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Face Drowsiness Detection Using Open CV

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ABSTRACT: In this day where there are more no of cars on the road leading to huge traffic on the roads all the time significantly increasing the daily commute time of an average Driver, this situation leads to a dangerous increase of Driver fatigue which often becomes a direct cause of many traffic accidents and loss of lives. Therefore, there is a need to develop the systems that will detect and notify a driver of her/his bad psychophysical condition and warn him about his condition, which could significantly reduce the number of fatigue-related car accidents. However, the development of such systems encounters many difficulties related to fast and proper recognition of a driver's fatigue symptoms. One of the technical possibilities to implement driver drowsiness detection systems is by opting to a vision-based approach which requires a camera facing the driver. This Project is an attempt to add to the features currently used driver drowsiness detection systems by using latest Libraries provided in python platform such as OpenCV, dlib, pygame. Here we are detecting the driver drowsiness by his/her facial analysis and detection on a regular basis.

KEYWORDS: Drowsiness, Dlib , Pygame , Real Time Drowsiness Detection, OpenCV.

I. INTRODUCTION

Fatigue detection in the non intrusive form may be done efficiently by increasing the number of parameters on which the driver is being monitored. This will lead to a complex algorithm which can be easily flexible to detect fatigue. Such a driver fatigue detection system has tremendous scope in the car industry. There are millions of cars being manufactured every year and it is a universally accepted fact that fatigue among drivers is a potent accident factor. Hence, car manufacturing companies are the biggest market for such a system. Mercedes Benz has introduced a fatigue detection system in certain models of high end cars. However, the proposed prototype that this project aims at creating shall be far more inexpensive as compared to that model, thus creating a bigger market for this product. Indian roads are prone to fatigue related accidents essentially among truck drivers, long distance bus drivers and BPO employees during the late hours. Introduction of such a system in long distance vehicles and in public transport would reduce the number of accidents.[1]

1.1 Face Detection Using Image Processing

Image processing is a physical process used to convert an image signal into a physical image. The image signal can be either digital or analog. The actual output itself can be an actual physical image or the characteristics of an image. In this project, it is required to detect the face of the driver and then detect the driver's eyes and mouth to check whether he is blinking and yawning respectively. We have used image processing to synthesize and analyze the real time captured images of the driver from the camera to detect the face and use them for probable fatigue detection. There have been many varied ways to detect the human face that have been tested positively till now in various parts of the world. However, the aim of this project is to have fast and efficient detection of face and features of the face and hence real time face detection is necessary.[4]

1.2 Related Work

Literature survey is the most important step in any kind of research. Before start developing we need to study the previous papers of our domain which we are working and on the basis of study we can predict or generate the drawback and start working with the reference of previous papers. In this section, we briefly review the related work on Detecting the drowsiness with their different techniques. The paper proposed WE in a sliding window (WES), PP-ApEn in a sliding window (PP-ApEnS), and PP-SampEn in a sliding window (PP-SampEnS) for real-time analysis of driver fatigue. The real-time features obtained by WE, PP-ApEn, and PP-SampEn with sliding window were applied to artificial neural network for training and testing the system, which gives four situations for the fatigue level of the subjects, namely, normal state, mild fatigue, mood swing, and excessive fatigue. Advantages are: The driver fatigue can be estimated better by using the method based on EEG, EOG, and EMG signals. The paper presents a nonintrusive

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drowsiness recognition method using eye-tracking and image processing. A robust eye detection algorithm is introduced to address the problems caused by changes in illumination and driver posture. Six measures are calculated with percentage of eyelid closure, maximum closure duration, blink frequency, average opening level of the eyes, opening velocity of the eyes, and closing velocity of the eyes. Advantages are: The video-based drowsiness recognition method that provided 86% accuracy. Disadvantages are: Need to improve accuracy. The paper presents visual analysis of eye state and head pose (HP) for continuous monitoring of alertness of a vehicle driver. The proposed scheme uses visual features such as eye index (EI), pupil activity (PA), and HP to extract critical information on non-alertness of a vehicle driver. Advantages are: It gives highest classification accuracy. Minimize the number of errors. Disadvantages are: The SVM classifier shows a low Type-I error, which is more critical.

1.3 Problem Statement

In this day where there are more no of cars on the road leading to huge traffic on the roads all the time significantly increasing the daily commute time of an average Driver, this situation leads to a dangerous increase of Driver fatigue which often becomes a direct cause of many traffic accidents and loss of lives.

