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MACHINE LEARNING BASED FEATURE EXTRACTION METHODS FOR ESTIMATION OF DRIVER'S DROWSINESS

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ABSTRACT: At present, the number of vehicles in the cities are increasing rapidly and also which may cause accidents, so the prevention of accidents is a major challenge. According to autonomous vehicle technology and development, machine learning methods have been used to detect the driver's condition to improve the safety of the passengers and commuters in the road. Apart from the basic characteristics such as age, gender, driving experience, driver's previous accident history of the driver, driver's condition can be identified by considering the factors such as driver's facial expressions, eye blinking, head movements, usage of cell phone while driving, alcohol and accident sensor. Recent technologies such as video processing, image processing, and analysis using machine learning algorithms could be used to capture the constant images and videos of the driver to detect the behavior and to calculate the level of drowsiness. For example, a driver driving a long distance may feel tired and can be warned to take rest by giving a warning signal by an audio alarm. Thus, this work uses machine learning-based feature extraction methods for determining the drowsiness level of a driver.

Keywords: Accident Sensor, Alcohol Sensor, Cell phone Detector, Eye Blinking, Head Movements, Machine Learning

1. Introduction

Most of the road accidents happened due to drowsiness and inebriated state of the driver, since it depends on the working environments, nap, and time factor.

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The drivers cannot be an active decision maker due to his drowsiness and inebriated state. Also, the perception level of the driver gets affected due the aforementioned factors. Many techniques are available to recognize the driver's drowsiness by sensing the physical activities such as eye blinking, head movement, facial expression and moving vehicles. Interactive services are provided for safe driving by analyzing the intrinsic characteristics and status of drivers. For example, a driver who got exhausted after a long period of driving should be warned to stop driving by giving an alarm. Hence, a psychological model is required to be built that reflects the behavior and psychological characteristics of the driver. This paper presents a system that determines the condition of a driver by monitoring the motion of the vehicle, driver's vital signs such as eye blinking, head movement, and facial expression using a camera. Machine learning-based feature extraction method is used to improve the training speed due to the use of Graphics Processing Unit (GPU), image analysis are receiving attention in many fields. A survey on traffics reveals that 20 % and 31 % of road accidents are due to the driver's fatigue and inebriated state of the drivers respectively. To reduce the road accidents due to driver's drowsiness, the drowsiness and alcohol detection system has to be designed [5]. The captured frame is to be processed by a personal computer with a camera algorithm is implemented using Python.

2. Related work

H. U. Rehman et al [4] presented an IR sensor-based eyewear in which the driver has to wear a glass which calculates the eye blink rate and detects the drowsiness of a driver. But during driving, it's not suitable as it is connected to the driver's body[4].So, there is no comfort to the person during driving and the sensor value may depend upon light intensity [2]. It produces less accurate results. In this IR Sensor based eyewear system; two cameras are required for monitoring head movements and facial expression separately and also attaching more sensors to the body of the driver may influence discomfort to the driver during driving. At times, it may not give accurate results in certain conditions and also due to the aging of sensors.

Thus, to avoid accidents the driver drowsiness detection system utilizing image processing is required. This paper presents a Machine Learning (ML) based approach to detect driver's drowsiness more accurately. In this ML based approach, there will be a camera fixed facing the driver which detects the drowsiness of a driver using facial expressions such as eye blinking, head movements, cell phone detector, and accident detector. It raises an alarm when the drowsiness is detected such that it helps in preventing accidents [6,7].

Driver drowsiness detection is classified into contact approaches [14]–[15][16] and non-contact approaches [1],[17], [18]. In contact approaches, drivers use

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wearable devices to collect the physiological parameters to measure the drowsiness level. Warwick et al. [14] proposed the BioHarness 3 on the driver's body to retrieve the parameters and detect the drowsiness.

Li et al. [15] proposed a smart watch to measure the driver's physical condition based on electroencephalographic (EEG) signal. Jung et al. [16] restructured the steering wheel and an embedded sensor is used to identify the variation in the electrocardiogram (ECG) signal of the driver, but the price of contact devices and installation are the major setbacks of contact approaches. The other methods are tag-free approaches to identify and measure the driver physical state, where the devices need not to be fixed in the body of the driver.

