A Survey on Driver Drowsiness Detection Techniques

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***Abstract*: The developments in technology over the years bring the support to drivers using smart vehicle systems. In past few years, there has been substantial increase in road accidents in India and worldwide as well. The most significant reasons for the same are drowsiness and fatigue. Therefore, driver drowsiness and fatigue detection is major possible area to prevent a large number of sleep induced road accidents. Considering this problem, this article proposes different methods for Driver Drowsiness Detection System applicable in motor vehicles. The system employed various applications using blink rate, eye closure and yawning to effectively and quickly identify the drowsiness of a driver while driving the vehicle and alarm the driver accordingly.**

***Keywords*: Drowsiness Detection, Prevention, Road Accidents, Eye State, Alarm**

I. INTRODUCTION

Driving fatigue is a common phenomenon due to long time of driving or lack of sleep. It is a significant potential hazard in traffic safety. As many as 100,000 traffic accidents caused by driving fatigue which led to 400,000 people injured and 1550 people killed happened in the United States each year [1].

Driver Drowsiness Detection is a car safety technology which helps prevent accidents caused by the driver getting drowsy. Various studies have suggested that around 20% of all road accidents are fatigue-related, up to 50% on certain roads. Some of the current systems learn driver patterns and can detect when a driver is becoming drowsy. Various technologies can be used to try to detect driver drowsiness.

1) Steering pattern monitoring- Primarily uses steering input from electric power steering system. Monitoring a driver this way only works as long a driver actually steers a vehicle actively instead of an automatic lane-keeping system.

2) Vehicle position in lane monitoring- Uses lane monitoring camera. Monitoring a driver this way only works as long as a driver actually steers a vehicle actively instead of an automatic lane-keeping system.

3) Driver eye/face monitoring- Uses computer vision to observe the driver's face, either using a built-in camera or on mobile devices.

4) Physiological measurement- Requires body sensors to measure parameters like brain activity, heart rate, skin conductance, muscle activity [2]

According to WHO, road accidents are rapidly increasing. Since the drivers are often tired due to environmental conditions or mental stress, if preventive actions are not taken before an accident occurs then it would cause serious deaths. A driver drowsiness detection (DDD) system plays a vital role to prevent road accidents. There has been extensive research and a number of research papers have put forth possible methodologies to detect inattentiveness and drowsiness in a driver in the last two decades. The traditional techniques are elaborated which are based on physiological measurements including brain waves, heart rate, pulse rate and respiration. However, these techniques are intrusive in nature.

Drowsiness in humans is characterized by a few very specific movements and facial expressions - the eyes begin to close, mouth opens in a yawn, the jaw goes slack and the neck tilts. This paper focuses on tracking the eyes and mouth to detect drowsiness and detects whether the driver is drowsy. For real time application of the model, the input video is acquired by mounting a camera on the dashboard of the car and can accommodate the driver’s face, hands, upper body and occlusions such as non-tinted spectacles.

According to literature, artificial intelligence and computer vision algorithms are mostly utilized in the past systems to detect driver fatigue. In practice, there are several vision-based techniques proposed in the past to detect fatigue. According to past literature, change in weather conditions, environmental parameters and long-drive are some of the factors which contribute to drowsiness. Although, state-of-the-art Driver Drowsiness Detection systems are considered effective and reliable during day-time but provide subtle results during night time driving. In previous works, it has been observed that there are several problems presented. Those problems are natural light, head center-off position and the detection of eyes due to large sunglasses were not perfect. Moreover, most modern methods tested on video data where people simulate fatigue behaviour but less focused on real-time detection of driver fatigue. They did not experiment with real-time data, where people are naturally stressed. Since the last few years, many researchers were working on developing

Driver Drowsiness Detection systems using many diverse techniques. The driver's attentiveness can also be driver-driven with a focus on vehicle manner. Other technical methods are based on the driver's state. The best ways for correct and relatively accurate detection is based on human drivers such as brain waves and heartbeats.

