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Nap detection and alert system using OpenCV

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ABSTRACT

In recent years driver fatigue is one of the major causes of vehicle accidents in the world. A direct way of measuring driver fatigue is measuring the state of the driver i.e. drowsiness. So it is very important to detect the drowsiness of the driver to save life and property. This project is aimed towards developing a prototype of a drowsiness detection system. This system is a real-time system which captures image continuously and measures the state of the eye according to the specified algorithm and gives a warning if required. Though there are several methods for measuring the drowsiness, this approach is completely non-intrusive which does not affect the driver in any way, hence giving the exact condition of the driver. For detection of drowsiness eye aspect ratio value of the eye is considered. So when the closure of eye exceeds a certain amount then the driver is identified to be sleepy. Corrections for drowsiness include both in and out vehicle alarms and its repetition turns the engine off after giving a signal to the vehicles behind. We are also providing security for the owner i.e., if the vehicle is driven by another person and does any kind of suspicious activities then, not the actual person but the owner will face problems, in order to avoid the problem for the owner, when the engine starts we automatically capture the image of the driver along with date and time without knowledge of the driver. Then he can easily identify the person who is driving and the owner will be saved.

Keywords— *Face Detection, Locating Eyes, Eye-Aspect Ratio, Security, Drowsiness*

1. INTRODUCTION

The attention level of driver degrades because of less sleep, long continuous driving or any other medical condition like brain disorders etc. Several surveys on road accidents say that around 30 per cent of accidents are caused by fatigue of the driver. When a driver drives for more than a normal period for a human then excessive fatigue is caused and also results in tiredness which drives the driver to sleepy condition or loss of consciousness.

Drowsiness is a complex phenomenon which states that there is a decrease in alerts and conscious levels of the driver. Though there is no direct measure to detect the drowsiness several indirect methods can be used for this purpose. [1]

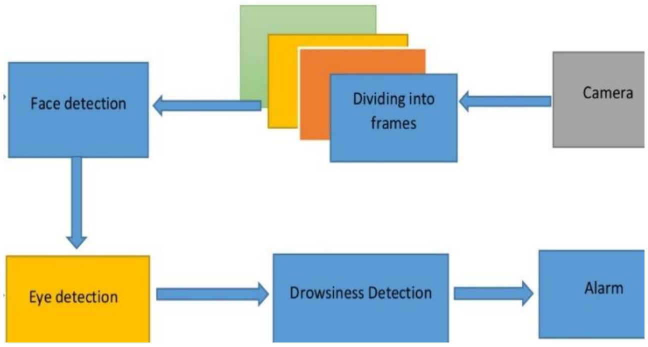

Fig. 1: Process diagram of Nap detection and alert system

2. FACTORS CAUSING DRIVING DROWSINESS

Driver Drowsiness is commonly caused by four main factors: sleep, work, time of day, and physical. Regularly people try to do much in a day and they suffer from the lack of sleep. The shortage of sleep over a number of days results in the collapse of the body and finally, the person falls asleep. For the efficient functioning of the body proper sleep is essential. People sometimes are on reparation that creates fatigue or have physical afflictions that cause these issues. In addition to the above factors, being psychologically stressed will cause the body to get fatigued sooner.

3. VARIOUS NAP DETECTION TECHNIQUES

3.1 Physiological measures

Some of the methods include ECG, EOG and Head motion. In some of this type of methods, drivers had to wear head gear while driving. ECG sensor can be installed in a steering wheel to monitor the driver's pulse. Special caps embedded with electrodes measures the brain waves to identify fatigue. These two were not reliable most of the time and they require physical contact with the driver thus they are not practical. [2] [3]

3.2 Vehicular based methods

Another approach for detecting driver drowsiness involves vehicle-based measurements. In most of the cases, these measurements are determined in a simulated environment by installing sensors on various vehicle components, such as steering wheel and the acceleration pedal; these signals help in analyzing the level of drowsiness. The two most commonly used vehicle-based measures are [4]

- The steering wheel movement
- The standard deviation of lane position.

