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Driver's Drowsiness Detection System

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Abstract

One of the main causes of road accidents worldwide in recent years is driver fatigue. Assessing a driver's mood, or how sleepy they are, is a clear approach to gauge their level of exhaustion. Therefore, detecting driver fatigue is very important to save lives and property. The creation of a prototype drowsiness detection system is the aim of this research. The system operates in real time, continuously capturing images and measuring the eye's condition based on a given algorithm, issuing warnings when necessary. Since driver weariness is one of the main causes of traffic accidents globally, monitoring driver drowsiness is crucial to maintaining road safety. Although there are various techniques available to detect drowsiness—such as wearable sensors, steering behavior analysis, and physiological signal monitoring, many of these methods are invasive or uncomfortable for the driver. In contrast, the approach implemented in this project is entirely non-invasive, meaning it does not require any physical contact or wearable equipment. This makes it highly user-friendly and allows for more accurate and natural observation of the driver's behavior without causing any distraction or discomfort. The primary focus of this system is the analysis of the driver's eye behavior, particularly eye closure. Prolonged eye closure is a strong indicator of fatigue or drowsiness. The device uses a real-time video feed to continuously monitor the driver's eyes. If the eyes remain closed beyond a certain threshold duration or at a high frequency, the system interprets this as a sign of drowsiness and can trigger alerts to regain the driver's attention. To implement this functionality, advanced computer vision techniques are used, specifically through libraries such as OpenCV and Dlib. In order to determine the eye aspect ratio (EAR), a number that shows whether the eyes are open or closed, and to recognize facial landmarks, these libraries are essential. When the EAR falls below a set limit for a certain number of frames, the system concludes that the driver may be sleepy. This real-time, automated system enhances vehicle safety and reduces the risk of accidents by providing timely alerts. Moreover, it is scalable and can be integrated with other vehicle safety systems. Future developments could incorporate additional features like head pose estimation, yawning detection, and even AI-based fatigue prediction models for more comprehensive monitoring.

Keywords: Driver drowsiness detection, non-invasive monitoring, eye aspect ratio (EAR), computer vision, OpenCV, Dlib libraries

