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A Review on Intelligent Transport System using Drowsiness Detection of Driver

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Abstract: ***Driver drowsiness is the major problem in the world, which is leading to numerous road accidents. It affects the human brain which reduces driver capacity on driving for safety. Such factors may increase errors which will leads to more human deaths. Drowsy driver detection system can detect the drowsiness using hybrid features and reduce the accidents based on the status of the driver. The system is developed by collecting the video by camera placed on the dashboard and continuously monitoring driver for different reactions like continuous eye blinking, yawning frequently and also head nodding. Main goal of this system is not to disturb the driver that is to develop a non-intrusive system. The detection system should start when the vehicle starts without the knowledge of the driver and must be able for handling in different condition such as in day, night, with sunglass and without sunglass etc. We have conducted the survey of various designs on drowsiness detection technique to reduce the number of accidents.***

Keywords: Drowsiness, Classification, Feature Extraction, Preprocessing

1. Introduction

Recent technologies in the field the automobile industry have made drastic changes. Comparatively the vehicle speed, braking system, airbag facility, power steering has created an extra energy for a driver which has made the driving easy but also increased the percentage of accidents due to different parameters. Driver Drowsiness is an intermediate state in between alertness and getting sleep. It is the state when the awareness of the driver is reduced which is major factor in road accidents. Sleepiness slows the driver reaction time and decreases the awareness which leads to impaired judgement. The various profile in [1] shows age of the persons who had accident in 2016, which reveals that the age group between 18 - 35 passed accounted 46.3% (69,851 victims) also the age between 18-45 found 68.6% (1,03,409 persons) and the working age group of 18-60 accounted 83.3% (1,25,583 victims) in road accident which are happened in India [1]. The National Highway Traffic Safety Administration (NHTSA) estimates approximate crashes of 100000 each year, and those are happened primarily by the driver fatigue in United States [2].

In Japan, the attention lapse including drowsy driving, is the main reason for traffic accidents in 2012. The Ministry of Economy, Trade and Industry, Japan have reported the number of accidents of such type have increased 1.5 times in 12- year period that is between 1997 to 2012 [3].

1.1 Different drowsiness detection techniques

The following techniques can be used for drowsiness detection.
Behavioural Measure
Vehicular Measure
Physiological Measure

1.1.1 Behavioural Measure

In this mechanism the features like Eye Closure, Eye blinking, Yawning and Head nodding are used to detect drowsiness. The different frames are processed and classified based on the results and compared with the standard results [4]. The following are the behavioral changes which are observed during drowsiness.

1) Frequently Yawning.
2) Eye closure rate.
3) Blinking.
4) Deviation of Head.

1.1.2 Vehicular Measure

This Mechanism mainly concentrates on three parameters Deviation of vehicle on road with respect to Lane, Pressure at the different pedals and movement of the steering wheel. The rear end camera is used to catch the video which are processed regularly for a fixed time period if the vehicle is moving continuously with irregular distance of white lane, Driver may be drowsy. In the process of driving, the steering wheel will be observed continuously, if the driver does not move the steering for a time period indicates drowsiness. The pressure applied on pedals will be observed if sudden decrease in pressing pedal leads to drowsy. The researchers are using these nonintrusive techniques for detecting the drowsiness.

This can be achieved by:

1) Calculating the distance for lane to vehicle that is rapid deviation in vehicle from lane.
2) Movement of vehicle's steering wheel.
3) Pressure applied on the pedals which are brake, acceleration and clutch.

Above all measures uses some fixed threshold values which are used to decide whether the driver is drowsy.
Advantages:

1) Vehicular method is noninvasive.
2) It provide accurate results.

Disadvantages:

1) Vehicle based measures mostly affected by the geometry of road which sometimes unnecessarily activates the alarming system.
2) The driving style of the current driver needs to be learned and modeled for the system to be efficient.
3) The condition like micro sleeping which mostly happens in straight highways cannot be detected.

In this mechanism the vehicle is continuously observed for features like Steering stiffness, Lane deviation, the pressure applied on brake, accelerator and clutch. The reaction time is compared with the threshold value to measure the drowsiness.

1.1.3 Physiological Measure

In this mechanism the physiological signals are continuously recorded using ECG, EEG, EOG and EMG. The signals are processed and verified with threshold value to know the driver drowsiness.
Physiological measures considered to be objective measures in which physical changes occur in the human body due to drowsiness. Physiological changes computation can be observed by their respective equipment as follows:
Electro cardiogram [ECG]
Electromyogram [EMG]
Electrooculogram [EOG]
Electroencephalogram [EEG]

Heart Rate Variation Monitoring: The steering wheel is mounted with a EEG Sensor to keep a record of pulse rate of driver. The recorded data is continuously processed in which drastic sudden variation shows a sign of Drowsiness. Additionally, ECG sensor can be placed on the forearm of a driver to read the signals.

