STM JOURNALS

Journal of
Electro-Mechanics and
Material Behavior

Volume 2, Issue 1, 2024
January–June
DOI Journal: 10.37591/IJEMB

https://journals.stmjournals.com/ijemb

Research IJEMB

Driver Drowsiness Alert System

D.S.S.N. Raju[1], Bhavana M.[2,*], Rishitha V.[2], Bharat Chandu N.[2], Harshit B.[2]

Abstract

In the present era, the increasing frequency of accidents during prolonged road trips, primarily attributed to driver fatigue, is a matter of serious concern. Recognizing this challenge, our goal is to develop a driver drowsiness alert system to effectively address and alleviate these incidents. The proposed system utilizes a webcam to capture real-time images of the driver's eyes, employing machine learning algorithms to promptly identify signs of fatigue. Upon detecting drowsiness, the system activates a buzzer alarm to immediately alert the driver. If the driver remains unresponsive, the system initiates an autopilot mode until the driver awakens and manually disengages the mode. This innovative system, when seamlessly integrated into commercial automotive environments, has the potential to significantly reduce the frequency of accidents resulting from driver drowsiness.

Keywords: Face detection, eye aspect ratio (EAR), Python, drowsiness, eye extraction, Dlib, facial extraction, autopilot mode, Raspberry Pi OS

INTRODUCTION

According to an article published by the World Health Organization, annually an alarming toll of approximately 1.19 million lives is prematurely extinguished due to road traffic accidents. Beyond this staggering loss, an additional 20 to 50 million individuals endure non-fatal injuries, often resulting in disabilities. The National Safety Council (NSC) states that intoxicated driving is one of the main causes of traffic accidents, accounting for approximately 100,000 collisions, 71,000 injuries, and 1,550 fatalities.

In today's fast-paced world, individuals often prioritize their work over their health, neglecting crucial such as proper sleep. While maintaining fitness is crucial, it is imperative to recognize that health encompasses various facets, including adequate rest. Sleep is a fundamental human need, essential for maintaining overall well-being.

***Author for Correspondence**
Bhavana M.
E-mail: 5201411034@gvpcdpgc.edu.in

[1]Associate Professor, Department of Computer Science and Engineering, Gayatri Vidya Parishad College for degree and PG courses (Autonomous), Visakhapatnam, Andhra Pradesh, India
[2]Student, Department of Computer Science and Engineering, Gayatri Vidya Parishad College for degree and PG courses (Autonomous), Visakhapatnam, Andhra Pradesh, India

Received Date: May 20, 2024
Accepted Date: June 05, 2024
Published Date: June 18, 2024

Citation: D.S.S.N. Raju, Bhavana M., Rishitha V., Bharat Chandu N., Harshit B. Driver Drowsiness Alert System. International Journal of Electro-Mechanics and Material Behavior. 2024; 2(1): 1–10p.

However, when it comes to driving, falling asleep at the wheel poses a severe threat to road safety. Drowsy driving not only endangers the individual behind the wheel but also poses a threat to the surrounding environment, putting nearby vehicles at risk due to one's carelessness [1]. We have seen in the past how a lapse in concentration can turn the whole life of an individual completely upside down. When it comes to drowsy driving, it poses a direct threat to not only the person behind the steering but also those who lose their life due to the carelessness of the driver. Hence, the imperative for a comprehensive system to monitor drivers' conditions and promptly alert them in cases of fatigue and drowsiness becomes evident. Such a system aims to mitigate the occurrences of preventable accidents on the road.

Figure 1. Drowsy.

In this research paper, we offer a technique that uses OpenCV, Dlib Raspberry Pi (OS), histogram of oriented gradients (HOG), eye extraction, and facial extraction to identify driver drowsiness [2]. Our system is designed to operate seamlessly on both Windows and Linux platforms. Specifically, we have successfully installed the Raspberry Pi (OS) on Linux, providing comparable functionality to its Windows counterpart. This compatibility ensures that our system can be efficiently implemented in real-time scenarios, particularly within vehicles. The RaspberryPi, known for its compact size, serves as an ideal platform for hosting our code. Notably, the system is adept at handling diverse camera resolutions, supporting any resolution in Windows and accommodating 320 × 240 resolutions in Linux. This versatility enhances the system's adaptability, making it suitable for deployment across various operating systems and hardware configurations.

However, our proposed system extends beyond mere alerting mechanisms. It incorporates an innovative feature wherein the vehicle seamlessly transitions into autopilot mode upon detecting signs of driver fatigue or drowsiness [3, 4]. This autopilot mode can only be disengaged manually by the driver, adding an extra layer of safety and accountability. By implementing this feature, we aim to significantly reduce the incidence of road accident attributed to driver fatigue and drowsiness, thereby enhancing overall road safety (Figure 1).