Omidyeganeh et al. [17] has used camera to capture the driver's facial appearance which can be used to identify the driver's state. Zhang and Hua [19] used Local Binary Pattern (LBP) features and also used Support Vector Machines (SVM) to estimate the driver's state, but the complexity of this algorithm is bigger. Picot et al. [20] proposed electrooculogram (EOG) signal based approach in which blinking feature is used for measuring the driver's drowsiness. Akrout and Mahdi [21] and Oyini Mbouna et al. [22] proposed fusion system to measure the level of drowsiness using eye state and head position as parameters.

3. Experimental Setup and Analysis

When a driver starts driving, he/she tends to gaze left or right side of the road. However, as time goes on, the frequency of head movement decreases. The reduction of blinking rate means that the eyes of driver get closed unconsciously and head flops. These temporal behaviors can be observed continuously from different angles using a video camera fixed in the driver's cabin [8]. Apart from eye and head movements, other causes are his/her distraction caused due to the usage of mobile phone.

In case, if the sytem detects any fatique or sleepy mood in the drivers face, the message will be sent using Global System for Mobile communication(GSM), and the buzzer will be turned on until a normal indication is received from the system.When the driver does not respond to the alarm, the electric current in the motor can be reduced using Pulse Width Modulation (PWM) which results in reducing the speed of the vehicle gradually and turns it into an off state.

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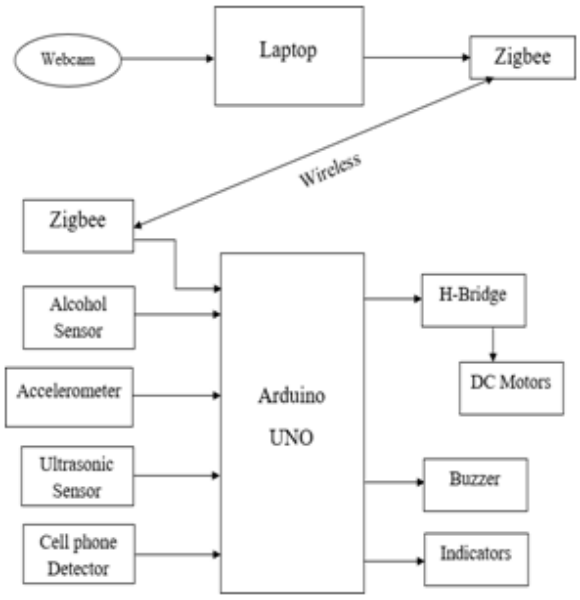

Figure 1: Block Diagram of Driver's Drowsiness Detection System

In this system, all the live inputs are given to laptop through webcam. A wireless zigbee connection is used to communicate between hardware and software. In the hardware part Arduino UNO is connected with DC Motors through H-Bridge, which allows DC motors to move forward or backward. Sensors are used to check the drowsiness state of the driver or to detect obstacles around the vehicle. Cell phone detectors are used to alert the driver when in use with it while driving by giving an alarm. Thus, the system helps to check conditions of driver which is used for alerting them and prevent accidents that can happen if conditions are neglected.

Estimating face direction from landmarks:

Facial landmark detection process has been used for determining the head pose, face swapping and, blinking of eyes. Having obtained the facial landmarks, it can be used to find the position of the face. The 2D face landmark points are determined according to the head shape. To avoid this, the 3D model of a generic human head is utilized to determine a number of facial landmarks [13].

A training set of labeled facial landmarks on a human face is taken for this study is shown in Figure 2. These images are labeled manually, specifying specific (x, y)-coordinates of regions surrounding each facial structure such as eyes, nose etc. In python, a facial landmark detector that has been pre-trained is present. The aforementioned detector method is used to determine the location of all the 68 coordinates of the human face. The values of the 68 coordinates are shown in Figure 3.

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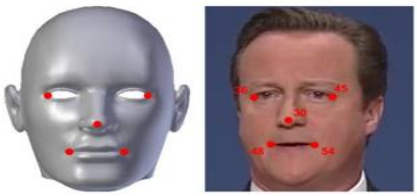

Figure 2: 3D Model of a Generic Human Head

Figure 3: 68 Co-ordinates of a face

Eye blinking is analyzed based on the Eye Aspect Ratio (EAR). If there is no eyelid movement for a particular threshold period of time, then the blink event is taken into account. Otherwise, the blink event is considered as normal eye blinking. In this study, the threshold period time is taken as 5 seconds that has been obtained by training the sample data (Normal) [2].

