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Driver Drowsiness Detection System to Reduce Accident

Prof. N. B. Madke, Ritesh Patil, Bhavesh Patil, Pushkar Patil, Jayesh Patel

Department of Computer Engineering, Sandip Institute of Engineering and Management, Nashik, Maharashtra,
SPPU, India

Assistant Professor, Sandip Institute of Engineering and Management, Nashik, Maharashtra, SPPU, India

ABSTRACT: Driver fatigue stands out as a significant contributor to accidents worldwide. Recent years have witnessed a surge in vehicle accidents attributable to driver fatigue. A direct approach to gauge driver fatigue involves assessing their level of drowsiness. Hence, detecting driver drowsiness assumes paramount importance in safeguarding lives and property. The focus of this project lies in crafting a prototype for a drowsiness detection system. Operating in real-time, this system continuously captures images and evaluates the state of the driver's eyes based on a predefined algorithm, issuing alerts when necessary.

Numerous accidents stem from driver drowsiness, emerging as a critical factor in contemporary roadway incidents. Current statistics underscore the prevalence of drowsiness-induced accidents, resulting in numerous fatalities. Over 30% of accidents are attributed to drowsiness, necessitating the development of a proactive system capable of detecting and notifying drivers of impending drowsiness, thereby saving lives.

This project introduces a methodology for driver drowsiness detection wherein the driver's vigilance is continuously monitored via webcam. Employing image processing techniques, the system primarily focuses on the driver's face and eyes. It extracts facial features and discerns eye blinking patterns, crucial indicators of drowsiness. This proposed system serves the dual purpose of enhancing driver and road safety. Initially, the webcam captures the driver's facial image, followed by face detection to pinpoint the eye regions, which serve as templates for subsequent eye tracking. Additionally, an ultrasonic sensor is utilized to detect nearby objects, enhancing the system's efficacy. The tracked eye images are then analyzed to detect drowsiness, triggering warning alarms when necessary.

KEYWORDS: Python, Webcam, Haar-cascade frontal face, Drowsiness Detection, Distraction, Eye detection, Eye Tracking, Face Detection, Object Detection.

I. INTRODUCTION

Transportation is a great invention that allows human beings to explore the other places for a long-range distance. In this contemporary era, traffic is a basic need for every human being and the number of transportations on the road is increasing obviously year by year. This situation causes a traffic jam which leads to the time of travel become longer. This may cause the driver feel drowsiness during the long term of traveling time. Drowsy driving is one among the key causes behind fatal road accidents. one among the recent study shows that one out of 5 road accidents are caused by drowsy driving which is roughly around 21 percent of road accidents, and this percentage is increasing each year as per global status report on road safety 2015, supported the information from 180 different countries. This certainly highlights the very fact that across the planet the whole numbers of road traffic deaths are very high because of driver's drowsiness. Driver fatigue, drink-and-drive and carelessness are coming forward as major reasons behind such road accidents. Many lives and families have gotten affected because of this across various countries. All this led to the event of Intelligent Driver Assistance Systems time drowsy driving detection is one in every of the most effective possible major that may be implemented to help drivers to create them awake to drowsy driving conditions. Such driver behavioral state detection system can help in catching the motive force drowsy conditions early and might possibly avoid mishaps. Heavy traffic, increasing automotive population, adverse driving conditions, tight commute time requirements and also the work loads are few major reasons behind such fatigue.

II. LITERATURE REVIEW

Several studies in a variety of ways have been done on Driver Drowsiness detection system. In [1] authors propose It uses machine learning techniques to predict driver states and emotions, providing information that improves road safety. This paper focuses on developing a contactless system that can detect drowsiness and warn in a timely manner. The system monitors the driver's eyes with a camera. Algorithms can be developed to detect early signs of driver fatigue and avoid accidents. When signs of fatigue are detected, the seatbelt sounds and vibrates to alert the driver. Warnings are disabled manually, not automatically. This paper uses an algorithm that is faster than PERCLOS. The system detects driver fatigue by processing the eye area. After capturing an image, the first stage of processing is facial recognition. when you blink. Tian et Qin [2] build a system that checks the driver eye states. Your system uses the Cb and Cr components of the YCbCr color space. The system finds faces with the vertical projection function and eyes with the horizontal projection function. Once the eye locations are identified, the system uses the complexity function to compute the eye state. Hong et al. [4] Define a system that detects real-time eye conditions to identify driver drowsiness. Face region recognition is based on the optimized method of Jones and Viola [5]. The eye area is obtained by horizontal projection. Finally, a new complexity function with dynamic thresholds for identifying eye conditions. Authors [10] propose a system that uses video images to detect driver fatigue, called DriCare. B. Yawning, blinking, and time with eyes closed without the device on the body. Due to the shortcomings of the previous algorithms, we introduce a new face tracking algorithm to improve the tracking accuracy. Furthermore, they developed a new face region detection method based on 68 key points. These face regions are then used to assess the driver's condition. By combining eye and mouth functions, DriCare can issue fatigue warnings to drivers. Experimental results showed that DriCare achieved an accuracy of about 92%.