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INTRODUCTION

A driver's concentration decreases due to lack of sleep, prolonged driving, or other medical conditions such as brain disease. According to numerous studies on traffic accidents, driver weariness accounts for approximately 30% of the collisions. When a driver spends more time behind the wheel than usual, he or she experiences severe fatigue and loss of energy, which can lead to drowsiness or loss of consciousness. Drowsiness is a complex condition that leads to decreased driver alertness and consciousness. While determining drowsiness cannot be performed directly, several indirect methods can be employed [1–5]. The condition of drowsiness itself is intricate and multidimensional, involving psychological (such as motivation and mental workload) and physiological (such as brain activity and sleep cycles) interactions. It can develop gradually and frequently goes unnoticed by the driver until it reaches a hazard level. Inadequate sleep at night, long-distance or monotonous highway driving, circadian rhythm disruptions (such as those encountered during late-night or early morning driving), stress, adverse drug reactions, and long-term health issues, such as sleep apnea, are all potential causes of drowsiness. Drowsiness cannot be evaluated in the same way as in other conditions because it develops gradually and lacks a clear, quantifiable indicator. Drowsiness and sleepiness during driving are the leading causes of road accidents. Fatigued driving poses a safety hazard to the road and can sometimes lead to serious injury, death, and economic loss. Drowsiness is a condition in which a person feels sluggish, has trouble concentrating, and feels tired while driving. Most accidents in India are caused by careless drivers [6–8]. Over time, drowsiness can lead to a decrease in a driver’s ability to drive. We created a technology that can identify driver weariness and issue instant warnings to prevent this. Many people drive on the highways all day and night. These include bus drivers, truck drivers, taxi drivers, and people who travel long distances and do not get enough sleep. Driving a car when you are tired from a lack of sleep can be very dangerous. A study of the Australian Transport Agency’s Road Fatality Database found that 16.6 per cent of deaths were caused by sleep deprivation, while a report from the Ontario Ministry of Transportation found that 25.5 per cent of crashes were caused by a lack of sleep. Injuries due to lack of sleep accounted for 17.8% of accidents. In India alone, more than 148,000 people died due to road accidents in 2015. Of these 1.4 million crashes, at least 21% were caused by fatigued driving, which caused drivers to make serious mistakes. However, this number is relatively small because the role of fatigue in the occurrence of accidents has largely been underestimated [9]. Physiological indications, including increased blinking, extended eyelid closure, frequent yawning, eye redness, relaxed facial muscles, decreased head stability, and abnormal heart rate patterns, are examples of these indirect indicators. Fatigued drivers frequently exhibit poor lane-keeping performance, slower reactions to road dangers, delayed braking, inconsistent or inappropriate speed management, wandering attention, and abrupt or jerky steering movements, all of which are behavioral indicators that are crucial in diagnosing drowsiness. Advanced driver monitoring systems have been developed as a result of advances in automobile technology, in addition to these human-observable signs. In order to continuously monitor the driver’s face features and gaze direction, modern cars may incorporate cameras, infrared sensors, and eye-tracking technologies. In developing countries like India, where roads and bridges are in poor condition, fatigue can lead to disaster. Unlike alcohol and drugs, fatigue cannot be measured, and its levels can be accurately measured and easily tested. The best way to address crashes caused by drowsy and fatigued driving is to increase awareness and encourage drivers to recognize fatigue when necessary. The first solution is difficult and costly, while the second is impossible without the first, as fixed-term employment contracts have long been an excellent option for drivers. This amount depends on salary. As the attractiveness of industry-related jobs continues to grow, the corresponding salaries are also growing. The same occurs when driving a truck at night. Fatigue-related driving remains a serious concern in many parts of the world and contributes significantly to road accidents and fatalities. Drivers often make poor and risky decisions for financial reasons, such as choosing to drive long hours or throughout the night, even when they are exhausted. This behavior is especially common among commercial drivers who may be under pressure to meet tight delivery deadlines or earn more income by taking extra shifts. One of the main issues is that drivers often fail to recognize the dangers of driving while being fatigued. Unlike alcohol or drug impairment, fatigue is a silent threat; it develops gradually and can severely impair reaction times, decision-making abilities, and overall alertness without the driver realizing it. To address this problem, some countries have implemented regulations that limit the number of permitted continuous driving hours and require rest periods between [10, 11]. However, enforcing these rules is complex and expensive, particularly when monitoring a large number of vehicles or independent drivers. Additionally, these measures alone are not always sufficient to prevent fatigue-related incidents, highlighting the need for smarter technology-driven solutions such as drowsiness detection systems to ensure driver safety on the road.

TOOLS AND TECHNOLOGIES USED

A functional requirement is defined as a part or element of a product within the overall programming methodology of a system or building, specifying the basic services that the system is required to provide to the end user.

- Recording the driver's behavior at the beginning of a trip.
- Continuous assessment of the driver's facial features over a long period of time.
- Triggering an alarm if the driver feels drowsy.
- On the dashboard or display screen, flash visual alerts.
- When sleepiness indicators surpass thresholds, alert mechanisms are triggered.

NON-FUNCTIONAL REQUIREMENTS

Non-functional requirements are essentially quality constraints that the system must satisfy based on a project contract. They are also called optional behaviors.

- The camera that records video must have high resolution.
- The system must also work in low-light conditions.
- The alarm must be set at a high volume to wake the driver.

