the vehicle. Regardless of driver violations involving drinking and driving, fatigue and drowsiness, 80 percent of the mishaps occur. Factors influence the ability of the driver to regulate the vehicle such as vision, natural reflexes, and understanding. Reducing these factors will lead to accidents. Our paper attempts to evaluate the driver's daily behaviors to determine the extent of drowsiness. Various reports have indicated that tiredness accounts for around 20 percent of all road accidents. Driver exhaustion is a significant factor in many automobile collisions. A major problem in the field of accident prevention systems is the recent development of technology to detect or prevent drowsiness on the wheel.

While the former method is more effective, it is not practical because highly sensitive electrodes will have to be connected directly to the driver’s body, which can be bothersome and distracting to the driver. It is very necessary and reasonable to use image processing in the following step, as it provides one of the best solutions for early detection of drowsiness and saves time to work to avoid accidents. In this approach, the processing of images is used to process the images collected from the person driving the vehicle. Furthermore, long work will result in convection on the sensors, reducing their accurate monitoring capability. The second method is to monitor physical changes (i.e. open/closed eyes for detecting fatigue) because it is not invasive to detect changes in the real world. Therefore, micro periods of sleep that are brief sleep cycles of 2 to 3 minutes are strong markers of exhaustion. Thus, one can detect the

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driver's sleepy condition by constantly watching the driver's eyes, and a timely alert is provided.

A. Drowsiness

Drowsiness is a state of sleepiness. By implication, this is abnormal when it is

- Persistent
- Occur at inappropriate times, or is
- Excessive in nature.

Somnolence is a concern more often because it interferes with regular daytime activities.

2. Literature Survey

Within this section, we addressed numerous methodologies that researchers have proposed within recent years for the detection of drowsiness and blink detection.

Sukrit Mehta, Sharad Dadhich, Sahil Gumber, Arpita Jadhav Bhatt in 2019, has proposed a real-time system that monitors and detects the loss of attention of drivers of vehicles is proposed. The driver's face was identified by recording facial landmarks and the driver was warned to prevent crashes in real-time. Non-intrusive measures were chosen over invasive measures to prevent interference of the driver by the sensors attached to his body. The proposed approach uses the Eye Aspect Ratio and Eye Closure Ratio with adaptive thresholding to detect driver's drowsiness in real-time. This is useful in situations when the drivers are used to the strenuous workload and drive continuously for long distances. The proposed system works with the collected data sets under different conditions. The facial landmarks identified by the program are processed, and algorithms for recognition were used for machine learning. The framework offers 84 percent best-case accuracy for random forest classifier.

Numerous methods have been suggested to detect drowsiness in drivers. This section summarizes the methods available to diagnose drowsiness. **Rateb et al. (R. Jabbar, K. Al-Khalifa, M. Kharbeche, W. Alhajyaseen, M. Jafari, and S. Jiang,2018)** detected real-time driver drowsiness using deep neural networks. They developed an Android application. **Shailesh et al.(S. Sangle, B. Rathore, R. Rathod, A. Yadav, and A. Yadav,2018)** used a camera fixed on the dashboard to capture and send images to Raspberry Pi server installed in the vehicle, to detect faces using Harr classifier and facial points using the Dlib Library. **Vibin Varghese (V. Varghese, A. Shenoy, S. Ks, and K. P. Remya,2018)** detected landmarks for every frame captured to compute the EAR (between height and width of eye) using the landmark points of face. After computing the EAR; **(V. Varghese, A. Shenoy, S. Ks, and K. P. Remya,2018)** determined the driver as drowsy if the EAR was less than the limit for 2 or 3 seconds (because the eye blink lasts approximately 100-400ms). **Ashish Kumar (A. Kumar and R. Patra,2018)** used Mouth Opening Ratio as a criterion for identifying yawning during somnolence.

In 2016, Manu B.N proposed a system that uses Haar feature-based cascade classifiers to detect the face. Firstly, the algorithm needs plenty of positive pictures (face pictures) and negative pictures (faceless pictures) to prepare the classifier to identify the object. So along with the Haar feature-based classifiers, cascaded AdaBoost classifier is utilized to recognize the face region and then the contracted image is divided into numbers of rectangle regions, at any location and scale within the main image. The hair-like appearance is effective for face detection in real time because of the difference in facial appearance. This can be calculated based on the difference in the quantity of pixels quantities in the rectangle region and during the procedure the AdaBoost algorithm will allow all face samples and reject non-face picture samples.

