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Facial Landmark Fatigue Detection

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Abstract—Fatigue while driving is a silent contributor to thousands of road accidents each year. Detecting driver drowsiness early can significantly reduce the likelihood of collisions, yet many existing solutions are either intrusive or reliant on costly hardware. In this research, we propose a computer vision-based system to monitor driver alertness using facial features. By utilizing Python, OpenCV, and the Dlib library, our solution calculates the Eye Aspect Ratio (EAR) from detected facial landmarks to determine the driver's level of alertness. The system is non-contact, real-time, and cost-effective, making it suitable for implementation in both personal and commercial vehicles. When the EAR falls below a critical threshold, an audible warning is triggered to regain driver attention.
Keywords: Computer Vision, Drowsiness Detection, Eye Aspect Ratio, Facial Landmarks, OpenCV, Dlib, Real-time Monitoring
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I. INTRODUCTION

Road safety is an increasingly important issue as the global number of motor vehicles continues to rise. Among the many causes of traffic accidents, driver fatigue remains one of the most preventable yet under-addressed factors. Numerous studies have linked prolonged driving, lack of sleep, and monotonous road conditions with a decline in driver responsiveness and attention.

Traditional methods of detecting drowsiness often involve physical sensors or wearable devices, which can be intrusive and inconvenient. Alternatively, advancements in computer vision and real-time image processing now offer new, less invasive methods of monitoring driver behavior.

In this study, we explore the use of eye-tracking and facial landmark detection to assess alertness in real time. Specifically, we use the Eye Aspect Ratio (EAR) — a geometric measurement derived from eye landmarks — to identify prolonged eye closure and other symptoms of fatigue. By doing so, we aim to design a prototype that not only monitors driver vigilance but also issues timely warnings to help prevent accidents caused by drowsiness.
Real-timefootageiscapturedwhenacameraisaimed straight at the driver's face in an attempt to identify driver drowsiness.

II. LITERATURE SURVEY

Multiple approaches have been proposed to tackle the issue of drowsy driving. Researchers have explored machine learning models trained on image sequences to classify states such as "drowsy," "alert," or "inattentive." A notable contribution comes from hierarchical neural architectures such as HM-LSTM (Hierarchical Multiscale Long Short-Term Memory networks), which show promising accuracy in analyzing temporal facial expressions using minimal computational power.

The Real-Life Drowsiness Dataset (RLDD) has been widely used to evaluate these models. Systems trained on RLDD using deep learning frameworks have achieved accuracy rates upwards of 92%. These methods highlight the importance of

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combining spatial facial features with time-series analysis for robust fatigue detection.

However, most of these approaches either require high-end hardware or are too complex for real-time deployment in consumer vehicles. Our goal is to simplify this process while retaining effectiveness by focusing on visual cues, particularly eye activity, for fatigue recognition.

Introducing the monitoring system for sleepiness detection. It employs a mobile phone that resembles a mini PC and a portable application that runs on the Android operating system to construct a system for human-computer interaction.The most importantvisual clues that indicate a driver's condition of tiredness are eye movements, yawning, and lateral and frontal acknowledgments of the head.

Regardless of whether riders are wearing hats, hearing aids,oreyeglasses,theframefunctionseffectivelyunder typical lighting circumstances.

Artificial intelligence applications have been made possiblebyimprovementsinmobilephonefeatures.[2] Youne's "Real-Time System for Driver Fatigue Detection Based on Recurrent Neural Networks" Ed Doughmi article acknowledges his accuracy of 92 percent. a method that analyses and forecasts driver fatigue using iterative neural networks. In order to identify driver weariness, he employed an iterative neural network design on his multi-layer model-based 3D convolutional network, which he formed and validated using datasets. Providing a neural network HIS architecture for sensible and portable driver drowsiness detection is the primary objective. improvements in mobile phone features. [2] Youne's "Real-TimeSystemforDriverFatigueDetectionBased on Recurrent Neural Networks" Ed Doughmi article.

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Sections of the film with the labels "drowsiness,""inattentiveness,"and"concentration."TheRealLife Dataset(RLDD)hasaboutthirtyhoursofvideoinit. This article presents a Hierarchica approach.

