"SMART DROWSINESS DETECTION AND SAFETY SYSTEM USING MACHINE LEARNING"

A PROJECT REPORT

Submitted to

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPURAMU

In partial fulfilment of the requirements for the award of the degree of

Bachelor of Technology

In

Computer Science and Engineering

By

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St. JOHNS COLLEGE OF ENGINEERING & TECHNOLOGY

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CERTIFICATE

This is to certify that the Project Report entitled **"SMART DROWSINESS DETECTION AND SAFETY SYSTEM USING MACHINE LEARNING"** is bonafide work of **K.Samrudhi (20G31A0533)** submitted to the Department of Computer Science & Engineering, in partial fulfillment of the requirements for the award of degree of **Bachelor of Technology** in **COMPUTER SCIENCE AND ENGINEERING** from **Jawaharlal Nehru Technological University, Anantapuramu.**

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DECLARATION

I here by declare that the project Report entitled **"SMART DROWSINESS DETECTION AND SAFETY SYSTEM USING MACHINE LEARNING"** submitted by **K.Samrudhi (20G31A0533)** to the Department of Computer Science and Engineering, **St. Johns College of Engineering &Technology**, **Yerrakota, Yemmiganur,Kurnool,** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology in Computer Science and Engineering** is a record of bonafide work carried out by me under the supervision of Professor **Dr.P.VEERESH M. Tech., Ph. D.,** I further declare that the work reported in this project has not been submitted and will not be submitted, either in partor in full, for the award of any other degree or diploma of this institute or any other institute or university.

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The project report entitled **"SMART DROWSINESS DETECTION AND SAFETY SYSTEM USING MACHINE LEARNING"** is prepared and submitted **K.Samrudhi (20G31A0533).** It has been found satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology in Computer Science and Engineering** in St. Johns College of Engineering & Technology, Yerrakota, Yemmiganur, Kurnool, A.P.

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With gratitude

K.Samrudhi

(20G31A0533)

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ABSTRACT

This project addresses the crucial issue of drowsy driving, a significant contributor to road accidents. The proposed system employs cutting-edge technology to monitor the driver's level of drowsiness through computer vision. By analyzing facial cues and eye movements, the system can detect signs of fatigue and alertness in real-time. When drowsiness is detected, the system takes proactive measures to keep the driver awake and alert. It automatically plays an alarm to stimulate the driver's senses and mitigate drowsiness.

The system also includes a hand detection module to determine whether the driver is active if the alert is activated a certain number of times. This function is essential since inactivity during a state of exhaustion might result in serious consequences. The technology alerts the driver and averts possible collisions when it detects a driver's condition of drowsiness. The technology reacts instantly in emergency scenarios if the driver's fatigue approaches a threshold and prolonged inactivity is noted. The driver's current position is shared with the chosen emergency contacts through an alert message. The overall goal of this project is to improve road safety through the efficient detection and mitigation of driver fatigue and the provision of prompt assistance in emergency situations.

CHAPTER 1: INTRODUCTION

1. INTRODUCTION

Drowsiness is a state of near sleep, where the person has a strong desire for sleep. It has two distinct meanings, referring both to the usual state preceding falling asleep and the chronic condition referring tobeing in that state independent of a daily rhythm. Sleepiness can be dangerous when performing tasks thatrequire constant concentration, such as driving a vehicle. When a person is sufficiently fatigue while driving, they will experience drowsiness and this leads to increase the factor of road accident.

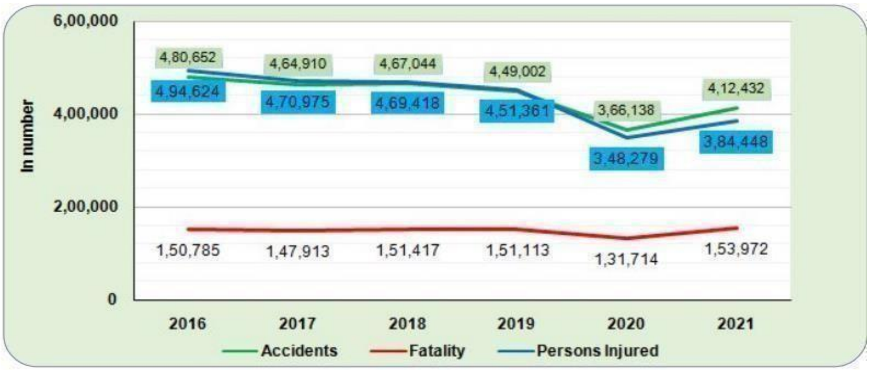


Fig 1.1.1: Trends in number of Accidents, Fatalities and Persons Injured: 2016 to 2021

Figure 1 shows the statistic of road accident in India from the year 2016 to 2021 provided by MRTH (Ministry of Road transport and Highways). The numbers of vehicles involved in road accident keep increasing each year. Road traffic injuries are the leading cause of death globally and the principal causeof death in the age group of 15 to 49 years.

We all pass through the drowsiness state on the way to sleep. It may not be a dangerous state if you are sitting watching television, but it certainly is a high risk if you're driving a car. Our thinking and reactiontimes slow down, and these changes inevitably make us a higher risk when on the road.

Fig 1.1.2: shows the difference between fatigue and drowsiness condition.

Quite simply, as a driver’s sleep is decreased, they become drowsy and the ability to make fast decisions,assess danger and pay attention to the road is affected. Driving while drowsy represents a significant riskto fatal or serious car crashes and is attributed to approximately 20% of motor vehicle crashes.

The development of technologies for detecting or preventing drowsiness while driving is a major challenge in the field of accident avoidance system. Because of the hazard that drowsiness presents on the road, methods need to be developed for counteracting its affects.

The aim of this project is to develop a simulation of drowsiness detection system. 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's drowsiness can be detected in sufficientlyearly stage, to avoid a car accident. Yawning detection is a method to assess the driver’s fatigue. When aperson is fatigue, they keep yawning to ensure that there is enough oxygen for the brain consumption before going to drowsiness state. Detection of fatigue and drowsiness involves a sequence of images of aface, and the observation of eyes open or closed duration. Another method to detect eye closure is EAR.This detection method is based on the time of eyes closed which refers to percentage of a specific time. The analysis of face images is a popular research area with applications such as face recognition, and human identification and tracking for security systems. This project is focused on the localization of theeyes, which involves looking at the entire image of the face, and determining the position of the eyes, by applying the existing methods in image-processing algorithm. Once the position of the eyes is located, the system is designed to determine whether the eyes are opened or closed, and detect fatigue and drowsiness.

MOTIVATION

Drowsy driving is a pervasive and deadly issue on roadways worldwide, responsible for a significant portion of accidents and fatalities. The consequences of drowsy driving are alarming, affecting not only the drivers themselves but also other road users and pedestrians. As a team, our motivation for this projectis grounded in our dedication to road safety, our passion for technological innovation, our desire to makea positive social impact, and the practical and life-saving applications of the system we are developing. We are determined to address the critical issue of drowsy driving and contribute to a safer and more secure transportation environment.

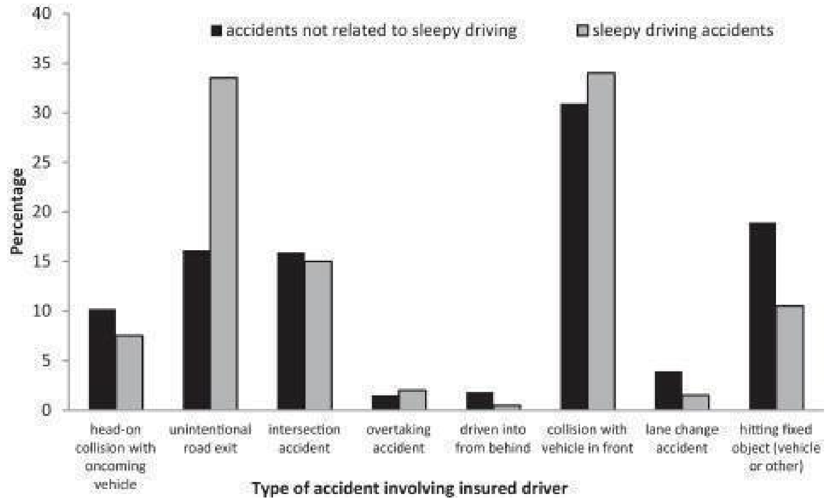


Fig 1.2.1: Accidents relating and not related to sleepy driving

Our system employs computer vision technology to continuously monitor a driver's state of drowsiness through the analysis of facial cues and eye movements. The system's capacity to detect early signs of fatigue and alertness in real-time is pivotal. By proactively sounding an alarm and stimulating the driver'ssenses, it aims to prevent accidents by keeping the driver awake and alert.

Moreover, the inclusion of a hand detection module enhances the system's capability to determine driver activity. This function is of paramount importance, as it can avert potentially catastrophic outcomes resulting from driver inactivity in a state of exhaustion. Therefore, the motivation for this project is deeply rooted in the goal of enhancing road safety by effectively detecting and mitigating driver fatigue, as wellas providing swift assistance in emergency situations, ultimately contributing to a safer and more secure road environment.

PROBLEM DEFINITION

Current drowsiness detection systems monitoring the driver’s condition requires complex computationand expensive equipment, not comfortable to wear during driving and is not suitable for driving conditions; for example, Electroencephalography (EEG) and Electrocardiography (ECG),i.e. detectingthe brain frequency and measuring the rhythm of heart, respectively.

A drowsiness detection system which use a camera placed in front of the driver is more suitable to be use but the physical signs that will indicate drowsiness need to be located first in order to come up with a drowsiness detection algorithm that is reliable and accurate. Lighting intensity and while the driver tilt their face left or right are the problems occur during detection of eyes and mouth region. Therefore, this project aims to analyze all the previous research and method, hence propose a method to detect drowsiness by using video or webcam. It analyzes the video images that have been recorded and come up with a system that can analyze each frame of the video.

OBJECTIVE OF THE PROJECT

The project's objectives encompass the creation of an all-encompassing drowsiness detection and alertsystem, employing state-of-the-art computer vision technology. This system is designed to actively monitor a driver's level of drowsiness by analyzing various indicators such as facial cues and eye movements in real-time. When signs of fatigue are detected, the system will instantly trigger an alert mechanism, featuring auditory alarms designed to reinvigorate the driver's senses and counteract drowsiness. Furthermore, the project integrates a hand detection module to evaluate driver activity, ensuring that the driver remains actively engaged in the driving process. In emergency scenarios wheredrowsiness becomes severe and prolonged inactivity is observed, the system will rapidly dispatch an alert message to pre-selected emergency contacts, providing timely assistance.

LIMITATIONS OF THE PROJECT

While Computer Vision hold promise for drowsiness detection, it is essential to recognize their limitations. Understanding these constraints is critical for developing effective and reliable drowsinessdetection systems. This section outlines some of the key limitations associated with using Computer Vision for this purpose:

1. **Environmental Factors:**

   Adverse weather conditions, poor lighting, or other environmental factors may impact the system's performance, potentially leading to false positives or negatives in drowsiness detection.

2. **Individual Variability:**

   Driver behavior and physiological responses to drowsiness can vary significantly among individuals. The system may not account for all personal variations, potentially leading to false alarms or overlooking signs of fatigue in certain users.

3. **User Acceptance and Compliance:**

   The success of the project relies on user acceptance and compliance. Drivers may disable or ignore the system's alerts, diminishing its overall effectiveness in preventing drowsy driving incidents.

4. **Integration Challenges:**

   Integrating the drowsiness detection system seamlessly into a diverse range of vehicle models may present technical challenges and compatibility issues, potentially limiting widespread adoption.

5. **Privacy Concerns:**

   The system involves constant monitoring of the driver, raising potential privacy concerns. Striking a balance between ensuring safety and respecting individual privacy rights poses a challenge.

6. **False Positives and Negatives:**

   Achieving a balance between sensitivity and specificity in drowsiness detection algorithms is challenging. The system may produce false positives, issuing alerts when a driver is not drowsy, or false negatives, failing to detect signs of fatigue.

In conclusion, while the Driver Drowsiness Detection System holds immense promise for enhancing road safety, it is crucial to acknowledge and address its inherent limitations. To create more effective and ethical solutions, researchers and developers must acknowledge and address these constraints whileexploring complementary approaches and techniques to enhance the accuracy, robustness, and fairnessof drowsiness detection systems. As with any innovative technology, mitigating these limitations requires a collaborative effort involving technologists, policymakers, and the public to ensure the system's continued development, improvement, and widespread adoption. The journey towards safer roads demands not only cutting-edge technological solutions but also a nuanced understanding of the challenges and a commitment to refining and adapting these systems in the face of evolving circumstances.

ORGANIZATION OF THE REPORT

This is to follow up the next chapters i.e., Chapter 2 contains the information about the system specifications. It clearly explains the libraries offered by the system. Software requirements and hardware requirements are also mentioned in the chapter. The next chapter i.e., Chapter 3 deals with the Literature survey conducted to know about the existing systems. The next chapter i.e., Chapter 4 deals with the design and implementation of the project. It covers the technology that is used for the project i.e. OpenCV, Python. It also contains the source code of the project and the output screenshots of the project. The last chapter i.e., Chapter 5 provides the concluding information of the project. The report ends with a list of references that have been used.

CHAPTER 2: LITERATURE SURVEY

2. LITERATURE SURVEY

INTRODUCTION

In the past, there have been researches carried out by different groups, belonging to both, industry andacademia that bear similar resemblance to or are based on a topic similar to what I am doing.

EXISTING SYSTEM

- **System 1: Pooja D.C, Driver Drowsiness Detection using Raspberry PI, 2022**

  The proposed drowsiness detection and prevention system integrates both hardware and software components to effectively address the issue of drowsy driving. The hardware components include a Raspberry Pi, a camera, and a buzzer, while the software components involve the Raspberry Pi OS and Python programming.