Various methodological techniques for the detection and prediction of driver fatigue have been developed through advanced image processing, machine learning and computational intelligence algorithms. The purpose of this study is to first investigate the underlying intelligent algorithms that are applied to detect driver fatigue and then use advanced techniques to accurately detect driver fatigue suitable in the day and night-time driving.

All the state-of-the-art classification techniques for Driver Drowsiness Detection systems are error-prone. Hence, they have some limitations and problems regarding their use in real-life scenarios. In practice, the authors focused more on developing Driver Drowsiness Detection assistance systems and they aimed at helping drivers for detecting their moments of distraction and generate warning alarm.

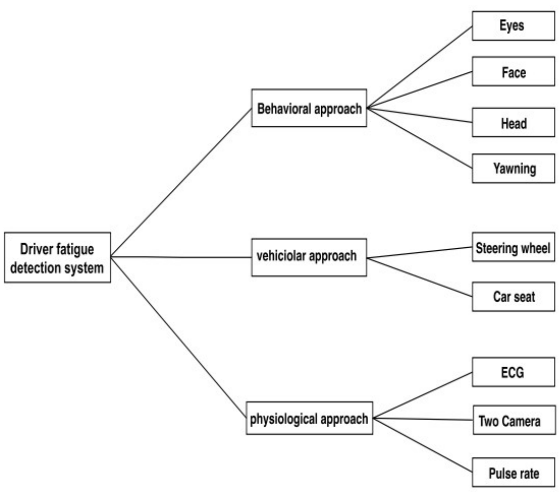

Fig. 1. A Visual Example of Driver Fatigue Detection (DDD) Systems based on different Approaches

II. LITERATURE SURVEY

Drowsiness Detection of a Driver using Conventional Computer Vision Application (2020)

In this paper, pre-existing features for facial landmark detection is used. The stepwise process of the system is shown in Figure 2. The methodology uses 68- facial landmark (a predefined landmark) for shape prediction in order to identify various regions of the face like eye brows, eye, mouth region etc as shown in Figure 3.

The facial landmark recognition is carried out as follows:

- Input the image and clearly identify the face using Viola Jones Algorithm
- Clearly detect 68 points to identify (x,y) coordinate various region of the face.
- Localize the landmarks to detect eye, mouth region etc.
- Change in the shape of said region reports various expressions for drowsiness and fatigue.

High vision cameras are embedded to monitor, capture and extract frames one by one and generate the alerts accordingly. Each extracted frame is analyzed to study the pattern of facial features; using Haar Cascade Classifiers and determined Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR) for each frame. EAR and MAR values exceed their respective threshold values, a blink and a yawn is considered respectively. The system alerts the driver by playing an alarm if eye blinking rate and yawns are suspected for a certain number of consecutive frames. The alarm is activated to grab the driver’s attention and keep on ringing until driver wakes up [3].