1.4 Existing System

The Present system used in high end cars use steering wheel touch sensors to estimate whether the user is alert or not. The driver is thought to be sleeping if the hands of the user are not in contact with the steering wheel. Major companies such as Tesla use these systems to check on the drowsiness of the user.

1.5 Proposed System

I intend to use a visual approach to monitor his/her facial expressions in search of drowsiness.The user will be alerted if he is found to be in a sleepy state.Entire implementation is done by using an offline application that does not require an internet connection hence the user privacy is protected.

II. SYSTEM ARCHITECTURE

A system architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system that supports reasoning about the structures and behaviors of the system.

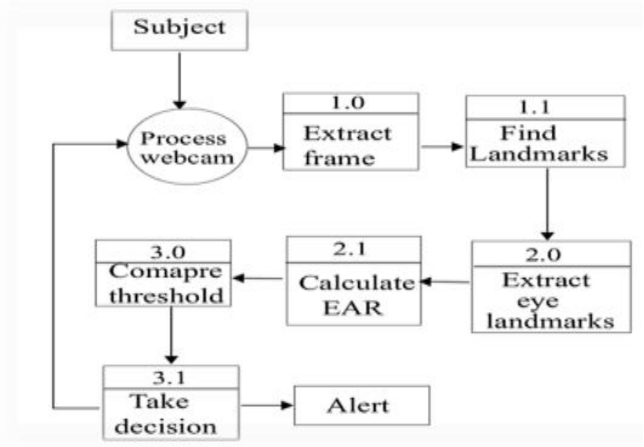

Fig. 1 System Architecture

2.2 Architectural Design

This process of defining a collection of hardware and software components and their interfaces to establish the framework for the deveiopment of a computer system.

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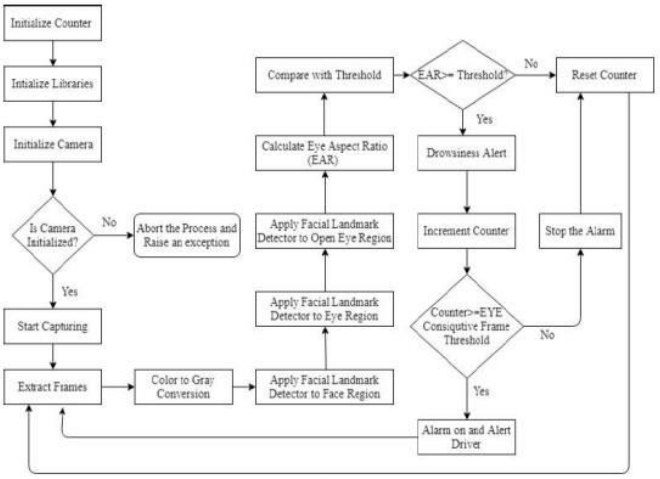

Fig. 2 Design Architecture

III. TECHNOLOGIES USED

3.1.1 Machine Learning

Machine learning is the kind of programming which gives computers the capability to automatically learn from data without being explicitly programmed. This means in other words that these programs change their behavior by learning from data. Python is clearly one of the best languages for machine learning. Python does contain special libraries for machine learning namely scipy, pandas and numpy which great for linear algebra and getting to know kernel methods of machine learning. The language is great to use when working with machine learning algorithms and has easy syntax relatively.

3.1.2 Open CV

OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD-licensed product, OpenCV makes it easy for businesses to utilize and modify the code. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects, extract 3D models of objects, produce 3D point clouds from stereo cameras, stich images together to produce a high resolution image of an entire scene, find similar images from an image database, remove red eyes from images taken using flash, follow eye movements, recognize scenery and establish markers to overlay it with augmented reality, etc. OpenCV has more than 47 thousand people of user community and estimated number of downloads exceeding 18 million. The library is used extensively in companies, research groups and by governmental bodies.[5]

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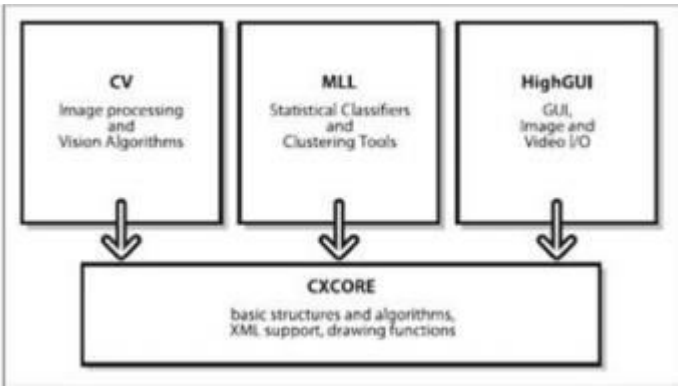

Fig 3 Structure Of Open CV

3.1.3 Dlib

Dlib is a modern C++ toolkit containing machine learning algorithms and tools for creating complex software in C++ to solve real world problems. It is used in both industry and academia in a wide range of domains including robotics, embedded devices, mobile phones, and large high performance computing environments. Dlib's open source licensing allows you to use it in any application, free of charge.