LITERATURE SURVEY

Drowsiness Detection with OpenCV. 2021 Second International Conference on Electronics and Sustainable Communication Systems (ICESC) [1]

This paper uses the concept of OpenCV and face recognition to monitor the area between a driver's eyes. By analyzing eye movements and calculating the ear aspect ratio (EAR) to check if the driver has closed the eye or not. As the system's reliance on eye movement may be less robust in challenging conditions like poor lighting or when drivers wear glasses, affecting accuracy.

Driver Drowsiness Detection and Alert System. International Journal of Scientific Research in Computer Science, Engineering and Information Technology [5]

It uses the concept of image processing techniques using OpenCV and Dlib libraries to detect facial landmarks, particularly eye movements. The EAR is calculated to identify driver drowsiness. It also notifies the family members via SMS and email if the drowsy driver does not respond, contributing to road safety.

Driver Drowsiness Detection System Using Deep Neural Network. 2022 3rd International Conference on Computing, Analytics and Networks (ICAN) [6]

This paper uses the concepts of deep neural networks, focusing on video stream processing and eye aspect ratio. The study employs facial landmarks and a convolutional neural network (CNN) model. A potential disadvantage could be increased computational complexity due to deep learning, impacting real-time responsiveness in resource-constrained environments.

Deep CNN Based Approach for Driver Drowsiness Detection. 2022 IEEE International Power and Renewable Energy Conference (IPRECON) [3]

This literature review explores in order to identify driver drowsiness, the study presents a deep CNN-based method that analyzes facial photographs. Using a CNN architecture, the approach first preprocesses and augments the data before extracting, detecting, and classifying features (Table 1). To improve performance, it also makes use of transfer learning models such as VGG-16 and ResNet-50. A disadvantage, though, would be its only dependence on face photos, which could leave out other vital physiological or behavioral signs necessary for accurate drowsiness detection in some situations (Figure 2).

RESULTS OF ALERT SYSTEM

Results in Windows

When a driver's eyes are not opened for five frames or more, the suggested alert system recognizes their tiredness and sounds an alarm. The car will enter autopilot mode if the driver is still not aware or tired. Our alarm system is proficient of distinguishing between tiredness and a typical eye blink [2]. Any car can be simply equipped with the non-intrusive technology.

- Here, we can see our alert system is competent enough to detect the face landmarks and has correctly identified the driver to be active (Figures 3–7).
- Here, we can see our alert system is correctly detects the face landmarks and has correctly identified the driver to be active.
- The picture demonstrates the driver’s eyes are in sleepy mode and hence the alert system has started to give out alerts to the driver in order to wake him up [7].
- The alert system has put the vehicle on autopilot mode successfully.
- Now in the picture, we can see that the driver has woken up and the alert system has correctly identified that the driver is active.
- Finally, the driver has to manually switch off the autopilot mode in order to take control of the vehicle and drive to his destination.

Table 1. Difference between existing and proposed systems.

Feature	Existing system	Proposed system
Purpose	Detect driver drowsiness using image processing	Develop a comprehensive drowsiness alert system with facial recognition
Detection method	Detect driver drowsiness using image processing	Utilizes OpenCV, Dlib, and Raspberry Pi for facial and eye detection
Alert mechanism	Buzzer alarm and SMS/email notifications	Alert and autopilot mode activation
Hardware	Webcam required	Compatible with Windows, Linux, and Raspberry Pi
Software	Python with Tkinter for GU OpenCV for processing	Requires Python, OpenCV, Dilb, and Raspberry Pi OS
Kay modules	Login, eye extraction, drowsiness detection, alert	Eye extraction, drowsiness detection, autopilot mode
Results	Emphasizes accurate drowsiness detection	Demonstrates accurate detection and autopilot mode for safety
Future scope	Emphasizes accurate drowsiness detection	Integration of backend infrastructure and communication mechanisms
Compatibility	Designed for webcams and desktops	Suitable for desktop and embedded systems, including vehicles
Real-time	Capable but performance depends on hardware	Optimized for real-time performance with minimal latency
Expandability	Foundation for further research and development	Scalable with potential for new sensors and communication protocols
Integration	Can be integrated with vehicle systems	Seamlessly integrates with automotive environments and aftermarket solutions
Cost	Relatively low-cost with off-the-shelf components	Cost-effective and scalable for various budgets and deployment scenarios

