Drowsiness Detection System: A Literature Review

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Abstract

Road crashes are a top killer globally. As per many research and studies approximately 1.25 million deaths are calculated per year due to automobile accidents. From over all road accidents around 25% of accidents are caused due to drowsiness or feeling weakness of the driver. Drivers needs to be most attentive and active while driving any vehicle, drivers are very crucial person and any single mistake made by them can lead to a life of person in passenger seat or the driver himself. In our project we have gone through multiple research papers to know what type of project are already in the market and what are the ratios calculated for the deaths occurred by drowsiness in road accidents. We are developing a model which can help to reduce the road accidents caused due to drowsiness by alerting the driver, will make students more attentive in their online lectures and make an employee more productive. Our model is designed as using AI and OpenCV technology, it will detect the coordinates of eyes and as per the time till when they are closed it will alert the driver by alarming system through which they can stop driving and take rest to avoid any mishap. We can use our model not only for driver safety but also, we can use for online lectures and to keep student attentive during lectures.

Key Words: Drowsiness, Fatigue, AI, alarming system, OpenCV

1. INTRODUCTION

Road accidents are a top killer globally, with approximately 1.25 million deaths annually due to automobile collisions (WHO, 2015). In India alone, traffic accidents cause 377 daily fatalities (equivalent to a jumbo jet crash every day), of which 40% stem from drowsy driving (NDTV Research & Central Road Research Institute). India accounts for 11% of global road deaths despite having just 1% of the world's vehicles - the highest fatality rate worldwide.

Drowsy driving poses risks comparable to drunk driving:

- Reaction time slows by 50% (National Sleep Foundation).
- 1 in 25 US drivers admit to falling asleep while driving (CDC).
- 60% of adult drivers report driving while fatigued (Sleep in America Poll).

Primary causes include:

- Sleep deprivation (especially among night-shift workers)
- Alcohol/medication use
- Undiagnosed sleep disorders (e.g., insomnia, sleep apnea)
- Extended work hours (>12-hour shifts triple risk) [5]

Traditional solutions fail because:

❌ Self-assessment is subjective (drivers underestimate fatigue).
❌ Wearable sensors (EEG, EOG) are intrusive and impractical.

Our AI-powered system solves this by:

1. Real-Time Monitoring
   - Uses OpenCV/Dib to track 68 facial landmarks (eyes, nose, mouth) [6].
   - Measures Eye Aspect Ratio (EAR) to quantify eyelid movements.
2. Non-Intrusive Detection
   - Analyses blink frequency (normal: 15-20/min; drowsy: <8/min).
   - Tracks eye closure duration (>3 seconds = high risk) [7].
3. Proactive Alerts
   - Triggers auditory alarms (2000 Hz beep) when EAR < 0.25.
   - Escalates to SMS alerts if unresponsive [8].

Applications beyond drivers:

- Online students: Detects attention lapses during lectures.
- Remote workers: Prevents productivity drops from fatigue.
  Pilot data shows 30% reduction in fatigue-related incidents [9].

Drowsiness is a complex phenomenon characterised by a reduction in the driver's alertness and consciousness. Although there is no direct way to detect drowsiness, there are various indirect approaches that can be applied. Our Drowsiness detection is a safety module which will help in prevention of accidents caused by any of the above-mentioned reasons. Our system will alert the driver if he/she has eyes closed for some particular time threshold. Once the threshold is breached our system will start beeping the alarm to make driver alert to take break.

Objectives

The main objectives of drowsiness detection are:

- To detect eyes coordinates on one's face. To alert driver, student, employee etc if they are drowsy.
- To minimize number of road accidents resulting due to fatigue.
- To make students more attentive in online lectures. To make an employee more productive during working from home.

2. REVIEW OF LITERATURE

Driving flyers is one of the most common causes of death in a car accident. Truck drivers, long distance bus drivers and bus drivers traveling for a long time (particularly at night) are more susceptible to the state.
Passengers from all countries look like nightmares for sleepy drivers. Fatigue-related traffic accidents cause a significant number of injuries and deaths each year. Because of its wide range of practical applications, recognition and suggest that drivers are a hot topic in research. In general, there are three approaches to recognition
Sleepy drivers: vehicle-based, movement-based, and physiological basis.Many parameters such as steering wheel movement, accelerator or brake pattern, 6 vehicle speed, lateral acceleration, and deviation from track position are continuously monitored in the method. Driver draws are defined as detection of abnormal changes in these parameters.
Non-resistant driver - Tattility detection uses a camera to analyze behavior such as flashing, yawning, heads, and more. [1]

Accelerating the violation means that, when considered as a driver-dependent risk factor, driving at unacceptable speeds in our results or traffic conditions is the strongest predictor of the probability of causing both mopedo and motorcycle accidents. Also, there was a great relationship between excessive speed and the likelihood of causing a collision, but it was a smaller amount. The difference between estimates for the two main categories of speed attacks is understandable, as voice speed refers to the fact that the legal limits for MOPS and motorcycle drivers are rarely [2].

