Drowsiness Detection using facial landmarks

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Abstract: **Drowsiness is the reason for most of the road accidents. It is not an easy task to manually trace the drowsy driver, because thousands of vehicles are running on the roads every day. That's to reduce the number of accidents because of drowsiness, researchers around the world develop some methods for detecting drowsiness automatically on driver's face. This paper presents a survey of these techniques. These techniques detect the driver drowsiness by observing the driving patterns.**

Keywords**: Drowsiness Detection; Facial Expression; Machine Learning; Behavioural Measures.**

I. INTRODUCTION

Sixteen Indians died in road accidents every hour. According to the Global Road Safety Report 2015, total 1,41,526 persons were killed and approximately five lakh people injured in India because of road crashes. This number do not properly estimated because all accidents do not reported to the police. In the United State every year approximately 1,00,000 crashes occur due to driver drowsiness or fatigue estimated by NHTSA (National Highway Traffic Safety Administration [1]. NHTSA reported that in 2013 because of driver drowsiness 72,000 crashes, 44,000 injuries and 800 deaths occurred [2]. The critical analysis of factors responsible for these accidents reveals that driver's faults is the most important factor which accounts for 78%of the total road accidents. The Statistics of Ministry of Transport, Government of India (GOI), Indicates that driver fatigue is a major cause behind driver's fault. These indicates have lead researchers around the world to investigate method for early warning drowsiness detection and warning. In addition, many countries and government officials are paying attention to the implementation of solutions to improve driving safety.

Figure 1. As per category accidents of road crashes and casualties.

Drowsiness or sleepiness can be described as a biological state where the body is in-transition from an awake state to a sleeping state. At this stage, a driver can lose consentration and be unable to take actions such as avoiding head-on collision or braking timeausly. There are obvious sign that suggest a driver is drowsy, such as:

- Frequently Yawning.
- Inability to keep eyes open.
- Swaying the head forward.
- Face comlexion changes due to blood flow.

In this system, one of the important benefits is it promote safety. It gives warning to the driver and driver falling asleep the drowsy driver detection system detects the fatigue and drowsiness of the driver. There are many technologies are available to detect the driver drowsiness and each technique with it own limitations.

II. DRIVER DROWSINESS DETECTION SYSTEMS

Driver Drowsiness Detection System (DDDS) continuously scans for various parameters/features of vehicle [3], driver [4] or the surrounding enviornment to detect abnormality in the pattern of driving [4], [5]. On the basis of entity under observation, the DDDS are classified as shown in fig. 2

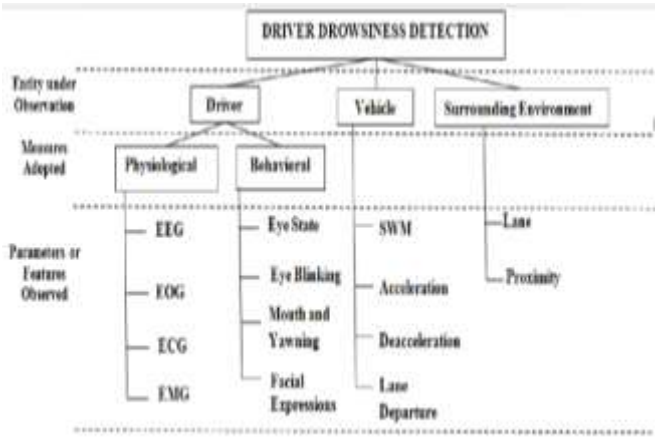

Figure 2. Classification of Driver Drowsiness Detection systems.