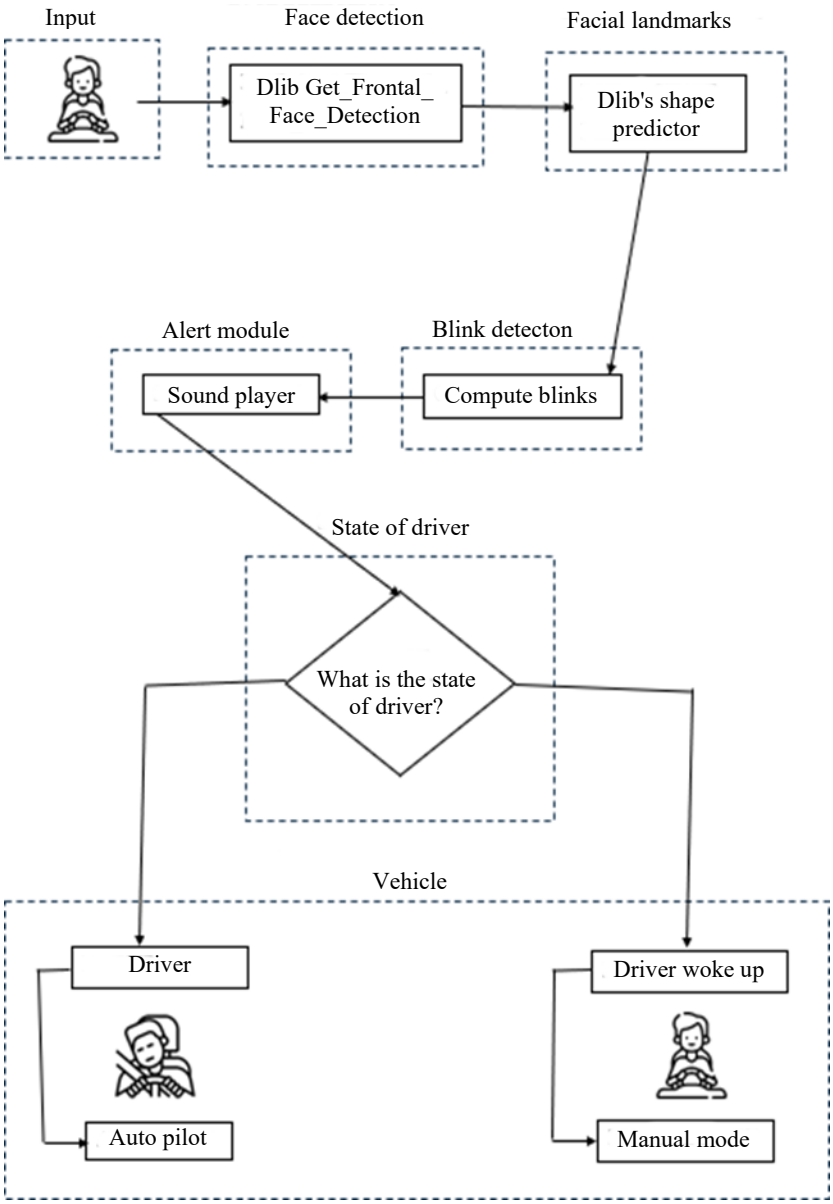

Figure 2. System design.

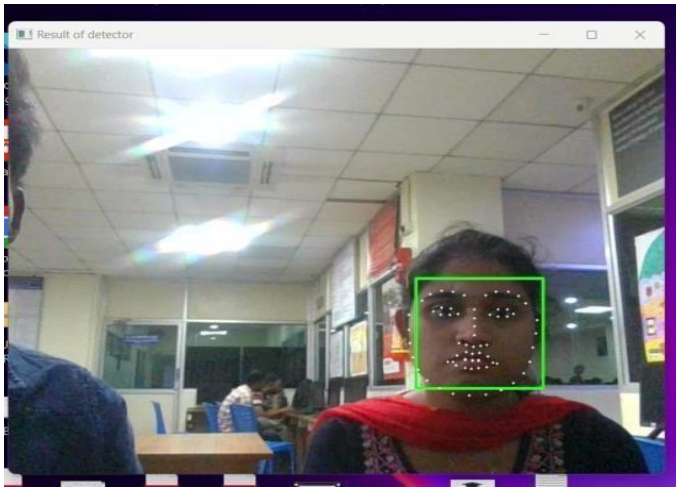

Figure 3. Face detect by eye extraction module.

