Drowsiness and Yawn Detection System

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***Abstract* - Various investigations show that drivers' Drowsiness and fatigue are one of the leading causes of road accidents. The current technology in a digital computer system allows researchers worldwide to study fatigue behavior. This study aims to detect the Drowsiness in drivers to prevent accidents and improve the safety on the highways. Real-time face detection is implemented to locate the driver's face region. Driver's fatigue impacts the alertness and response time of the drivers and increases the chances of being involved in car accidents. National Highway Traffic Safety Administration (NHTSA) analysis data indicates that driving while Drowsiness contributes to 22 to 24 percent of car crashes. Driving while drowsily results in 4-6% higher near-crash/crash risk relative to alert drivers. This high accident rate is because sleepy drivers fail to take corrective actions before a collision. A vital irony in driver's fatigue is that the driver may be too tired to realize his level of Drowsiness. The driver often ignores this critical problem. Therefore, assisting systems that monitor a driver's level of vigilance is crucial to preventing road accidents. These systems should then alert the driver in the case of Drowsiness or inattention. In this paper, we study whether drivers' eyes remain closed for more than a certain period; drivers are drowsy, and an alarm is sounded. Yawn similarly is detected when a person yawns several times. The programming is done in python language and Open CV using the Haar cascade library and shape predictor library for the detection of facial features and yawning detection.**

***keywords* - Drowseness Detection and Yawn Detection**

I. INTRODUCTION

Due to the increase in the number of automobiles in recent years, problems created by accidents have become more complex. The traditional transportation system is no longer sufficient. In recent years, the intelligent vehicle system has emerged and has become a popular topic among transportation researchers. However, the research on safety in vehicles is an essential subset of intelligent vehicle system research. Meantime, the active warning system is one of the designs of dynamic safety systems. The safety warning systems, mostly active warning systems for preventing traffic accidents, have attracted much public attention.

Therefore, developing a real-time safety system for drowsiness-related road accident prevention is essential.
Artificial Intelligence & Digital image Processing technology is used to make a system that contains face recognition and yawn recognition; drowsiness detection and id card detection are the various fields of security widely using AI and DIP.
Therefore, there is a need to alert the driver in advance automatically.

In this paper, we propose an expert system for yawning detection and drowsiness detection. The proposed approach is computationally less complex and robust and has less reaction time.

II. RELATED WORKS

Drowsiness detection can be differentiated into three main categories.
(1) Vehicle-based, (2) Behavioral-based, (3) Physiological based. Fig.1 below shows different approaches for drowsiness detection. A detailed review of these measures will provide insight into the working systems, issues associated, and the enhancements needed to make a robust system.

Vehicle-based measures: A number of benchmarks, including aberration from one side of the lane to the other, sudden motion of the steering wheel, high pressure on the acceleration pedal, etc., are constantly observed, and any change in these that crosses a setdown threshold indicates a significantly increased probability that the driver is drowsy.

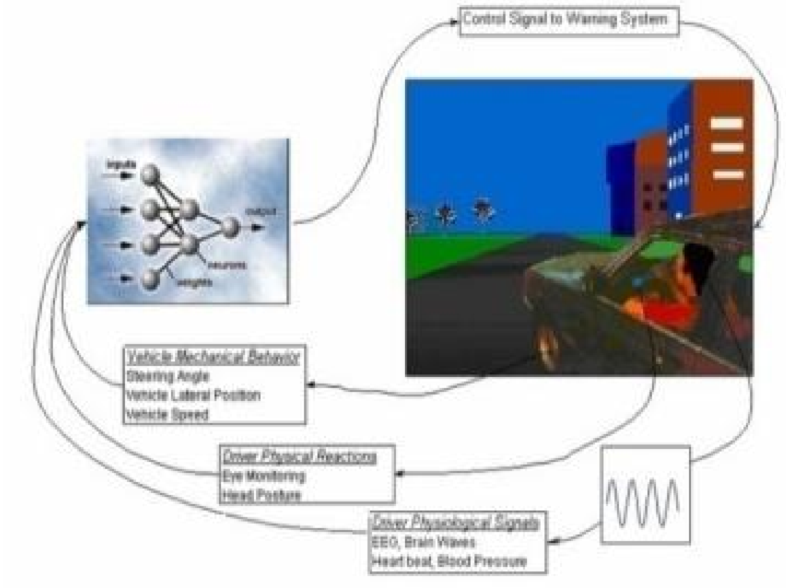

Fig 1 Approachable Detection Systems

Behavioral-based measures: The driver's behavior, including yawning, eye closure, eye blinking, and head pose, are visualized through a camera, which continuously evaluates the driver's posture and is alerted if any of these drowsiness symptoms are detected. An Example of this type of system is the PERCLOS method.

