DRIVER DROWSINESS DETECTION SYSTEM

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Abstract:

Driver drowsiness has always been a major cause of road accidents. In this project, we have designed a drowsiness detection system that can monitor drivers and prevent potential disasters. We have considered behavioral measures to detect the drowsiness conditions. We have used Computer Vision techniques to create our detection algorithm. EAR (eye aspect ratio), MAR (mouth aspect ratio) and head tilt are the measurements that we chose to detect drowsiness.

Introduction:

Recent statistics estimate that annually 1,200 deaths and 76,000 injuries can be attributed to fatigue related crashes. Drivers who do not take regular breaks when driving long distances run a high risk of becoming drowsy a state which they often fail to recognize early enough. 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 numbers of cases are increasing every year and it has always been a challenge to come up with a low latency detection system that can prevent this issue. We designed a system that alerts the user on reaching a certain saturation point of the drowsiness measure.

Any existing system uses the following measures to detect drowsiness.

i) **Vehicle-based measures:** movement of steering wheel, deviations from lane position, pressure variations on acceleration pedal etc. are constantly monitored to check if the driver is drowsy.

ii) **Behavioral measures:** Yawning, eye closure, frequency of eye blinks, head pose etc. are monitored through a camera to detect drowsiness.

iii) **Physiological measures:** Physiological measures such as ECG, EEG, EoG are monitored to detect any signs of fatigue.

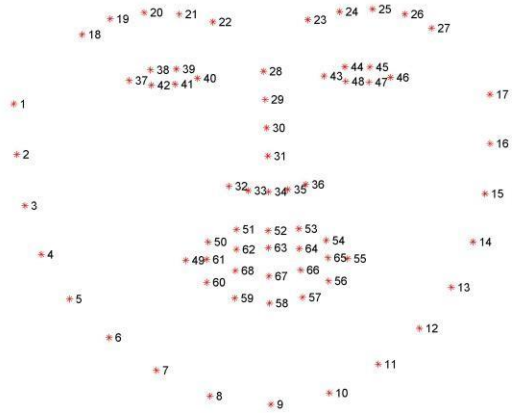
We have only considered Behavioral measures to detect driver drowsiness for our final system. We have thought of using steering wheel angle sensor and heart rate sensor to bring in the other two measurements. But since hardware was neither affordable nor readily available, we tried to look for the corresponding data sets. Unfortunately, we couldn't find any free data sets that could help us.

Proposed Solution:

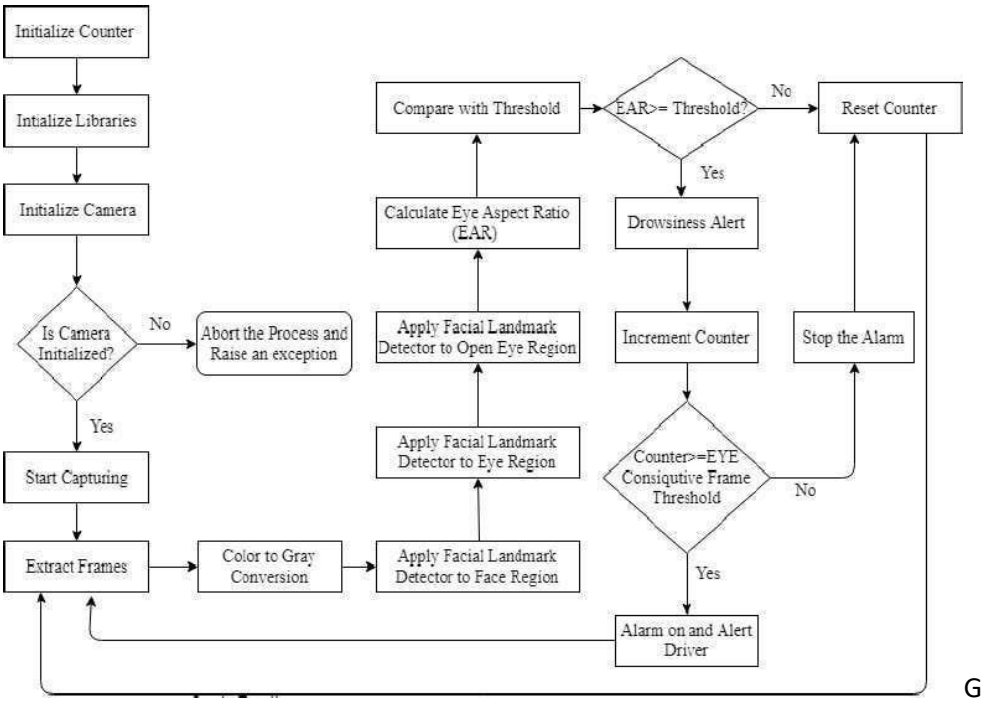
We have developed a prototype drowsiness detection system which focuses on Behavorial measures such as ***sleeping, yawning and head tilting*** by monitoring face, eyes and mouth of the driver. By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. We have used OpenCV library to implement our computer vision algorithm. Haar cascading classifiers based on ***Viola Jones algorithm*** are used to identify interest points in our face.