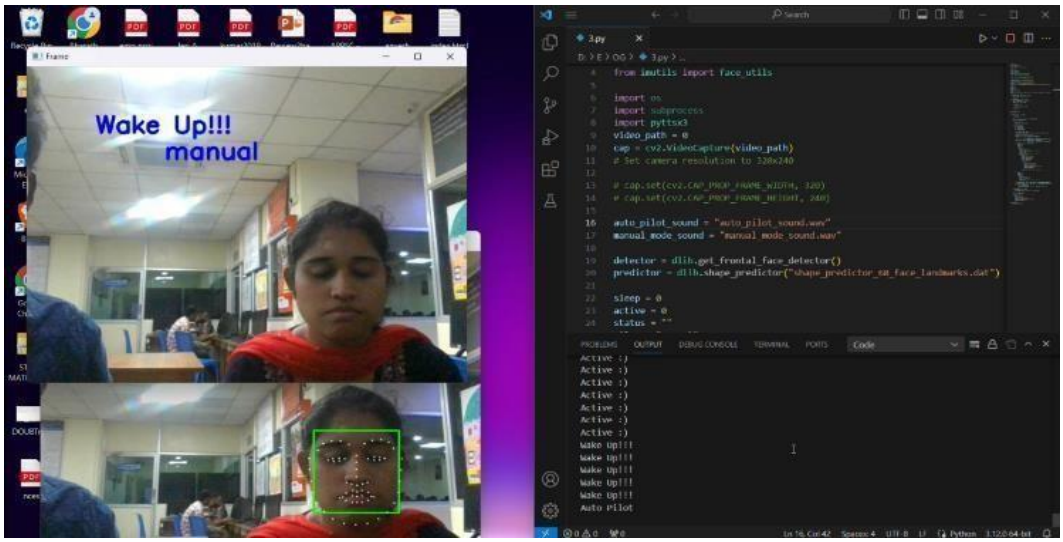

Figure 4. Drowsy status (wake up) using drowsiness detection module.

Figure 5. Autopilot mode.

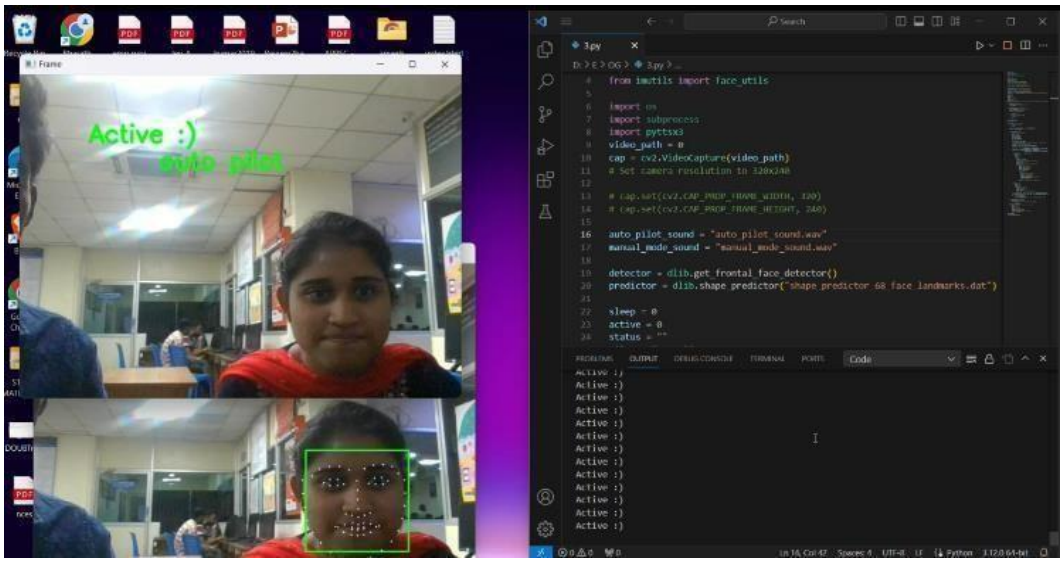

Figure 6. Active.