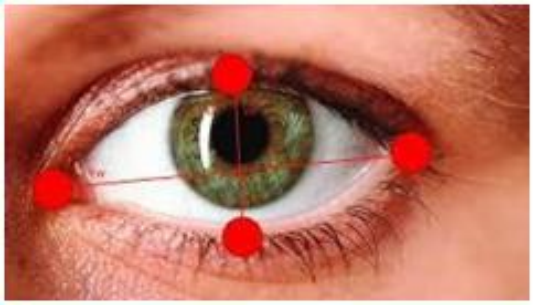

Figure 4: 68 Calculations of Blink Events

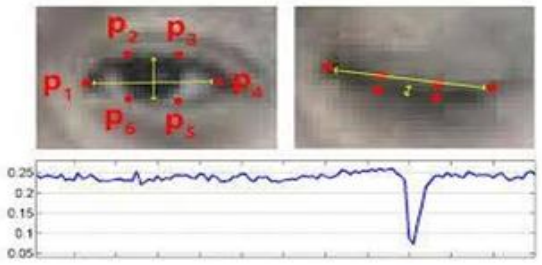

Figure 5: 68 Calculation of Blink Events

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

where p_1, p_2, p_3, p_4, p_5, and p_6 are 2D facial landmark positions as shown in the figure 5. p_1-p_4 is the interspace between the horizontal eye landmarks and p_2-p_6 and p_3-p_5 are the interspace between the vertical eye landmarks. A weight of 2 is added to the denominator because there is only one pair of horizontal eye landmarks.

Objectives:

- Eye Blinking: To capture and find eye detection quickly using non-intrusive methods.
- Head Movements: To detect the head positions for checking the level of drowsiness.
- Alcohol Sensor: To detect the alcoholic state of a driver.
- Cell phone Detector: It raises an alarm if the driver is using the phone while driving.
- Accident Sensor: Alerts the commuters if any accident takes place.

Advantages:

The various advantages of the implemented system are mentioned below

- This system is used to prevent road accidents.
- It provides information that helps in increasing road safety.
- It helps in alerting the driver when the drowsiness state is detected.
- It can be implemented in real-time due to which passengers can travel in public transportation without any fear.
- It will save the life of drivers and avoids vehicle damage.

Applications:

The drowsiness detection system is used especially in driving heavy vehicles. Usually, the drivers who drive heavy vehicles used to drive for a long period. This may cause the driver to feel drowsy. Also, it can be used for commercial driving. To provide security to the people who travel in the public transportation, this system could be used. Accidents may be avoided in overloaded cranes and mobile cranes by detecting the drowsiness of the driver [11].

4. Discussion of Additional Features of Machine Learning Based Feature Extraction for Estimation of Driver's Drowsiness

This paper presents the driver drowsiness detection system using image processing and video processing methods with an aim to avoid accidents.

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Here, a camera fixed facing the driver which detects the drowsiness of a driver using facial expressions such as eye blinking, head movements [10]. Apart from only facial expressions cell phone detector and accident detector are implemented to detect the state of the driver. It raises an alarm when the drowsiness is detected such that it helps in preventing from accidents [6, 7].

5. Conclusion and Future Work

The level of drowsiness of a driver can be detected using feature extraction methods by considering factors such as eye blinking, head movements, drunken state, and accident detection. It helps in providing information to improve road safety and thus reduces accidents. Apart from the factors related to driver's characteristics, the future work may include factor related to environment such as vehicle states, sleeping hours, current weather conditions etc., for the detection of drowsiness. Driver drowsiness will cause a severe problem in highway traffic. Twenty-four-hour operations, high annual mileage, exposure to challenging environmental conditions, and demanding work schedules all contribute to this serious safety issue. Preventive measure to be taken includes monitoring driver's state of drowsiness and giving feedback accordingly about the driver condition. As of now, there is no provision to adjust the camera for zooming while in operation. In future, the camera can be adjusted so that the coverage area gets zoomed.

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