  The system operatesthrough a systematic flow that comprises three essential stages: face detection, eye detection, and drowsiness detection. This process begins with the identification of the driver's face, followed by the precise tracking of the driver's eyes. Continuous monitoring of the driver's facial and eye movements is crucial in ensuring the system's effectiveness. When the system detects signs of drowsiness, it triggers an alarm, which is designed to alert the drowsy driver. Additionally, the system takes a proactive approach to prevent potential accidents caused by drowsy driving. It achieves this by activating a water pump, which serves as a stimulating mechanism to awaken the drowsy driver. The results obtained from this innovative system demonstrate its capacity for successful drowsiness detection and prevention. These results underscore the significance of the system in addressing the critical issue of drowsy driving and its potential to significantly reduce accidents resulting from driver fatigue.

- **System 2: Ritish H, Real time driver drowsiness detection system using OpenCV, 2021**

  The system is designed to identify signs of fatigue by closely monitoring the driver's eyes throughout their journey. This process involves several distinct steps, commencing with the captureof images via an onboard camera, followed by the critical stages of eye detection and yawning detection. To accomplish these tasks, the system harnesses the capabilities of OpenCV, a powerful computer vision library renowned for its ability to handle various image processing tasks. The implementation of this system encompasses rigorous testing and evaluation at each stage, yielding valuable insights and conclusive results. The initial phase involves the successful capture of video data, a fundamental element of the monitoring process. Subsequently, the system excels in its abilityto extract and analyze features related to the driver's eyes and mouth. These features are pivotal inidentifying drowsiness-related cues. When the system detects signs of drowsiness, it promptly responds by providing audio alerts to the driver. These alerts are strategically triggered when predefined drowsiness-related thresholds are exceeded. By issuing timely warnings and notifications, the system plays a pivotal role in keeping the driver vigilant and awake, mitigating the risks associated with drowsy driving. In conclusion, the system emerges as a robust and reliable solution to the critical issue of drowsiness-related problems during driving. The successful implementation of image capture, eye detection, and yawning detection, coupled with its capacity toissue audio alerts when necessary, underscores its effectiveness in achieving its objectives. The system's ability to proactively detect and address drowsiness-related concerns positions. it as a valuable tool in enhancing driver safety and reducing the potential for accidents caused by driver fatigue.

- **System 3: Tawanda .M, Drowsiness driving detection, prediction and warning drowsinessdetection, 2022**

  The study employs a multifaceted approach to tackle the critical issue of driver drowsiness, drawingupon various techniques and technologies. These techniques encompass eye blinking analysis, facial landmark detection, mouth movement tracking, pulse rate monitoring, and the utilization of machine learning algorithms. This diverse set of tools is harnessed to comprehensively detect and address the onset of driver drowsiness. Machine learning algorithms play a pivotal role in this research, with a range of methods deployed, including Random Forest, Linear Regression, K- Nearest Neighbor, among others. These algorithms are tasked with the classification of eye and mouth states, enabling the system to discern subtle cues that may indicate drowsiness. The results achieved through the use of these machine learning techniques are notable, showcasing high accuracy rates in effectively categorizing the states of the driver's eyes and mouth.In essence, the study serves as a testament to the effectiveness of an integrated approach to driver drowsiness detection. By combining video processing, machine learning, and the monitoring of physiological parameters such as pulse rate, the research offers a comprehensive solution to enhance road safety.The positive outcomes and high accuracy rates achieved in the classification of eye and mouth states underscore the potential of these methods to significantly reduce the risks associated with drowsy driving, ultimately contributing to safer road conditions for all.

- **System 4: Jyothika, Drowsiness detection using CNN, 2021**

  The study introduces a novel drowsiness detection system designed specifically for drivers, merging the capabilities of OpenCV and deep learning techniques. This innovative approach hingeson the analysis of webcam images to identify the presence of faces and eyes. The pivotal componentof this system is a Convolutional Neural Network (CNN) model, which has the capacity to predictthe status of eye closure in real-time. The system calculates a score, which serves as a crucial metricfor monitoring the duration of closed-eye instances. When this score surpasses a predefined threshold, an alarm is promptly triggered. This alarm mechanism is a vital element of the system'sfunctionality, intended to alert the driver when prolonged eye closure indicates drowsiness. The outcomes of this study affirm the system's proficiency in distinguishing ordinary eye movements from the telltale signs of drowsiness. By successfully identifying instances of eye closure related todrowsiness, the system offers substantial potential in preventing accidents arising from driver fatigue. Its application in the realm of road safety is noteworthy, as it promises to be a valuable toolin mitigating the risks associated with drowsy driving, ultimately contributing to a safer driving environment.

DISADVANTAGES OF EXISTING SYSTEM

Driver drowsiness detection systems represent a significant advancement in road safety technology, aiming to prevent accidents caused by drowsy driving. However, like any technology, these systems come with a set of limitations and disadvantages that warrant careful consideration.

One prominent issue is the potential for false alarms. These systems rely on specific indicators of drowsiness, such as eye closure and yawning. While these indicators are generally reliable, there are instances where they might be misinterpreted. For example, a momentary distraction or a sudden headmovement that is unrelated to sleepiness can trigger false alarms. Frequent false alarms can lead to driver frustration and a decreased level of trust in the system's alerts. As a result, striking the right balance between sensitivity and specificity in these systems is a constant challenge.

Another limitation arises from the variability in how drowsiness presents itself among individuals. Driver drowsiness can manifest differently from person to person. While some drivers may yawn frequently or have visibly heavy eyelids, others may not exhibit such pronounced symptoms. This variability in behavior can make it challenging for these systems to consistently detect drowsiness in all drivers effectively.

Environmental factors can also have a substantial impact on the performance of these systems. Lighting conditions, both inside and outside the vehicle, play a crucial role. Sudden changes in lighting, such as entering a tunnel, can momentarily affect facial and eye tracking accuracy. Similarly,the quality of the road surface and vehicle vibrations can introduce errors into the system's assessments. These external variables can be challenging to mitigate, potentially leading to inaccuracies in drowsiness detection.

Moreover, the reliance on audio alerts, such as alarms or voice warnings, may not be suitable for all individuals. Drivers with hearing impairments or those using sound-canceling devices may not hear these alerts, rendering the system less effective for this subset of the population. In some instances, drowsiness detection systems require the use of invasive sensors that come into direct contact with the driver's body, such as electrodes to monitor physiological signals like heart rate or skin conductance. While these sensors can provide valuable data, they can be uncomfortable and may discourage some individuals from using the system.

Privacy concerns are another significant consideration. Many of these systems employ cameras and other sensors that continuously monitor the driver's behavior. The constant surveillance may raise privacy issues, as some drivers may be uncomfortable with the idea of being recorded while driving.Striking a balance between safety and privacy is an ongoing challenge in the development and adoption of these systems.

Cost is also a factor. The high implementation costs associated with integrating these systems into vehicles, particularly in cases where retrofitting is required for older vehicles, can be a substantial barrier to widespread adoption. Furthermore, ongoing maintenance and calibration are necessary to ensure that these systems remain accurate over time. Sensors may drift, and software updates may beneeded to address emerging issues. This ongoing maintenance can be burdensome for both individualdrivers and fleet operators.

Lastly, many drowsiness detection systems come with predefined settings for alert thresholds and timing. These settings may not always align with individual driver preferences and sensitivities. Consequently, some drivers may experience either excessive and annoying alerts or insufficient warnings, potentially impacting the system's overall effectiveness. Despite these challenges, ongoing research and technological advancements are actively addressing these limitations. Improved algorithms, advancements in artificial intelligence and sensor technologies, and better user interfacesare continuously enhancing the effectiveness and user-friendliness of drowsiness detection systems.

PROPOSED SYSTEM

The proposed system for addressing drowsy driving is a comprehensive solution that leverages cutting-edge technology to enhance road safety by monitoring driver fatigue in real-time and taking proactive measures to mitigate drowsiness. Here's an overview of the key components and functionsof the system:

1. Drowsiness Detection:

Computer Vision: The system uses computer vision technology to analyze the driver's facial cues and eye movements continuously.

Real-time Monitoring: It constantly monitors the driver's behavior to detect signs of drowsiness, suchas drooping eyelids, slow or erratic eye movements, and changes in facial expressions.

In the realm of drowsiness detection, the proposed system incorporates cutting-edge technology in the form of computer vision. This advanced approach involves the continuous analysis of the driver'sfacial cues and eye movements. By employing intricate algorithms and image processing techniques,the system can discern subtle changes in the driver's expressions, allowing for a comprehensive understanding of their alertness levels. A pivotal aspect of this system is its commitment to real-timemonitoring. Through a continuous and high-frequency stream of data, the system vigilantly observesthe driver's behavior. It remains attentive to key indicators of drowsiness, including the nuanced signssuch as drooping eyelids, slow or erratic eye movements, and alterations in facial expressions. This continuous monitoring ensures that the system is not only responsive but also capable of early detection, thus enhancing its overall effectiveness in preventing potential accidents caused by drowsydriving. The implementation of threshold-based detection adds a layer of sophistication to the system. By setting predefined thresholds for drowsiness, the system establishes a dynamic baseline for each driver. This approach recognizes that individual drivers may exhibit varying signs of drowsiness, and the system adapts accordingly. When the driver's behavior surpasses this predetermined threshold, the system promptly identifies them as being in a state of drowsiness. This dynamic thresholding mechanism contributes to the system's ability to tailor its response to the unique characteristics and patterns of each driver. In essence, the integration of computer vision, real-time monitoring, and threshold-based detection creates a robust framework for the detection of drowsiness. This not only allows for the accurate identification of early signs of fatigue but also ensures that the system's responses are finely tuned to the individual nuances of each driver's behavior. The aim is to create a comprehensive and adaptive system that significantly contributes tothe mitigation of drowsy driving, ultimately fostering safer road conditions.Threshold-Based Detection: The system sets a predefined threshold for drowsiness, and when the driver's behavior crosses this threshold, it identifies them as drowsy.

2. Proactive Measures:

Alarm Activation**:** When drowsiness is detected, the system activates an alarm designed to stimulate the driver's senses and help them stay awake. In the domain of proactive measures, the proposed systememploys a multi-faceted approach centered on alarm activation. When the system detects signsof drowsiness, it promptly initiates an alarm designed with precision to stimulate the driver's senses.This strategic intervention is not merely an alert; rather, it serves as a targeted mechanism to jolt the driver into a heightened state of awareness, counteracting the onset of fatigue. The alarm system is thoughtfully crafted to engage the driver through auditoryand visual alerts. Auditory alerts are tailoredto capture attention effectively, ranging from gentle reminders to more urgent and attention-grabbingsignals. This auditory element is designed to cut through any ambient noise within the vehicle and ensure that the driver is promptly and unmistakably alerted to the potential danger of drowsiness.

Simultaneously, visual alerts complement the auditory signals to create a comprehensive alerting experience. Visual cues may manifest as flashing lights on the dashboard or a heads-up display, strategically positioned within the driver's line of sight. The integration of visual alerts serves as a redundant layer, enhancing the overall effectiveness of the alarm system and catering to drivers who may respond more promptly to visual stimuli. This dual-channel approach, combining both auditory and visual elements in the alarm activation process, maximizes the chances of capturing the driver's attention. The goal is not only to alert the driver to their drowsy state but also to elicit a response that ensures they remain actively engaged in the driving task. By employing a well-calibrated blend of auditory and visual alerts, the system seeks to create a proactive and user-centric solution that goes beyond conventional alarm systems.

3. Hand Detection Module:

Active Driver Check: To ensure the driver remains actively engaged while the alert is activated, the system includes a hand detection module. Incorporating a critical dimension to driver engagement, the proposed system integrates a sophisticated hand detection module. This module serves as an active driver check, ensuring that the driver is not only aware of the alert but also actively engaged

in the control of the vehicle. By incorporating this module, the system takes a proactive stance in addressing the potential challenges associated with driver inactivity during alert scenarios. The hand detection module operates by continuously monitoring the driver's hand movements in real-time. Through advanced image processing and pattern recognition algorithms, the system distinguishes between intentional inactivity, such as during hands-free driving scenarios, and instances where the driver may be genuinely disengaged. This nuanced understanding enables the system to make accurate assessments of the driver's level of engagement with the vehicle.

Continuity checks play a pivotal role in the hand detection module's functionality. The system meticulously tracks the driver's hand movements to ascertain if they are actively controlling the vehicle. This ongoing assessment provides valuable insights into the driver's responsiveness and attention during the alert phase. If the system detects prolonged inactivity of the driver's hands whilethe alert is active, it triggers further actions to mitigate the risk associated with potential lapses in attention. The continuous monitoring of the driver's hand movements and the implementation of a hand detection module ensure that the system maintains a comprehensive understanding of the driver's level of engagement. By doing so, it adds an extra layer of assurance to the overall safety strategy, addressing scenarios where the driver's hands may be momentarily inactive during an alert.This proactive approach aligns with the system's overarching goal of not just detecting drowsiness but also actively promoting sustained driver attentiveness for enhanced road safety.

Continuity Checks: The system tracks the driver's hand movements to determine if they are actively controlling the vehicle. If the driver's hands are inactive for an extended period while the alert is active, the system takes further actions.

4. Emergency Response:

Collision Avoidance: In emergency scenarios where the driver's drowsiness approaches a critical level and prolonged inactivity is observed, the system takes immediate action to prevent collisions.