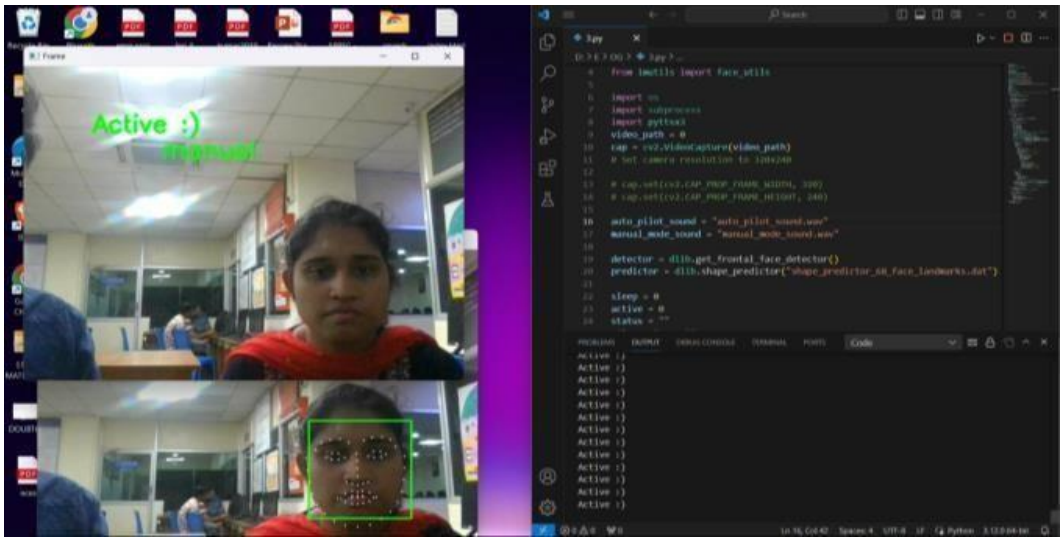

Figure 7. Manual.

Results in Raspberry Pi (OS)

Eye Extraction Module

Within this module, it operates by identifying eyes and facial landmarks through a live webcam feed, employing advanced algorithms on the images to ascertain whether the driver is feeling sleepy or is alert enough. The system utilizes this approach to assess the driver's condition by analyzing key features like eyes and facial landmarks, ultimately determining if the driver is drowsy or not (Figure 8).

Drowsiness Detection Module

Within this component, it is designed to identify the driver's eyes in real-time through a live webcam feed. Employing advanced algorithms on the captured images, the module is proficient of discerning whether the driver is experiencing drowsiness or not. Then it will give a buzzer song and Displays “Wake Up”. If the driver is active then it displays “Active” (Figure 9) [4].

Autopilot Mode

In this module, if the driver does not respond after three alerts, the autopilot mode is activated and it displays “Autopilot mode activated”. The auto-pilot mode remains active until the driver manually turns it off (Figure 10).

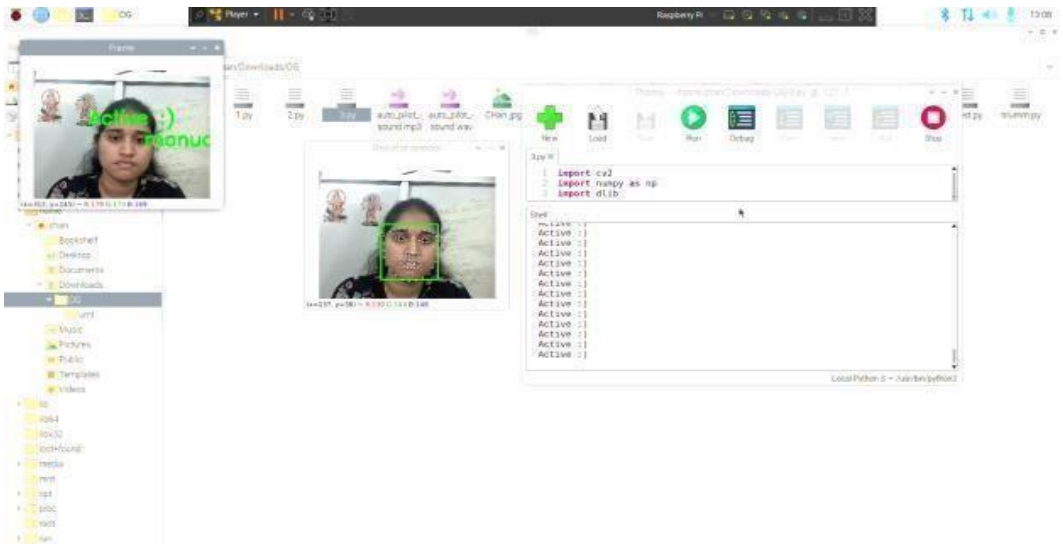

Figure 8. Face detect.