But they were too slow to alert the driver before he fell asleep. These methods alert driver only after they fell asleep, not before they were in the episode of the drowsy state.

3.3 Image processing based techniques

In image processing based techniques, drivers face images are used for processing so that one can find its states. Whether the driver is awake or sleeping can be determined using some of these techniques. We can classify these techniques in two sub-categories.

3.3.1 Yawning based technique

Yawn is one of the symptoms which show the drowsiness of the driver. Involuntarily open one's mouth wide and inhale deeply due to tiredness is a yawn. By detecting the face and mouth, yawn rate is determined and alert the driver. [5]

3.3.2 Eye State monitoring technique

Another important factor which detects driver drowsiness is the state of eyes, i.e. whether they are open or closed.

In eye closure method the count of eyeblink of the driver is measured to acquire the state of the driver. The main techniques used for eye blink detection are Eye Aspect Ratio (EAR) method and Template Matching method. In the normal state, the value of EAR is almost constant. If the driver is in fatigue the EAR value will be approximately near to zero. Thus we can detect whether the driver is in sleepy or not. In the Template Matching method, one can use the states of eye i.e. if the driver closes eye/s for some particular time then the system will generate the alarm. [6]

4. IMPLEMENTATION

The implementation of the system is shown in figure 2.

4.1 Image capture

Using a webcam we capture the video of the driver and the live stream video to be divided into frames which are sent as an input to the algorithm for detection of drowsiness of the driver.The camera used in the system is shown in figure 3.

4.2 Dividing into frames

We are dealing with a real-time situation where the video is recorded and has to be processed. But the processing or application of algorithm can be done only on an image. Hence the captured video has to be divided into frames for analysing.

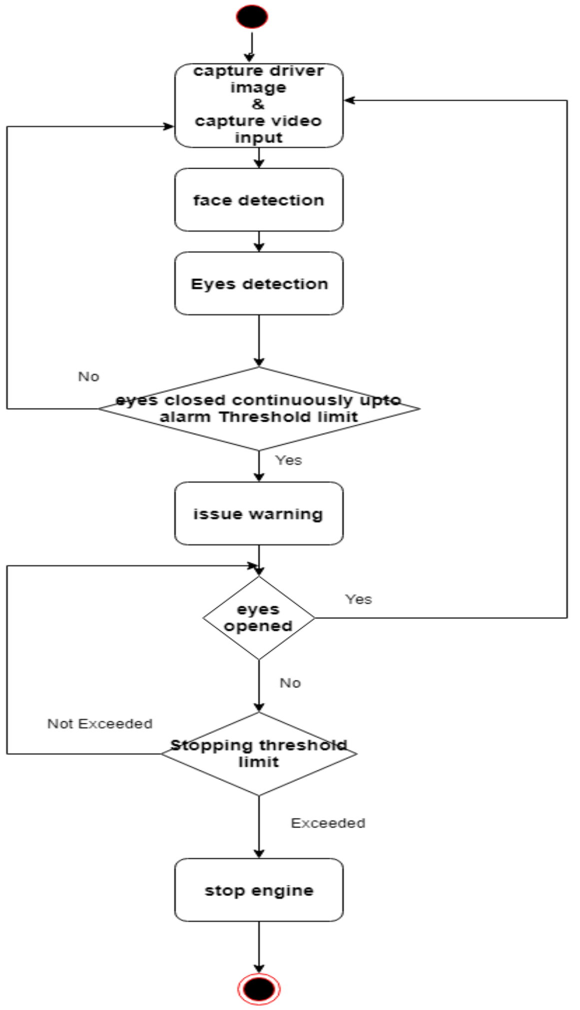

Fig. 2: a Flow chart for Nap detection and alert system

Fig. 3: Camera used for implementing nap detection system

4.3 Face detection

Here, in this stage, we detect the region containing the face of the driver. A specified algorithm in open CV is used for detection of a face in every frame. Face detection includes locating the face in the given frame ignoring all other types of objects like buildings, trees, cars etc.