PERCLOS is a system where the percentage of eyelid closure over the pupil over time is calculated. The Formula for calculating using PERCLOS:

PERCLOS = **frames of the eyes closed / (frames of eyes open + frames of eyes closed) × 100%**

Fig 2: PERCLOS

Physiological based measures: The interrelationship between physiological signals ECG (Electrocardiogram) and EOG (Electrooculogram). Drowsiness is detected through blood pressure, heartbeat, and brain information.

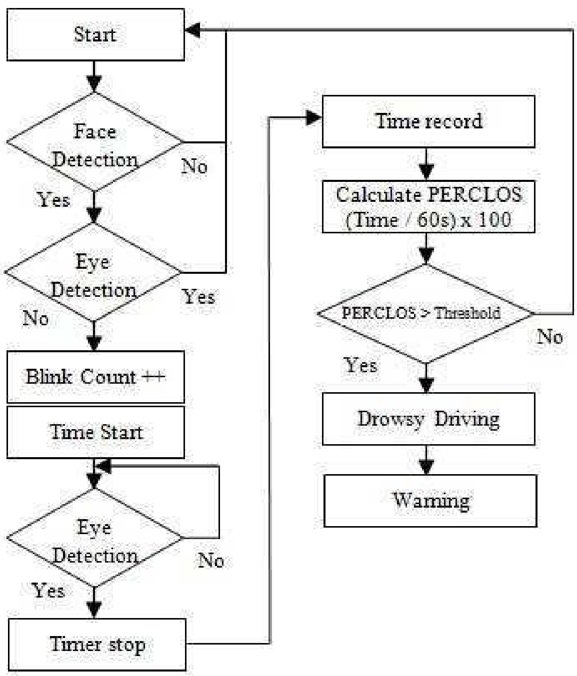

Fig 3: PERCLOS based system

III. PROPOSED SYSTEM:

A split system is made to carry out the detection of Drowsiness and yawning separately. First, yawning detection is based on skin tone detection, and second, on blob dimensions and face containment. As the first step towards yawning detection, we separate the face from the background.
Whereas for Drowsiness, we use cameras to monitor a person's behavior. This includes monitoring their pupils, head position, and various other factors.

1. Face Detection:

We need a facial detection system for drowsiness and yawn detection; we use Haar cascade sample face detection.
Face Detection is a widely popular subject with a vast range of applications. Modern-day Smartphones and Laptops come with in-built face detection software, which can authenticate the user's identity. Numerous apps can capture, detect, and process a face in real-time, identify the age and gender of the user, and apply some cool filters. The list is not limited to these mobile apps, as Face Detection has a wide range of applications in Surveillance, Security, and Biometrics.
Nevertheless, the origin of its Success stories dates back to 2001 when Viola and Jones proposed the first-ever Object Detection Framework for Real-Time Face Detection in Video Footage.

Haar cascade face detection samples:
OpenCV includes a trainer and a detector. OpenCV already holds many pre-trained classifiers for the recognition of facial features. The XML files are stored in OpenCV/data/haarcascades/ folder. Let us create the face and eye detector with OpenCV.

2. Drowsiness Detection:

The Drowsiness of a driver is detected by using LBP (Local Binary protocol), where interest in image processing and computer vision begins. Local Binary protocol summarizes local structures of images efficiently by collating each pixel with its adjacent pixels. The essential features of the Local Binary protocol are its tolerance regarding monotonic illumination changes and its computational directness. This approach is mostly used for detecting emotions on the face like happiness, sadness, excitement, etc.

The emotions expressed are related to highlights of the eye (ordinary reflections from the eye) inside a video picture of the driver. The first point of this venture was to utilize the retinal reflection as an implication to find the eyes on the confront. After that, utilizing this reflection's nonappearance to identify when the eyes are closed. Applying this calculation to sequential video outlines may help calculate the eye closure period. The eye closure period for lazy drivers is higher than simple blinking. It is also found minimal longer time may result in an extreme crash. So, we will caution the driver immediately after a closed eye is identified.