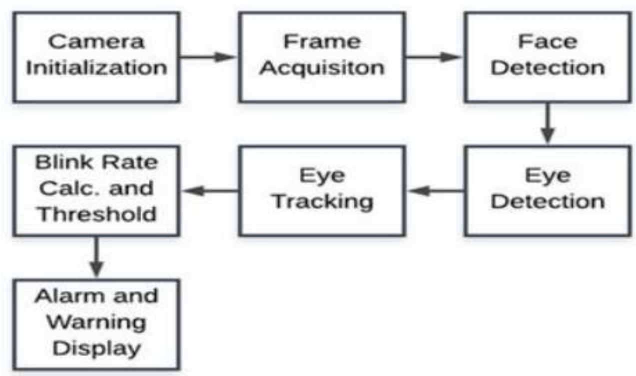

Fig. 2. Stepwise process Real Time Drowsiness Detection System

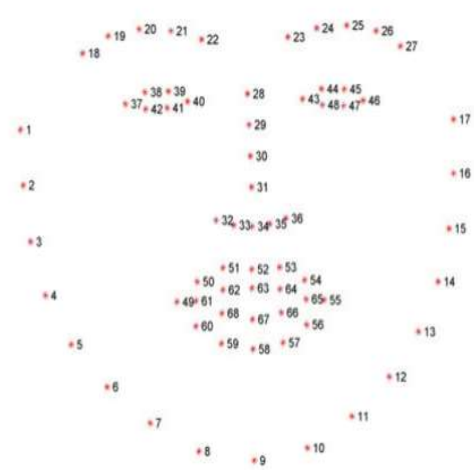

Fig. 3. Visualizing the 68 facial landmarks coordinates using Dilb facial plot

Hybrid Fatigue: A Real-Time Driver Drowsiness Detection using Hybrid Features and Transfer Learning (2020)

A systematic flow diagram of the Hybrid Fatigue system is given in Figure 4. The Hybrid Fatigue system is based on integrating visual features through PERCLOS measure and non-visual features by heart-beat (ECG) sensors. A hybrid system combines both visual and non-visual features. Hybrid features are extracted and classified as driver fatigue by advanced deep-learning-based architectures in real-time. A multi-layer based transfer learning approach by using a convolutional neural network (CNN) and deep-belief network (DBN) is used to detect driver fatigue from hybrid features.

The proposed Hybrid Fatigue system is developed based on the following stages:

- The first step is to use 68-different landmark points to track driver fatigue from the background video frames.
- After detecting and segmenting the landmarks points from two-mounted cameras on vehicle, the next step is to extract different visual features along with ECG non-visual features.
- After collecting those hybrid parameters thorough the CNN model at the collection site, this intelligent data is then passed on to automated and operator-assisted applications, which is developed through the DBN model for classification [4].

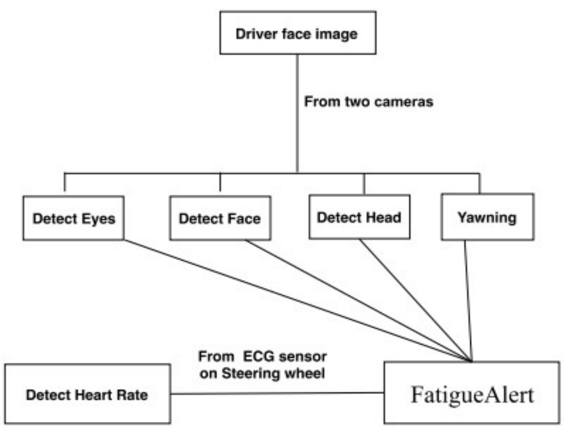

Fig. 4. A Systematic Diagram of Develop Systems of Hybrid Fatigue Algorithm

Design of Real-time Drowsiness Detection System using Dlib (2019)

Drowsy driver detection system is designed using Python and Dlib model. This model is trained to identify 64 facial landmarks. As shown in Figure 5, the drowsiness features are extracted and the driver is alerted in case of drowsiness. The Dlib library is used to detect and localize facial landmarks using Dlib's pre-trained facial landmark detector called Histogram of Oriented Gradients (HOG). In this method, frequencies of gradient direction of an image in localized regions are used to form histograms. It is used to map the coordinates of the facial landmarks of the input video and drowsiness detected by monitoring aspect ratios of eyes and mouth.

The following steps are followed for the testing of the model:

- Input video (pre-recorded or real-time) is fed into the model. Individual frames are resized and converted to grayscale.
- Dlib's HOG based face detector is initialised. The location of the face is pinpointed.
- The facial landmarks for the face region are determined by the predictor and mapped onto the face.
- Left eye, right eye and mouth coordinates are extracted, which are then used to compute aspect ratio for both eyes and mouth based on Euclidean distance respectively.
- The calculated aspect ratios are compared with fixed threshold values to determine signs of drowsiness. If the average aspect ratio of left and right eye falls below the threshold, it is recognized as a sign of drowsiness. Similarly, if the mouth aspect ratio exceeds the set threshold, there is a possibility for it to be a yawn.