In instances of emergency response, the proposed system unveils a robust strategy to avert potential accidents caused by severe driver drowsiness. This proactive approach involves collision avoidance mechanisms that are triggered when the system perceives the driver's drowsiness reaching a critical threshold and simultaneous prolonged inactivity. The system promptly intervenes to prevent collisions, leveraging a combination of advanced vehicle control systems such as automatic emergency braking and adaptive cruise control. This instantaneous response is calibrated to ensure swift and precise actions that align with the paramount objective of safeguarding lives and preventingaccidents. Beyond collision avoidance, the system incorporates an essential feature for emergency situations: position sharing. In the event of detected critical driver fatigue, the system diligently shares the driver's current position with pre-selected emergency contacts through an alert message. This strategic sharing of information empowers designated individuals, such as emergency responders or family members, with crucial details to provide swift and targeted assistance. The inclusion of this functionality emphasizes the system's commitment not only to detecting and mitigating drowsiness but also to seamlessly facilitating timely aid during unforeseen emergency scenarios. The overarchinggoal of this comprehensive system is to elevate road safety standards by seamlessly integrating cutting-edge technology with real-time monitoring capabilities. By efficiently detecting and mitigating driver fatigue, the system minimizes the risk of accidents stemming from drowsy driving. The combination of collision avoidance mechanisms and position- sharing features amplifies the protective umbrella extended to both the driver and other road users. This amalgamation of advancedtechnology and immediate emergency response mechanisms aligns with the core objective of the project: fostering safer road conditions through a holistic and proactive approach to drowsy driving prevention.

Position Sharing: The system shares the driver's current position with pre-selected emergency contacts through an alert message. Overall, the primary objective of this project is to enhance road safety by efficiently detecting and mitigating driver fatigue. It also aims to provide prompt assistancein emergency situations by sharing the driver's location with designated contacts. This comprehensive system combines advanced technology and real-time monitoring to reduce the risk of drowsy driving-related accidents and protect both the driver and others on the road.

CHAPTER 3 : SYSTEM APPLICATIONS

3. SYSTEM APPLICATIONS

SOFTWARE SPECIFICATION

Libraries:

- Numpy
- Scipy
- Pygame
- Dlib
- Imutils
- OpenCV
- Twilio
- Geocoder

Operating System:

- Windows

Coding Language:

- Python 3

HARDWARE SPECIFICATIONS

- Laptop with basic hardware.
- Webcam

CHAPTER 4: DROWSINESS DETECTION

4. DROWSINESS DETECTION

INTRODUCTION

The drowsiness detection describes the detecting of drowsiness, UML diagrams, dataset, implementation of the project, sourcecode and output screenshots. The UML diagrams include use case diagram, sequence diagram, class diagram, activity diagram. The implementation of the project provides the information about details like Data Processing, Datasets, and Model (Fake News Detection). The source code is providing in Python Programming Language. The output screenshots are the outputs we get after executing the source code.

Purpose

The purpose of this project is to develop and implement an advanced driver drowsiness detection system that leverages OpenCV module and computer vision, a cutting-edge technology. Guardian Drive serves several important purposes:

1. **Development of Advanced Drowsiness Detection System** Implementing cutting-edge technologies, including computer vision, to create a sophisticated driver drowsiness detection system.

2. **Proactive Identification of Drowsiness Signs** Design algorithms and mechanisms for real-time monitoring to proactively identify signs of driver drowsiness during the driving process.

3. **Road Safety Enhancement** Contribute to the reduction of accidents, injuries, and fatalities associated with drowsy driving by providing timely alerts and interventions based on the detected signs of drowsiness.

4. **Real-Time Monitoring Capability** Implement mechanisms for continuous real-time monitoring of driver behavior, focusing on indicators such as eye movements, facial expressions, and steering patterns to identify signs of drowsiness of driver in real-time.

5. **Compliance with Regulations** As awareness of the dangers of drowsy driving grows, regulatory bodies may mandate or encourage the inclusion of drowsiness detection systems in vehicles. Adopting these technologies ensures compliance with evolving safety standards.

6. **Improved Productivity in Commercial Vehicles** In commercial settings, such as trucking or public transportation, drowsiness detection systems contribute to improved driver productivityby

minimizing the risks associated with fatigue-related accidents, enhancing overall fleet safety.

DROWSINESS DETECTION AND SAFETY SYSTEM

Faciallandmarks:

Utilizing established facial landmark recognition features, we employ pre-existing annotations to identify signs of drowsiness and fatigue. Leveraging the dlib open-source Python library, we detect 68 facial landmarks, aiding in the prediction of facial shape by delineating key regions such as eyebrows, eyes, nose,and mouth.Variations in the characteristics of these specific points reflect the individual's range of expressions.

EAR Algorithm :

Eye Aspect Ratio (EAR) is a metric that evaluates the openness of the eyes by considering the ratio of width to height. Each eye is defined by six (x, y) coordinates, starting from the upper left corner and proceeding clockwise around the eye's perimeter . This innovative approach involves computing the ratio of the sum of vertical distances to twice the sum of horizontal distances between these points. Notably, EAR is computed independently for each left and right eye. Formula to calculate EAR

$$= \frac{||P2 - P6|| + ||P3 - P5||}{2||P1 - P4}$$

A) PREPROCESSING

In the pre-processing stage of capturing the driver's video, the system utilizes a camera installed within the vehicle cabin. This camera is strategically positioned to have a clear view of the driver's face, ensuring optimal capture of facial expressions and movements. Before recording begins, the system may adjust camera settings such as focus, exposure, and frame rate to optimize video quality and reduce potential distortions or blurriness. Additionally, any ambient lighting conditions may be taken into account to ensure adequate visibility of facial landmarks. Once the camera is properly configured, the system initiates video capture, continuously recording the driver's face throughout the duration of the journey. This video data serves as the input for subsequent processing stages, including facial landmark detection and drowsiness analysis.

B) DATA GATHERING

The process of gathering data begins with image preprocessing to ensure clear visibility of the driver's face. Dlib's face detector is then employed to accurately locate and delineate the facial region within the image. Utilizing the pre-trained facial landmark detector from the Dlib library, the system estimates the positions of 68 (x, y) coordinates corresponding to key facial features. These coordinates facilitate the establishment of a bounding box around the face, ensuring focused analysis. Proceeding from facial landmark localization, the system extracts the coordinates of the eyes and mouth, encapsulating this focused region into a polygon using a convex hull. Contours are then drawn around the eyes and mouth regions by connecting the coordinates along the boundary for visual shape analysis, aiding in feature extraction. Following this, the initial Eye Aspect Ratio (EAR) of the driver is computed promptly upon system activation, typically upon starting the vehicle and detecting a face. This approach addresses individual variations in EAR due to factors such as genetic diversity and facial structure, which can affect drowsiness detection accuracy. By calculating the driver's EAR at the onset, the system adapts to the unique characteristics of the individual, minimizing false alarms and optimizing performance.

C) DETECTION SYSTEM

The detection system operates with a meticulous approach to ensure accurate identification of driver fatigue. Initially, the system computes and stores the driver's baseline Eye Aspect Ratio (EAR). Subsequent frames are then captured in clusters of 30,this means that the system captures and analyzes 30 consecutive frames of video data at a time. This approach allows for a more comprehensive assessment of the driver's alertness levels over a short period. By analyzing a cluster of frames rather than individual frames, the system can observe changes and patterns in the driver's behavior more effectively, providing a more accurate understanding of their level of alertness. This method enables the system to detect subtle changes in the driver's eye movements, such as blinks or prolonged eye closures, which may indicate drowsiness or fatigue enabling comprehensive monitoring of the driver's alertness levels. Through real-time analysis of EAR fluctuations, the system discerns instances of eye closure and reopening, thus facilitating the detection of blinks.

By comparing the current EAR with the initial baseline, the system initiates a text warning if the real-time EAR remains below 20% of its baseline counterpart for more than 20 consecutive frames, indicative of frequent blinking. Recognizing the correlation between drowsiness and increased blink frequency, prolonged eye closures prompt the system to trigger an alarm if the driver's eyes remain shut for more than 20% of the initial EAR value across 48 frames. To account for variations in individual physiology and environmental factors, a conservative EAR threshold is maintained, ensuring reliable detection even in scenarios where the EAR does not reach zero during complete eye closure. This comprehensive monitoring process continues seamlessly until the vehicle engine is deactivated, ensuring continuous vigilance over the driver's alertness levels throughout the journey.

D) ALARM SYSTEM

The alarm system provides dual notification methods—text messages and audible alarms—to effectively alert the driver to potential drowsiness. However, these alerts are activated only when the system detects extreme drowsiness, defined by prolonged eye closure exceeding 20% of the initial EAR value across a span of 48 frames. To deactivate the alarm and restore normalcy, the system integrates a sophisticated smart alarm system that relies on hand gesture recognition. Upon activation of the alarm, the system immediately initiates the process of capturing frames to analyze hand gestures within a defined Region of Interest (ROI). By capturing and processing 30 frames from the live video stream and employing resizing and flipping techniques, the system ensures precise detection of hand movements. Utilizing Convex Hull, the system identifies the shape of the object within the ROI, enabling the drawing of contours using extreme points as coordinates to distinguish foreground from background. Upon confirmation of a detected hand, the audible alarm ceases, enabling the system to resume its primary function of monitoring the driver's drowsiness. Furthermore, to enhance the user experience and minimize distraction, any text warnings triggered by excessive yawning or blinking disappear automatically once the system detects that the driver has regained alertness or become active. This adaptive feature underscores the system's commitment to safety and user convenience. This proactive approach to alerting the driver encourages timely intervention and helps prevent potential accidents due to driver fatigue.

E) LOCATION TRACKING

The location tracking process, integrated with geocoder technology, enhances the safety features of the system by enabling real-time monitoring of the driver's whereabouts. Geocoding, a process that converts addresses into geographic coordinates, allows the system to accurately pinpoint the driver's location using GPS data. By continuously updating the driver's coordinates, the system can precisely track their movements throughout the journey. Leveraging this geolocation data, the system is equipped to respond swiftly in case of emergencies. In the event of a critical situation such as a detected instance of extreme drowsiness or a collision, the system activates its emergency protocol. This protocol includes sending automated text messages to designated emergency contacts via Twilio, a cloud communications platform. These text messages contain vital information, including the driver's current location obtained through geocoding. By promptly alerting emergency contacts with the driver's precise coordinates, the system facilitates rapid assistance and intervention in emergency situations.

Overall Description

The project aims to achieve the following objectives in a systematic and coordinated manner:

1. Identification of Technological Framework:

   -Evaluate and select the appropriate technological components, including computer vision, machine learning algorithms, and sensor integration.

2. System Development:

-Develop a robust and integrated driver drowsiness detection system based on theselected technological framework.

3. Real-Time Monitoring:

-Implement real-time monitoring capabilities to continuously assess driver behavior and alertness during the driving process.

4. Signs ofDrowsiness Recognition:

-Design algorithms to recognize key signs of drowsiness, such as eyelid movements, facial expressions, and steering patterns.

5. Alert Mechanisms:

-Integrate effective alert mechanisms, such as auditory and visual warnings, to notify thedriver promptly upon detection of signs of drowsiness.

6. Intervention Strategies:

-Explore and implement intervention strategies, such as automatic adjustments in vehicle settings or notifications to authorities, to prevent potential accidents.

7. Testing and Optimization:

-Conduct extensive testing under diverse driving conditions to ensure the system's accuracy and reliability.

-Optimize the algorithms and functionalities based on real-world performance data.

8. Integration with Vehicles:

- Collaborate with automotive manufacturers to seamlessly integrate the drowsiness detection systeminto existing and future vehicle models.

9. User Interface and Experience:

-Develop an intuitive and user-friendly interface for both drivers and vehicle manufacturers, ensuring ease of use and integration.

10. Documentation and Guidelines:

-Provide comprehensive documentation, guidelines, and training materials for users and manufacturers to facilitate proper implementation and utilization of the system.

11. Public Awareness and Education:

-Launch awareness campaigns to educate the public about the dangers of drowsy driving and promote the adoption of the new technology.

12. Continuous Improvement:

-Establish mechanisms for continuous monitoring, feedback collection, and system updates to adapt to evolving technologies and driving behaviors.

By following this structured flow, the project aims to deliver a state-of-the-art driver drowsiness detectionsystem that not only addresses the immediate goal of enhancing road safety but also ensures long-term effectiveness and sustainability of the driver in drowsiness state and also other drivers on road.

UML DIAGRAMS

I. USE CASE DIAGRAMS

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram definedby and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as usecases), and any dependencies between those use cases. The main purpose of a use case diagram is toshow what systemfunctions are performed for which actor. Roles of the actors in the system can be depicted.

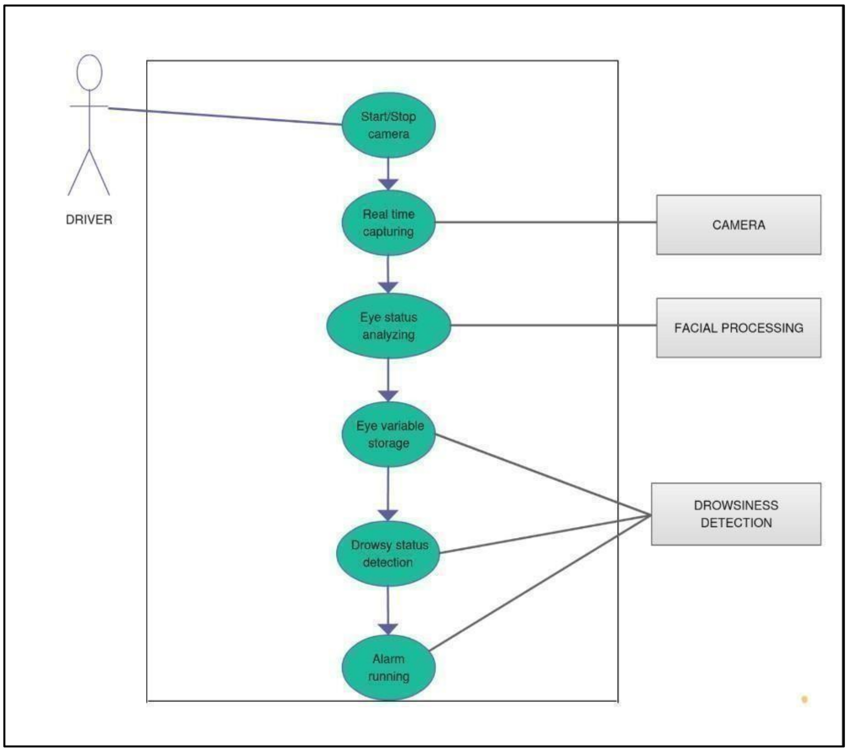


Fig 4.2.1: Use Case Diagram

II. SEQUENCE DIAGRAM

A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that showshow processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.