HM-LSTM, or multiscale long-short-term memory network.Minimalprocessingpowerandcapacityare neededforthesuggestedapproach.Wefoundthat,in histwo-placedestimationsofthe RLDDdataset,our techniqueperformsbetterthanhumanjudgement[5].

III. METHODOLOGYDESCRIPTION

Fatigue-related lossofawarenessbehindthewheelcan beidentifiedbyaprogressivealterationinthefollowing facial features: shifts in the driver's gaze direction, alterations tothesizeor location oftheeyelids,Abrupt variations in thehead's direction, posture, and blinking rate.

The proposed technique for identifying driver fatigue functions on two levels. The camera records live video frames at the start of the process, which are subsequentlyuploaded toalocalserver.Theserveruse the Dlib package to recognise face landmarks, and a threshold value is employed to ascertain the driver's level of sleepiness. After utilizing these facial landmarks, the EAR (Eye Aspect Ratio) is calculated and provided to the driver. Our technology compares the EAR value acquired at the application's end to a thresholdvalueof0.25.IftheEARnumberisbelowthe threshold,thedriverisconsideredsleepy.Atthatpoint, thedriverandpassengerswouldbealertedbyanalarm. A.Components

Python and OpenCV have been utilized for sleepiness detection.Using a pre-trained facial landmark detector, theDlibpackageisutilizedtoidentifyandisolatefacial landmarks. 68 face landmarks have been employed in this method.

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B.Faciallandmarkmarking

Facial landmarks are extracted by importing the Dlib library. Dlib makes advantage of a pre-trained face detector, which enhances the oriented gradient histogram. It comprises of two shape prediction models that locate 68 and 5 landmark points within a facial image, respectively, and were trained on the i-Bug 300- Wdataset.68facelandmarkshavebeenemployedinthis method.

This technique creates histograms by using the gradient direction of an image's frequency in certain areas. It is particularly well suited for face detection; it describes edgeandcontourfeaturesinawiderangeofobjectswith remarkable accuracy.

The system used the Facial Landmark Predictor to determine the lengths for the EAR values in order to record the facial landmarks.

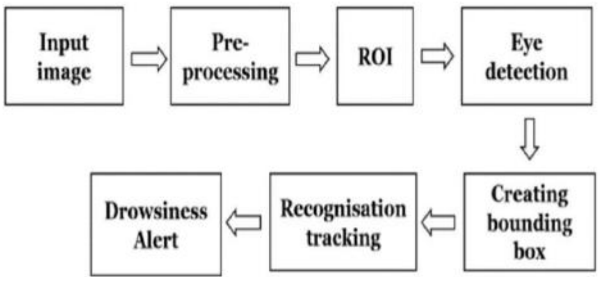

Fig.1.0:BlockDiagram

IV. PROPOSEDWORK

We provide an approach that makes use of Python technology and the OpenCV package to identify driver weariness.Awebcamcapableofcapturingsmoothvideo footage.

Theseareallofthe project'sdetails.

REQUIREDSOFTWARE:

- Ubuntu/Linux

Ubuntu isa Linux distribution that mostly consistsof freeandopen-sourcesoftware,withitsfoundationbeing Debian.ThreevariantsofUbuntuareformallyavailable: Desktop, Server, and Core for Internet of thingsgadgets and robots.

- Python-3.x

Python is a general-purpose, high-level programming language. With a strong emphasis on indentation, its design philosophy prioritises code readability. Python uses garbage collection and dynamic typing. It is compatible with several programming paradigms, such as functional, object- oriented, and structured programming.

GENERALFLOW:

- CameraOpening
- BreakingIntoFrames
- IdentifyingFaces
- ExtractingFeatures
- EyeRecognition
- Alert for Sleepiness Detection IMPORTEDLIBRARIESANDMODULES:
- scipy.spatial

Scipy.Spatial can use the Qhull library to calculate convexhulls,triangulations, and Voronoidiagramsfor a given set of points. Additionally, it includes utilities forcalculatingdistanceindifferentmetricsandKDTree implementations for nearest-neighbor point inquiries.

- Imutils

A collection of convenience functions to make using OpenCV and Python 2.7 and Python 3 for common image

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processing tasks like translation, rotation, scaling, skeletonization, showing Matplotlib images, sortingcontours,edgedetection,and much more simpler.

- threading

Pythonthreadingallowsforthesimultaneousexecution ofnumerousthreads,orjobsandfunctioncalls.Keepin mindthatthisdoesnotimplythattheyarerun on various CPUs.