Amna Rahman in 2015 suggested a system for detecting somnolence by using Eye blinking technique to detect eye condition. Next, the image is transformed to a grayscale in this process and the corners are identified using the Harris corner detection algorithm, which identifies the corner on both sides and at the bottom of the eyelid**.** After tracing the lines, it will make a straight line between the top two lines, finding the midpoint by line measurement, and connecting the midpoint to the lower point. Now it will perform the same process for each image and it measures the distance 'd' from the midpoint to the lower point to evaluate eye condition. Finally, the eye-state decision is made based on measured distance ' d.' Whether the difference is zero or close to zero, the eye status will be marked as "closed" otherwise the eye status will be "open." We also invoked the frame timer to know whether the person is feeling drowsy. It is achieved by taking person's mean blink period 100-400 milliseconds (i.e. 0.1-0.4 of a second) in consideration.

3. Image Processing

Digital image processing in computing science involves using digital computers to process digital images through an algorithm. Digital image processing has enormous advantages over analog image processing as a subcategory or field of digital signal processing. This avows the application of a spacious mixture of algorithms for input data and can eliminate problems such as noise creation and distortion during the process. Because images are depicted in two (perhaps more) dimensions, digital image processing can be fashioned as multidimensional systems.

Working Principle: Sleep deprivation driver monitoring system built using non-invasive computer vision concepts. The program uses a real-time camera that straight points to the driver's face and monitors the driver's head speed to detect fatigue. In such a locale, an SOS beep is given to alert the driver when lethargy is detected. The generated algorithm resembles any officially published article that is the main goal of the project. The system pinpoints the eye, nose, and mouth in a sever chunk of the image. If these are not visible, then for five consecutive frames, the software user will fall asleep.

Viola Jones Algorithm: The Viola-Zone Object Detection System was the first object detection system introduced by Paul Viola and Michael Jones in 2001 to provide competitive object detection levels in real time. It is mainly inspired by the catechism of facial recognition. The program is built using the library OpenCV.

Feature types and evaluation: The Face Recognition-Objective is only meant to identify the features (the classification is the first step in the identification phase). The algorithm consists of three steps:

- Haar feature selection
- AdaBoost Training
- Cascading Classifiers

The goal of the monitoring system is to equalize the number of image points in the rectangular areas. This is because they buck some kinship to each function routinely used in image-object detection. Additionally, the concept used by Viola and Jones depends on more than a single rectangular area, they are usually more complicated. The diagram on the right defines four types of attributes used throughout the method. Whatever the specific function is generated, the number of pixels cut from the pixel rectangles to the dark rectangles in the plain rectangles. Such rectangular features can be simplified when opposed to alternatives such as steerable filters. Figure 1 illustrates the Haar features and Figure 2 illustrates implementing Haar features on a face.