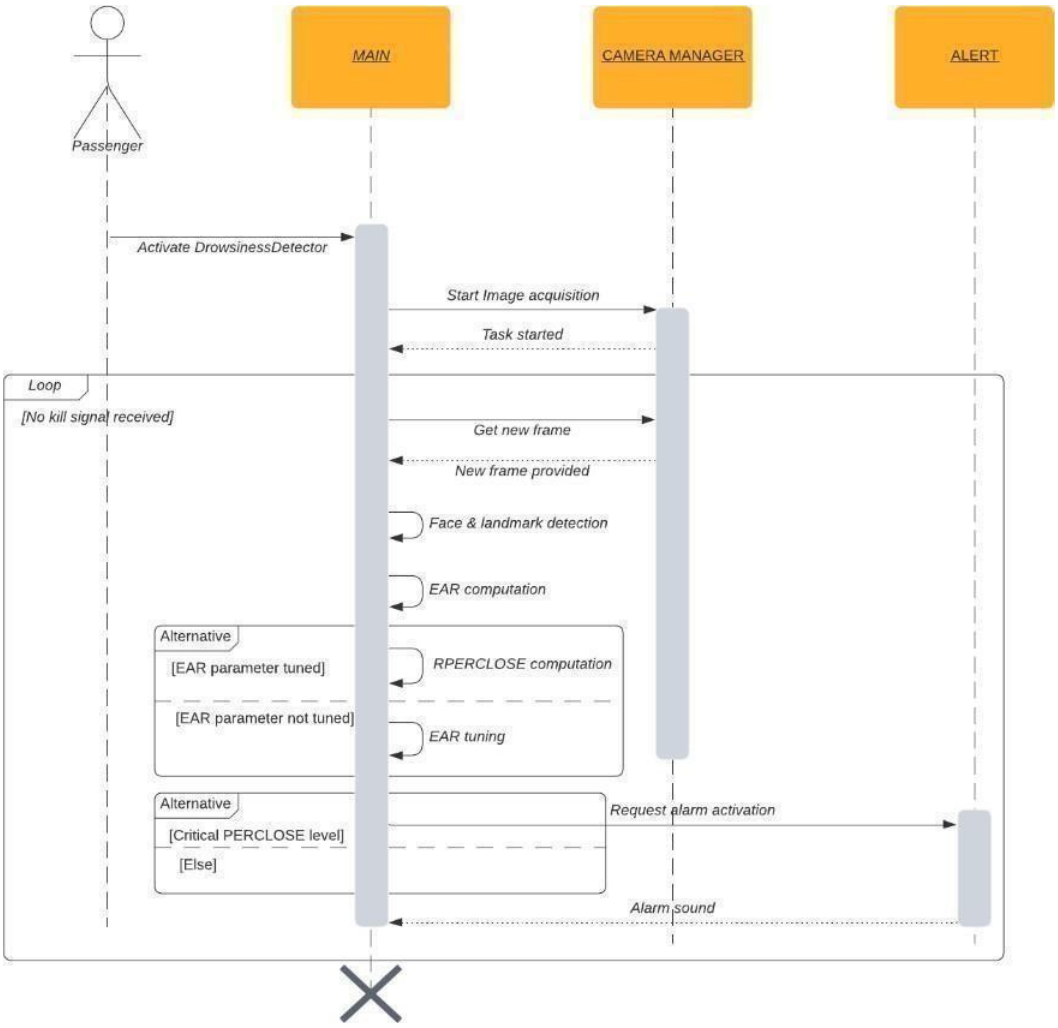


Fig 4.2.2: Sequence Diagram

III. CLASS DIAGRAM

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of staticstructure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information

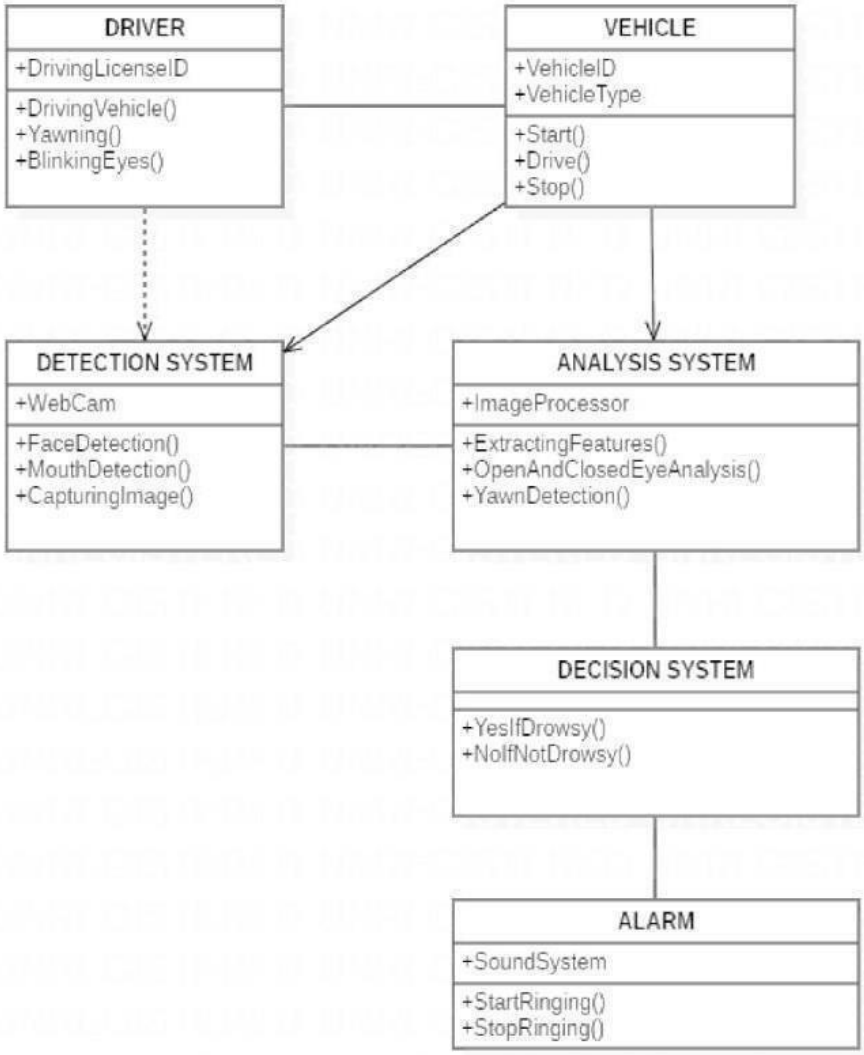


Fig 4.2.3: Class Diagram

IV. ACTIVITY DIAGRAM

Activity diagrams are graphical representations of workflows of stepwise activities and actions withsupport for choice, iteration and concurrency. In the Unified Modeling Language, activity diagrams can be used to describe the business and operational step-by-step workflows of components in a system. An activity diagram shows the overall flow of control.

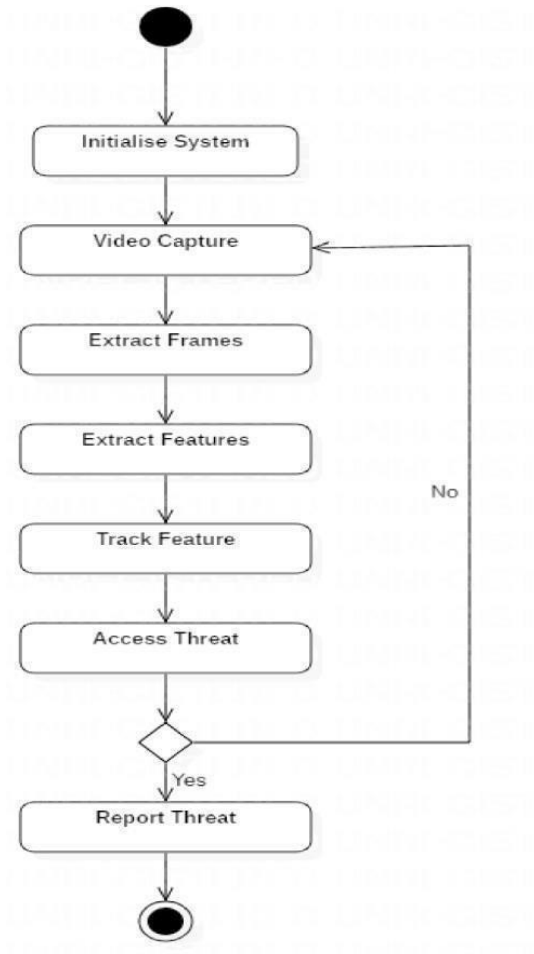


Fig 4.2.4: Activity Diagram

MODULE DESCRIPTION

I. Numpy

Numpy is a general-purpose array-processing package. It provides a high-performance multidimensional array object, and tools for working with these arrays. It is the fundamental package for scientific computing with Python. It contains various features including these important ones:

- Apowerful N-dimensional array object
- Sophisticated (broadcasting) functions
- Tools for integrating C/C++ and Fortran code
- Useful linear algebra, Fourier transform, and random number capabilities

Besides its obvious scientific uses, Numpy can also be used as an efficient multi-dimensional container of generic data. Arbitrary data-types can be defined using Numpy which allows Numpy to seamlesslyand speedily integrate with a wide variety of databases.

To use NumPy in your Python code, you need to install it using a package manager such as pip or conda. Once installed, you can import it into your Python script or Jupyter notebook and start using its functions and arrays for numerical computations. NumPy's official documentation is extensive and provides detailed information on how to use its various functions and features for different use cases.

To install NumPy using pip, follow these steps:

Open a command prompt or terminal window.

Ensure that you have Python and pip (Python's package manager) installed on your system. If not, you can download Python from the official Python website (https://www.python.org/) and pip will be included with it.

Enter the following command to install NumPy using pip:

```
pip install numpy
```

Press Enter to execute the command.

pip will download and install the NumPy package along with its dependencies.

Once the installation is complete, you can import NumPy in your Python script or Jupyter notebook using the following statement:

Python

```
import numpy as np
```

Now you are ready to use NumPy in your Python code for numerical computing tasks! NumPy's official documentation (https://numpy.org/doc/stable/) provides detailed information on how to use its functions and features for various numerical computations

II. PyGame

Pygame is a cross-platform set of Python modules designed for writing video games. It provides functionalities for handling various aspects of game development, including graphics, sound, input devices, and more. Pygame is built on top of the Simple DirectMedia Layer (SDL), a low-level multimedia library, and it simplifies the process of creating games by providing a higher-level interface. The sound module in Pygame enables you to load and play sound files, making it possible to add background music, sound effects, and other audio elements to your games.

III. GeoCoder

The geocoder module in Python is a library that provides a simple and consistent interface for geocoding (converting addresses to geographic coordinates) and reverse geocoding (converting coordinates to human-readable addresses). This module makes it easy to work with various geocodingservices without having to worry about the specific API details of each service.

IV. Imutils

Imutils is a Python package designed to make working with OpenCV, a popular computer vision library, more convenient. It provides a set of utility functions that simplify common tasks, making codecleaner and more readable. One of its key features is the ability to resize, rotate, and display images with just a single line of code, reducing the complexity of these operations. Additionally, Imutils includes functions for working with file paths and directories, making it easier to load and save images.

The simplicity and efficiency offered by Imutils make it a valuable tool for developers and researchers working on computer vision projects. Imutils can enhance your workflow and accelerate the development of image processing applications.

Here's an overview of imutils and its key features:

1. Image Resizing: imutils provides functions for resizing images, including resizing by a specific width or height, maintaining aspect ratio, and resizing to a target size while preserving the aspect ratio.

2. Image Rotation: imutils offers functions for rotating images by a specific angle, both clockwise and counter clockwise, and rotating images around a specific point or the center of the image.

3. Image Translation: imutils includes functions for translating images by a specified number of pixels in the x and y direction, allowing for image shifting or panning.

4. Image Flip and Mirror: imutils provides functions for flipping images horizontally or vertically, as well as functions for mirroring images along the x or y axis.

5. Image Drawing: imutils offers functions for drawing various shapes on images, such as lines, rectangles, circles, and text.

6. Image Channels and Colo spaces: imutils provides functions for splitting and merging image channels, as well as converting images between different colorspaces, such as RGB, BGR, grayscale, and HSV.

7. Image Filtering: imutils includes functions for applying common image filters, such as

Gaussian blur, median blur, and bilateral filter, to smooth or enhance images.

8. Image Thresholding: imutils provides functions for applying thresholding techniques, such as simple thresholding, adaptive thresholding, and Otsu's thresholding, to convert grayscale images to binary images.

9. Image Display: imutils offers functions for displaying images using popular GUI frameworks, such as OpenCV's high gui, matplotlib, and PyQt, making it easy to visualize images in Python applications.