3.1.3.2 Face Landmark Localization

The process that is able to extrapolate a set of key points from a given face image, is called Face Landmark Localization (or Face Alignment). The landmarks (key points) that we are interested in, are the one that describes the shape of the face attributes like: eyes, eyebrows, nose, mouth, and chin. These points gave a great insight about the analyzed face structure, that can be very useful for a wide range of applications, including: face recognition, face animation, emotion recognition, blink detection, and photography.

3.1.3.3 Dlib Pre Trained Models

The author of the Dlib library (Davis King) has trained two shape predictor models (available here) on the iBug 300-W dataset, that respectively localize 68 and 5 landmark points within a face image. Basically, a shape predictor can be generated from a set of images, annotations and training options. A single annotation consists of the face region, and the labelled points that we want to localize. The face region can be easily obtained by any face detection algorithm (like OpenCV HaarCascade, Dlib HOG Detector, CNN detectors, ...), instead the points have to be manually labelled or detected by already-available landmark detectors and models (e.g. ERT with SP68). Lastly, the training options are a set of parameters that defines the characteristics of the trained model. These parameters can be properly fine-tuned in order to get the desired behaviour of the generated model, more or less.[3]

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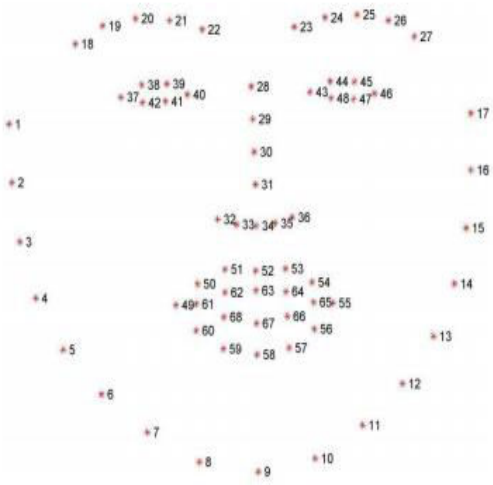

Fig 4 The set of 68-points detected by the pre-trained Dlib shape_predictor_68

3.1.4 Imutils

Imutils are a series of convenience functions to make basic image processing functions such as translation, rotation, resizing, skeletonization, and displaying Matplotlib images easier with OpenCV and both Python 2.7 and Python 3. In this project, we used Videostream sub package from imutils to capture the user's face using laptop default camera.

3.1.5 Scipy

SciPy package is used to compute the Euclidean distance between facial landmarks points in the eye aspect ratio calculation (not strictly a requirement, but you should have SciPy installed if you intend on doing any work in the computer vision, image processing, or machine learning space).

IV. ALGORITHM

4.2.1 Face And Eye Detection

This method starts by using:

1. A training set of labeled facial landmarks on an image. These images are manually labeled, specifying specific (x, y)-coordinates of regions surrounding each facial structure.

2. Priors, of more specifically, the probability on distance between pairs of input pixels.[2]

The pre-trained facial landmark detector inside the dlib library is used to estimate the location of 68 (x, y)-coordinates that map to facial structures on the face.The indexes of the 68 coordinates can be visualized on the image below:

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Fig 5 Driver is awake

4.2.2 Recognition of Eye's status

By applying linear svc algorithm, 1% of walking_ upstairs points and walking_ downstairs are overlapped. Over all accuracy of the system is similar to the logistic regression's accuracy.[6]

Eye Aspect Ratio Calculation:

For everyvideo frame, the eye landmarks are detected. The eye aspect ratio (EAR) between height and width of the eye is computed.

$$EAR = \|p2-p6\| + \|p3-p5\| / 2\|p1-p4\|$$

where p1, . . ., p6 are the 2D landmark locations, depicted in Fig. 1. The EAR is mostly constant when an eye is open and is getting close to zero while closing an eye. It is partially person and head pose insensitive. Aspect ratio of the open eye has a small variance among individuals, and it is fully invariant to a uniform scaling of the image and in-plane rotation of the face. Since eye blinking is performed by both eyes synchronously, the EAR of both eyes is averaged.[7]

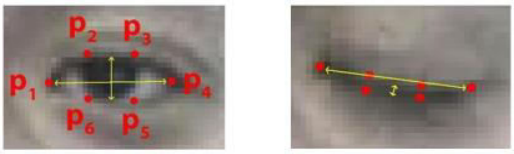

Fig 4.4: Open and closed eyes with landmarks p(i) automatically detected.

