© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 13 Issue: 03 | NCASIT- 2022 | April 18th 2022
Paper is available at http://www.jrps.in | Email : info@jrps.in
Refereed & Peer Reviewed

Review of Driver Drowsiness Detection System

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Abstract— India is one of those countries where automobiles are used in large numbers for transportation. Since vehicles are used by a large population, the country also contributes to an increasing number of road accidents. Road accidents mostly occur due to drivers' drowsiness or lack of concentration on the road while driving a vehicle. Due to slight ignorance of the driver, mishaps occur and an individual might have to pay in terms of injuries and sometimes life.

The paper puts a study on driver drowsiness detection systems that can be installed in cars and depending upon the eye aspect ratio the system throws an alert with the help of a buzzer, which helps the driver to remain active and avoid drowsiness during driving. This system takes input as video recording and detects the eyes for fatigue. And depending upon the detection of the eyes the system determines the eye aspect ratio. Eye Aspect Ratio (EAR) is the Euclidean distance of the corresponding eye coordinates. When the eyes are open the ratio value remains constant but when the ratio approaches zero it indicates that the eyes are closed. The system works efficiently when a sufficient amount of light falls on the face of the driver.

Some studies reveal that when the energy of the body is low the first sense organ to indicate that the body needs to take rest or sleep are eyes hence considering the eye aspect ratio is the key feature. In a road accident, individuals involved in the collision suffer damage. To replenish the fatality rate in the country a design and implementation of a driver drowsiness detection system using IoT have been studied.

Keywords- Drowsiness Detection, Eye Aspect Ratio, Python, Raspberry pi

1. INTRODUCTION

Sometimes while covering long distances on the highway the driver may lack focus while driving the automobile. A very slight assumption by the driver to shut eyes for a second to feel relaxed might cause injuries for a lifetime. The driver feels drowsy due to a lack of sleep. Studies suggest that drivers having slept for fewer than four hours have a high probability to get involved in a car crash. When compared to women, men are more likely to drive while they are sleepy. Everyone gets affected because of drowsiness when they are driving, but especially the population under the age of 25, which constitutes about 50% or more of drowsy driving crashes. This means awareness focusing on this age group of males will help in decreasing drowsy driving among those susceptible to it.[1]

According to the study by Central Road Research Institute (CRRI), drivers behind the steering wheel feel fatigued and exhausted due to which they doze off is responsible for car accidents. This analysis throws light on how drivers ignore taking rest while they are driving which in turn costs their life.[2] The statistics reveal that 148,707 people in India alone died due to car accidents out of this 21% of accidents were caused due to fatigue. The National Highway Traffic Safety Administration estimates that 100,000 accidents are the result of driver fatigue every year.[3] According to the Centre for Disease Control and Prevention (CDC), to avoid drowsy driving one should take ample sleep before driving (almost 7 hours) which gives the body more energy to stay focused and relaxed while driving on the roadway.

Also, it suggests that the driver should not consume alcohol or any medicine which makes them fall asleep.[4] To address the increased number of road accidents due to driver's drowsiness while driving. A driver drowsiness detection system is proposed. The system is a circuit consisting of a Web Camera and a buzzer attached through micro-USB cables to a raspberry pi which can be installed in the car at a safe distance and location from the driver. The code is developed in python (OpenCV) and it is stored in the hardware module which constantly monitors eye aspect ratio taking input in video format from the Web camera.

When a person feels drowsy it can be seen in his physiognomy such as a lack of attention, more hanging eyelids, redder eyes, yawning, more swollen eyes, and droopy corners of the mouth. Considering these characteristics, developing a driver drowsiness detection system using IoT is the most efficient technology to solve the problem. [5]

The proposed system will prevent drivers from drowsiness and ensures their safety. During the long duration of driving over the highways, there are drivers such as car drivers, truck drivers, and taxi drivers who suffer from fatigue and lose focus. The drowsiness detection system will help them to remain alert and awake.