- When continuous signs of drowsiness is detected over a longer duration, the driver is alerted [5].

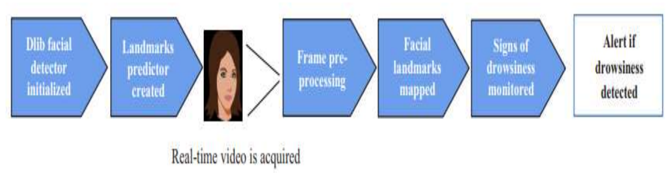

Fig. 5. Block diagram of proposed real-time drowsiness detection system

Driver Drowsiness Detection using Percentage Eye Closure method (2020)

One of the main reasons for accidents is drowsiness or fatigue in driver. Preventing the drowsiness prevents accidents and it employs road safety. There are many types of analysis done regarding the drowsiness which are seen in driver such as yawning, eye closure and head movement. The proposed system focuses on eye closure by the effective method named Percentage Eye Closure (PERCLOS). The PERCLOS establishes a parameter level to detect the drowsiness. The detection is carried out by Viola-Jones detector, which segments the driver face and image of the eye from the detector. The main concept of this method is that it rejects the non-face quickly and spends time on the face region.

The proposed flow of this system is given in Figure 6.

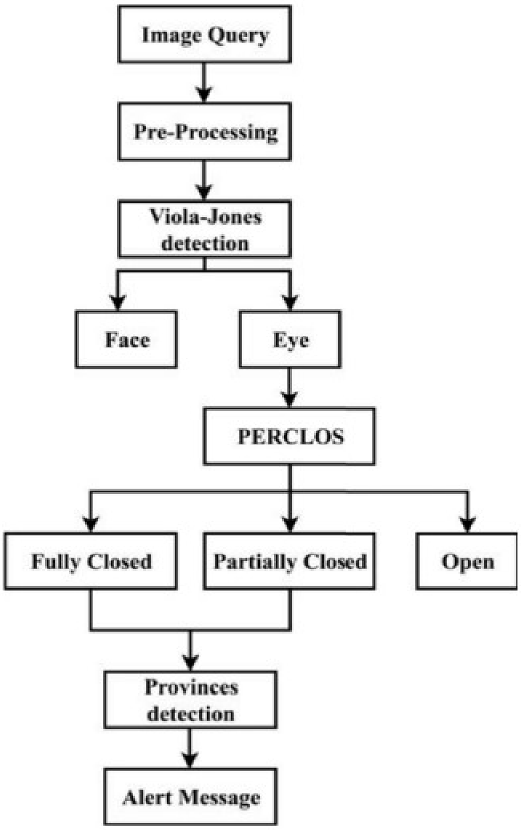

Fig. 6. Process flow of the Proposed System

It starts with capturing the original image and then it is observed by Viola-Jones method if it is face or not, which is done by AdaBoost. If it is face then by the PERCLOS method it detects the eye part, and it checks whether it is open or closed. PERCLOS is directly proportional to time for which the eyelids remain closed more than the required time period. It is searched and related with the help of database images if the eye is closed then the alert message is sent to the driver. If eye is open then the driver is alert and no measure is taken regarding this [6].

A Method of Driver's eyes closure and yawning detection for drowsiness analysis by Infrared camera (2019)

A challenge in the area of the driver drowsiness detection is to detect the drowsiness in low light condition. The proposed system is a method to detect driver's eye closure and yawning for drowsiness analysis by infrared camera. The flowchart of the proposed system is given in Figure 7. The advantage of this method is that it can detect eye closure and yawning in low light condition.