10. Video Processing: imutils includes functions for processing video frames, such as reading frames from video files, displaying video frames, and saving video frames to video files.

Overall, imutils is a handy library for performing common image processing tasks in Python. It provides a collection of utility functions that can simplify image processing operations and make it easier for developers to work with images in their Python applications.

V. OpenCV

OpenCV is the huge open-source library for the computer vision, machine learning, and image processing and now it plays a major role in real-time operation which is very important in today's systems. By using it, one can process images and videos to identify objects, faces, or even handwritingof a human. When it integrated with various libraries, such as NumPy, python is capable of processingthe OpenCV array structure for analysis. To Identify image pattern and its various features we use vector space and perform mathematical operations on these features.

Key features of OpenCV:

- **Object detection** OpenCV can be used for detecting and recognizing objects in images and videos.Techniques such as Haar cascades and deep learning-based approaches can be applied for object detection.

- **Face Recognition** OpenCV provides tools for face detection and recognition. It can be used to identify faces in images and videos, and even for facial expression analysis.

- **Computer Vision Algorithms** OpenCV includes a variety of computer vision algorithms, such as edge detection, image filtering, morphological operations, feature extraction, and stereo vision.

- **Augmented Reality** OpenCV is employed in AR applications for tasks like marker detection, poseestimation, and overlaying virtual objects onto real-world scenes.

- **Real-time Image and Video Analysis** OpenCV is often employed for real-time analysis of images and videos in applications like surveillance, quality control, and video analytics.

- **Feature Detection and Matching** OpenCV includes algorithms for detecting and matching features in images. This is useful for tasks like image stitching, panorama creation, and object tracking.

V1. Dlib

dlib is a popular open-source C++ library that provides tools and algorithms for various computer vision tasks, including face detection, face recognition, facial landmark detection, object detection, and image processing. dlib is widely used in the field of computer vision and machine learning due to its efficiency, accuracy, and ease of use. In addition to its C++ API, dlib also provides Python bindings, making it accessible for Python developers as well.

Here are some key features of dlib:

Face Detection: dlib provides highly accurate face detection capabilities using its deep learning-based face detection model. It can detect faces in images and videos, even under varying lighting conditions, orientations, and occlusions.

Facial Landmark Detection: dlib can accurately detect facial landmarks, such as the eyes, nose, mouth, and jawline, in facial images. These facial landmarks can be used for tasks such as facial expression analysis, face alignment, and facial feature extraction.

Face Recognition: dlib includes a state-of-the-art deep learning-based face recognition model that can be used to recognize faces in images and videos. It can identify individuals based on their facial features, making it useful for applications such as face authentication, face verification, and face clustering.

Object Detection: dlib supports object detection using its object detection model, which can detect various objects in images and videos, including cars, pedestrians, and other objects of interest.

Image Processing: dlib provides a variety of image processing functions, such as image resizing, image filtering, color manipulation, and geometric transformations, which can be used for tasks such as image pre-processing, augmentation, and manipulation.

Machine Learning Tools: dlib includes a wide range of machine learning tools, such as support vector machines (SVMs), k-nearest neighbors (KNN), and deep neural networks, which can be used for tasks such as classification, regression, and clustering.

Cross-Platform Compatibility: dlib is cross-platform compatible and can be used on various operating systems, including Windows, macOS, Linux, and embedded systems.

Integration with OpenCV: dlib can be easily integrated with OpenCV, a popular computer vision library, to perform more advanced image processing and computer vision tasks.

Extensive Documentation and Community Support: dlib has extensive documentation, tutorials, and examples available, making it easy to learn and use. It also has a large community of users and developers who provide support and contribute to its development.

Dlib is a powerful and versatile library that provides a wide range of computer vision tools and algorithms for various tasks. Its high accuracy, efficiency, and ease of use make it a popular choice among researchers, developers, and practitioners in the field of computer vision and machine learning

DATASET

The shape predictor 68 landmarks dataset refers to a collection of facial landmarks that are commonlyused in computer vision and facial analysis tasks. Facial landmarks are used to localize and representsalient regions of the face, such as:

- Eyes
- Eyebrows
- Nose
- Mouth
- Jawline

The 68 landmarks are often used for facial landmark detection, a crucial step in applications like facialrecognition, expression analysis, and head pose estimation. One popular dataset for this purpose is the68-landmark model from the Dlib library, which includes a pre-trained shape predictor model. This model can predict the positions of these 68 landmarks on a given face image.

1. Face detection: Face detection is the first method that locates a human face and returns avalue in x,y,w,h which is a rectangle.

   Images in the dataset were captured under diverse range of conditions, including variations in lighting, distance, resolution, face angle, and eye angle. These factors contribute to achieving favorable outcomes while minimizing the likelihood of low accuracy.

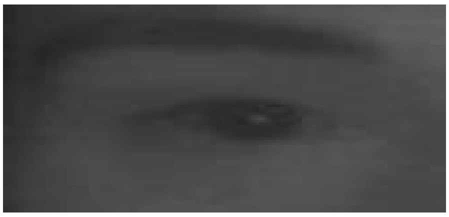


Fig 4.4.1: Open Eye

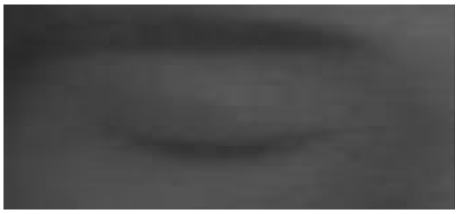


Fig 4.4.1 : Close Eye

The dataset comprises multiple versions, each containing different quantities of images. Version 1 consists of 10,000 images, evenly split between 5,000 images of closed eyes and 5,000 images of open eyes. Version 2 includes 5,000 images, with 2,500 images of closed eyes and 2,500 images of open eyes. Version 3 also contains 10,000 images, distributed as 5,000 images of closed eyes and 5,000 images of open eyes. Lastly,Version4comprises 4,000 images, with 2,000images of closed eyes and 2,000 images of open eyes.

2. Face landmark: After getting the location of a face in an image, then we have to through points inside of that rectangle.

   The dataset is valuable for training and evaluating facial landmark detection algorithms. Researchers and developers leverage these annotated images to create and fine-tune models that can accurately locate facial landmarks. The 68 landmarks provide a detailed representation of facial geometry, enabling more advanced and nuanced analysis of facial expressions and configurations.

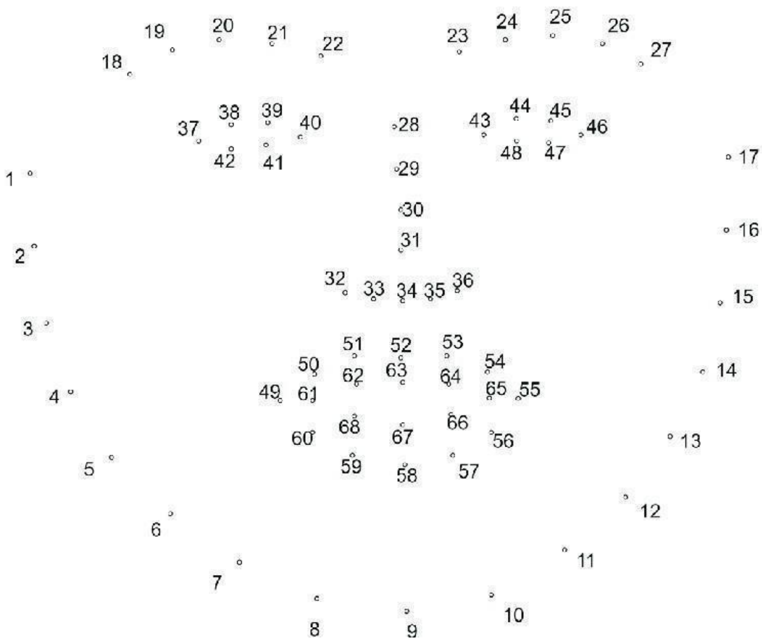


Fig 4.4.2: Facial landmarks

Overall, the shape predictor 68 landmarks dataset plays a crucial role in advancing the field of computervision and facial analysis.

IMPLEMENTATION

Implementing a drowsiness detection and safety system using computer vision involves several steps, including model building, face, eye and hand detection, and EAR algorithm Below is a step-by-step guide on how to implement drowsiness detection and safety system using computer vision.

Step 1: Import libraries

Import the required libraries and their functions. In our program we used Dlib, a pre-trained program trained on the shape_predictor_68_landmarks dataset to detect human faces using the pre-defined 68 landmarks

Step 2: Model Building

I.Face Detection

Starting by the video capture, we will use OpenCV to capture the system's webcam in an "infinite" loop and thus give the impression of watching a video. It's a landmark's facial detector with pre- trained models, the dlib is used to estimate the location of 68 coordinates (x, y) that map the facial points on a driver's face. Load all the models we need: a detector to find the faces, a shape predictor to find face landmarks so we can precisely localize the face, and finally the face recognition model.

```
cap = cv2.VideoCapture(0)

detector = dlib.get_frontal_face_detector()

predictor = dlib.shape_predictor('shape_predictor_68_face_landmarks.dat')
```

I. Eye detection

After passing our video feed to the dlib frame by frame, we are able to detect left eye and right eye features of the face. The Region of Interest (ROI) corresponding to the left and right eyes from facial landmark array. The boundaries are defined in these regions. Contours are drawn around the convex hull of eyes.

```
left_eye = shape[lStart:lEnd]

right_eye = shape[rStart:rEnd]
left_eye_hull = cv2.convexHull(left_eye)
right_eye_hull = cv2.convexHull(right_eye)
cv2.drawContours(frame, [left_eye_hull], -1, (0, 255, 0), 1)

cv2.drawContours(frame, [right_eye_hull], -1, (0, 255, 0), 1)
```

II. Hand Detection

Hands are detected in a video frame using a Haar Cascade classifier and visualizes the detection bydrawing green rectangles around the detected hand on the original frame.

```
hand_cascade = cv2.CascadeClassifier('palm.xml')

hands = hand_cascade.detectMultiScale(gray, 1.3, 5)

for (x, y, w, h) in hands:
cv2.rectangle(frame, (x, y), (x + w, y+ h), (0, 255, 0), 2)
```

Step 3: EAR Algorithm

Eye Aspect Ratio (EAR) calculates the level of eye openness based on the coordinates of facial landmarksrepresenting the eyes. The Euclidean distances between specific pairs of landmarks are calculated. A lower EAR typically indicates closed eyes, while a higher EAR suggests open eyes.

```
A = dist.euclidean(eye[1], eye[5])

B = dist.euclidean(eye[2],eye[4])

C = dist.euclidean(eye[0], eye[3])

ear = (A + B) / (2 * C)
```

Step 4: Emergency Alert

Once the system detects signs of drowsiness, it can activate an alarm to alert the driver or operator. The alarm can take various forms, such as audible alerts, visual warnings or haptic feedback. Here we are using audible alerts. The system designed to notify the driver of the potential danger.

```
pygame.mixer.init()

sound = pygame.mixer.Sound("alarm3.mp3")
sound.play()
time.sleep(4)
```

Step 5: Location tracking

Location tracking using a geocoder involves the use of a geocoding service to convert addresses or placenames into geographic coordinates (latitude and longitude), which can then be used to determine the location of a specific point on the Earth's surface. Geocoding is essentially the process of transforming human-readable location information into a format that can be used for mapping and spatial analysis.

```
g = geocoder.ip('me')
lat = g.latlng[0]
long = g.latlng[1]
current_location = g_maps_url.format(lat, long)
return current_location
```

Step 6: Location sharing

Location sharing while driving can be important for various reasons, primarily related to safety, navigation, and communication. Twilio primarily provides communication APIs for sending and receiving text messages, phone calls, and other forms of communication. Twilio's messaging capabilitiesin combination with other location-based services to implement location sharing in your application.

```
account_sid = "AC21735cda0a0fb2722ffdfbd321d9bfaa"
auth_token = "7f4972b6d2fe9cd1650558d9bd952247"
sender = "+12397192691"
message = "Test Message: {} doesn't seem okay. Please check. Last known location:
{}".format(driver,current_location)
client = Client(account_sid,auth_token)
for num in contact_list:
  client.messages.create(
  to="+91"+str(num),
  from_=sender,
  body=message
)
```

Step 7: Emergency Contacts

Fetching emergency contacts before driving involves the process of accessing and organizing a list of contacts designated for emergencies. This practice is particularly important for ensuring quick and efficient communication in case of unexpected situations while driving. By proactively fetching and organizing an emergency contacts list before driving, you enhance your preparedness for unforeseen circumstances.

```
contacts = []
print("Please enter your three emergency contacts: ")
contacts.append(input("Enter first contact: "))
```

```
contacts.append(input("Enter second contact: "))
 contacts.append(input("Enter third contact: "))
```