The measures commonly used to estimate driver drowsiness are :

I. Physiological Measures,
II. Vehicle-based Measures,
III. Behavioral Measures.

In the physiological Measures, measurements are obtained by accessing driver's conditions onto the skin through the addition of electronic devices. This includes Electroencephalography (EEG), Electrocardiography (ECG) and Electrooculography (EOG) [6] [7] [8]. These devices yield highly accurate results, because of their practical limitations they are not widly accepted. For the second category, a driver's drowsiness is analyzes based on vehicle control system, which could include steering wheel movements, braking patterns, and lane departure measurements [9]. Steering wheel measurements tend to yield better results than other vehicule-based methods [10]. Vehicle based methods are non-invasive, but may not beas reliable in detecting drowsiness accurately because they are dependent on the nature of the road and the driver's driving skills. The last category consist of behavioural or computer vision measures that tend to be reliable than vehicle based because they focus on the person rather than the vehicle. Firthermore, behavioral measures are non-invasive and more practical than physiological measures. To detect slight changes in driver's facial expressions, information is obtained by using cameras. As behavioral measures are non-invasive in nature, they becoming a popular way of detecting drowsiness[11].

III. DRIVER DROWSINESS DETECTION PROCESS

Levels of drowsiness measure by behavioral methods through the use of mounted cameras in the car to observe facial features such as head movement eye state, , yawning and blinking rate. Most researchers follow a general process to extract facial features from the camera feed. Further processing is applied after obtaining these features, to determine the level of drowsiness, typically by applying machine learning techniques such as Covolutional Neural Networks (CNN), Hidden Markov Models (HMM) or support vector machines (SVM). These techniques are trained using features and labelled output to build features and labelled output to build models that can be used for drowsiness prediction. The most challanging part of this process is finding a large dataset that covers the expected variability across races and different skin pigments. The general process followed in the behavioral measure based system is shown in figure 3.

The behavioural measure-based system observes and determine the abnormal patterns in driving on the basis of the following features [12].

1. *Eye closure analysis:* Eye state is an important feature that can help in driver drowsiness. The methods based on this feature observes the states. The metric used to detect drowsiness is PERCLOS. PERCLOS is percentage of eye closure over a period of time. The classification is done as open eye or closed eye based on value of PERCLOS.

2. *Eye blink rate:* The method based on eye blinking analysis is used blink frequency as a measure to detect driver drowsiness. Fatigue decreases the eye blink frequency, i.e. the eyelid closure duration increases

3. *Yawning analysis:* Fatigue and boredom leads to yawning, which is described as uncontrolled wide opening of mouth increase the oxygen supply in the body. Due to wide opening of mouth during yawning the geometric shape of mouth changes, which can be observed and can be used for driver drowsiness detection. The system based on this feature used mouth shape, position of lip corners and degree of mouth openness to determine yawning or driver drowsiness.

4. *Facial expression analysis:* A mix of more than facial feature can also be used to detect level of drowsiness in driver. The facial feature set includes blink, yawning, nose wrinkle, lip corner puller. As more than one facial feature is used in network and SVM can be used to optimize the detection.

Behavioural methods exhibit various limitations because their performance affected by lighting conditions, camera movements, and the frame rate used to capture image of the drivers face. Light variation can typically be eliminated by using infra-red (IR) cameras.

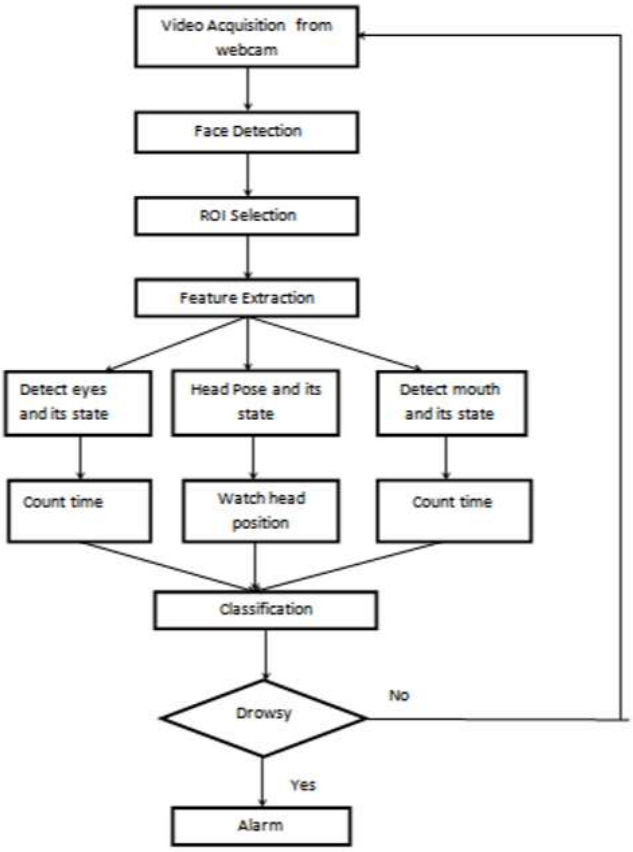

Figure 3. General process followed by behavioural measure-based system.