I. Ease of Use

A. *Driver Alert system and Health Monitoring Features[6]*

This proposed a system in which the Raspberry Pi Camera continuously monitors the movement of the eyes. Virtual Network Computing (VNC) viewer is software used to see the real-time facial expressions of the driver and read the blinking of the eyes. They also have sensors that check the driver's heartbeat, temperature, and alcohol level. Whenever an alcohol level is detected, the vehicle's motor stops. If the driver's eye movements or Health parameters are unusual, the buzzer will play its alert sound to notify the driver about his fatigue. When buzzers are activated, the speed of the vehicle slows down. This data is sent by the sensors along with the date and time to Xampp Apache for uninterruptedly keeping track of the database and information about the driver's status and can be observed by the driver by logging in through credentials. This whole feature is done using a breadboard with Raspberry Pi.

B. *Driver Drowsiness Detection System using CNN[7]*

The proposed a system where to find the eyes, first detect the head using Viola and Jones's algorithm, then find facial landmarks through the methodology of Kazemi and Sullivan's work.[8][9] It is a regression tree learning scheme trained on the iBUG 300-W face landmark dataset.[19] On reaching the landmark point of the eye, crop the ROI. If the face is an asymmetry figure, hence for drowsiness recognition, consider only one eye. It uses a histogram equalizer to match eye disparity and then sends it to the network. They monitor two datasets, which the first is the ZJU dataset, and the second is a mixed dataset of ZJU and is their own created database used for training the network and applied using a Fully Designed Neural Network. They used VGG16 and VGG19 as the proposed pre- trained networks. These networks learn low-level features with the weight of the image dataset also high-level feature extraction with three last added fully connected layers. They also used transfer learning for a deeper network with higher accuracy. If the network has a probability of closeness of the eye more than 50% and more than 12 consecutive images, then a threat is considered by sending an audio alarm to the driver.

C. *Driver Drowsiness Algorithm Based on Binary Eyes Image Data[10]*

Firstly, they capture an image through IR led Camera and then process it through MATLAB. Then crop eyes from the original image to reduce noise and data size to speed up the process. Convert the RGB Format image to Grayscale. For determining the threshold, evaluate a large amount of data. The image data is imported from the .mat file (MATLAB generated file) to examine black and white (BW) pixels. There can be holes in an image due to the reflection of light with noise in it which uses morphological and filtering operations to eliminate it. Process the eye image and decide whether or not the eyes are closed. Many image data are analyzed. The drowsiness Detection method is determined using Black to White pixels Ratio, Column Count Greater than the threshold value, Eye's Shape. The system sets itself to learn to tune the threshold at start- up.

D. *Android-Based Application to Detect Drowsiness by Juve Korompis[11]*

The first part is the application that displays the main menu, an input process, where users enter the input by clicking the start button and developed using Android Studio 2.1.1. Then, we scan the processing of a real-time image using OpenCV. After evaluating, it captures an image, which is the face of the user to be detected. When failure occurs in this process, it will again survey the image. If it succeeds, then it will mark the faces with a circle. Then, it will enter the process of analyzing the eyelids, where the user's eyes will be detected when exhausted. Then enter the input image of the eye for detection. But if the user's eyes are not closed, it will go back to analyzing the eyelids, and if the user's eyes are closed, it will mark the eyes with a circle. Then, it sends a warning sound alert built using Google Voice Engine API. The dashboard of the android application consists of the Start option to begin the detection object for the drowsy driver detection system. The About option is a menu that displays the definition of the application. The Help option shows the manual function of the application and the Exit option for halting the application.

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E. Wristband Driver Vigilance System through Smartwatch[12]

A scenario set up with a Logitech steering wheel connected to a laptop for highway driving simulation, a wearable sort monitoring system consisting of the sensor unit and smartwatch module. Then calculate photoplethysmography (PPG) signals from the finger. Then it is amplified, filtered, and transmitted to an Arduino Lilypad controller capacitated by a lithium-polymer battery. The filtered analog signals are transformed into digital signals by a built-in A/D converter in Arduino Lilypad. A BLE4.0 module integrated on the Lilypad transmits the PPGs to the smartwatch. It finds PPG-Derived Respiration (PDR) via the PPG peaks divergence. Two motion sensors readings are collected, linear acceleration force and rate of rotation around the x, y, and z-axis from the accelerometer and gyroscope. The rotation angles are derived and treated as steering wheel angles. The vigilance features are derived from PPG, PDR, and SWA signals and are input features to the vigilance classifier. If the driver's vigilance level has reached a predefined warning threshold, it triggers visual and vibration warnings from the smartwatch to notify the driver.