- numpy

A vast set of high-level mathematical functions to operate on huge, multi-dimensional arrays and matrices, as well as support for these arrays, are provided by the NumPy library for the Python programming language.

- playsound

Playingaudiofilesispossiblewiththecross-platform playsound module. There are no dependencies for this.

- argparse

The argparse package facilitates the creation of intuitive command-line interfaces. The software indicates the arguments it needs, and argparse will determine how to extract those from sys.argv. Help and usage messages are also automatically generated by the argparse module.

- dlib

dlib is a framework for developing real world machinelearning and dataanalysisapplicationsin C++. WhilethelibraryisinitiallydesignedinC++,itincludes good, easy to use Python bindings.

cv2

Every library function has a specific purpose and is employed in accordance with the objectives of the programmer'swork.Withtheexceptionof"dlib,"which isprimarilyusedtoimportandofferanenvironmentfor utilising C++ features on other platforms, all packages are simple to get. It is essential to the functionality of your programming.

Equations

With the use of technology based on image processing, the driver may view the images being processed and determine their mental state. The driver appears to be dreaming or disturbed based on the image ontheirface.Driverdrowsinesscanbedefinedusingthe sameimage.Becausethedriver'seyesareclosedinfacial photos when they depict him in a light sleep state.

Three main components form the basis of the implemented project:

Scale-invariant facial and ocular identification via webcam usage.

Eye Feature Extraction: Use EAR to extract eye featuresforsleepinessdetectionandsingle- eye extraction.

$$\text{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

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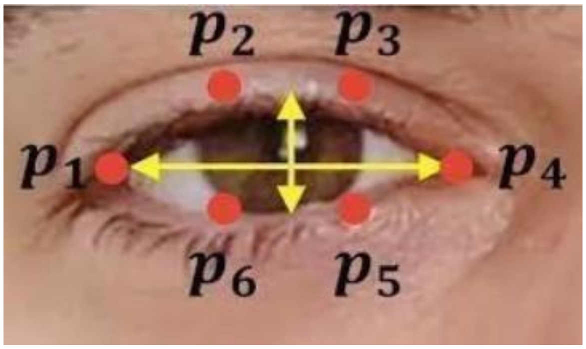

Fig2.0:*EyeCo-ordinates*

EAR(EyeAspectRatio):-
where p1,...,p6 denotes the locations of the two- dimensional facial markings. There is only one set of horizontal points and two sets of vertical points in this formula; the numerator determines the distance between eye marks in the vertical direction, and the denominator determines the distance between eye marks in the horizontal direction. therefore give the denominator the appropriate weight. When the eye is open, its aspect ratio is almost constant; but, when it blinks, it rapidly decreases to zero. The aspect ratio of an eye drops sharply to almost zero when a person blinks. Figure 2 illustrates how the aspect ratio of the eyestaysconstantuntilitquicklyapproaches0andthen rises once more. This suggests that a single blink has occured.

PythonfunctiontocomputeEAR def eye_aspect_ratio(self, eye):
A=dist.euclidan(eye[1], eye[5])
B=dist.euclidan(eye[2],eye[4])
C=dist.euclidean(eye[0],eye[3])
ear= (A+ B)/(2.0*C)oppositeear.

V. IMPLEMENTATION

Two levels make up the proposed method for detectingdriverdrowsiness:first,acamerarecordslive video frames, which are streamed locally to his 4466 server.Ontheserver,heusesthedliblibrarytoidentify face tags and uses thresholds to determine whether the driver is sleepy. His EAR (Eye Aspect Ratio) is then calculated in the using these facial markings and provided to the driver; the last captured EAR for the applicationiscomparedtothesystemthresholdof0.25.

If the EAR value is less than the threshold, the driver is drowsy, and an alarm will sound to warn the driver and passengers.

A. Elements

OpenCV and Python were utilized to identify tiredness. The pre-trained Dlib face feature detector is used with the Dlib library to identify and distinguish between facial features. 68 face cues were employed in this method.

