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Drowsiness Detection System using ML

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Abstract: *The number of automobile accidents due to driver drowsiness is increasing at an alarming rate. If you have driven before, you've been drowsy at the wheel at some point. It's not something we like to admit but it's an important problem with serious consequences that needs to be addressed. The scariest part is that drowsy driving isn't just falling asleep while driving. Drowsy driving can be as small as a brief state of inattentiveness when the driver is not paying full attention to the road. An automated non-contact system that can identify driver drowsiness early is the need of the hour. Our project describes a machine learning approach for drowsiness detection. Face detection is employed to locate the regions of the driver's eyes, which are used as the templates for eye tracking in subsequent frames. Finally, the tracked eye's images are used for drowsiness detection in order to generate warning alarms. This proposed approach has three stages: detecting Face, detecting Eyes and detecting drowsiness. Thus, we propose a system to locate, track, and analyse both the drivers face and eyes to measure PERCLOS, a scientifically supported measure of drowsiness associated with slow eye closure.*

Keywords: Driver drowsiness, eye detection, yawn detection, blink pattern, fatigue

I. INTRODUCTION

Drowsiness detection is one of those common problems needed to be solved to prevent road accidents. In recent time's automobile fatigue connected crashes have increased. Driver's inattention might be the result of a lack of alertness when driving due to driver drowsiness and distraction. Driver distraction occurs when an object or event draws a person's attention away from the driving task. Unlike driver distraction, driver drowsiness involves no triggering event but, instead, is characterized by a progressive withdrawal of attention from the road and traffic demands. Both driver drowsiness and distraction, however, might have the same effects, that is decreased driving performance, longer reaction time, and an increased risk of crash involvement.

II. LITERATURE SURVEY

2.1 Survey of Existing System

1. A Machine-Learning Approach for Driver-Drowsiness Detection based on Eye-State using methodologies of Image processing, Histogram Equalisation algorithm, Canny Edge detection algorithm approach for Driver-Drowsiness Detection based on Eye-State. Proposed system achieved more than 95% accuracy. The system effectively identifies the state of the driver and alerts the driver with an alarm. [5]
2. Driver Drowsiness Detection using methodologies Perclos, Camshift, HAAR Training, Viola Jones Algorithm.This proposed a novel system for evaluating the driver's level of fatigue based on face tracking and facial keypoint detection. [3]
3. Driver Drowsiness Detection using Machine Learning Approach using methodologies HAAR Cascade Classifier, Region of Interest. This paper experimented in a bright room with constant light. In addition, there were several limitations including light conditions and the darkness of the skin. The embedded device can calculate a drowsiness level from the driver using a combination of Raspberry Pi 3 Model B and Raspberry Pi Camera. [2]
4. Real-Time Driver Drowsiness Detection System Using Eye Aspect Ratio and Eye Closure Ratio using methodologies Data Procurement, Facial Landmark Marking, Classification In this work, a real time system that monitors and detects the loss of attention of drivers of vehicles is proposed. Non-intrusive methods have been preferred over intrusive methods to prevent the driver from being distracted due to the sensors attached

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on his body. The system gives a best case accuracy of 84%. [1]

5. Driver drowsiness detection using Behavioral measures and machine learning techniques using methodologies of SVM, CNN, and HMM. This paper presented a survey of approaches to driver drowsiness detection using machine learning techniques and discussed the range of features and measures used for classification. [4]

2.2 Limitations of Existing System and Research Gap

PROPOSED SYSTEM	EXISTING SYSTEMS
Implemented using Python	Make use of traditional means such as capturing photos manually
Uses just the eyes to detect the current state of the driver	Makes use of the entire face to detect the current state of the driver
Much faster than other models even implemented using Python	They're slower as compared to our model
Making use of minimal aspects of live imagery by just implementing the functions on the eyes of a user	Make use of more than required aspects of live imaging as they try to detect by inputting the whole face / body
The training of the dataset presents us with maximum accuracy as only the eyes are being used	Trained dataset is going to give us less accuracy even after being trained for more number of hours as the aspects and nodes inside the image are high
Making use of trained datasets of the eyes itself	Making use of a vast amount of dataset which contains unnecessary aspects of the whole body or face

Table 1. Difference between proposed and existing systems

III. PROPOSED SYSTEM

3.1 Introduction

Drowsiness can be due to the adverse driving conditions, heavy traffic, workloads, late night Drowsiness is a phenomenon which is the transition period from the awake state to the sleepy state and causes decrease in alerts and conscious levels of driver. It is difficult to measure the drowsiness level directly but there are many indirect methods to detect the driver fatigue. Driver drowsiness detection can be measured using HOG + Linear SVM , Contourfitting , Eye Aspect Ratio (EAR). These are monitored through a camera and these drowsiness symptoms are detected. Behavioural state detection system helps to detect the drowsy driving condition early and avoid accidents. In this application real time drowsy detection is used which is one of the best possible method to detect driver fatigue early. Real time driver detection system using image processing captures driver eyes state non- intrusively using a camera and raspberry pi is used for this.