This method consists of four steps, namely,

- Face detection
- Eye detection
- Mouth detection
- Eye closure and yawning detection

The main concept is detecting the driver's face and set it to Region of Interest (ROI). Next use ROI to find targets as eye and mouth. This process starts by getting input from infrared 2D camera and processing by MATLAB. First step author will set the infrared camera at the top of the vehicle facing the driver and records the driver's random action like blink, closing eyes and yawn randomly. When the program detects the symptoms of driver drowsiness, program will print red rectangle around symptom area such as yawning will print red rectangle around driver's mouth and eyes closure will print with red rectangle around driver's eyes area [7].

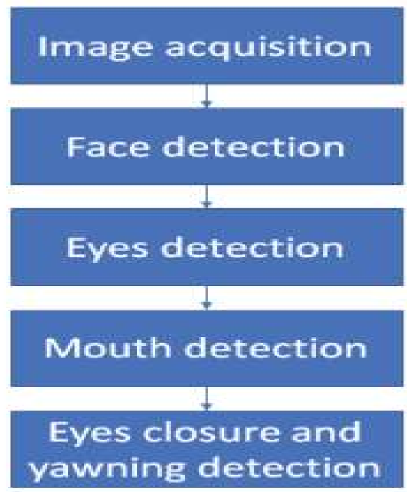

Fig. 7. Flowchart of the proposed method

Alert System for Driver's Drowsiness using Image Processing (2019)

Accidents occur all over the world cause of not being able to concentrate on the road while driving. The concentration is missed due to driving the car without resting or if consumed alcohol which makes the person drowsy. This problem is overcome by developing the various system in detecting the sleep. The architecture of the proposed system is given in Figure 8. The system uses the Raspberry Pi and various sensors like Gas Sensor, Vibration Sensor for the detection of the type of drowsiness. The driver is been monitored by placing a camera which captures the vital sign. If the eye is closed for a longer period of time then the image of the person is sent to cloud.

The accident is detected using a vibration sensor and the server is notified by sending latitude and longitude. The location of the car is sent by the IOT modem which is embedded in the car. This system goes one step ahead and detects if the driver has consumed alcohol with the help of gas sensor. If the driver is found unfit to drive then an alert message is sent to the driver. This system detects not only drowsiness but also detects if the car is met with slight accident and sends information to the cloud [8].

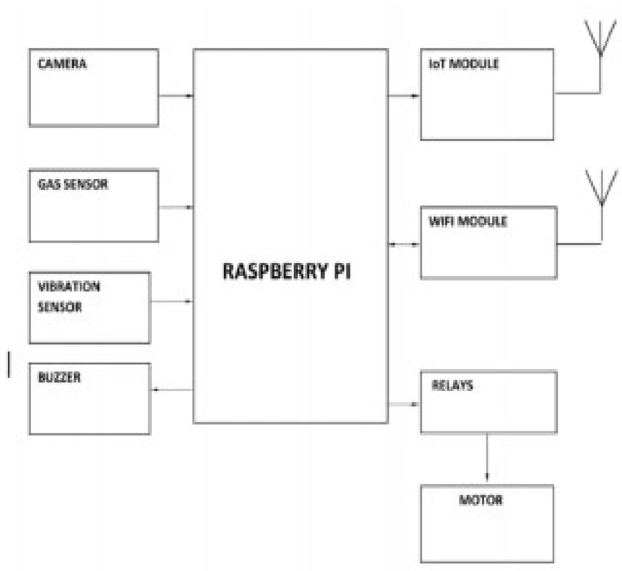

Fig. 8. Architecture of the proposed system

III. CONCLUSIONS

Drowsiness in drivers while travelling is the major cause for the accidents. An elaborate literature survey is carried out on drowsiness detection of drivers while travelling and a comparison is made on the various methods of detecting drowsiness. This paper surveys the various methods to classify and detect the eye closure levels like facial landmark recognition, PERCLOS measure, Dlib model, Viola-Jones method and sensor.

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