F. Driver Drowsiness System based on head tilt angle[13]

Head tilt measure is another method currently used. The system starts finding the location of the head and face using the algorithm of Viola and Jones. Once facial links are detected, the distance between them is recognized. If the face moves, the coordinates changes and thus the inclination. In other words, this measures the angle at which the pinnacle moves. Sound alarms are square measurements transmitted to the driver's ear when the spinal inclination reaches a certain level. Such a principle applies to BMW. The market is nowadays using reed switches to detect head tilt angle.

G. Driver Drowsiness System based on steering-wheel angle sensor data [14]

A new unconventional neural network is formed that includes a variety of self- organizing, flexible learning strategies for organizing a competitive network and for extracting fatigue issues. Using a repetitive neural network with four layers, it constructs this model. Inputs like steering wheel angle, brake force, left and right steering, can break yaw rate, and video images are captured and sent to the VBOX data acquisition system. It provides output features such as data display, video surveillance, and data recording. Along with videos, we acquire photos of the driver's face on which it makes points to construct a driver's fatigue website. When the driver starts to get tired and drowsy, the steering frequency increases, the operating time decreases, and thus alerts the driver. Here, it looks forward to the driver's attitude and reflects the operational behavior.

H. Driver Drowsiness System using eye- blink sensors [15]

In this system, the eye blink sensor consists of three main components, an eye blink sensor frame, an IR sensor, and a relay. A device that acts as the vibrator is connected to the eye blink sensor frame. When the driver falls asleep this device vibrates and alerts the driver. The IR transmitter sends IR rays into the driver's eye and receives the reflected rays when the eyes are closed. The system is developed using Keil IDE. The programming language used is embedded in C. The system can also be connected to an android application developed using Android studio for performance enhancement. The other modules would be a microcontroller, IR sensor, LM358 comparator used to fulfill power requirements, an accelerometer that helps speed and steering movement tracking, an LCD for displaying messages, and an android phone for running the application.

I. Driver Drowsiness System using Eye Aspect Ratio and Eye Closure Ratio [16]

This method starts by capturing live pictures from the camera and is sent to the native server. Dlib library is used to check facial landmarks, and a value is set to check whether or not the driver is drowsy. These facial landmarks are used to work out the EAR (Eye facet Ratio) and sent back to the driving force. In our context, the EAR price received would be compared with the threshold value taken as 0.25(T. Soukupova and J. Cech, 2016). If the price is smaller than the threshold value, this might indicate fatigue. In this case, the passengers would be alerted by an alarm.

J. Driver Drowsiness System using Eye Aspect Ratio and Eye Closure Ratio [17]

The system developed by a group of researchers at Universidad de las Fuerzas Armadas - ESPE, Ecuadorshowcase a surveillance system that monitors the drowsiness of a vehicle driver with the help of an android mobile application, and sends alert to the driver in case if drowsiness is detected. It creates a Human-Computer Interaction system with the help of a smartphone-like small computer and analyses parameters like the behavior of the eyes, the lateral and frontal assent of the head, and the yawn. Despite natural light conditions or accessories like glasses, caps, etc., this method is 93.37% accurate in drowsiness detection.

K. A Smartphone-Based Driver Safety Monitoring System Using Data Fusion [18]

This method uses the approach of data fusion to monitor the data. This system uses an application on the mobile phone connected via Bluetooth. In this system, the change in the driver's condition can be detected in 0.2 seconds. Also, it focuses on several features such as heart rate, blood pressure, temperature, etc. A fuzzy Bayesian Network is implemented to analyze the driver's vigilance. If the evaluation index crosses 75% a call is initiated to alert the driver.