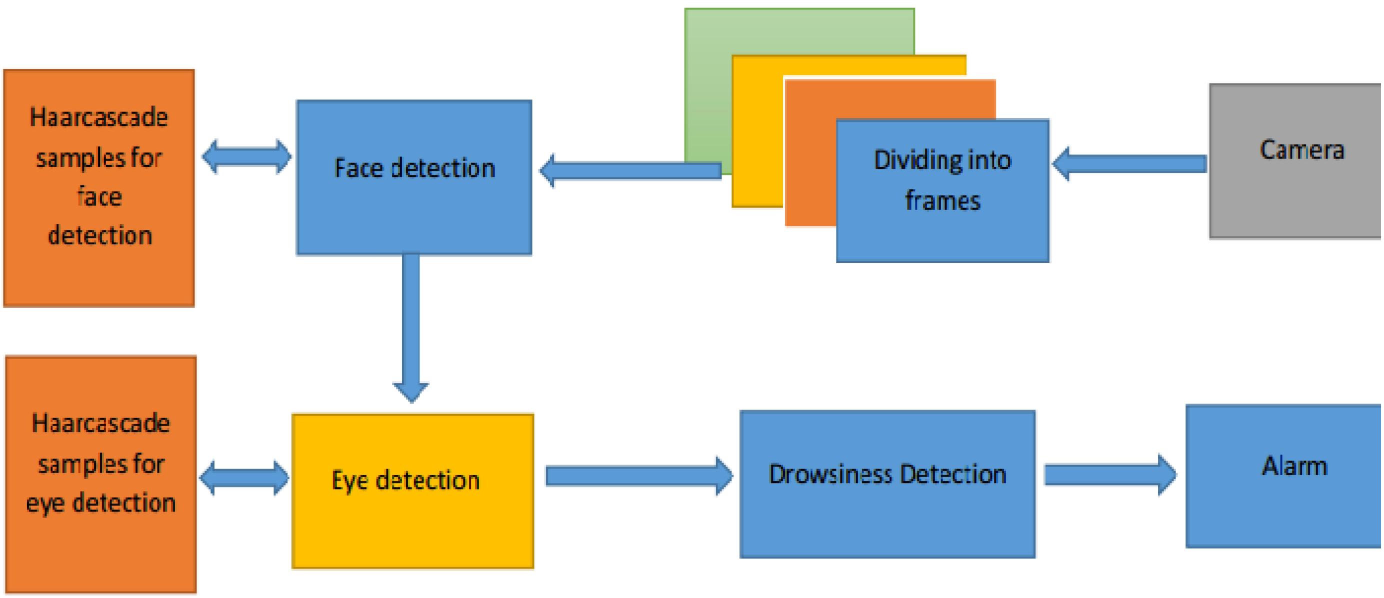

Fig 4: Drowseness Detection Using harrcascade libraries

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

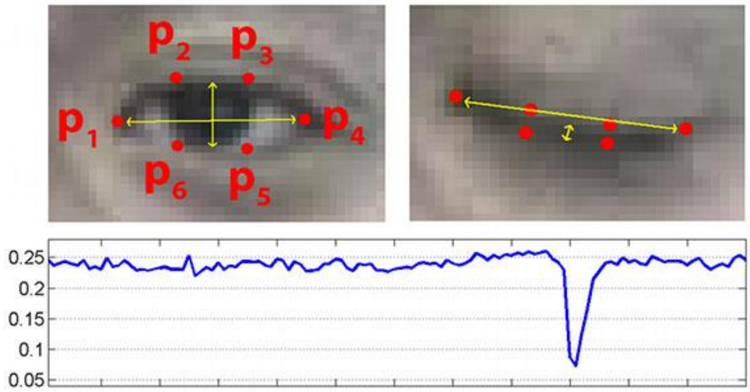

Fig 5: Calculating EAR and detecting the peaks.

3.YAWN DETECTION:

In the first step toward yawning detection, we separate the face from the background. A two-fold yawning detection system is proposed in this paper. The word two-fold is used as the yawning is detected in two ways. First, yawning detection is based on skin tone detection, and second, on blob immersions and face containment.