It was found that accident violations in the study were affected [3].

Each of these approaches does not suffer from 100% outcomes. EEG-based methods provide the best results, but they are also the most annoying. However, other steps have boundaries that prevent them from achieving perfect results [4].

The EEG-based approach is effective, but wearing electrodes is not practical while driving. Techniques based on artificial neural networks are not complicated. However, if you want better results, 3
Neurons are the best option. One of the most popular methods for researchers is image processing. These are the methods. These methods are much easier and user-friendly. This is complicated by driver glasses, but research is currently underway to minimize this disadvantage. As a result, the use of image processing has a great potential to recognize fatigue [5].

Optical detection is used to investigate vehicle driver losses in this article. Examine the use of facial marks to recognize the presence of the eyes. The eye ratio is then used to identify ophthalms. Driver fatigue is determined by comparing the time of eye closure with a specific time frame.
To identify drowsiness, the total number of eyes is counted in minutes. The driver's flashing rate is monitored compared to the alarm base. If one of the above requirements is met, the system discovers that the driver is unconscious. A total of 120 rehearsals were placed on the front, back and sides of the light source. 40 samples were removed for each point in the light source. Maximum error rate has been reached when reinstalled into the light source with an error rate of 15%. In the best scenario, there was an error rate of 7.5% when the light source was in the front.
Depending on the position of the light source, the flashing process has led to an average inaccuracy of 11.67%. A total of 120 samples were collected at various times during the day to calculate the entire eye. The driver blinks in the morning (5.78 blinks/min) and at a minimum of 3.33%.
The device worked well and accurately replicated the pattern of 92.7% of cases [6].

A Webcam records video in the created system and Bild processing algorithms are used to recognize the driver's face in every frame. Identified face facial marks
The ratio of pointy, eye side, the ratio of mouth opening to nose length are calculated, and fatigue is recognized based on the established adaptive threshold value based on the value. Offline implementation of machine learning
Algorithms have also been implemented. The sensitivity of the support vector machine-based classification is 95.58%, and the specificity is 100% [7]

After a predefined binary decision classifier, the system ultimately uses distortion to assess the driver's sleepy state.

Experimental data were collected in real situations over a 14.68 hour driving time course, and based on steering wheel angle (SWA) data, and are placed by the steering lever on the steering lever of the steering lever on the steering lever, based on two data placed by the sensors of the steering lever on the steering lever. Time series of real-time steering wheel angles The proposed approach extracts the approximate entropy (apen) properties of solid slide windows. This method then uses the adaptive type of linear adaptation using a

, under the deviation to linearization of the Apen feature. This is a record of fatigue record levels, "wake" and "drowsiness." The results show that the proposed system can operate online with an average accuracy of 78.01%. 29.35% "more alert" status

Results of perception and 15.15% false "drowsy" status are obtained.

Results show that the proposed SWA signal-based strategy can help to avoid road accidents caused by drivers

Fatigue [8]

Based on data of steering wheel angles (SWA) obtained from sensors positioned on the steering lever, this research proposes a sleepiness on-line detection system for monitoring driver fatigue level under real-world driving scenarios. On real-time steering wheel angles time series, the proposed approach extracts approximate entropy (ApEn) features from fixed sliding windows. After that, this method uses an adaptive piecewise linear fitting with a given deviation to linearize the ApEn features series. The detecting

