# Driver Drowsiness Detection System

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***Abstract*** **- Machine learning techniques have been used in order to predict the condition and emotion of a driver to provide information that will improve safety on the road. It is and application of artificial intelligence. Artificial Intelligence is a method by which systems can automatically learn as well as improve without being explicitly programmed. A driver's condition can be estimated by bio-indicators, behavior while driving as well as the expressions on the face of a driver. In this paper we present an all-inclusive survey of recent works related to driver drowsiness detection and alert system. We also present the various machine learning techniques such as PERCLOS algorithm, HAAR based cascade classifier, OpenCV which are used in order to determine the driver's condition. Finally, we identify the challenges faced by the current systems and present the corresponding research opportunities.**

***Index Terms*** **- Artificial Intelligence, Autonomous Vehicle Technology, Drowsiness Detection, Machine Learning.**

## I.INTRODUCTION

Highlight a Car accidents are one of the major causes for injury or death. Statistics show that car accidents are globally the 9th cause of death: 1.3 million people die in car accidents annually, or 3287 per day. Fatigue at the steering wheel has the following symptoms: frequent yawning, hard to keep the eyes opened and to focus on the road, not remembering what happened in the last few minutes of driving, not keeping the correct distance from the car in front, missing traffic signs and getting too close to the side or center of the road. Statistics have shown that over 10% of accidents are due to fatigue, most of which occur on highways or after driving on a large number of kilometers. The influence of fatigue on accidents has been proven throughout several studies. According to National Highway Traffic Safety Administration
(NHTSA), an annually average from 2009 to 2013, there were over 72,000 police-reported crashes involving drowsy drivers, injuring more than 41,000 people, and killing more than 800. The following is a concise description of the papers surveyed. The paper presents an arithmetic based method to solve the problem related to the detection of drowsiness.
Three stages were involved. They are Face detection, Eye position detection and Eye tracking. This paper provides an efficient method for the detection of the state of the driver [2]. This framework uses the motion of the eyes to detect the state of the driver and gives an alert within 0.5 seconds. The performance of the driver is transcribed in the form of a graph [6]. A new method for fatigue detection is presented. YCbCr colour space and canny edge detection methods are used. These methods are used to determine if the driver is under fatigue. When the driver is drowsy, an alarm system is turned on [9]. A distinct system which focuses on the concept of computer vision is designed. A software algorithm is developed. This algorithm is partially tested and is found to be working effectively. Research is in progress in order to develop a full-blown system [4]. A drowsiness detection system which is dependent upon an algorithm known as "shape predictor algorithm" and eye blink rate is developed. It is based on the concept of image processing. The system provides a non-invasive approach.
This system also proposes the incorporation of yawning as a parameter to detect drowsiness [7]. In order to estimate a driver's condition, certain facial features were identified.
Using python libraries they were examined. These features were rate of eye closure, ECD, per closure, head positions and rate of yawning. Certain limitations were also highlighted.

## II. LITERATURE REVIEW

The developed system is a real time system. It uses image processing for eye and face detection. HAAR based cascade classifier is used for face detection. An algorithm to track objects is used to track the eyes continuously. In order to identify the drowsy state of the driver, the PERCLOS algorithm issued [2]. The

paper focuses on developing a nonintrusive system which can detect fatigue and issue a warning on time. The system will monitor the driver's eyes using a camera. By developing an algorithm, the symptoms of driver fatigue can be detected early enough to avoid accident. When the signs of fatigue have been identified output in the form of sound and seat belt vibration is provided to alert the driver. Warning will be deactivated manually rather than automatically. This paper uses a faster algorithm than PERCLOS. This system will detect driver's fatigue by the processing of the eye region. After image acquisition, the first stage of processing is face detection. If eyes are blinking normally no warning is issued. If the eyes are closed for more than 0.5 seconds, this system issues warning to the driver. The warning is in form of an alarm and vibration. MATLAB is used for the processing of the image [6]. System makes use of the number of eye blinks for detecting the state of drowsiness in a driver. The system makes use of OpenCV and Raspberry Pi module with a single camera view. The eye status is obtained through image processing algorithms. This paper takes into account only the state of the eyes, it does not focus on the frequency of yawning [7]..In this system computer vision and alcohol gas sensor combination is used to detect drowsiness and alcohol intoxication. This system makes use of Raspberry-pi and Arduino UNO with I2C protocol. The proposed system is based on computer vision and embedded system applications. Eye closure is detected using HAAR based cascade classifier and an alcohol gas sensor which functions as a Breathalyzer [4]. This system includes two modules. The two modules are the face and eye detection module followed by the face tracking module. CAMSHIFT algorithm is used for continuous face tracking. This system also uses cascade classifiers in order to improve the accuracy of face detection. The system is a real time nonintrusive model [8]. To reduce the number of accidents caused by drowsiness, various methods for detecting drowsiness automatically have been developed. Three ideas are discussed in this paper; the first idea is creating a dataset of drowsy facial expressions. The second idea is to combine visual, non-visual, and vehicular features into one. The last idea is to develop wearable hardware such as smart watches in order to detect drowsiness [11].