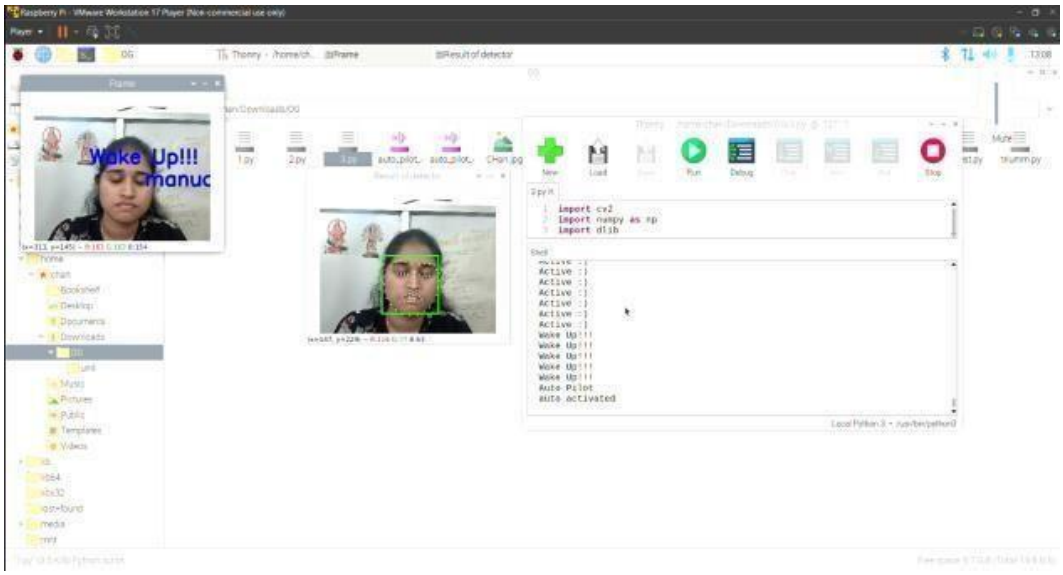

Figure 9. Drowsy status (wake up).

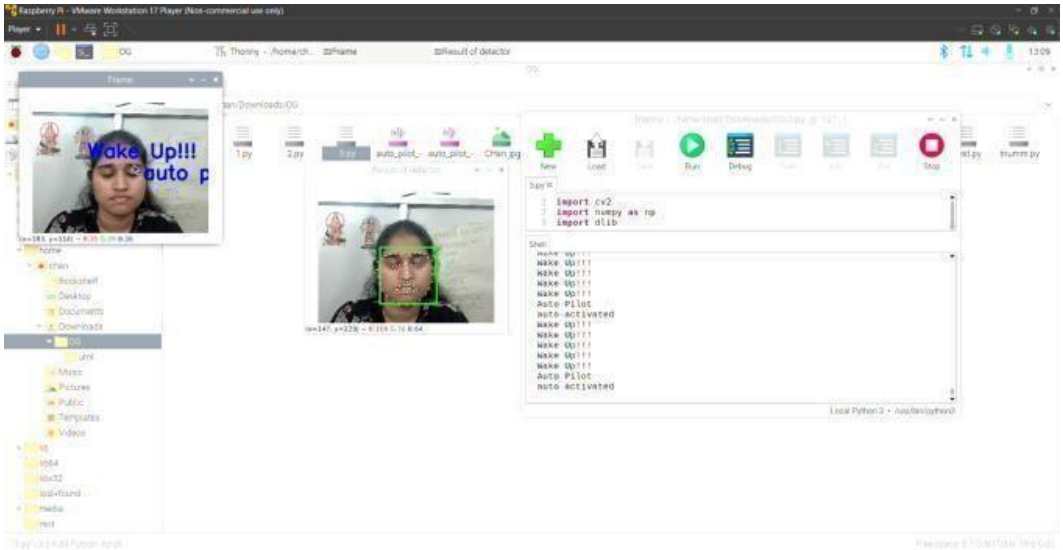

Figure 10. Autopilot mode activated.

Minimum System Requirements

- RAM: 4 GB
- ROM: 64 GB
- Processor: i5 or Ryzen5
- Camera compatibility: 320*240 (Linux)

METHODOLOGY

OpenCV

OpenCV, the Swiss Army Knife of ComputerVision, boasts versatile modules to tackle diverse challenges. Notably, its robust architecture and memory management alleviate concerns related to image and video processing, ensuring efficient memory handling.

The framework's flexibility is evident from its capacity to deploy both built-in algorithms and bespoke solutions tailored to specific needs, enhancing developers' efficacy. Crucially, OpenCV's optimized image processing functions empower real-time video stream analysis, a pivotal capability across applications.

By leveraging OpenCV's prowess, the author conducts real-time analysis of live video streams, emphasizing its practical importance and cementing OpenCV as a foundational tool in the expansive realm of computer vision [8, 9].