This proposed system describes a machine learning approach for drowsiness detection. Face detection is employed to locate the regions of the driver's eyes, which are used as the templates for eye tracking in subsequent frames. Finally, the tracked eye's images are used for drowsiness detection in order to generate warning alarms. This proposed approach has three stages: detecting Face, detecting Eyes and detecting drowsiness. Image processing is used to recognize the face of the driver and then its extracts the image of the eyes of the driver for detection of drowsiness. The HOG + Linear SVM algorithm takes as captured frames of image and then the detected face is considered as output. Next, Contourfitting is used for tracking eyes from the detected face. Using EAR (Eye Aspect Ratio) the eye state is detected. The system uses frames for face and eye-tracking, and the average correct rate for eye location and tracking could achieve 95.0% based on some test videos. Thus, the proposed approach for real-time driver drowsiness detection is a low-cost and effective solution method

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3.2 Architecture/Framework

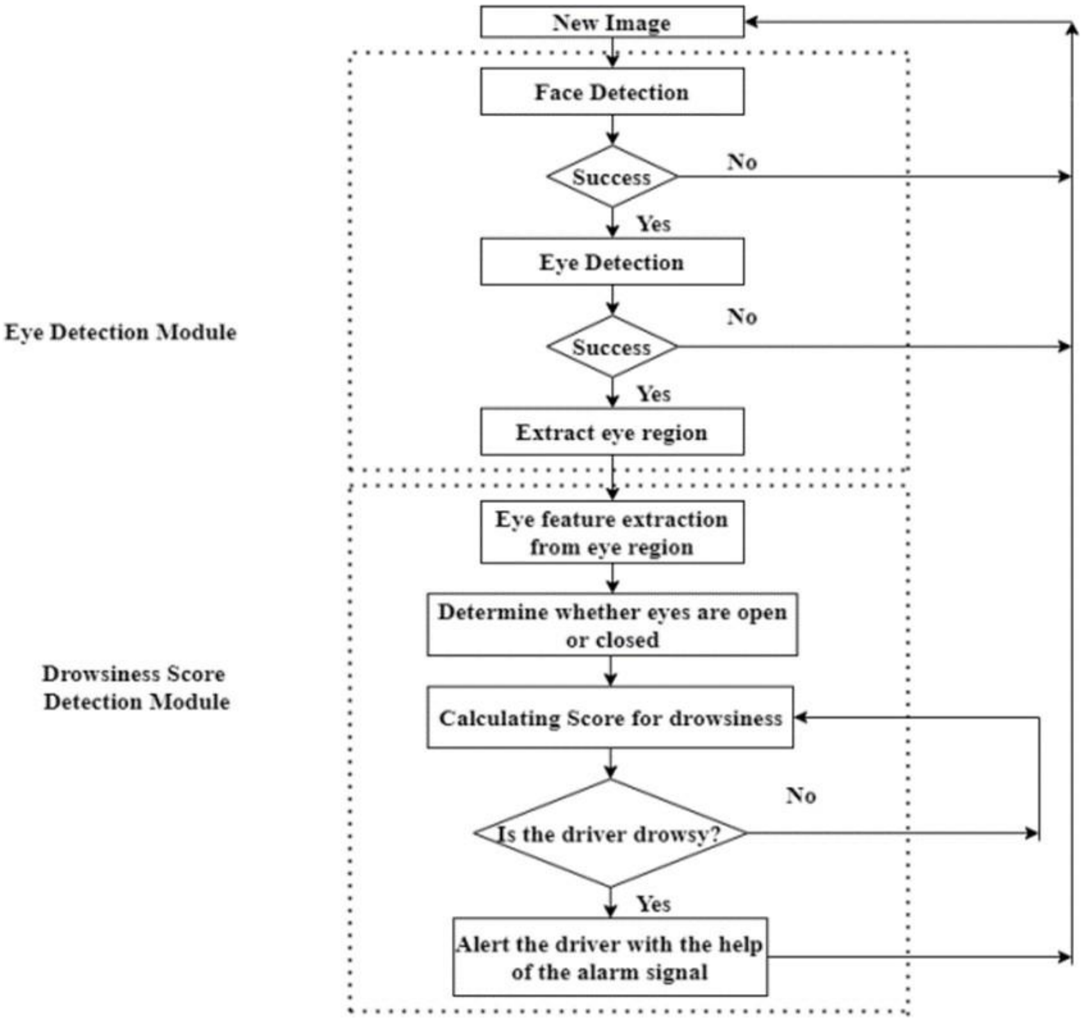
New Image
Face Detection
Success
No
Yes
Eye Detection
Eye Detection Module
Success
No
Yes
Extract eye region
Eye feature extraction from eye region
Determine whether eyes are open or closed
Drowsiness Score Detection Module
Calculating Score for drowsiness
No
Is the driver drowsy?
Yes
Alert the driver with the help of the alarm signal