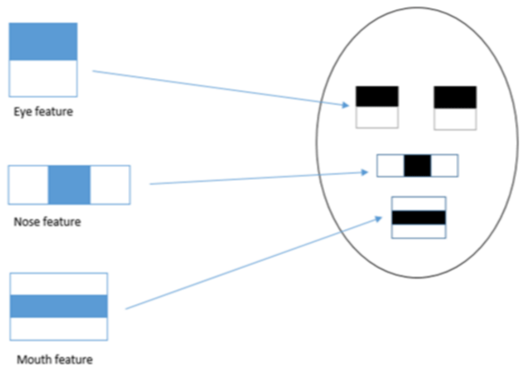

Figure 1: Feature Selection

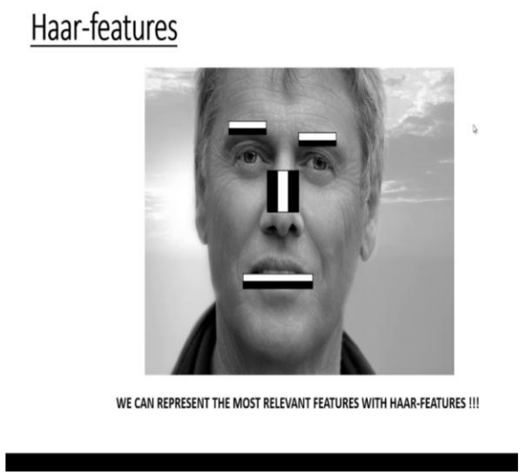

Figure 2: Implementing Features on Human Face

A. Harr features

Some special features of the human face: the eye area is darker than the upper cheeks. The area of the nasal bridge is lighter than the lips. Characteristics of facial features: Position and shape: Bridge of eyes, mouth, nose: gradient in intensity of dependent pixels. The face photograph looks for four features that fit this pattern.

4. Detection Methods

A. Face detection

In 2016, Manu B.N. proposed “Rapid Object Detection in Boosted Cascades of Simple Features”. The proposed method of object detection proposed in 2016 is used for face recognition. This is a technique of machine learning, which prepares cascade function from both positive and negative pictures. It can be used in other images to identify objects. We focus on facial recognition here. To train the classification, the algorithm initially requires very positive images (facial images) and negative images (facial images). After this, we remove the facilities. The Haar properties shown in the diagram below can be used for this purpose. We are like our kernels in punishment. This function is the same value obtained by subtracting the number of pixels from the number of pixels below the black rectangle under the white rectangle.

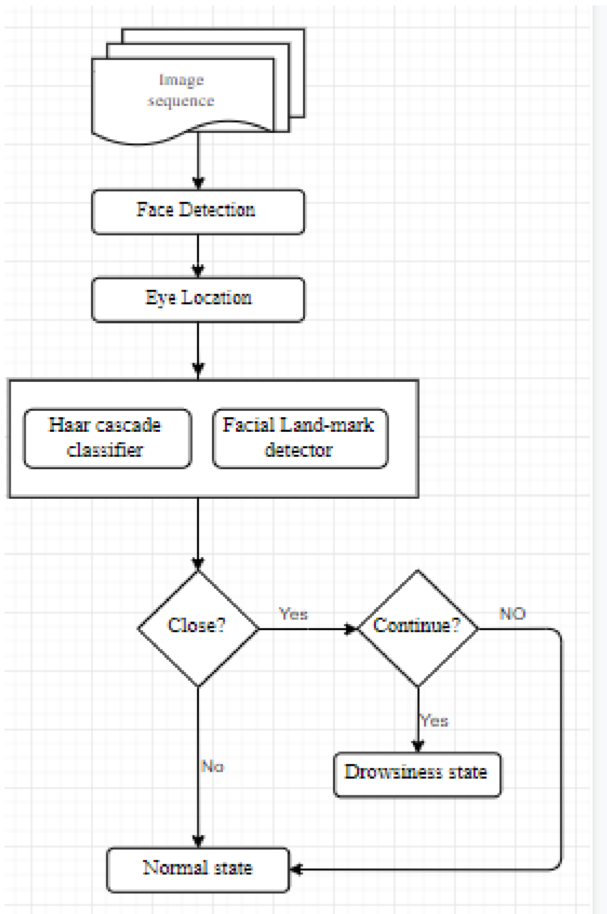

Figure 3: Flow Chart for Drowsiness State Detection

Figure 3 illustrates the flow chart for drowsiness state detection. The AdaBoost classifier with features like HAR is used to identify the face area. Subsequently, within the main image, the compensation image breaks down into increasing numbers and the number of rectangles in the scale. Because of the different features of the face, a hair-like feature can be used to detect the face in real-time. Each poor classification is fitted using the AdaBoost algorithm. Going through the AdaBoost classification in the target pattern cascade you will find the area on the nose. Almost all face samples can be turned off, though non-face samples can be done.