Fig. 4: Faces detection in the given frame ignoring all other objects

4.4 Facial landmarks location

Once the face gets detected, then the algorithm locates all the important features of the face. Facial landmarks are used to localize and represent salient regions of the face, such as

- Eyes
- Eyebrows
- Nose
- Mouth
- Jawline

As shown in figure 5. Among all these features, what we are really concerned is the state of eyes.

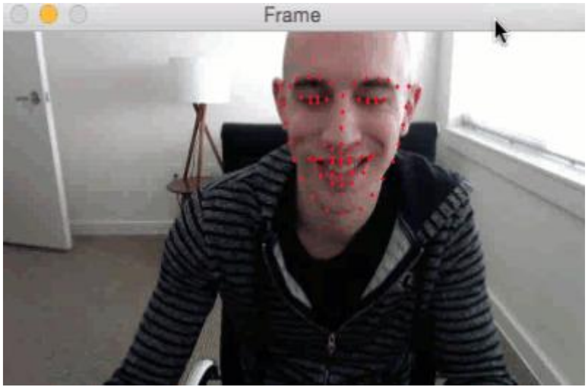

Fig. 5: Demo how the face and important features in the face are detected

4.4.1 Understanding dlib's facial landmark detector

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 as shown in figure 6.

The indexes of the 68 coordinates can be visualized on the image below:

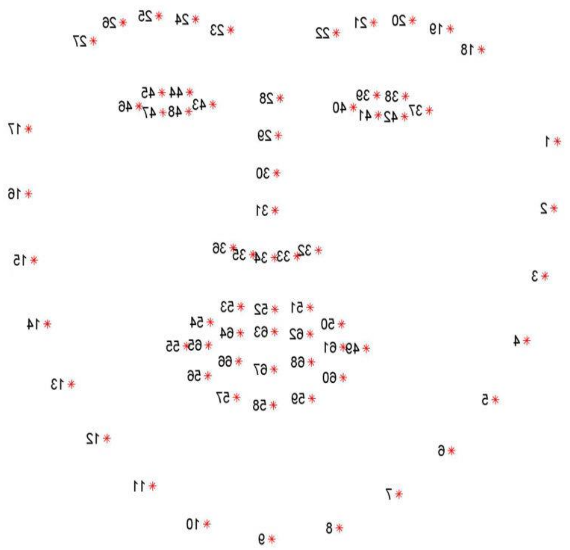

Fig. 6: Visualizing the 68 facial landmark coordinates from the iBUG 300-W dataset

The program uses a facial training set to understand where certain points exist on facial structures. The program then plots the same points on the region of interests in other images, if they exist. The program uses priors to estimate the probable distance between key points.

These annotations are part of the 68 points iBUG 300-W dataset which the dlib facial landmark predictor was trained on. The dlib face landmark detector will return a shape object containing the 68 *(x, y)*-coordinates of the facial landmark regions.

4.4.2 Calculation of Eye-Aspect-ratio: The Eye Aspect Ratio is a constant value when the eye is open, but rapidly falls to 0 when the **eye** is closed. For eye blinks we need to pay attention to points 37-46, the points that describe the eyes.