Fig 1. Architecture of the System

3.3 Modules Covered

A. Eye Detection Module

In this module, the system detects the face and later on the eyes. Once the detection is done successfully, the system extracts the eye region which is required for the next module.

B. Drowsiness Score Detection Module

In this module, using mathematical operations, the system calculates the drowsiness score which is then compared with a threshold. If the score is less than the threshold then the system will alert the driver with the help of the alarm signal.

3.4 Algorithm and Process Design

A. HOG + Linear SVM

This project is based on the HOG (Histogram of Oriented Gradients) feature descriptor with a linear SVM machine learning algorithm to perform face detection. HOG is a simple and powerful feature descriptor. It is not only used for face detection but also it is widely used for object detection like cars, pets, and fruits. HOG is robust for object detection because object shape is characterized using the local intensity gradient distribution and edge direction

- Step1: The basic idea of HOG is dividing the image into small connected cells
- Step2: Computes histogram for each cell.

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- Step3: Bring all histograms together to form feature vector i.e., it forms one histogram from all small histograms which is unique for each face

To detect faces using HOG, dlib library has a straight forward method to return HOG face detector “dlib.get_frontal_face_detector()”

The get_frontal_face_detector function does not accept any parameters. A call to it returns the pre-trained HOG + Linear SVM face detector included in the dlib library. Dlib’s HOG + Linear SVM face detector is fast and efficient.

Also, just detecting the face will not help. We need more information about the face, i.e. whether a person smiles, laughs, or dimples seen while smiling etc. (In this case we need to see whether the user's eyes are closed or open) In short, facial expressions too give us information. In order to get more information about the face, we take the help of Facial Landmarks.

What are Facial Landmarks?

Facial landmarks are used for localizing and representing salient regions or facial parts of the person’s face, such as: Eyebrows, Eyes, Jaws, Nose, Mouth, etc. In this context of facial landmarks, our vital aim is to detect facial structures on the person’s face using a method called shape prediction.

The above method of shape prediction is also achieved using the HOG + Linear SVM Algorithm. The facial landmark detector of the dlib library which is pre-trained inside the dlib library of python for detecting landmarks, is used to estimate the location of 68 points or (x, y) coordinates which map to the facial structures. These indexes of 68 coordinates or points can be easily visualized on the image below:

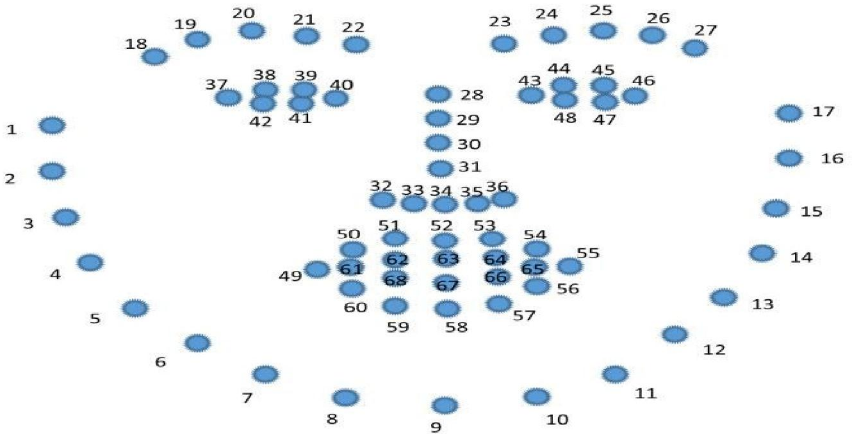

Fig 2. Facial Recognition and Landmarking by Algorithm

Some of the prerequisites for this algorithm are :

- Installation of dlib and opencv library
- Downloading the dlib shape predictor. It is a file with the .dat extension

A. Contourfitting

This technique is used in order to draw a convex hull near the eyes which tells us whether the system is able to detect our eyes or not

B. Eye Aspect Ratio (EAR)

Each eye is represented using 6 landmarks points. The EAR for a single eye is calculated using this formula:

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

Fig 3. Eye Aspect Ratio formula

The more the EAR, the wider the eye is open. We would decide a minimum EAR value i.e. the threshold value and use this to decide if the eye is closed or not.