3.1. Mouth Region Detection

Mouth region detection the region containing the mouth, i.e., the mouth window, can be detected using a method based on intensity or color information. A region is roughly estimated from face location based on a piece of prior knowledge,
1) mouth resides in the lower half of the face region;
2) lip corners have some distance from the border of the face region; and
3) lower lip has a certain distance from the chin.
The estimated region is the searching space for mouth region detection, which decreases the searching space and avoids disturbing the background pixels with a similar color.

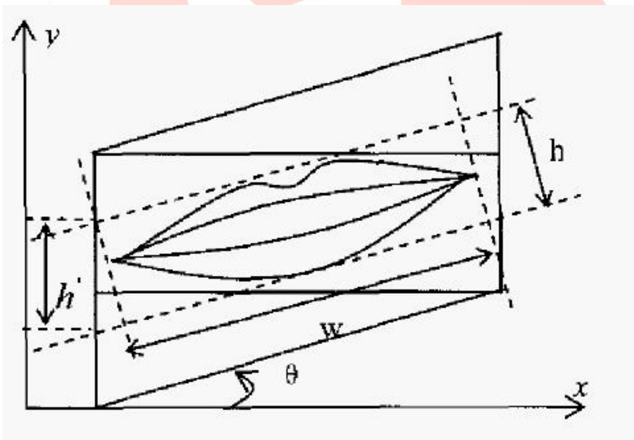

Fig 6: Mouth Model

3.2 Mouth features detection

We use a projection-based method to detect mouth features, which is simple but efficient and effective in detecting facial landmarks. Several projection functions for eye detection, such as IPF (Integral Projection Function), VPF (Variance Projection Function), and HPF (Hybrid Projection Function), were compared, and the conclusion was drawn that all the projection function-based method is effective in detecting eye features.
Lip corners are located by analyzing the mouth window with integral projection in the vertical direction. Noting that the mouth has more local variation in the vertical direction, we project the vertical difference of the mouth region vertically. The projection result is thresholded to get two columns containing the lip comers. Moreover, the lip corners are the two darkest points in the two columns.
The line linking the two lip corners establishes the orientation of the mouth, which is the direction of projection in detecting two lines running through lip boundaries.

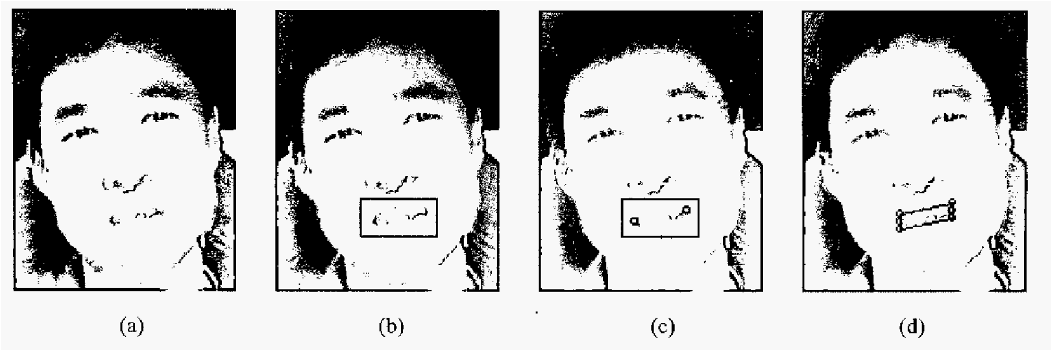

Fig 7: (a) Original face region (b) Mouth region labelled in the face region (c) Two lip comers are detected by projection (d) Mouth openness detected based on detected features

3.3 Yawning detection

Yawning is a process of continuous largemouth openness, which is different from talking with temporary largemouth openness. Degree of mouth openness over a predefined threshold T for continuous N frames means the happening of yawning. The parameters T and N are chosen through experiments.