## III. METHODOLOGY

After surveying a number of different papers, the following methodologies have been identified:

### A. PERCLOS

Initially, in order to identify the driver's drowsy state using PERCLOS, we need to perform the following steps as per
[2]:

- Perception of face and face pursuit.
- Position of eye and eye pursuit.
- Identification of the state of the eyes.
- Calculation of percentage of eyelid closure.
- Identification of the drowsy state.

PERCLOS is one of the measures to notice the state ofndrowsiness.

### B. CAMSHIFT

A robust and nonparametric technique is used [2]. It implements the CAMSHIFT algorithm. CAMSHIFT (continuously adaptive mean-shift) is an efficient and lightweight tracking algorithm. It is based on the concept of mean shift It is suitable for tracking targets in simple cases. It is not efficient in tracking objects in complex situations. A detection algorithm can be applied to successive frames of a video sequence to track a single target [2]. According to [2] the detection algorithm can be described by the following steps:

1. Initialize the size as well as the position of the search window.
2. Calculate the mass centre (Xc, Yc) of the window.
3. Adjust centre of the window to mass centre.
4. Repeat 2 and 3 until distance of the two centres (centre of the window and the mass centre) is less than some threshold value.

### C. HAAR TRAINING

The OpenCV library provides numerous functions for face and feature (eyes, mouth, sunglasses, etc) detection. Some of these functions can be used to train classifiers. The classifiers can be trained for the process of detection of face This is known as HAAR training. Object. Here, a cascade function is trained from a number of images, both positive and negative. Each feature is a single value obtained by subtracting sum of pixels under various regions of the images [3]. The pixels used for extraction is different for each feature. All the extracted features will not be useful for the required process. The Adaboost technique is used to extract the relevant features. Each and every feature

is applied on the training images. The best threshold is determined for each feature which classifies images from positive to negative. Features which provide the least error rate are chosen. Initially each feature is given an equal weight. As the process continues, the weights are updated according to the results obtained order to improve the accuracy. The weighted sum of the weak classifiers is the final classifier.

## IV. HELPFUL HINTS

### A. Figures and Tables

Alternative methods, which have not been tried out on larger scale by the leading automotive companies, that can detect the state of awareness of the driver can be taken into account. Three of these methods are based on EEG (Electroencephalography) and EOG (Electrooculography) signals measurement and on the eye state (closed or opened) image classification. The EEG method monitors the brain activity through a sensor placed on a specific part of the scalp, the EOG method tracks the eye movements by measuring the signals from the muscles which are acting on the eye and the eye image analysis can monitor the opened or the closed state of the eye. The authors discussed about the development of such a system in [1]. A scheme of the system presented in [1] is shown in figure 1. Each of the methods used in the system has its advantages and disadvantages. For example, the EEG and EOG sensors, electrodes which have to be fixed with a conductive gel and in most devices must transmit the signal by wire, present a major discomfort. Important research in the field of advanced materials and MEMS technology may solve these problems, as for example the use of dry electrodes for EEG, presented in [2].

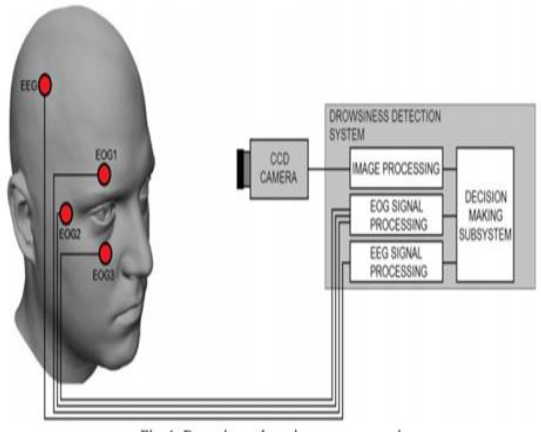


Fig. 1. Drowsiness detection system overview.