IV. LITERATURE SURVEY

Cyun-Yi Lin, Alan Wang[13] System use gray scale image without any color information and it works effectively in day time and night time. For the face detection the system used the machine learning to detect face position and face size, and the face geomatrical position is used to reduce the searching range of eyes. To judge whether the driver wears glasses or not, eye detection algorithm for the eye location is saparated into two different modes.

B. Reddy et al. [15] Highly optimized deep neural network model for driver's drowsiness detection is designed and compressed for embedded system. The minimise facial landmarks utilised as a input to detect driver's drowsiness and a compression techniques of knowledge distillation applied to be implemented on real-time embedded system.

Oraan Khunpis, Taweechai Chotchinasri[16] Authors applied image processing and C++ language skills in order to build an embedded device. Used a combination of Raspberry Pi 3 model B and Respberry Pi camera. Respberry Pi 3 model B is a processor to calculate whether or not a driver is drowsy. In real time, it retrieves images from the camera, which is fast enough to detect a driver's features. Face detection is done by the haar cascade classifier.

Mina Zohoorian Jafari Yazdi[18] Used depth information, the location of the minimum depth data in the face image was found and considered as the location of the nose tip. Then, used the nose tip, the bottom half of the face area was separated. Used the depth image, an open or closed mouth was detected with an accuracy of 86% Also by combined the results of the application of active contour and results. of finding the mouth binary image from the masked depth image, an individual's yawn was detected.

Author	Year	Metric	Technique	Accuracy
Cyun-Yi Lin, Alan Wang[13]	2018	Face Detection	Haar Adaboost	95
B. Reddy et al. [15]	2017	Eye state and mouth	MTCNN and DDDN	89.5
Oraan Khunpis, Taweechai Chotchinasri[16]	2016	head tilting & blinking of the eyes	Raspberry Pi Camera and Raspberry Pi 3 Model B.	99.59
Mina Zohoorian Jafari Yazdi [18]	2019	State of the mouth & yawning	Depth information & Active contour model	95

Table 1. Comparative Analysis

Problem statement: Numerous methedologies are used in past decades, include four parts[13] which are the face detection, the eye detection, the eye closure detection and the eye-glasses bridge detection. Eye and mouth play the major roles [15] in drowsiness classification. 3% of accuracy comparing to that of mouth, face and eyes. This can happen when the model try to learn unneccesary data from face. The utilisation of a Raspberry Pi Camera and Raspberry Pi 3 module, which were most effectively able to calculate the level of drowsiness in drivers[16]. Blinking of the eyes and the frequency of head tilting was used to determine whether a driver felt drowsy or not. applied image processing and C++ language skills in order to build an embedded device that could alert drivers when feeling sufficiently drowsy.

V. CONCLUSION

By the machine learning and gradient statistics based technologies, the driver drowsiness detection is existed for the real-time application. This paper presented a survey of approaches to drive drowsiness detection using a combination of Raspberry Pi 3 Model B and Raspberry Pi Camera. Raspberry Pi 3 Model B have been found to be the easiest and cost effective to detect driver drowsiness. Among various behavioral measures such as eye state, eye blink rate, yawning and facial expression analysis. These techniques have found to be more precise in detecting driver drowsiness. The main goal of these systems is to detect a slight change in a driver's facial expression. Although there are different methods that can be used to measure the level of drowsiness this review has focused on embedded system methods because they are non invasive, work in various light conditions. Future work will focus on the creation of a suitable system that will be more reliable and effective for Driver Drowsiness Detection.

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