SOURCE CODE

```
import time
import sys
from threading import Thread
from imutils import face_utils
import numpy as np
import cv2
import dlib
fromscipy.spatial import distance as dist
from twilio.rest import Client
import pygame
import geocoder
import time
defdetect_hand():
    # Load the cascade classifier
      hand_cascade = cv2.CascadeClassifier('palm.xml')
      start_time = time.time()
    # Read the video fromthe webcam
    while True:
        # Read the frames
        ret, frame = cap.read()
        # Convert the frames to grayscale
        gray= cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
        # Detect hands in the frames
        hands = hand_cascade.detectMultiScale(gray, 1.3, 5)
        # Draw rectangles around the hands
        for (x, y, w, h) in hands:
            cv2.rectangle(frame, (x, y), (x + w, y+ h), (0, 255, 0), 2)
```

```
# Display the frames
        cv2.imshow('Hand detection', frame)
        # Stop the video capture after 'duration' seconds
        elapsed_time = time.time() - start_time
        if elapsed_time >= 60 or len(hands)>0:
            break
        # Exit on 'q' key
        if cv2.waitKey(1) & 0xFF == ord('q'):
            break
        # Release the video capture and close the windows
        cv2.destroyWindow('Hand detection')
        time.sleep(0.01)
        # If hands are detected, return true
        if len(hands) > 0:
            return True
        # If not, return false
        else:
            return False
    def eye_aspect_ratio(eye):
        # compute the euclidean distance between the vertical eye landmarks
        A = dist.euclidean(eye[1], eye[5])
        B = dist.euclidean(eye[2], eye[4])
        # compute the euclidean distance between the horizontal eye landmarks
        C = dist.euclidean(eye[0], eye[3])
        # compute the EAR
        ear = (A + B) / (2 * C)
        return ear
    def play_alarm2():
        pygame.mixer.init()
        sound = pygame.mixer.Sound("alarm3.mp3")
        sound.play()
```

```
time.sleep(4)

    def get_current_location(g_maps_url):
        g = geocoder.ip('me')
        lat =  g.latlng[0]
        long = g.latlng[1]
        current_location = g_maps_url.format(lat, long)
        return current_location
  def send_alert_message(driver, contact_list, current_location):
    # twilio credentials
    account_sid = "AC21735cda0a0fb2722ffdfbd321d9bfaa"
    auth_token = "7f4972b6d2fe9cd1650558d9bd952247"
    sender = "+12397192691"
        message = "Test Message: {} doesn't seem okay.Please check.Last known location:
  {}".format(driver, current_location)
     client = Client(account_sid, auth_token)
     for num in contact_list:
         client.messages.create(
        to="+91"+str(num),
        from_=sender,
        body=message
     )
  def fetch_contact_list(driver):
      # create an empty list that will store the user's contact numbers
      contacts = []
      print("Please enter your three emergency contacts: ")
      contacts.append(input("Enter first contact: "))
      contacts.append(input("Enter second contact: "))
      contacts.append(input("Enter third contact: "))
      return contacts
  driver = input("Hi Driver! Please enter your name: ")
  contact_list = fetch_contact_list(driver)
  JAWLINE_POINTS = list(range(0, 17))
  RIGHT_EYEBROW_POINTS = list(range(17, 22))
  LEFT_EYEBROW_POINTS = list(range(22, 27))
```

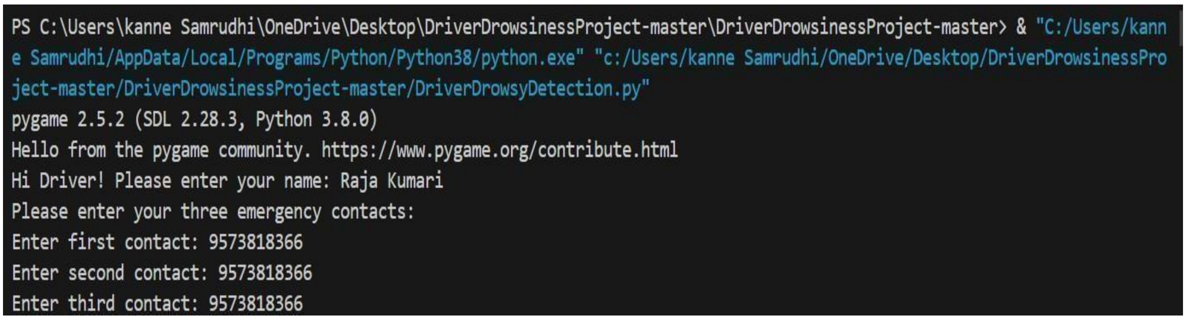
```
NOSE_POINTS = list(range(27, 36))
RIGHT_EYE_POINTS = list(range(36, 42))
LEFT_EYE_POINTS = list(range(42, 48))
MOUTH_OUTLINE_POINTS = list(range(48, 61))
MOUTH_INNER_POINTS = list(range(61, 68))
EYE_AR_THRESH = 0.22
EYE_AR_CONSEC_FRAMES = 6
EAR_AVG = 0
CONTINUOUS_FRAMES = True
COUNTER = 0
TOTAL = 0
ALARM_ON = False
g_maps_url = "http://maps.google.com/?q={},{}"
(lStart, lEnd) = face_utils.FACIAL_LANDMARKS_68_IDXS["left_eye"]
(rStart, rEnd) = face_utils.FACIAL_LANDMARKS_68_IDXS["right_eye"]
    # to detect the facial region
    detector = dlib.get_frontal_face_detector()
    predictor = dlib.shape_predictor('shape_predictor_68_face_landmarks.dat')

    # capture video from live video stream
    cap = cv2.VideoCapture(0)
    while CONTINUOUS_FRAMES:
    # get the frame
    ret, frame = cap.read()
    #frame = cv2.resize(frame, (0, 0), fx=0.5, fy=0.5)
    if ret:
      # convert the frame to grayscale
        gray= cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
        rects = detector(gray, 0)
        for rect in rects:
            shape = predictor(gray, rect)
            shape = face_utils.shape_to_np(shape)#converting to NumPy Array
```

```
left_eye = shape[lStart:lEnd]
right_eye = shape[rStart:rEnd]
# draw contours on the eyes
left_eye_hull = cv2.convexHull(left_eye)
right_eye_hull = cv2.convexHull(right_eye)
    cv2.drawContours(frame, [left_eye_hull], -1, (0, 255, 0), 1) # (image, [contour],
all_contours, color, thickness)
cv2.drawContours(frame, [right_eye_hull], -1, (0, 255, 0), 1)
# compute the EAR for the left eye
ear_left = eye_aspect_ratio(left_eye)
# compute the EAR for the right eye
ear_right = eye_aspect_ratio(right_eye)
# compute the average EAR
ear_avg = (ear_left + ear_right) / 2.0
# detect the eye blink
if ear_avg < EYE_AR_THRESH:
    COUNTER += 1
    print(COUNTER)
    if COUNTER >= EYE_AR_CONSEC_FRAMES: #TOTAL += 1
        #print("Eye blinked")
        if not ALARM_ON:
            ALARM_ON = True
            TOTAL+=1
            t = Thread(target=play_alarm2)
            t.daemon = True
            t.start()
        # draw an alarm on the frame
        cv2.putText(frame, "DROWSINESS ALERT!", (10, 30),
                cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)
        # if long inactivity is found
      if COUNTER >= 40:
          print("Something wrong?")
          CONTINUOUS_FRAMES = False
```

```
        break
    elif TOTAL==5:

    TOTAL=0

    cv2.putText(frame, "PLEASE SHOW YOUR HAND TO THE CAMERA", (10, 30),
            cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)
    if detect_hand()==True:

    cv2.putText(frame, "YOU ARE GOOD TO GO. PLEASE DRIVE SAFE!!!", (10, 30),
            cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)
    else:

        current_location = get_current_location(g_maps_url)
        send_alert_message(driver,contact_list,current_location)

    else:
        COUNTER = 0

        ALARM_ON = False

cv2.putText(frame, "EAR {}".format(ear_avg), (10, 60), cv2.FONT_HERSHEY_DUPLEX,

  0.7, (0, 255, 255), 1)

  cv2.imshow("Winks Found", frame)
  key = cv2.waitKey(1) & 0xFF
  # When key 'Q' is pressed, exit
  if key is ord('q'):

      break
  # release all resources

  cap.release()
 # destroy all windows
 cv2.destroyAllWindows()
# send message to the person's 3 immediate contacts
current_location = get_current_location(g_maps_url)
send_alert_message(driver, contact_list, current_location)
sys.exit()
```

OUTPUT

To run the project, click on run in visual studio code.



```
PS C:\Users\kanne Samrudhi\OneDrive\Desktop\DriverDrowsinessProject-master\DriverDrowsinessProject-master> & "C:/Users/kanne Samrudhi/AppData/Local/Programs/Python/Python38/python.exe" "c:/Users/kanne Samrudhi/OneDrive/Desktop/DriverDrowsinessProject-master/DriverDrowsinessProject-master/DriverDrowsyDetection.py"
pygame 2.5.2 (SDL 2.28.3, Python 3.8.0)
Hello from the pygame community. https://www.pygame.org/contribute.html
Hi Driver! Please enter your name: Raja Kumari
Please enter your three emergency contacts:
Enter first contact: 9573818366
Enter second contact: 9573818366
Enter third contact: 9573818366
```

Fig 4.7.1: Listing Emergency Contacts

After clicking on the run option in visual studio code, the program greets the “Hi! Driver.” Then asks to enter the name of the driver. After entering your name, press Enter. Then the program asks the driver to enter three emergency contacts to which the emergency messages are to be sent. Then press Enter to start the webcam.

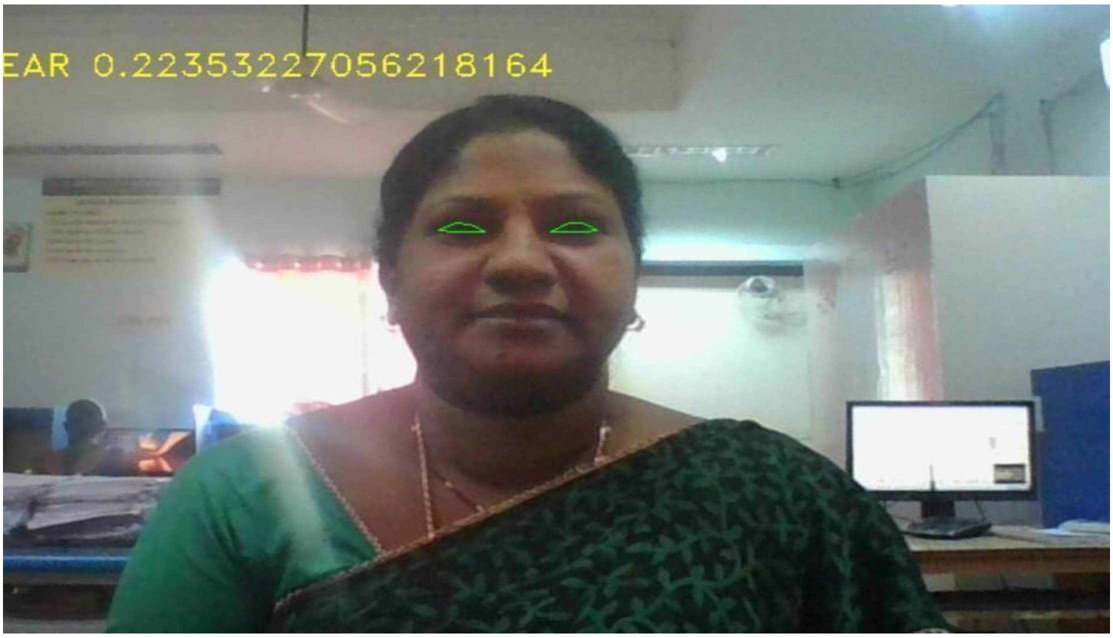


Fig 4.7.2: Drowsiness detecting and EAR calculation

After start of the webcam, a separate window gets opened with the title "Winks Found". Eye detection gets started and a green contor lines are drawn on both left and right eye. EAR value will be calculated and displayed on the screen. And also the seconds of eye closure will be displayed.

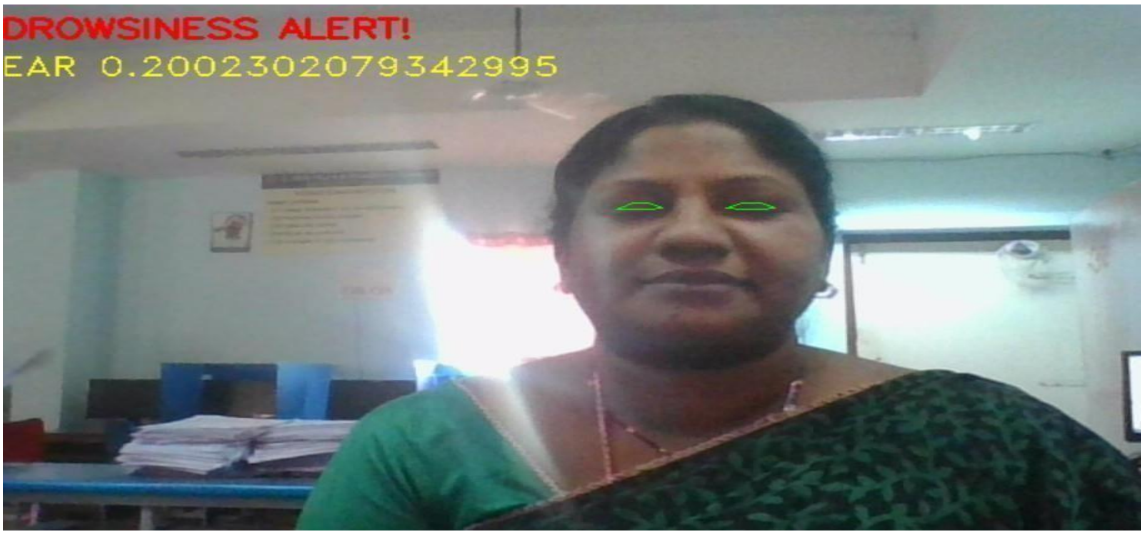


Fig 4.7.3: Drowsiness alert message

Frames will be captured and displayed continuously. The EAR value will also be calculated for each frame. As the time runs and drowsiness detected for more than 6 seconds then a red alert message will be displayed as "Drowsiness Alert". And an alarm sound will be played from the next four seconds of detection. This wakes up the driver. But the system will be running and video capture is on process.