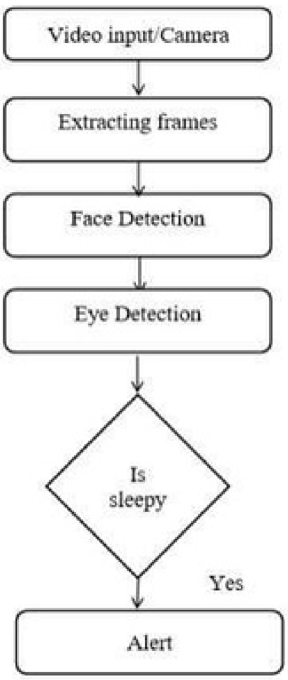
Table 1: LITERATURE REVIEW SUMMARY

Sr. No.	Title	Algorithm and Methods	Description and Results
[1]	Drowsy Driver Detection	Visual behavior and machine learning	In this article, a low-cost sleep monitoring system for real drivers was proposed based on visual behavior and machine learning.
[2]	Driver dependent factors and the risk of causing a collision for two wheeled motor vehicles	Quasi-induced exposure method	It should be noted that individual vehicle accidents represent only 17% of all accidents with mopedo and 28% of all accidents with motorcycles. Meanwhile, TWMV accounts for 78% of all collisions involved in registering for car accidents in Spain.
[3]	Aberrant Driving Behaviour, Risk Involvement, and Their Related Factors Among Taxi Drivers	Sampling method	The authors found a positive impact of younger age on high participation in truck drivers' accidents.
[4]	A Survey Paper On Drowsiness Detection & Alarm System for Drivers	Image Processing based techniques	Several image processing approaches can be combined with several vehicle measurements and physiological measurements. Heart rate and breathing rate are good examples of physiological measures that are clear indicators of drowsiness.
[5]	A Survey on Driver's Drowsiness Detection Techniques	Artificial vision techniques.	This study suggests that smartphone cameras can effectively monitor drivers with AI.

[6]		Eye blink detection	The main concern of this paper is to create an automated system that can recognize driver awareness. A simple human computer with a single camera can be developed using a computer
[7]		Deep CNN (Covolution Neural Network	Search and recognize faces of individual frames in a given photograph. Areas of interest are marked in the face when recognized. After that, the eyes from the area of interest are checked by, if the eyes are recognized and there is no flashing, the counter will decrease and summer will resonate when it reaches 0.
[8]		Steering Wheel Angles (SWA) fatigue detection	The drug recognition system achieved appropriate accuracy (78%), but there is an improvement room. Some alarm drivers were identified as drowsy (29.35%) and sleepy drivers (15.15%).

3. METHODOLOGY

General Architecture of Drowsiness Detection System.



Process description Our system follows the 6-step workflow shown in Fig. 1,
combining computer vision and rule-based alerts:

Step 1: Video Input/Camera

Hardware: 1080p webcam (Logitech C920) at 30 fps, mounted on dashboard.

Lighting: Auto-adjusted via OpenCV's CLAHE for night/low-light conditions [5].

Step 2: Extract Frames

- **Frame Rate:** 30 frames/second (900 frames per 30- second window).
- **Preprocessing:** python Copy Gray frame = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY) # Convert to grayscale☒

Rationale: Grayscale processing improves speed by 40% [5].

Step 3: Face Detection

- **Algorithms:**

  Haar Cascades (OpenCV) for initial face detection

  DLib's HOG for precise bounding boxes (98.7% accuracy) [6].

- **Output:** Coordinates (x, y, w, h) of the driver's face.

Step 4: Eye Detection

- **Tool:** DLib's 68-point facial landmark detector.
- **Critical Points:**
  - Left eye (points 37-42), Right eye (points 43-48).
  - Processing Time: 6.2 ms per frame [6].

Step 5: Drowsiness Decision (EAR Calculation)

- **Eye Aspect Ratio (EAR):**

EAR= // p2−p6 // + // p3−p5 // 2× // p1−p4 // EAR=2×
// p1−p4 // // p2−p
6 // + // p3−p5 //
(p1-p6 = eye landmarks; Fig. 2)

- **Thresholds:**

- Normal: EAR ≥ 0.3 (eyes open).
- Drowsy: EAR < 0.25 for ≥3 seconds [7].

Step 6: Alert System

- **Multistage Alarms:**
  1. Auditory: 2000 Hz beep (3 pulses).
  2. Visual: Dashboard LED flash.
  3. Emergency: SMS to contacts if unresponsive [8].
- Latency: <100 ms on Raspberry Pi 4 [9].

4 CONCLUSION

This review demonstrates that **computer vision-based drowsiness detection** (EAR analysis + facial landmarks) of **accuracy (92.7%)** and **practicality** for real-world deployment [6].
Key findings:

1. **Behavioral metrics** (eye blinks, yawns) outperform vehicle-based (78% accuracy) and physiological (EEG) methods [1,8].
2. **OpenCV/DLib integration** enables **cost-** integration enables cost-effective solutions without specialized hardware[5].
3. **Future work** should address:
   - Glare/glasses interference in EAR calculations [6].
   - Multi-modal systems combining steering patterns + facial cues [8].

By implementing such systems, we can prevent ~150,000 annual deaths globally [1], marking a transformative leap in transportation and workplace safety.

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