Sr no.	Title	Description	Output	Drawbacks
1	Driver Alert System and Health Monitoring Features	A system that monitors the blinking of the eyes along with checking the health parameters using various sensors.	It displays whether the driver is sleepy, the Alcohol level of the driver, and Health parameters like heartbeat and temperature.	There can be aging of sensors and all these sensors are attached to the driver's body which may affect the driver. They have only considered eye movements to detect the drowsiness of the driver.
2	Driver Drowsiness Detection System using CNN	They are using various algorithms and training the data to find the drowsiness of the system. They also consider half face for detecting fatigue.	It sends an alarm to the driver when drowsiness is detected and this data send to the network for training the dataset.	They are capturing 12 successive images to check if the eyes are closed but it happens that in between the accident taking place. They can reduce the number of successive images taken.
3	Driver Drowsiness Algorithm Based on Binary Eyes Image Data	They are converting captured eye to binary eye and Detecting drowsiness.	It captures live images, detects whether eyes are closed, and sends alerts to the driver.	The system will not give correct results due to the light effect or position of the driver.
4	Android-Based Application to Detect Drowsiness	An android application-based system that analyses real-time eyelid images using OpenCV and alerts the user when drowsy.	If the system detects the user's eyes closed, it will send an alert through google voice alert API on mobile.	Eye movements and blinking differ from person to person making them subjective parameters for the system. It may not be enough to provide accurate results every time.
5	Wristband Driver Vigilance System through Smartwatch	This system analyses the photoplethysmography (PPG) signals, PPG Derived Respiration (PDR), and SWA signals of the user through a smart wristwatch and tracks the drivers' real-time behavior.	If the driver's behavior is detected as drowsy, the wristwatch will generate a visual alert and vibration on the driver's wrist and make him alert.	A sick person's pulse can give wrong input to the wristwatch leading to unwanted alerts from the system in his case.
6	Driver Drowsiness System based on the head tilt angle	This system tracks the head and faces location of the driver and analyses the head inclination angle to check if the driver is drowsy.	Sound alarms are sent to the user's ears if the inclination of the spine is above a certain level.	It might detect normal head movements as a sign of drowsiness and the system can give false-positive results.
7	Driver Drowsiness System based on steering - wheel angle sensor data	A new unconventional neural network is formed that includes a variety of strategies for organizing a competitive network and for extracting fatigue issues.	It provides output features such as data display, video Surveillance and data recording. Along with videos, we acquire photos of the driver's face on which it makes points to construct a driver's fatigue website.	This system uses multi-distributed sensors in real vehicle systems which may, in turn, result in high cost. The system is based on the results obtained from the previous methods performed. Error in any of the methods may break the system.

8	Driver Drowsines s System Using eye-blink sensors	The system uses various sensor modules. All the results are based on the inputs given and the outputs received. It carries out functionalities such as slowing down the vehicle's speed, alerting the driver, and displaying the message.	The inputs are the signals from the ports of the microcontroller. The output from SST is passed to other devices and various functions would be carried out as per the demand of the project.	The positioning of IR transmitters needs to be taken into consideration for correct results. This system uses an app for location detection from mobile phones. Thus, the driver needs to always carry a mobile for receiving alerts and for the owner to access the location, else the whole system fails.
9	Driver Drowsiness System using Eye Aspect Ratio and Eye Closure Ratio	Live pictures from the camera are sent to servers, facial landmarks are being checked to state whether the driver is drowsy or not.	Eye aspect ratio is noted which is then compared with the threshold value taken as 0.25. If the value is smaller than the threshold value then it detects fatigue and the driver would be alarmed.	The accuracy of this system depends upon the brightness and lighting of the surrounding environment.
10	Driver Drowsiness System based on Driver's Face image behavior	The system is an automobile driver surveillance system that uses computer vision technology and sensors to detect drowsiness	It detects drowsiness if the eyes are closed for a period of four or more frames.	The proposed system cannot indicate the frequency of yawning which is one of the indications of drowsiness.
11	A Smartphone-Based Driver Safety Monitoring System	A real-time system that captures the images using the camera on Smartphone and stores them in a local server and determines drowsiness using eye aspect ratio values	The alert for drowsiness is issued to avoid crashes.	The system does not support any other operating system other than the android operating system while there could be iOS users

FUTURE SCOPE

Road accidents are a major threat to the drivers in most parts of the world and key measures should be taken to avoid them... Future work may help in focusing on factors such as sleeping hours, weather conditions, and health. Also, every person has different eyes. Also, we can include zooming in on the driver's eyes for a better observation. Further, we can develop a system where the car will start when the registered face is detected. This would prevent the car from being robbed.

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