The algorithm for eye-closure involves monitoring the number of frames for which the eyes are closed. If the number of frames exceeds a certain value, then a warning alarm will be played to alert the driver indicating that driver is drowsy. First, we input the face using a webcam. In our case, we have used the 'IP webcam' android application to use our mobile phone's front/back camera to stream our face. From the live stream we check if a face is present or not using ***'Haar cascade frontal face' algorithm***. Haar cascade is a machine learning detection algorithm that uses edge and line detection features for object detection. We have

used the pre-trained Haar cascade algorithms that are offered by OpenCV.



Next in order to localize the landmarks of the face, we used an estimator from ‘dlib’ library. This estimator gives 68 landmark points such as tip of the nose, eye lids, chin etc. Using the eye landmarks, we measured the ***Eye Aspect Ratio (EAR)***. In every obtained frame, we calculate the Euclidian distance between the eye landmarks which give us the height and width of an eye. The ratio between the height and width will give us the EAR value. EAR mostly stays constant when the eye is opened. It decreases and approaches to zero when an eye closes. Whenever our EAR decreases below a threshold value for a specified duration, the alarm rings. Since yawning is an effective sign of a person having drowsiness and fatigue, under the similar concept, ***Mouth Aspect Ratio (MAR)*** is calculated which increases with increase in distance between upper lip and lower lip. If the height is greater than our threshold value, the person is considered yawning. We have also tried to implement the rotation vector of the face through head pose estimation. Here the rotation vector corresponds to nodding(X-axis), shaking(Y-axis) and tilting(Z-axis). The solvePnP function in OpenCV is used to estimate the pose by projecting the 3D points of camera coordinates to image coordinate system.



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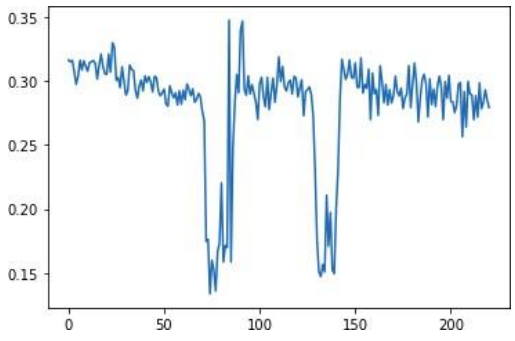
Results:

We have combined more than one measurement associated with the drowsiness of a driver in order to yield an optimum result.

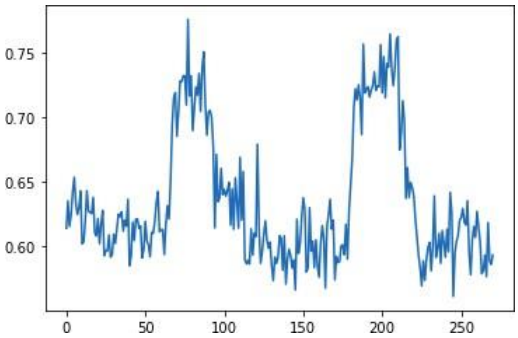
Since we have used the pre-trained Haar classifier, the execution time is very less. We have not detected any False positive detection, but when our face was not looking into camera or looking sideways, the face doesn't get detected. Such issues can be solved using trained models such as linear SVM or YOLO models. But the models are quite complex and since our pre trained model was sufficient for our project, we continued to use it.

EAR and MAR values are observed for some time in order to decide the threshold values. From the below graphs we can observe that, EAR values are oscillating around 0.30 and decreasing to almost 0.15 whenever an eye closure is detected. Similarly, MAR values are

oscillating between 0.60 and 0.65 and increasing up to 0.75 whenever a yawn is detected.



EAR vs Frames



MAR vs Frames

Demo:

From the below pictures, we can observe that the system can successfully detect a person's face, eye closure and yawning. The green bounding box represents the detected face. The elliptical contours around the eyes and mouth determine the EAR and MAR values. When calibrated properly, the angle between the red and blue vector will be very low. Whenever the angle between them increases, it indicates that the person is tilting his/her head.

Demo link:
https://drive.google.com/drive/folders/1OzR9_I3VWd8UIG3jTD2EzQSXBK9DxsRp?usp=sharing

Conclusion:

Through this project, we tried to provide a solution for fatigue-related accidents. We believe, monitoring and detecting a driver's drowsiness which is the main cause of such accidents can greatly reduce the number of cases. Our system has been tried and tested in different lighting conditions and with different people with varied facial characteristics. It has been experimentally found that absolute accuracy is achieved when the lighting conditions are bright and favorable. The biggest drawback experienced till now is the presence of sunglasses or spectacles on the driver's face. This interferes with the detection of eyes and mouth and may lead to false triggering.

This model can be improved even further by considering other parameters like heart rate, steering angle from vehicle-based and physiological measures which were not considered in our project due to hardware and dataset constraints. 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. Since we can detect multiple faces at a time, it can also be used to detect and alert sleepy students in a classroom.

References:

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