Brain Waves Observation: Special caps which are embedded with different electrodes to measure the driver brain waves which are further used to identify driver fatigue and report results in real time. Then classification is performed for each of the brain waves accordingly for identifying driver drowsiness.

Monitoring driver muscle fatigue: Drowsiness is directly dependent on the muscle fatigue. We can observe during the fatigue, pressure applied on the vehicle steering wheel found to be reduced and response of several muscle drastically reduces hence it can be measured by installation of pressure sensors at steering wheel or by measuring the muscle response with applied stimuli to detect the fatigue.

Eye movements: Electrooculogram mechanism is used to measure the frequent movement of eyes. This mechanism makes uncomfortable for driver. This method uses electrodes which are place on driver's head, face and chest, these electrodes create more disturbance for driving. To get appropriate reading the driver should cooperate with the electrodes. Which helps to alert the driver with less time period.

1.1.4 Hybrid Measure

In this mechanism, combination of behavioural, physiological and vehicular features are used to measure the drowsiness. Hybrid features have more percentage of avoiding the accidents but requires more efforts to collect and process the features for appropriate results.

2. Literature Survey

In 2017, AgataManolova et. al. [1], developed a supervised facial feature detection method which monitor the eyes blink and mouth. YawnDD dataset is used to compute the yawning. To find the facial features Voila jones algorithm is used which is an operational algorithm, provide accurate results and despite algorithm requires the frontal upright faces. The driver average frequency of the eye blink is verified with the normal driver during real time using which driver drowsiness is detected.

In 2017, AldilaRiztiane et.al. [2], author has used android application which can track the movement of the driver eyes. The application uses Haar Cascade detection and template matching in OpenCV to find and keep track of the eyes using the camera. The author has used template matching procedure which returns minVal to detect dark area of the image. In case of eyes, that is pupil. If the driver found to fatigue, algorithm does not return any value which leads to trigger the alarm.

In 2017, Samra Naz et.al. [3] developed an intelligent driver safety system using facial features. Initially the face is captured using high definition camera followed by detecting the eyes for eyes closure, mouth for yawning and head angle on which some threshold value is compared. Initially the frames are converted to grayscale image. The threshold is applied to calculate the difference by counting the white pixels. The decision is taken based on the comparison and vibrators or buzzers are used to alert the driver if he or she found to drowsy.

In 2016, Jun-Juh Yan et.al. [4], author mainly collects three features. First, locating the face and driver eyes. In the second step analyzing the data and collect facial features from the images to set the new fatigue model. Once the new model is found to be ready the drowsiness can be detected using physical state of driver. If drowsiness is found, an alert signal is used to make the driver alert. Author has used Sobel Operator edge detection method to measure edge pixels.

In 2016, Belhassen AKROUT et.al. [5], presented an approach to detect yawning to monitor driver drowsiness. Viola - Jones technique is applied to extract some of the descriptors and a classifier based on Adaboost implemented. They have carried out localization as well as segmentation of interest zone. The experiments are conducted by using both YawDD and MiraclHB Databases.

In 2016, Feng You et.al. [6], author has focused mainly on how to detect drowsiness during night. An Infrared capturing is used to driver's image in the night and designed two algorithms, a face detection algorithm to detect face and eye detection algorithm. The position of the eye located using Gabor filter with template matching. Finally eye blinking parameters are used to detect driver fatigue.

In 2016, OraanKhunpisuth et. al. [7], author proposed method the level of drowsiness is calculated by using

Raspberry Pi Camera and Raspberry pi3 module on the features like frequency of head tilt and eye blinking. Initially a video sensor is used to detect drivers face. Haar Cascade Classifier is used to detect the region of interest followed by the blink rate of eye is used to detect the drowsiness. A ration of eye area can be obtained by Haar Cascade Classifier. Template matching mechanism is used to compare the image with input images.

In 2015, Amna Rahman et.al. [8], author has used Viola Jones algorithm for detecting face from input video. Then the interested region like eye can be detected using Viola Jones cascade classifier. A Haar Cascade Classifier is applied to detect the eye region; the region is converted to grayscale using Luminosity algorithm. Then corner detection, midpoint calculation, distance calculation and eye state determination are performed. Finally, results are compared eye closure for two seconds to alert the driver.