SYSTEM CONFIGURATION

Software Requirements

- *Language:* Python 3
- *IDE:* Visual Studio Code, PyCharm
- *Operating System:* Windows 10/8 (including 64-bit), Mac OS, Linux

Hardware Requirements

- *Processor:* 64-bit, quad-core, at least 2.5 GHz per core
- *RAM:* 4 GB or more
- *Display:* Monitor with a resolution of 1024 x 768 or higher
- *Camera:* Webcam

LIBRARY USED

- *SciPy*: SciPy is an open-source Python library. It relies on NumPy, which makes working with N-dimensional arrays quick and straightforward. The package SciPy. The Euclidean distance between the lips and eyelids was spatially determined.
- *NumberPy*: A Python package called NumPy offers a multidimensional array of objects, a few derived objects (including matrices and masked arrays), and a collection of functions for quick array operations.
- *Time of date*: Classes for working with dates and times were provided by the Python Datetime package. These classes offer numerous capabilities to manage dates, times, and time ranges. It was employed to compute the time intervals and obtain the current time.
- *Dlib*: A variety of machine learning algorithms, such as classification, regression, clustering, data transformation, and structured prediction, were implemented using the open-source C++ library Dlib.
- *PyGame*: A well-liked Python package for creating multimedia apps and video games is called PyGame. It is perfect for creating 2D games because it has modules for managing sounds, graphics, and user interaction. By utilizing PyGame's straightforward, user-friendly API, developers can quickly produce interactive games and visual projects.
- *Pyttsx3*: A Python package called Pyttsx3 is used to convert text to speech. It supports multiple speech engines and works offline, allowing developers to generate spoken outputs from text. Pyttsx3 provides easy control over the speech rate, volume, and voice type, making it

useful for accessibility tools, virtual assistants, and other speech-enabled applications (Figures 1–3).