B. Eye Detection

We used facial landmark assessment to identify the eyes in the system. Facial milestones are used to identify and describe facial features, for example:

- Eyes
- Eyebrow
- Nose
- Mouth
- Jawline

Facial areas have been effectively applied for orientation, head position estimation, facial lighting, blink detection and more. Using this algorithm, we are going to identify some facial features that we can use to find EAR. Identifying facial spots is an old-fashioned process:

- Identify the face in the image.
- Face Identify the main facial structures ROI facial structures

Identify the face in the image: Her feature-based cascade classifiers detect the face image, which is discussed in the first stage of our algorithm, i.e. face recognition. Find the main facial features on the face of ROI: There are many face monitors, however, all approaches aim to classify the following facial areas:

- Right eyebrow
- The mouth
- Left eyebrow
- Right eye
- Left eye
- Nose

This method starts using:

1. A training set of milestones labeled on the image. Such images are manually labeled, defining the regions (X, Y) surrounding each facial structure.
2. Priors, more precisely, are the probabilities of the distance between pairs of input pixels. A pre-learned face mark predictor is used in the dlib library to calculate the state of the 68(x, y) -coordinates, which plot the ground on the face.

In the image Figure 4 below you can see the indexes of the 68 coordinates:

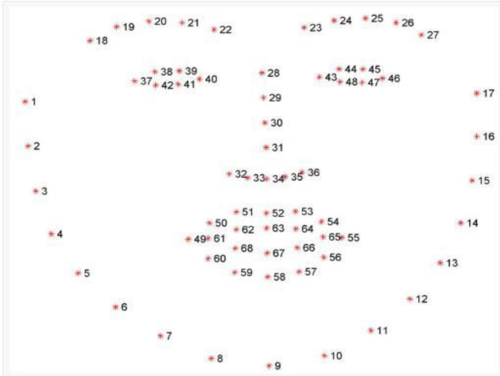

Figure 4: Co-ordinates of Facial Landmarks

- The following facial landmark index shows that we can detect and control both regions of the eye
- The right eye using [37, 42].
- The left eye with [43, 48].

Such annotations are part of the 68-point iBUG 300-W dataset on which the dlib phase mark predictor is learned. It should be noted that a variety of landmark face predictors can be tested in the Helen dataset, including the 194-point model. Even using a dataset, the same DLIB system can be used to train the shape predictor over the input training data.

C. Eye Aspect Ratio Calculation

The eye coordinates are identified for each video frame. The eye-aspect ratio (EAR) is measured between eye height and width.

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

where p1, . . ., p6 are the 2D landmark point. If an eye is open, the EAR is mostly constant and gets down to zero when closing the eye. It is a partially disrespectful person and head position. The open eye ratio is different than the closed eye ratio. Since both eyes blink at the same time, we find the mean EAR of both the eyes. Figure 5 illustrates the identification of all the eye landmarks.

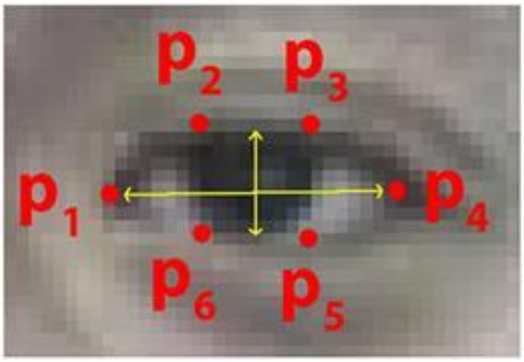

Figure 5: Selecting Points For EAR

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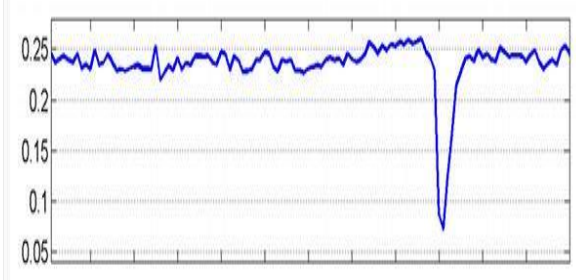

Figure 6: Graph showing Threshold Time Vs EAR

5. Drowsiness Detection System

To design the proposed system to detect passivity following components are used. Software Requirements are Windows, OpenCV Library, QT as editor. Hardware Requirements are Camera, Raspberry Pi Board, Buzzer.
The final step of the proposed design is to find the condition of the person based on a pre-drowsiness condition. A person blinks for a duration of approx. 100-milliseconds. Therefore, if a person's eye closure is somnolent, it will go past this interval. We set a 5-second time. When the eyes stay closed for five seconds or longer, somnolence is observed and this is caused by alerting pop. Figure 7 illustrates the detection of the face and Figure 8 illustrates the drowsiness alert and EAR value.