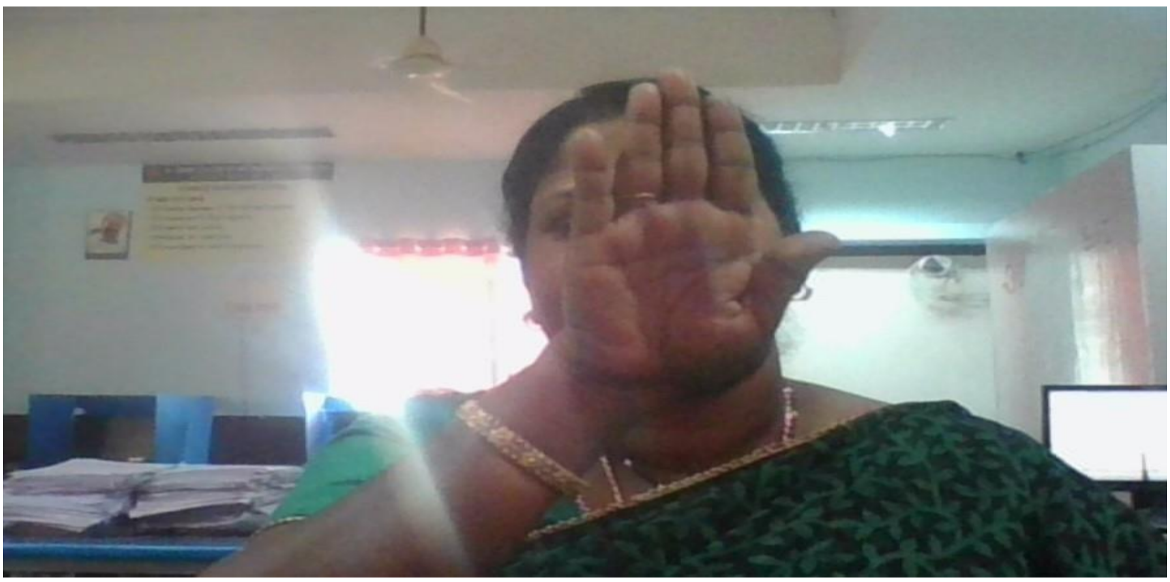


Fig 4.7.4: Hand detection module

If drowsiness is detected continuously for five times and alarm keeps getting activated, this indicates thatdriver is in fatigue state. To make the senses of driver active and to know activeness of the driver hand detection module is built. When it gets activated, a separate video capture window is opened with the title “Hand detection”. This asks the driver to show his palm to indicate that he is in his senses and is responding to the system. If the hand is not detected in the next 120 seconds this indicates that driver is not responding to the system and emergency alert message is send to the emergency contacts.

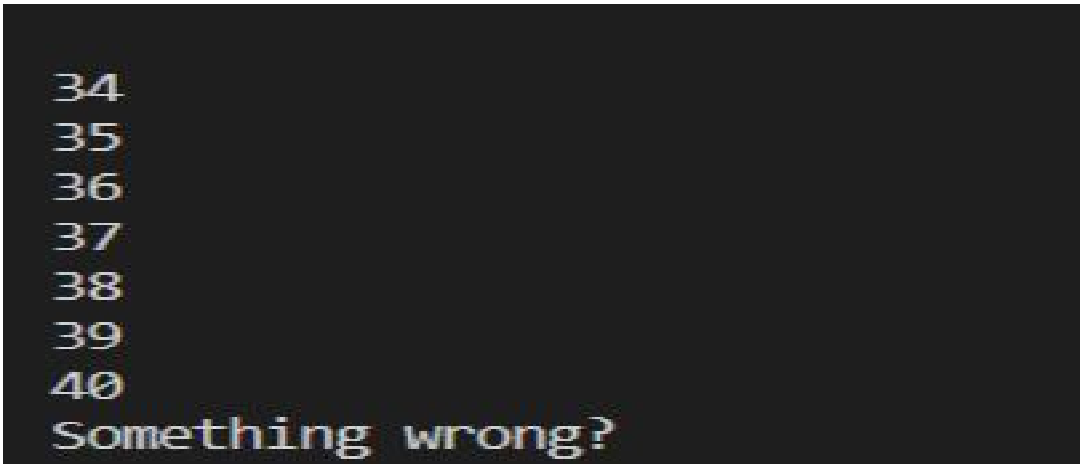


Fig 4.7.5: State of emergency

If in the previous video capture hand is detected within the threshold time, then hand detection module gets closed and drowsiness detection gets activated again. If the driver didn’t respond to the alarms and continuously has his eyes closed for 40 time frames then this indicates that driver felt asleep and is a chance of accident. So geolocation is taken using geocoder and with help of twilio emergency alert messages along with the link to the location is sent to the emergency contacts fetched at the start.

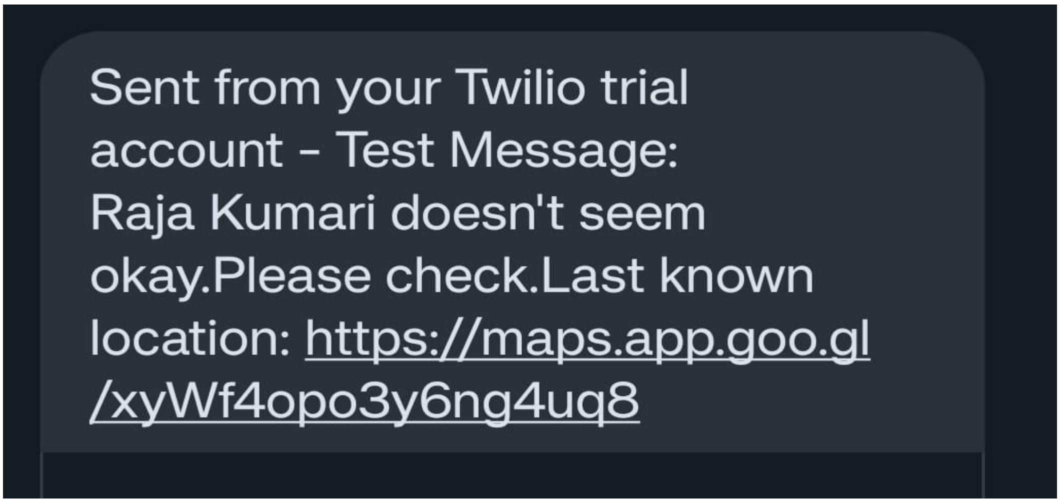


Fig 4.7.6: Emergency alert message

The figure shows the message sent by twilio as an alert message which says, Driver doesn’t seem okay. Please check. Last known location: with a link to google maps along with the coordinates. As soon as theperson receives the message he will understand that the driver is not okay and he need to respond by calling texting or checking for the person in the location. This way if any emergency has occurred then medical help will be fast and driver can be saved. To get the message from twilio we need to add the number to our twilio account at first otherwise the message will not be sent.

As the receiver clicks on the link sent along with the message the last known location of the driver canbe seen.

Fig 4.7.7: Google map location

CHAPTER 5: SYSTEM TESTING

SYSTEM TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

5.1 TYPES OF TESTING

5.1.1 Unit testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

5.1.2 Integration testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

5.1.3 Functional testing

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.
Functional testing is centered on the following items:

Valid Input: identified classes of valid input must be accepted. Invalid Input: identified classes of invalid input must be rejected. Functions: identified functions must be exercised.

Output: identified classes of application outputs must exercise.
Systems/Procedures: interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

5.1.4 System Testing

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

5.1.5 White Box Testing

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

5.1.6 Black Box Testing

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot "see" into it. The test provides inputs and responds to outputs without considering how the software works.

5.2 Test strategy and approach

Field testing will be performed manually and functional tests will be written in detail.

5.2.1 Test objectives

- All field entries must work properly.
- Pages must be activated from the identified link.

- The entry screen, messages and responses must not be delayed.

5.2.2 Features to be tested

- Verify that the entries are of the correct format
- No duplicate entries should be allowed
- All links should take the user to the correct page.

5.3 Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects.The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

5.4 Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

CHAPTER 6: CONCLUSION

6.CONCLUSION

It completely meets the objectives and requirements of the system. The framework has achieved an unfaltering state where all the bugs have been disposed of. It takes care of the issue of stressing out for individuals having fatigue-related issues to inform them about the drowsiness level while driving.

The ultimate goal of the system is to check the drowsiness condition of the driver. Based on the eye movements of the driver, the drowsiness is detected and according to eye blink, the alarm will be generated to alert the driver and if the driver does not respond to the alarm and drowsiness is still detected,then the system automatically sends the current location of the vehicle to the emergency contacts provided. To stop the alarm, the driver should raise their hand (palm). When the system detects the hand,then alarm automatically turns off. By doing this, many accidents will be reduced and provides safety tothe driver and vehicle. A system that is driver safety and car security is presented only in luxurious costly cars. It completely meets the objectives and requirements of the system. The framework has achieved an unfaltering state where all the bugs have been disposed of. It takes care of the issue of stressing out for individuals having fatigue-related issues to inform them about the drowsiness level while driving.

The ultimate goal of the system is to check the drowsiness condition of the driver. Based on the eye movements of the driver, the drowsiness is detected and according to eye blink, the alarm will be generated to alert the driver and if the driver does not respond to the alarm and drowsiness is still detected,then the system automatically sends the current location of the vehicle to the emergency contacts provided. To stop the alarm, the driver should raise their hand (palm). When the system detects the hand,then alarm automatically turns off. By doing this, many accidents will be reduced and provides safety to the driver and vehicle. A system that is driver safety and car security is presented only in luxurious costlycars. Using eye detection, driver security and safety can be implemented in normal car also.

6.FUTURE ENHANCEMENT

The model can be improved incrementally by using other parameters like blink rate, yawning, state of the car, etc. If all these parameters are used it can improve the accuracy by a lot.

We plan to further work on the project by adding a sensor to track the heart rate in order to prevent accidents caused due to sudden heart attacks to drivers. Same model and techniques can be used for various other uses like Netflix and other streaming services can detect when the user is asleep and stop the video accordingly. It can also be used in application that prevents user from sleeping.

User Customization: Allow users to customize the system based on their preferences and specific needs.This could include choosing different levels of alerts, setting personalized emergency protocols, or selecting preferred communication methods.

In-Car Voice Commands: Integrate in-car voice command systems to enable hands-free interaction withthe emergency contact system. Users should be able to fetch emergency contacts, make calls, or send messages using voice commands.

Machine Learning for Predictive Analysis: Utilize machine learning algorithms to analyze user behaviorand driving patterns. This could help predict potential risks or issues, allowing the system to proactively suggest safety measures or notify emergency contacts in advance.

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Smart Drowsiness Detection and Safety System using Machine Learning

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I. ABSTRACT

Abstract—According to National Highway Traffic Safety Administration (NHTSA), drowsy driving leads to over 71,000 injuries, 1,500 deaths, and $12.5 billion in monetary losses per year. Drowsy driving poses a significant risk, resulting in numerous injuries, fatalities, and economic losses annually. This paper presents a novel solution to address this issue by introducing a system capable of detecting driver drowsiness and issuing timely warnings. Utilizing a non-intrusive approach based on Eye Aspect Ratio (EAR), the system monitors and analyzes the driver's eyes, even in low-light conditions. By comparing real-time EAR with baseline values, the system accurately predicts drowsiness. Moreover, it incorporates a smart alarm system that can be deactivated through hand gestures. In addition to warning the driver, the system includes location tracking and the capability to send text messages to emergency contacts, enhancing safety measures. Experimental results demonstrate high accuracy in detecting drowsiness across various conditions, including different facial features and lighting environments.

Keywords— Drowsiness Detection, Eye Aspect Ratio, Facial Landmarks, Hand Gesture Detection, Smart Alarm System,LocationTracking,EmergencyContact Messaging.

II .INTRODUCTION

Drowsiness poses a significant hazard to road safety, especially among drivers, as it diminishes cognitive abilities and increases the likelihood of accidents. With road traffic injuries on the rise globally, effective strategies to detect and counteract drowsy driving are imperative.Traditionalmethods such as Electroencephalography(EEG) and Electrocardiography (ECG) are cumbersome and unsuitable for driving conditions. Therefore, there is a pressing need for non-intrusive, real-time drowsiness detection systems.

This paper addresses this need by introducing a novel smart driver drowsiness detection and safety system. Leveraging advancements in machine learning and computer vision, the system monitors driver behavior to identify signs of drowsiness promptly. By analyzing facial expressions and eye movements, it detects subtle indicators of fatigue**,** enabling timely intervention to prevent accidents.

Motivated by a commitment to enhancing road safety, this research aims to develop a comprehensive solution to the pervasive issue of drowsy driving. The introduction sets the stage for further exploration into the system's design, implementation, and evaluation, emphasizing its potential to contribute to a safer transportation environment.

III. LITERATURE REVIEW

- The real-time driver drowsiness detection system developed by Ritish H in 2021 utilizes OpenCV, a renowned computer vision library, to monitor signs of fatigue in drivers. Through image capture, eye detection, and yawning detection processes, the system identifies drowsiness-related cues. Upon detecting such signs, the system issues timely audio alerts to keep the driver vigilant and mitigate the risks associated with drowsy driving. This approach aligns with existing literature on drowsiness detection systems, which emphasizes the importance of monitoring driver behavior, particularly eye movements and facial expressions, to prevent accidents caused by fatigue-induced impairment. The system's successful implementation of key components, including image capture and feature extraction, highlights its effectiveness in addressing drowsiness-related concerns and enhancing driver safety.