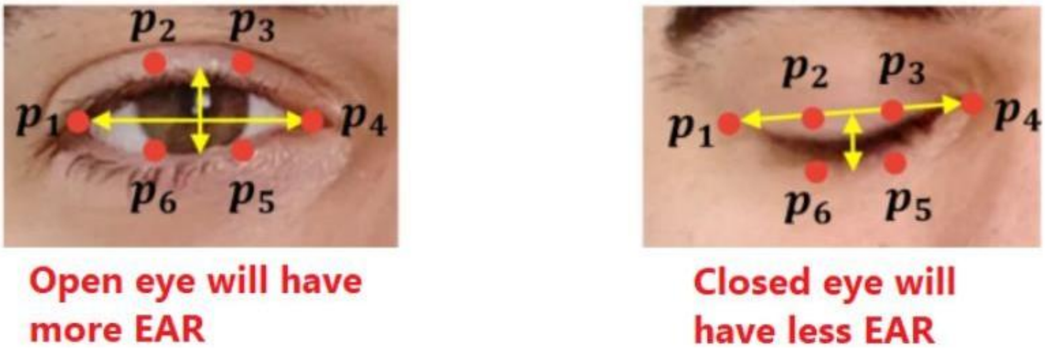

Fig 4. Difference between an open eye analysis and closed eye analysis

C. Assumptions

- Connectivity of web cam is assumed.
- Only one single user is assumed to use this technology to be precise.
- We are assuming that the user is looking straight at the direction where the camera is located.

D. Constraints

- It won't work without a webcam or a GUI based application.
- There is a limitation on where the user looks exactly, it won't be able to detect eyes if the user is far enough or faces more or less 90 degrees from the camera angle.
- Accuracy of this project is 94%, so there are chances that it might not work for about 6% cases

3.5 Details of Hardware and Software

Hardware	• WebCamera • Laptop
Coding Language	• Python
External Tools	• Python • Python Libraries – Dlib , OpenCV , SciPy , Imutils ,Pygame
System Requirement	• 4.0 GB RAM • Intel or AMD x86–64 processor • Hardware accelerated graphics card supporting OpenGL 3.3 with 1GB GPU memory is recommended.
Operating System	• Windows 11 • Windows 10 (version 20H2 or higher) • Windows Server 2019 • Windows Server 2022

Table 2. Hardware and Software Requirements

IV. CONCLUSION

In conclusion, the implementation of a drowsiness detection system using machine learning techniques has been a promising area of research in recent years. The ability to accurately detect driver drowsiness has the potential to significantly reduce the number of accidents caused by driver fatigue, which is a major contributing factor to road accidents. The research presented in this paper has highlighted the various techniques and methodologies used in the development of a drowsiness detection system. Through the use of machine learning algorithms, a system can be trained

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to accurately detect drowsiness based on physiological signals such as eye movements, head movements, and electroencephalogram (EEG) signals.

Various studies have been conducted to evaluate the effectiveness of different machine learning algorithms and features for drowsiness detection. Support Vector Machines (SVMs), Random Forests (RF), and Artificial Neural Networks (ANNs) have been identified as the most effective algorithms for drowsiness detection. Additionally, features such as eye closure duration, blink frequency, and EEG spectral power have been shown to be reliable indicators of drowsiness.

One of the challenges in developing a drowsiness detection system is the need for a reliable and non-invasive method for capturing physiological signals. In recent years, wearable devices such as smartwatches and head-mounted cameras have been developed to capture physiological signals in real-time. This technology has made it possible to develop non-invasive and reliable drowsiness detection systems.

Another challenge in developing a drowsiness detection system is the need for a large dataset of labeled samples for training the machine learning algorithms. The availability of large datasets is a major limitation for the development of drowsiness detection systems. However, recent studies have shown that transfer learning can be used to develop accurate drowsiness detection systems with smaller datasets.

The drowsiness detection system has the potential to significantly improve road safety by alerting drivers when they are at risk of falling asleep at the wheel. By alerting the driver, the system can prevent accidents caused by driver fatigue. Additionally, the system can be integrated with other safety features such as automatic braking to prevent accidents.

In conclusion, the development of a drowsiness detection system using machine learning techniques has been a promising area of research in recent years. The ability to accurately detect driver drowsiness has the potential to significantly reduce the number of accidents caused by driver fatigue. While there are still some challenges that need to be overcome in developing an accurate and reliable drowsiness detection system, recent advancements in wearable technology and machine learning algorithms have made it possible to develop non-invasive and effective systems

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