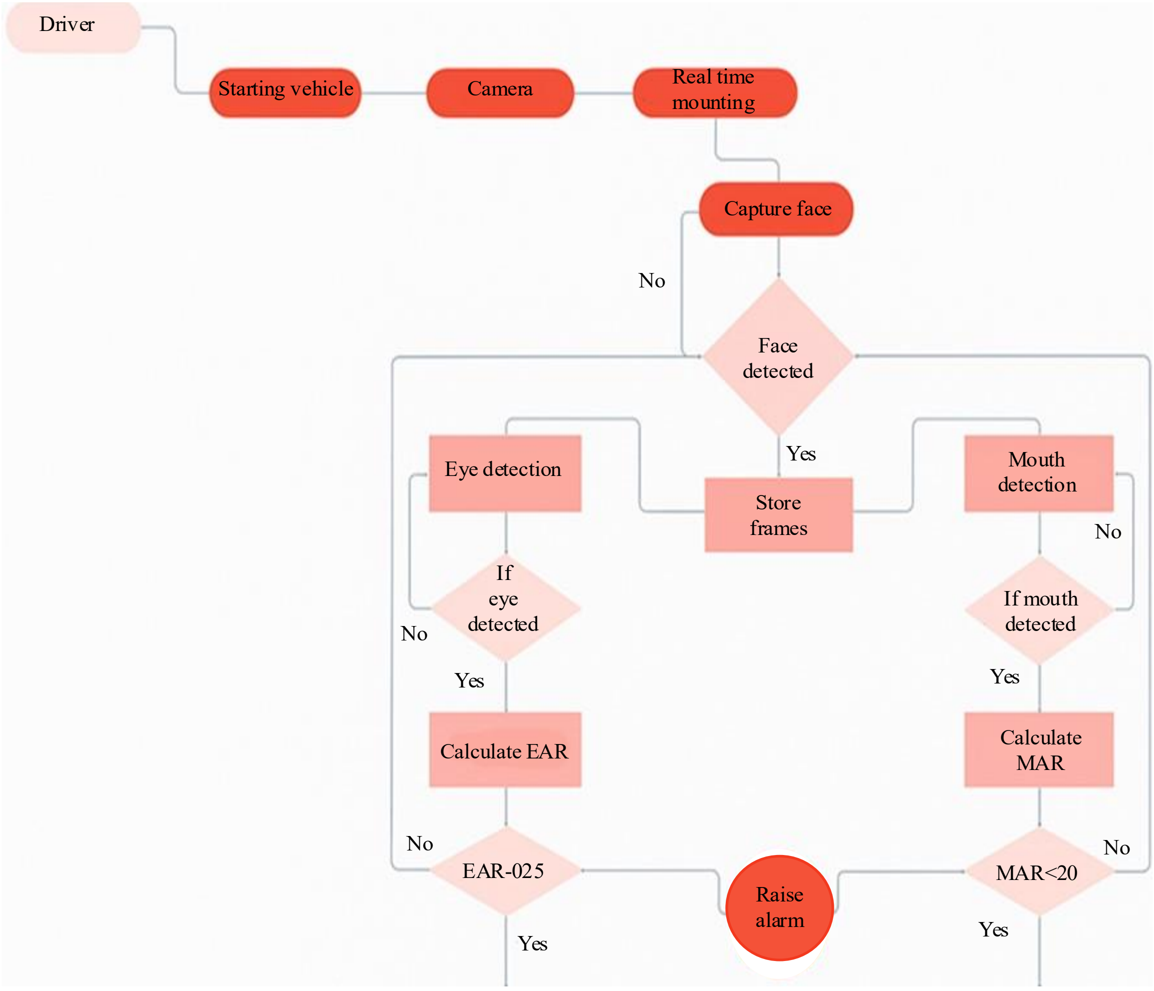

Figure 1. Flowchart of the methodology.

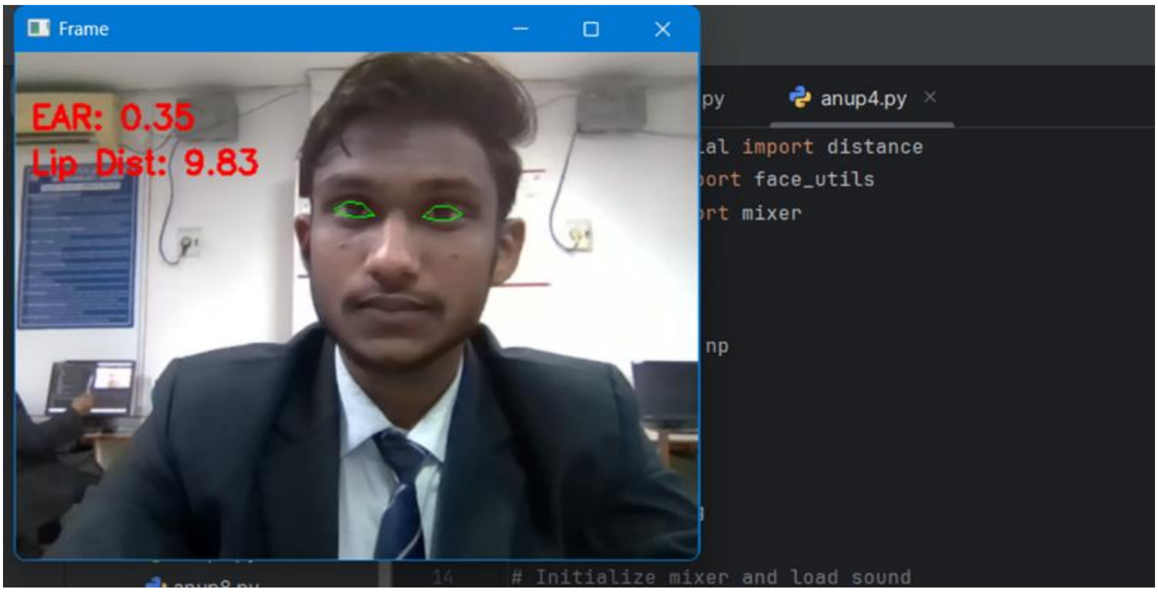

Figure 2. Testing (when eye is open).