Dlib

Dlib a modern C toolkit, stands out for its diverse algorithms tailored for machine learning, empowering the creation of advanced C++ solutions across various domains, from robotics to mobile phones and high-performance computing. Its open-source nature, supported by permissive licenses, ensures widespread accessibility without financial constraints, making it a vital tool in both industry and academia. In the realm of machine learning, the author utilizes Dlib's power to implement histogram of oriented gradients (HOG), a robust technique for facial feature detection. Dlib's optimized functions and pretrained detectors showcase its practicality, particularly in computer vision, affirming its role as a foundational tool for tackling complex computational challenges.

Histogram of Oriented Gradients

In our system, the utilization of Dlib serves as a cornerstone in our driver drowsiness alert system, using the HOG algorithm for robust facial feature analysis. HOG, appreciated for its efficacy in object detection, meticulously examines gradients and intensity variations in localized facial regions, capturing subtle cues like drooping eyelids and characteristic head movements associated with fatigue. Through Dlib's optimized prediction functions and pretrained detectors, our system seamlessly integrates HOG-based facial feature detection. This allows for swift and accurate recognition of drowsiness indicators, empowering real-time monitoring and timely alerts to prevent potential accidents. By strategically implementing HOG, our system plays a pivotal role in enhancing road safety by addressing the risks associated with driver fatigue.

Eye Aspect Ratio

The eye aspect ratio, or EAR, is determined by evaluating the ratio of the vertical distance between eye landmarks to the horizontal distance between reference points on the eyes. The numerator signifies the measurement of the vertical span, while the denominator calculates the horizontal span, adjusting the weight accordingly due to the presence of only one reference point.

Typically, the aspect ratio remains relatively stable when the eyes are open, but experiences a sudden decrease, approaching zero, during a blink. Figure 11 illustrates that the aspect ratio maintains constancy, undergoes a swift decline to zero during a blink, and subsequently rises again, indicating the occurrence of a single blink.

Face Detection

Face detection is a critical component of driver drowsiness alert systems, acting as the initial step in assessing a driver's condition. In this system, face detection is implemented using Dlib, a library renowned for its accuracy in identifying facial features. The working mechanism involves analyzing each frame of the captured video using Dlib's face detector, which precisely locates the driver's face within the image.

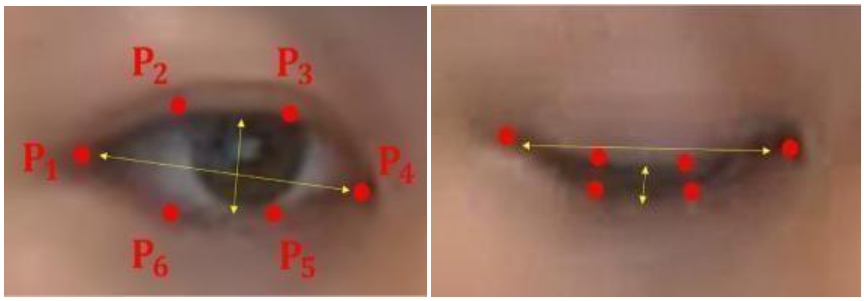

Figure 11. Eye aspect ratio.

This process defines the region of interest for subsequent analyses. Once the face is detected, the system proceeds to employ facial landmark detection to monitor specific features, such as the eyes, enabling the evaluation of critical indicators like blink patterns for drowsiness detection. Face detection serves as the foundation for real-time assessment, contributing to the overall effectiveness of driver drowsiness alert systems in enhancing road safety.

NumPy

NumPy, a potent Python library for numerical computing, plays a critical role in the efficiency of a driver drowsiness alert system. By adeptly handling numerical data through its array and matrix operations, NumPy enhances the system's capability to process and analyze image data from sensors like cameras. It becomes particularly invaluable in facial feature extraction, precisely identifying crucial regions like the eyes for monitoring driver alertness. NumPy's array functions support swift calculations, aiding algorithms in assessing blink rates and eye movement patterns, crucial for accurate drowsiness detection. Overall, NumPy significantly contributes to the robustness and real-time effectiveness of the driver drowsiness alert system by ensuring precise numerical analysis of visual data.

Imutils

Imutils is a Python library designed to simplify common tasks in image and video processing. In the context of a driver drowsiness alert system, Imutils proves invaluable for its convenience functions, facilitating efficient manipulation of video feeds. Its resizing, rotation, and translation functions streamline the preprocessing of image data, enhancing the system's overall performance. Additionally, Imutils supports threading, allowing the system to execute multiple tasks concurrently and improving real-time responsiveness. By providing these essential tools for image and video processing, Imutils plays a crucial role in optimizing the functionality and efficiency of driver drowsiness alert systems, contributing to enhanced road safety.