B. MarksontheFace

Importing the dlib library allows for the extraction of facial features. Dlib makes use of better histograms of directed gradients in conjunction with apre-trained face detection.Itiscomposedoftwoshapepredictionmodels, eachofwhichcanrecognize68and5landmarksonface photos, after being trained on the i-Bug 300-W dataset [4]. 68 face markers were employed in this method.
This technique creates a histogram by using the gradient direction frequencies in certain areas of the image. It works very well for facial recognition.
Exceptionallygoodatdescribingtheedgesandcurves of different objects. The facial landmark predictor was utilizedbythesystemtodeterminethelengthoftheEAR value in order to record face landmarks.
The Dlib library facet that is utilized to calculate the EAR is shown in the following diagram.

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Test Case No.	Test Cases		
	Eye Detection	***Closure***	***Result***
Case 1	NO	NO	NO ALERT
Case 2	YES	NO	NO ALERT
Case 3	YES	YES	ALERT

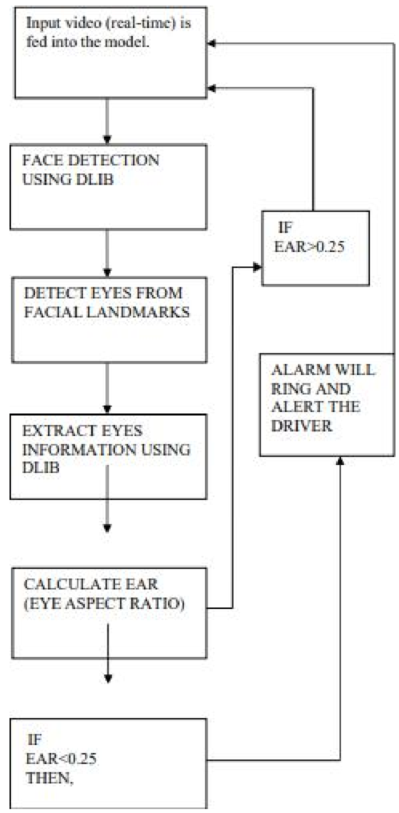
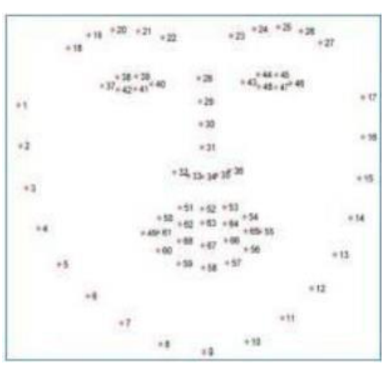


Fig3.0StepsInvolvedinFacialRecognition

VI. RESULTS DISCUSSION

A.TestRun

Fig2.1:Facial Markings



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We used my laptop's webcam for this endeavor. Whenthedriverexhibitssignsofdrowsiness,thedevice usesanintegratedspeakertoofferanauditoryoutputto wake them up. Several individuals tried the frames in various lighting environments (day and night).

The following table shows the three test cases that the needstoencounter whiledoing thisproject that affect driver fatigue.

Serial No.	Result Table		
	Samples	*Eye Detection Accuracy*	*Drowsiness Accuracy*
1.	***Sample 1***	***83.34%***	***80%***
2.	***Sample 2***	***80%***	***62.5%***
3.	***Sample 3***	***75%***	***83.34%***
4.	***Sample 4***	***87.5%***	***100%***
5.	***Total***	***81.17%***	***78.50%***

VII. CONCLUSION

A non-invasive method for tracking weariness and locating the eye has been devised. An algorithm for imageprocessingthattheauthorcreatedisusedtoextract information about eye position. The technology can detect if the eyes are open or closed when it is monitoring. An alert will sound if your eyes are closed for an extended period of time. Furthermore, the technology has the ability to automatically identify any potential inaccuracies in eye localization that may have happenedwhilemonitoring.Intheeventofsuchanerror, the system is able to properly locate and repair the eye.
Thefollowingdeductionsweremade:
Highly accurate and dependable sleepiness detection is made possible by image processing.
Imaging provides a non-invasive method for identifying sleepiness without being bothersome or distracting.
The drowsiness detection system, which was developed using the principles of image processing, determines the driver's state of arousal by analyzing the sequence of eye closures.
80%accuracyindicatesasystemwithobviousflaws.

VIII. ACKOWLEDGEMENT

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in making this research feasible. We owe our supervisors a debt of gratitude for giving of their valuable time and counsel during this critical moment for the project.

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