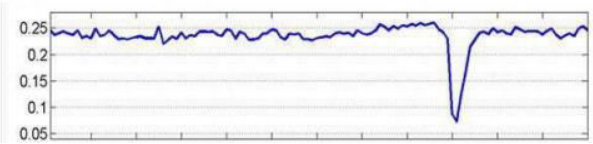

Fig 6: Plotting the eye aspect ratio over time. The dip in the eye aspect ratio indicates a blink

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V. TEST CASES AND PERFORMANCE GRAPHS:

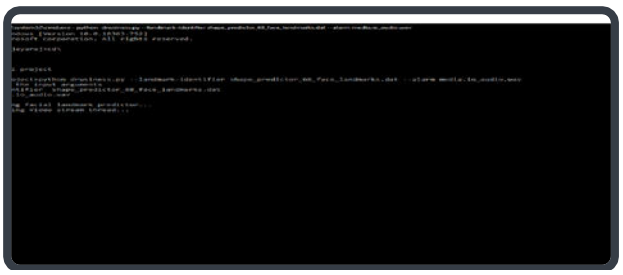

Fig 7 Execution

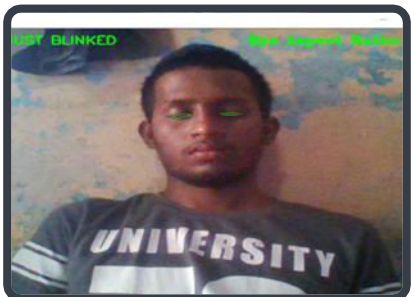

Fig 8 Driver Blinked

Fig 9 Drowsiness Alert

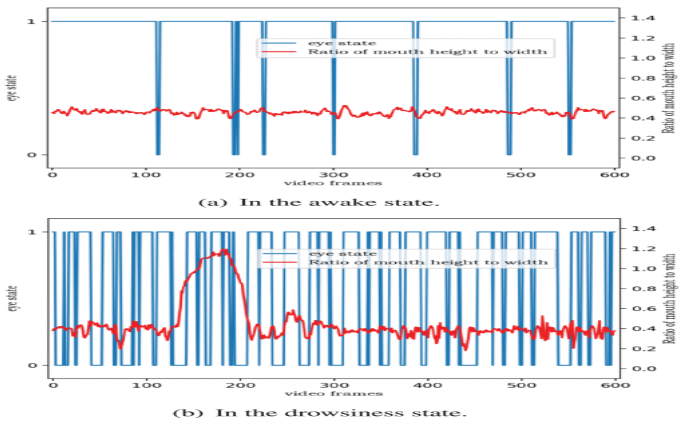

Fig 10 Graph for awake and drowsiness state

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V. CONCLUSION AND FUTURE WORKS

The fatigue detection system in drivers has thus been simulated in Open CV. The real time system has been successfully created to detect the face and hence the eyes and of the user to check whether he is blinking to acquire information about his level of alertness. The webcamera fixed in the laptop continuously captures images of the user and these images are one by one processed. If the eyes are detected to be closed in more than threshold consecutive frames, the alarm will ring to awake the user. If the eye are detected to be open in less than threshold no.of frames the alarm will stop automatically.

Limitations:

Use of spectacles: In case the user uses spectacle then it is difficult to detect the state of the eye. As it hugely depends on light hence reflection of spectacles may give the output for a closed eye as opened eye. Hence for this purpose the closeness of eye to the camera is required to avoid light**.**

Multiple face problem: If multiple face arises in the window then the camera may detect more number of faces undesired output may appear. Because of different condition of different faces. So, we need to make sure that only the driver face comes within the range of the camera.

Future Scope

The future scope for this project includes increasing the speed of operation of the system and hence increases the accuracy rate. Further, this concept can be extended to provide an inexpensive solution for commercial vehicles.
The difficulties faced due to bad lighting that may occur while driving during night time is a potent problem that needs to be taken care of. Bearded men and people wearing spectacles too should be able to use this system accurately. This is drawback that needs to be mended as future scope. Another area for further work would include involving the dynamics. This, if used with extreme discretion, can help further reduce road accidents. The speed of the vehicle can be reduced or a remote terminal can be warned about fatigue detected in the driver.

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