- In the pursuit of addressing the perilous issue of driver drowsiness, Tawanda .M's 2022 study employs a multifaceted strategy, amalgamating various techniques and technologies. Through the analysis of eye blinking, facial landmark detection, mouth movement tracking, and pulse rate monitoring, alongside the application of machine learning algorithms like Random Forest and Linear Regression, the research endeavors to comprehensively detect and predict instances of drowsiness. Notably, the utilization of machine learning algorithms for classifying eye and mouth states yields promising results, showcasing remarkable accuracy rates. By integrating video processing, machine learning, and physiological parameter monitoring, the study offers a holistic solution to bolster road safety. The findings underscore the potential of these methods in mitigating the hazards associated with drowsy driving, ultimately fostering safer road conditions for all motorists.

Jyothika's 2021 study introduces an innovative drowsiness detection system tailored for drivers, combining OpenCV with deep learning methodologies. This pioneering system relies on webcam imagery analysis to detect faces and eyes accurately. At its core lies a Convolutional Neural Network (CNN) model, capable of real-time prediction of eye closure status. By computing a score indicative of closed-eye duration, the system triggers an alarm when this score exceeds a predefined threshold, crucial for timely driver alertness. The study confirms the system's effectiveness in discerning typical eye movements from drowsiness-related closures, thereby demonstrating its potential to prevent fatigue-induced accidents. Positioned as a pivotal tool in road safety, the system offers significant promise in mitigating the dangers associated with drowsy driving, ultimately fostering a safer driving environment.

IV.DROWSINESS DETECTION AND SAFETY SYSTEM

Data

Images in the dataset were captured under diverse range of conditions, including variations in lighting, distance, resolution, face angle, and eye angle. These factors contribute to achieving favorable outcomes while minimizing the likelihood of low accuracy.

OPEN EYE CLOSED EYE

The dataset comprises multiple versions, each containing different quantities of images. Version 1 consists of 10,000 images, evenly split between 5,000 images of closed eyes and 5,000 images of open eyes. Version 2 includes 5,000 images, with 2,500 images of closed eyes and 2,500 images of open eyes. Version 3 also contains 10,000 images, distributed as 5,000 images of closed eyes and 5,000 images of open eyes. Lastly,Version4comprises 4,000 images, with 2,000images of closed eyes and 2,000 images of open eyes.

Faciallandmarks

Utilizing established facial landmark recognition features, weemploy pre-existing annotations to identify signs of drowsiness and fatigue. Leveraging the dlib open-source Python library, we detect 68 facial landmarks, aiding in the prediction of facial shape by delineating key regions such as eyebrows, eyes, nose,and mouth (illustrated in Fig. 1). Variations in the characteristics of these specific points reflect the individual's range of expressions.

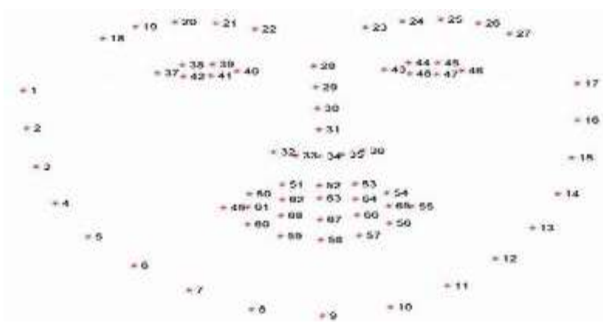

Figure 1: 68- points facial landmark

EAR Algorithm

Eye Aspect Ratio (EAR) is a metric that evaluates the openness of the eyes by considering the ratio of width to height. Each eye is defined by six (x, y) coordinates, starting from the upper left corner and proceeding clockwise around the eye's perimeter (as depicted on the left). This innovative approach involves computing the ratio of the sum of vertical distances to twice the sum of horizontal distances between these points. Notably, EAR is computed independently for each left and right eye.

Figure 2: 6-coordinates

$$EAR = \frac{||p2 - p6|| + ||p3 - p5||}{2||p1 - p4||}$$

Formula to calculate EAR

Fatigueness of the driver is one of the most casual factors for traffic accidents. Almost 1.2 million people lose their lives in traffic accidents every year around the world . Thus, this paper proposes a non-intrusive system to detect and keep a track of driver's fatigue level based on its facial features.

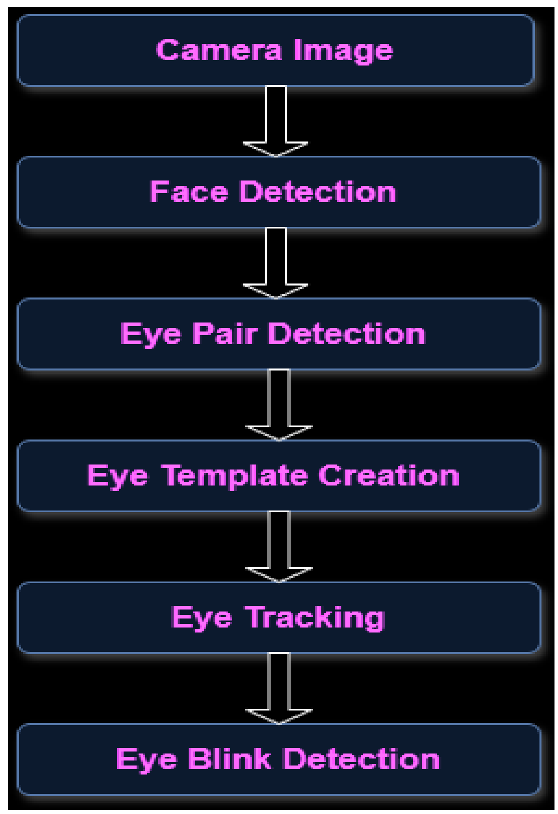

Figure 3: Drowsiness Detection FlowGraph

A) PREPROCESSING

In the pre-processing stage of capturing the driver's video, the system utilizes a camera installed within the vehicle cabin. This camera is strategically positioned to have a clear view of the driver's face, ensuring optimal capture of facial expressions and movements. Before recording begins, the system may adjust camera settings such as focus, exposure, and frame rate to optimize video quality and reduce potential distortions or blurriness. Additionally, any ambient lighting conditions may be taken intoaccount to ensure adequate visibility of facial landmarks. Once the camera is properly configured, the system initiates video capture, continuously recording the driver's face throughout the duration of the journey. This video data serves as the input for subsequent processing stages, including facial landmark detection and drowsiness analysis.

B) DATA GATHERING

The process of gathering data begins with image preprocessing to ensure clear visibility of the driver's face. Dlib's face detector is then employed to accurately locate and delineate the facial region within the image. Utilizing the pre-trained facial landmark detector from the Dlib library, the system estimates the positions of 68 (x, y) coordinates corresponding to key facial features. These coordinates facilitate the establishment of a bounding box around the face, ensuring focused analysis.

Proceeding from facial landmark localization, the system extracts the coordinates of the eyes and mouth, encapsulating this focused region into a polygon using a convex hull. Contours are then drawn around the eyes and mouth regions by connecting the coordinates along the boundary for visual shape analysis, aiding in feature extraction.

Following this, the initial Eye Aspect Ratio (EAR) of the driver is computed promptly upon system activation, typically upon starting the vehicle and detecting a face. This approach addresses individual variations in EAR due to factors such as genetic diversity and facial structure, which can affect drowsiness detection accuracy. By calculating the driver's EAR at the onset, the system adapts to the unique characteristics of the individual, minimizing false alarms and optimizing performance.

C)DETECTION SYSTEM

The detection system operates with a meticulous approach to ensure accurateidentification of driver fatigue. Initially, the system computes and stores the driver's baseline Eye Aspect Ratio (EAR). Subsequent frames are then captured in clusters of 30,this means that the system captures and analyzes 30 consecutive frames of video data at a time. This approach allows for a more comprehensive assessment of the driver's alertness levelsover a short period. By analyzing a cluster of frames rather than individual frames, the system can observe changes and patterns in the driver's behavior more effectively, providing a more accurate understanding of their level of alertness. This method enables the system to detect subtle changes in the driver's eye movements, such as blinks or prolonged eye closures, which may indicate drowsiness or fatigue.enabling comprehensive monitoring of the driver's alertness levels. Through real-time analysis of EAR fluctuations, the system discerns instances of eye closure and reopening, thus facilitating the detection of blinks.

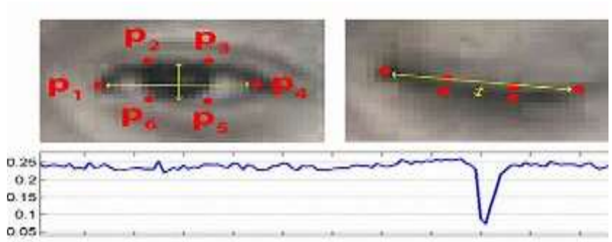

Figure 4: Change in EAR on opening and closing of eye

By comparing the current EAR with the initial baseline, the system initiates a text warning if the real-time EAR remains below 20% of its baseline counterpart for more than 20 consecutive frames, indicative of frequent blinking. Recognizing the correlation between drowsiness and increased blink frequency, prolonged eye closures prompt the system to trigger an alarm if the driver's eyes remain shut for more than 20% of the initialEAR value across 48 frames.

To account for variations in individual physiology and environmental factors, a conservative EAR threshold is maintained, ensuring reliable detection even in scenarios where the EAR does not reach zero during complete eye closure. This comprehensive monitoring process continues seamlessly until the vehicle engine is deactivated, ensuring continuous vigilance over the driver's alertness levels throughout the journey.

D)ALARM SYSTEM

The alarm system provides dual notification methods—text messages and audible alarms—to effectively alert the driver to potential drowsiness. However, these alerts are activated only when the system detects extreme drowsiness, defined by prolonged eye closure exceeding 20% of the initial EAR value across a span of 48 frames. To deactivate the alarm and restore normalcy, the system integrates a sophisticated smart alarm system that relies on hand gesture recognition. Upon activationof the alarm, the system immediately initiates the process of capturingframes to analyze hand gestures within a defined Region of Interest (ROI). By capturing and processing 30 frames from the live video stream and employing resizing and flipping techniques, the system ensures precise detection of hand movements. Utilizing Convex Hull, the system identifies the shape of the object within the ROI, enabling the drawing of contours using extreme points as coordinates to distinguish foreground from background. Upon confirmation of a detected hand, the audible alarm ceases, enabling the system to resume its primary function of monitoring the driver's drowsiness. Furthermore, to enhance the user experience and minimize distraction, any text warnings triggered by excessive yawning or blinking disappear automatically once the system detects that the driver has regained alertness or become active. This adaptive feature underscores the system's commitment to safety and user convenience. This proactive approach to alerting the driver encourages timely intervention and helps prevent potential accidents due to driver fatigue.

E)LOCATION TRACKING

The location tracking process, integrated with geocoder technology, enhances the safety features of the system by enabling real-time monitoring of the driver's whereabouts. Geocoding, a process that converts addresses into geographic coordinates, allows the system to accurately pinpoint the driver's location using GPS data. By continuously updating the driver's coordinates, the system can precisely track their movements throughout the journey. Leveraging this geolocation data, the system is equipped to respond swiftly in case of emergencies.

In the event of a critical situation such as a detected instance of extreme drowsiness or a collision, the system activates its emergency protocol. This protocol includes sending automated text messages to designated emergency contacts via Twilio, a cloud communications platform. These text messages contain vital information, including the driver's current location obtained through geocoding. By promptly alerting emergency contacts with the driver's precise coordinates, the system facilitates rapid assistance and intervention in emergency situations.

The integration of geocoder technology and Twilio's messaging capabilities enhances the system's effectiveness in ensuring driver safety. Geocoding enables accurate location tracking, while Twilio facilitates immediate communication with emergency contacts, thereby streamlining emergency response efforts. This proactive approach to safety empowers both drivers and their loved ones with timely information and support, enhancing overall peace of mind and mitigating potential risks on the road.

V.RESULT AND DISCUSSION

Sample	Time of Day	Ini. EAR	Rec. EAR	Detected Drowsy	Actual Drowsy
S1	Day	0.31	0.24	Yes	Yes
S2	Day	0.33	0.26	Yes	Yes
S3	Day	0.28	0.21	Yes	No
S4	Day	0.32	0.30	No	No
S5	Day	0.34	0.29	No	No
S6	Night	0.35	0.28	Yes	Yes
S7	Night	0.34	0.26	Yes	Yes
S8	Night	0.29	0.28	No	No
S9	Night	0.32	0.24	Yes	Yes
S10	Night	0.30	0.23	Yes	Yes

Table:Drowsiness Detection Statistics

From the embedded drowsiness detection system tested on a car dashboard, observations were gathered from 10 adults with varying initial Eye Aspect Ratio (EAR) values, recorded in Table II. Utilizing high-resolution cameras, the system captured video frames even during nighttime, ensuring effectiveness in low-light conditions. The study accounted for factors such as time of day and facial features like beards or spectacles. Results revealed the system's ability to detect drowsiness accurately in diverse conditions, showcasing its reliability in real-time monitoring and prediction of driver alertness levels.

We notice that the system can plot facial landmarks and detect drowsiness even wearing spectacles(shown in below fig) while driving with the same precision and pace as the one who does not have either.

Figure: Facial coordinates' detection with glasses

This system gains an edge by detecting drowsiness even when the face is at an angle that is not directly in front of the camera, provided maximum part of both eyes is visible(shown below)

Figure: Facial coordinates' detection from a side angle

VI.CONCLUSION

In summary, the system effectively fulfills its objectives by tackling issues related to driver fatigue and improving overall road safety. Through eye movement detection, the system reliably identifies signs of drowsiness and promptly alerts the driver. Additionally, it automatically notifies emergency contacts of the vehicle's location if the driver fails to respond to the alarm. The inclusion of hand gesture recognition allows for easy deactivation of the alarm, enhancing usability and safety. This comprehensive approach ensures that even standard vehicles can benefit from advanced safety features, ultimately reducing the risk of accidents and ensuring the well-being of drivers and passengers alike.

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