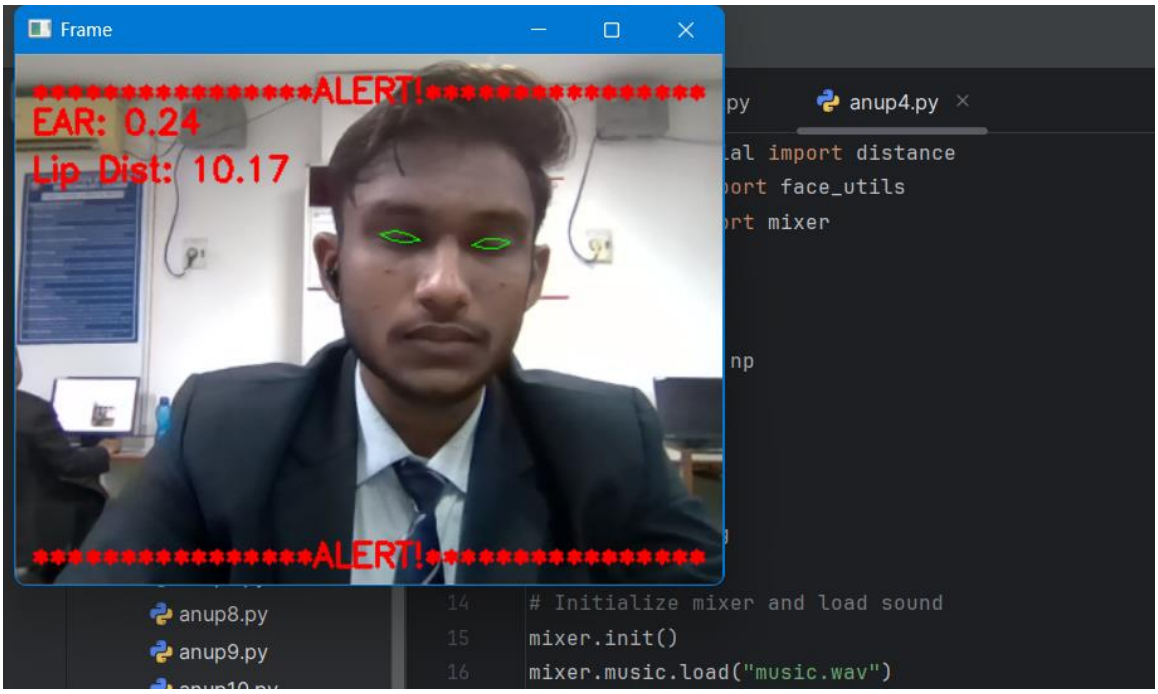

Figure 3. Testing (when eye is closed).

CONCLUSION

This project considers the real-time detection of driver fatigue while driving with closed eyes. Yawning. The advantage of this technique is that it detects fatigue early and provides warnings. Before the accident. OpenCV is considered highly suitable for driver drowsiness detection systems owing to its powerful capabilities in real-time computer vision applications. This is the perfect option for adding safety features to cars because it is an open-source library with a large selection of tools for image and video analysis. Based on the proposed work, OpenCV can meet essential requirements, such as low cost, efficient performance, compact size, and ease of integration with existing hardware systems. This technique effectively detects and tracks facial features, such as eyes, mouth, and face, using a video camera. By continuously analyzing the video frames, the system can determine whether the eyes are open, as shown in Figure 2, or closed, and whether the mouth is in a yawning position. If the driver’s eyes remain closed, as shown in Figure 3, for an extended period, or if repeated yawning is detected, both of which are strong indicators of drowsiness, the system immediately triggers a warning signal or alarm to alert the driver. This approach significantly enhances road safety by providing timely feedback and preventing potential accidents caused by fatigue or inattentiveness while driving.

Future Scopes

- The system can be made more accurate by using various other parameters, such as the condition of the vehicle and the detection of foreign substances on the surface.
- It is possible to create an application that can warn the user or prevent them from falling asleep.
- It can be used to create an Internet of Things (IoT) gadget that can be mounted on a vehicle to identify the driver’s level of tiredness.
- Other uses for similar models and techniques are possible; for instance, streaming services such as Netflix and Hotstar can recognize when a user is sleeping and pause the film appropriately.

Acknowledgement

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