In 2014, Gustavo A. Peláez C et.al.[9], author has found the solution for monitoring driver behavior and event detection using the 3D data. The prescribed system uses 2D and 3D techniques to find the head pose and identify the region of interest. This system uses Kinect Sensors to monitor the data like the color image, an infrared information and depth information. The algorithm uses Kinect sensor to capture the cloud of points and remove the background by applying distance filter. Later, from the cloud a color image if formed, where fast 2-D-based technique is applied to search face. When the face of the driver is found, a point cloud is fetched from the original, which is created from those corresponding points of the face. The algorithm calculates constantly the head pose by comparing with the first detected and real time face. Thus rotation matrix of the new face image is drawn, therefore the Euler angles (3DoF) corresponding to the rotation between the two clouds. Finally, the actual face is used to search regions of interest.

In 2012, Wei Zhang et. al. [10], author discussed non-intrusive drowsiness detection method by using eye-tracking. An Active Shape Model algorithm for eye detection is introduced to find the problem due to the changes in illumination and driver posture. The following measures are used to evaluate the drowsiness, mainly PERCLOS, MCD, BF, AOL, OV, CV of eyes. Fishers Linear Discriminant functions are used to find and evaluate the quantitative relationship which is also used to reduce their correlations to compare the classification capabilities. By this approach author has achieved 86% accuracy.

In 2012, Shen W., Sun H., Zhu QC, Heng E., and Li Q et. al. [11], proposed a method where drowsiness is measured using pupil by extracting features using Red eye effect and Texture detection methods. Ada-boost algorithm is used to detect drowsiness. Later ratio of eye-height and eye-width is used to classify whether the driver is drowsy or not. Using this approach author got 92% positive drowsy detection accuracy.

In 2010, Flores, M. et. al. [12] In this method a IR Camera is used to continuously keep track on the status of the eye and collected the video data. The Gabor filter is applied to detect drowsiness and Condensation algorithm is used to find different features. Support Vector Machine [SVM] classification method is used for accurate result and obtained 93%.

In 2009, Sun, Y.-F., Yin, B.-C.; Fan, X. et. al. [13], author describes drowsiness is detected using camera, camera is used to collect multiscale dynamic features, these features are filtered using Gabor filter for detecting the drowsiness. Local Binary Pattern method is used for feature extraction. These obtained features are classified using Ada boost classification mechanism to obtain results up to 98.33%.

In 2009, Lingling Li et.al. [14], author explains yawning detection method, author has used two CCD cameras to collect the geometric characters of the mouth. one camera is used continuously to monitor the head position and other camera is used for locating the mouth portion of the driver and extract the information. Haar features are used to detect drivers mouth and keep a record according to the historical position. Finally, if yawning during the drive is detected a warning audio signal is produced.

In 2008, Hong Su et. al. [15], In this paper author proposed new technique to detect multiple eyelid movements based on information fusion method. The drowsiness is predicted using eyelid movement features using Partial Least Squares Regression. The proposed solution was extended to the conventional statistical model of appearance to the component-based Active Appearance Model [AAM] by combining a global model with a series of sub-models (the two eyes separately). The method was applied successfully to robust eye tracking.

In 2007, Xiao Fan et. al. [16], Yawning is considered as evidence to detect driver drowsiness. Author has used Gravity Center template for face detection followed by Gabor Wavelets are used to find the drivers' texture feature. Finally features are classified using LDA to detect the yawning.

In 2007, D'Orazio, et. al. [17], author used Fire wire camera to detect driver percentage of eye closure period and number of time eye closure using Hough transform technique. Then applied Discrete Wavelet Transform feature extraction method to calculate features. The results are classifies using Neural Classifier to obtain better result. Author has got 95% of accuracy.

In 2007, Lew, M., et. al. [18], described the use of digital video camera for capturing the facial action continuously. Gabor filter is used to detect drowsiness and applied wavelet decomposition for different extracting the feature.Support-Vector Machine method is used to classify the results and obtained 96%.

In 2006, Bergasa, L.M., et. al. [19], author presented a novel approach using Infra-Red Illuminator and camera to detect the blink frequency, duration of eye closure using Two Kalman Filters for Detecting the eye pupil. The PERCLOS method is used to detect the drowsiness, that is the percentage of eye closure time during a certain time interval. The variation of the algebraic-distance technique to detect conics approximation and Finite-State-Machine are used for

feature extraction. Fuzzy classifier is used to classify the results and obtained close to 100%.

In 2005, Tiesheng Wang et. al [20], author has developed a system which is used to detect the drowsiness based on yawning by analyzing the video sequences. The face region is tracked using Kalman Filters. Author has used mean of projection results as thresholds to detect lip corners. The degree of mouth opening is calculated and compared to detect yawning.