$$LAR = \frac{|L2-L8| + |L3-L7| + |L4-L6|}{2|L1-L5|}$$

Fig 8: Calculating LAR for Yawn Detection

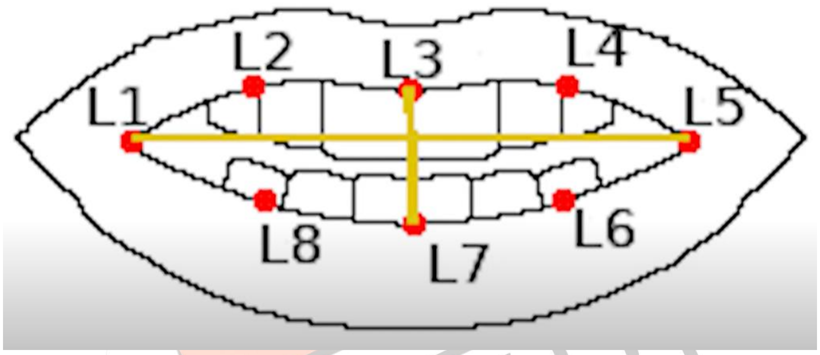

Fig 9: Lips distance points

IV. SYSTEM TESTING

We test the methods on over ten videos acquired in the car under natural conditions using a USB interface web camera. The size of the video is 320x240 pixels per frame with 30 fps. The platform is P4 2.4G PC environment. The curve of the degree of mouth openness of a typical driver yawning video is shown in Fig. 9. In experiments, we choose T =0.5 and N =20. When detection is missed or occlusion happens, the system can reinitialize. The detection results may be affected by the exposure of teeth and the selection of thresholds. We use mean of projection results as thresholds in detecting lip comers and lip boundary lines in all the frames, and this may not be appropriate in all situations. The above factors may affect the detection accuracy of our method.

However, it is within the tolerance for yawning detection where degrees of openness between yawning and non-yawning mouths are somewhat different. Another problem is that lip corners are difficult to detect, and the orientation will be hard to determine for a widely opened mouth. We use the line linking two eye centers as the direction of mouth orientation or the projecting direction. The width of the mouth bounding rectangle will be acquired by projecting the mouth window along the direction perpendicular to mouth orientation.

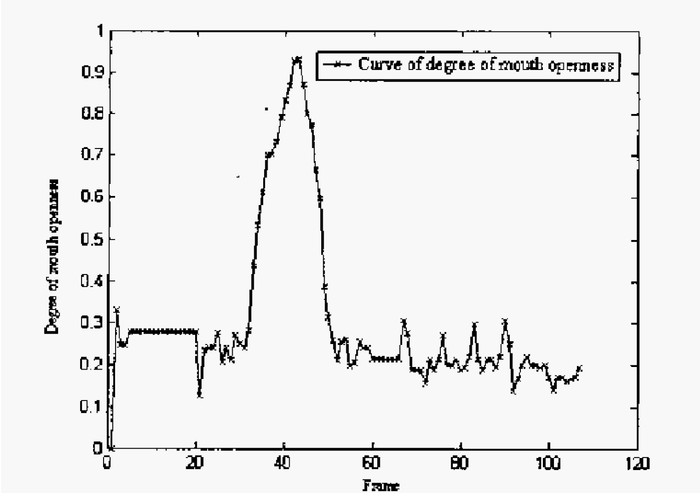

Fig 10: Curve of degree of mouth openness in a yawning video

Our method is computationally efficient, which means in real-time, on average, when the driver turns his head away, possibly caused by inattention, the eyes and mouth
may be occluded and not detected. This is another situation that should be reminded the driver, and other methods should be developed to deal with this
situation. Our system will reinitialize when the driver turns his face to the front.

V. OUTPUTS:

Fig 11: Working of Yawn Detection System

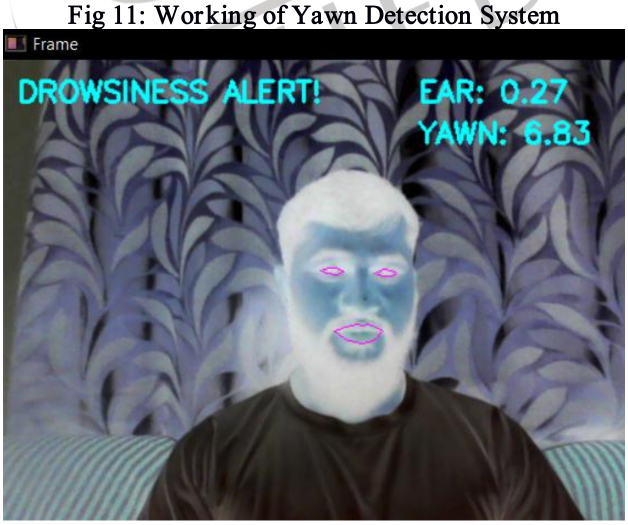

Figure 12: Working of Drowsiness Detection System

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