CONCLUSION

In conclusion, the successful development and deployment of our driver drowsiness alert system signify a significant advancement in tackling the crucial issue of drowsy driving and elevating overall road safety. By harnessing cutting-edge technologies like facial recognition algorithms and real-time monitoring, our system provides a proactive solution to mitigate the hazards associated with driver fatigue. Through rigorous testing, we have demonstrated the system's efficacy in accurately identifying signs of drowsiness and issuing timely alerts, effectively preventing potential accidents and saving lives.

Additionally, we have outlined future prospects for the project, emphasizing possibilities for further improvement and expansion, including the integration of user interfaces, backend infrastructure, and communication mechanisms. As we persist in refining our driver drowsiness alert system, our unwavering goal is to foster a safer driving environment for all, reducing the risks posed by drowsy driving. Through continuous research, innovation, and collaboration, we are dedicated to realizing this vision and contributing to global road safety, aspiring towards a future where every journey is secure and free from the perils of drowsy driving.

Future Scope

The future scope of our “driver drowsiness alert system” boasts an unprecedented potential for further enhancement and expansion. While the current iteration of the system focuses on real-time monitoring and alerting, there are several areas for future development that can significantly augment its capabilities and functionality.

Furthermore, the implementation of a backend infrastructure presents a prospect to centralize and store user data securely. This backend system can not only store historical data on driver alertness and behavior but also facilitate data analysis and insights generation. By leveraging machine learning algorithms, the backend can identify patterns indicative of fatigue and proactively provide tailored interventions to mitigate the risk of drowsy driving.

Moreover, integrating a communication mechanism within the backend system opens up the possibility of alerting family members or designated contacts in the event of prolonged driver drowsiness. By establishing a communication link between the vehicle and external parties, such as family members or emergency services, the system can ensure prompt assistance in critical situations, thereby enhancing overall safety on the road.

REFERENCES

1. Sanjay S, Banupriya N, Satish M, Sujay NH. Drowsiness detection with OpenCV. In: 2021 Second International Conference on Electronics and Sustainable Communication Systems (ICESC), Coimbatore, India, August 4–6, 2021. pp. 1421–1425. doi: 10.1109/icesc51422.2021.9532758.
2. Patnaik R, Krishna KS, Patnaik S, Singh P, Padhy N. Drowsiness alert, alcohol detect and collision control for vehicle acceleration. In: 2020 International Conference on Computer Science, Engineering and Applications (ICCSEA), Gunupur, India, March 13–14, 2020. pp. 1–5. doi: 10.1109/iccsea49143.2020.9132932.
3. Jumana R, Jacob C. Deep CNN based approach for driver drowsiness detection. In: 2022 IEEE International Power and Renewable Energy Conference (IPRECON), Kollam, India, December 16–18, 2022. pp. 1–6. doi: 10.1109/iprecon55716.2022.10059547.
4. Adochiei IR, Stirbu OI, Adochiei NI, Pericle-Gabriel M, Larco CM, Mustata SM, Costin D. Drivers' drowsiness detection and warning systems for critical infrastructures. In: 2020 International Conference on E-Health and Bioengineering (EHB), Iasi, Romania, October 29–30, 2020. pp. 1–4. doi: 10.1109/ehb50910.2020.9280165.
5. Titare S, Chinchghare S, Hande KN. Driver drowsiness detection and alert system. Int J Sci Res Computer Sci Eng Inform Technol. 2021; 7 (3): 583–588. doi: 10.32628/cseit2173171.
6. Ojha D, Pawar A, Kasliwal G, Raut R, Devkar A. Driver drowsiness detection using deep learning. In: 2023 4th International Conference for Emerging Technology (INCET), Belgaum, India, May 26–28, 2023. pp. 1–4. doi: 10.1109/incet57972.2023.10169941.
7. Nalavade JE, Patil RS. Driver drowsiness detection system using deep neural network. In: 2022 3rd International Conference on Computing, Analytics and Networks (ICAN), Rajpura, India, November 18–19, 2022. doi: 10.1109/ican56228.2022.10007191.
8. Agarkar AS, Gandhiraj R, Panda MK. Driver drowsiness detection and warning using facial features and hand gestures. In: 2023 2nd International Conference on Vision Towards Emerging Trends in Communication and Networking Technologies (ViTECoN), Vellore, India, May 5–6, 2023. pp. 1–6. doi: 10.1109/vitecon58111.2023.10157233.
9. Verma K, Beakta M, Srivastava P, Khan NU. A non-intrusive approach for driver's drowsiness detection. In: 2020 Sixth International Conference on Parallel, Distributed and Grid Computing (PDGC), Waknaghat, India, November 6–8, 2020. pp. 501–505. doi: 10.1109/pdgc50313.2020.9315326.