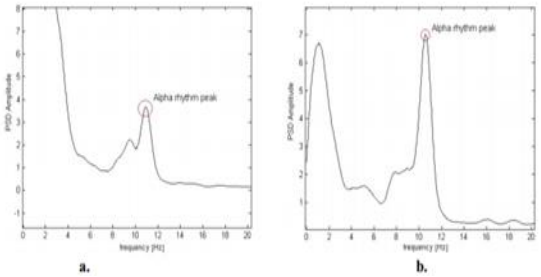


Fig. 2. Power Spectral Density amplitude versus frequency of an EEG signal, with the alpha rhythm peak in the 10-12 Hz frequency domain: a. alert state; b. drowsy state [7].

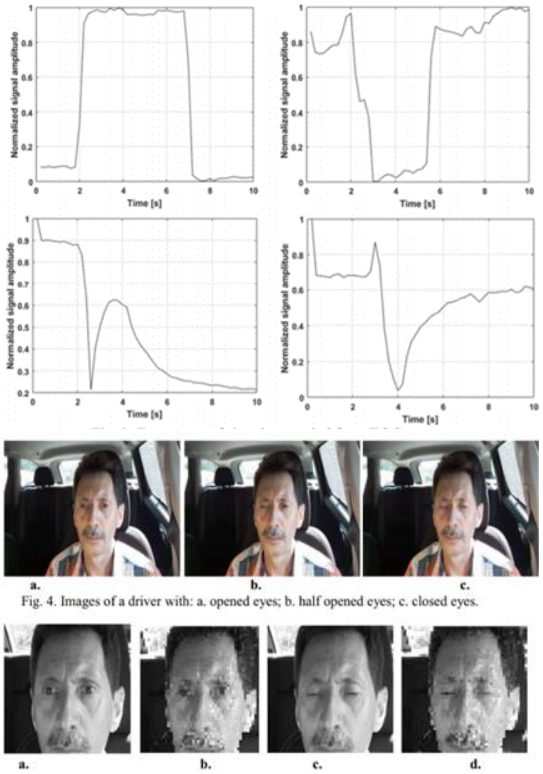


Fig. 4. Images of a driver with: a. opened eyes; b. half opened eyes; c. closed eyes.

Fig. 3. Cropped images of the driver with opened (a) and closed (c) eyes. Cropped and down-sampled images of the driver with opened (b) and closed (d) eyes.

## V. CONCLUSION

This paper provides a comparative study on papers related to driver drowsiness detection and alert system. In order to provide a solution to the problem of detecting the state of drowsiness, an arithmetic based method is used [2]. This system uses eye movement in order to detect fatigue. Eye movement is detected using a camera. This is done to recognize the

symptoms of fatigue in order to avoid accidents. [6]. It is based on the concept of eye-tracking. In order to obtain finer results, a hundred and fifty images of different people have been used. If the state of fatigue has been identified, an alarm system is turned on [9]. Computer vision with embedded systems is used. A software algorithm is developed. It was partially tested and found to be effective. There is much scope for further improvements [4]. The proposed system detects drowsiness if the eyes have been closed for a period of four or more frames. The detection system differentiates the normal eye blink from
Drowsiness. The developed system is a non-invasive system. The system can be further developed by adding various types of sensors [5]. The system is based on computer vision. It makes use of the Viola Jones algorithm, AdaBoost classifier and CAMSHIFT algorithm. A low-cost application can be devised by implementing this system using a raspberry-pi module [8]. The main aim of the paper is to develop a software tool detection of the state of fatigue. It was found to be a timely and accurate technique. Here, input is captured by a camera, processed by the Raspberry-pi module, and the output is in the form of a buzzer that alerts the user, as and when, drowsiness is detected [3]. It groups drowsiness detection techniques into two kinds, driver based, and vehicle based. It also provides a survey of numerous driver and vehicle-based techniques [11]. This system is based on the shape predictor algorithm. It provides a non-intrusive approach for drowsiness detection. In future, the frequency of yawning can also be used as a parameter to detect drowsiness [7]. In order to detect drowsiness, certain facial features were identified. This system uses the concept of video processing. It also mentions certain disadvantages of the proposed system and methods to overcome those disadvantages [1].

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