In 2006, BorkoFurht et. al. [21], in this mechanism author has mainly concentrated on four steps namely detection, in which the head position is detected followed by extracting the skin color using that they created a custom skin color model for comparison and collected the set of open/ closed samples of eyes. Followed by Tracking, in which continuously the monitoring driver eyes within the tracking area dynamically. Warning, during monitoring the eyes if the driver eyes found to be closed for prolonged time or starts to head nod, an alert signal is raised. Alert, any time if driver appears to be abnormal state, an audio/ visual signals are used to make the driver alert. A Dynamic two-threshold approach is implemented to detect abnormal head of driver. SVM Classifier algorithm is used to classify the results. By this approach author achieved 96% result.

3. Methodology

The block diagram shows the Driver Drowsiness Detection method.

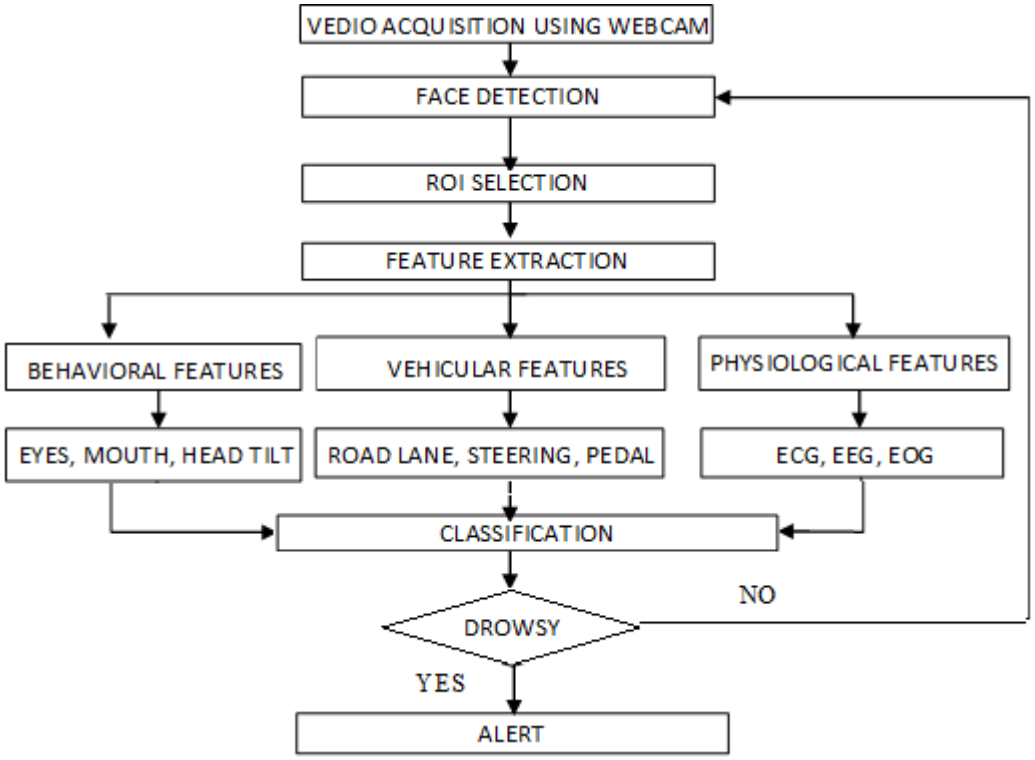

Figure 3.1: Drowsiness Detection of Driver

The Figure 3.1 shows the various steps to be performed to decide the driver drowsiness. Mainly Behavioral, Vehicular and Physiological features are considered for the study. The focus of this survey is mainly on Behavioral as it is non-intrusive in nature. Using Behavioral features we can obtain better results and time required to detect drowsiness can be reduced

Driver Video Collection: The important phase of this process is image acquisition. A high resolution camera is placed to capture the video from which the facial image frames are collected. It is continuous process which is processed for frames.

Driver Face Detection: The images are undergone for finding the driver face. Voila Jones face detection algorithm is used to crop the region of interest. Further the features like Behavioral, Vehicular and Physiological are considered for continuous feature extraction.

Drowsiness Detection: In this step the collected features are classified using different classifiers like ANN, SVM or HSM. Based on the category the system decided and puts the alarm if the driver found to be drowsy otherwise the system extract the new face images.

Alarm or Vibrator is used for alerting the driver if the driver found to be drowsy. The alarm may be in the form of audio signal, vibrators or image symbols blink on the screen on dashboard.

4. Conclusion

According to survey, 30 percent of accidents on road were happened due to the driver drowsiness in between the age group of 25 to 40. The parameters affected the drivers for their drowsiness are namely: less sleep in night, continuous drive, drunken drive and day dream. In this paper, a brief

review on various drowsiness detection techniques were presented. From the survey, it can be deduced that, many researchers have considered behavioral features in order to predict the status of driver, where in the accuracy of drowsiness can be predicted better with vehicular as well as physiological features. In this regard, a drowsiness detection system using combination of all three features can be developed in future.

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