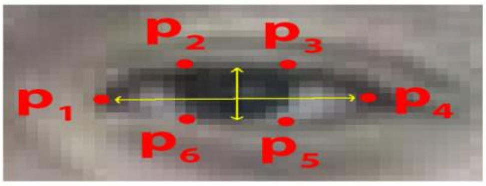

Fig. 7: Eye facial landmarks

The equation to find out the eye aspect ratio

$$EAR = \frac{||p_2 - p_6|| + ||p_3 - p_5||}{2||p_1 - p_4||} \quad (1)$$

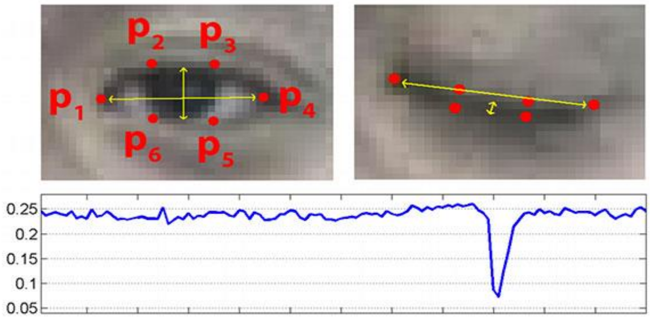

Fig. 8: A person's Eye Aspect ratio over time

A program can determine, if a person's eyes are closed and if the Eye Aspect Ratio falls below a certain threshold. If these conditions are met, an alarm is issued continuously until the driver opens his eyes, which means he is awake. Even after alerting the driver through the alarm, if he is not responding and sleep threshold limit is exceeded then we are going to stop the vehicle after giving the signal to vehicles around. Thereby, as drowsiness of the driver is detected and produced an alert in the initial stage itself, helps in minimizing the road accidents caused due to drowsiness of the driver.

4.5 Providing owner security

We are also providing security for the owner i.e., if the vehicle is driven by another person and does any kind of suspicious activities then, not the actual person but the owner will face problems, in order to avoid the problem for the owner, when the engine starts we automatically capture the image of the driver along with date and time without knowledge of the driver. Then he can easily identify the person who is driving and the owner will be saved.

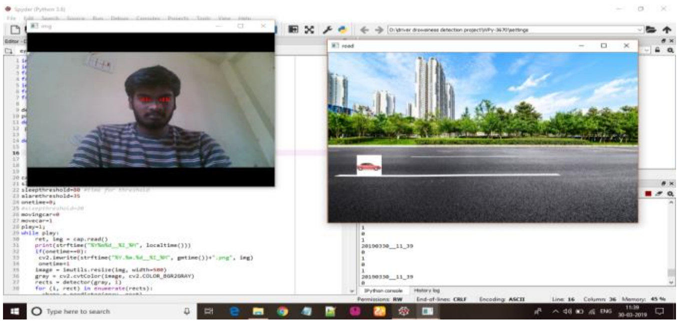

Fig. 9: Eye detection screenshot

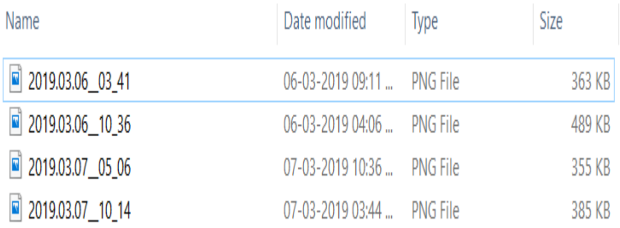

Fig. 10: List of all captured images

5. CONCLUSION

In this paper, a method for detecting the driver drowsiness using Open CV is presented. This is done by Successful runtime capturing of video with a camera. In this implementation during the drowsy state the eye we issue an alarm to alert the driver. If the driver is not responding even after giving an alert, then the engine is stopped automatically after giving the signal to the vehicles in the surrounding. We are also providing security for the owner by capturing the image of the driver when the system gets started and is used for future reference.

Our model is designed for detection of the drowsy state of the eye and give an alert signal or warning may be in the form of audio or any other means. But the response of driver after being warned may not be sufficient enough to stop causing the accident meaning that if the driver is slow in responding towards the warning signal then accident may occur. Hence to avoid this we can design and fit a motor driven system and synchronize it with the warning signal so that the vehicle will slow down after getting the warning signal automatically.

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