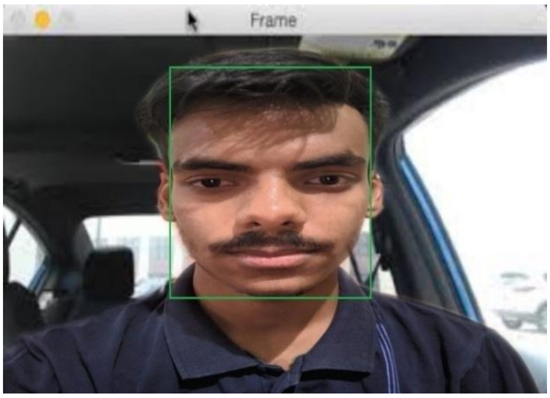

Figure 7: Face Detection

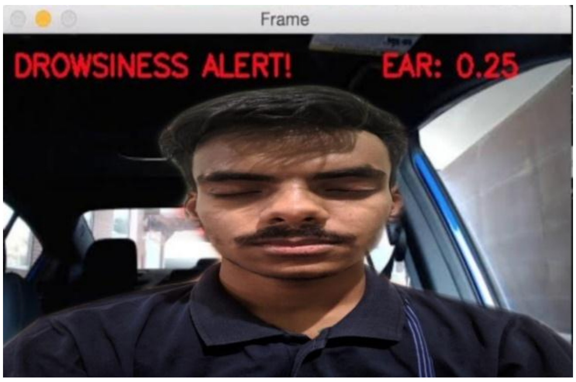

Figure 8: Drowsiness Alert

6. Expected New Applications

Our model is built in the form of an audio alarm to detect drowsy eye-state and set up alarm buzz. But if the driver responds lately to the alarm buzz, an accident is probably to occur. Therefore, we can build and install a motor-driven device in accelerator to slow down the vehicle to prevent this and synchronize it with the alarm buzz so that the vehicle can slow down automatically after the warning signal is received.

We can also provide the user with an Android application that will provide his / her drowsiness level information during any ride. The user would know Normal State, Drowsy State, how many times the eyes have blinked based on the number of frames captured.

Limitations:

- Use of spectacles: If the consumer uses spectacle then the state of the eye is hard to detect. Since it depends heavily on light, spectacle reflection may perform an open eye for a closed eye. For this reason, the camera must be close to the eye to avoid light.
- Multiple face problem: When several faces appear in the frame, the camera can be able to identify more unwanted output faces. Since different faces are in poor shape. So, we will only take the driver's face in the frame of the camera. The detection speed may decrease due to activity on multiple faces.

7. Results and Discussion

The average vertical gap estimation algorithm yielded the strongest outcomes, with an overall accuracy of 79%. The slopes estimation algorithm was the highest, with an average accuracy of 44.5%.

Table 1: Different Algorithms and Their Accuracy

ALGORITHM	ACCURACY WITHOUT GLASSES	ACCURACY WITH GLASSES	TOTAL ACCURACY
Slope using dlib coordinates	76%	13%	44.5%
EAR	90%	49%	69.5%
Vertical distance using dlib coordinates	93%	65%	79%

Table 1 shows the cumulative test runs. From all three algorithms, a dip in precision is observed while the person is wearing glasses. A growing number of high-end vehicles now have sophisticated screening devices for drowsiness. We have found that several pairs of eyes are identified if two or more faces are present in the picture. This blinds the system and the results are unpredictable. With just one pair of eyes in the picture, a potential challenge will be to generate a result.

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8. Conclusion

It proposed an algorithm for real-time eye blink detection. We have quantitatively shown that Haar feature-based cascade classifiers and regression-based facial landmark detectors are sufficiently accurate to accurately estimate the positive images of the face and a degree of eye openness. While they are resilient to poor image quality (in large measure poor image resolution) and in the wild.

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