III. AIM & OBJECTIVES

The overarching aim of the project is to develop a robust prototype for a drowsiness detection system aimed at enhancing driver and road safety. This system is designed to address the pressing issue of driver fatigue, which significantly contributes to vehicular accidents worldwide. The primary objective is to implement a real-time monitoring system that continuously captures images of the driver's face and evaluates their level of drowsiness using advanced image processing techniques. By focusing on facial features, particularly the eyes, the system aims to accurately detect signs of drowsiness, such as eye blinking patterns. Furthermore, the project aims to integrate additional sensors, such as ultrasonic sensors, to enhance the system's ability to detect potential hazards on the road. Ultimately, the project seeks to provide a proactive solution to mitigate the risks associated with driver fatigue by issuing timely alerts to drivers, thereby preventing accidents and saving lives.

IV. METHODOLOGY

Image Processing: Face and eye detection is a very vital and challenging issue in the field of image processing. It is also a crucial step in the recognition of the face. Open Source Computer Vision Library (Open CV) is used for the implementation of the Haar Cascade Classifier. In this project, the driver's sleepiness detection requires a video sensor to detect the eyes of the drivers. The driver's drowsiness level can be further determined by checking the eye blink rate. The methods used to detect face and eye, including eye blinks using the Haar Cascade Classifier and the Eye Aspect Ratio, respectively. Four key steps must be carried out in the Haar Cascade Classifier. The steps are Haar Feature, Integral Image, AdaBoost and Cascade Classifier. Besides Eye Aspect Ratio is used to measure eye blinks (open and close eyes) using a ratio formula based on both the width and height of the eyes.

Haar Cascade Classifier : The Haar Cascade Classifier is one of the few object recognition methods capable of detecting faces. It offers high-speed computing depending on the number of pixels within the rectangle and not depending on the pixel value of the image. This method has four steps to detect an object, namely a Haar-like feature, an Integral Image, AdaBoost Learning and a Cascade Classifier [24]. Haar characteristics are the core component of the Haar Cascade Classifier for facial detection. The presence of a feature in the given image can be detected using Haar feature. Each feature results in a single value determined by the aggregate of the pixels under the black rectangle. The Haar-like feature is a rectangular feature that provides a specific indication of the image for rapid face detection [25] In order to obtain the object detection value, the Haar-like feature value was calculated using an integral image. It starts scanning the image to detect the face from the top left corner and ends the process of face detection at the bottom right of the image to detect the face from the image. Integral image could measure values accurately and instantly by generating a new image presentation using the region value previously scanned with specific Haar-like features. The value at any point (x, y) is the summed table of the aggregate of all the pixels above and the left of (x, y) inclusive.

Eyes Aspect ratio : Drowsiness detection system is dominantly requiring detection of eye blink movement. The recorded blink detection through computer webcam can be done by calculating EAR using OPENCV platform and Dlib prediction, also known as Dlib pre trained Neural networkbased prediction. The EAR can be calculated based on the eye coordinates returned from OPENCV using the EAR formula.

V. PROPOSED SYSTEM

ALGORITHM :

1. Haar Cascade Frontal Face:

Haar like features are complete set of 2-D Haar functions. These Haar functions are used to encode a specific object in given image. Haar functions consist of two or more rectangular regions, which are enclosed in a template. Haar features are used to detect human frontal faces in digital photographs and to detect cardiac structures from magnetic response imaging (MRI). Haar features give more accurate and faster response than other object detectors. The result of Haar feature function consists of K rectangles. The main advantage of Haar features is that, it provides a very attractive trade-off between accuracy and evaluation's speed. Haar features are differing according to the template, by no of rectangles and orientation of the rectangles. The Haar features are mainly Edge features, Line features and Center-surround feature. Haar-like features are digital image features used in object detection. Or we can say that these are rectangle shaped dark and light areas having similar kind of features like our face. So basically we move those features throughout our face to find the output of each feature.

For example:

All faces share some similar properties

1. The eyes region is darker than the upper-cheeks.
2. The nose bridge region is brighter than the eyes.

So this features of face are used for developing haar like features.

Each feature is related to a special location in the face.

Output of Rectangle features:

We will move the related kind of rectangle throughout the face to get different values.

1. Value = Σ (pixels in black area) - Σ (pixels in white area).
2. Three types: two-, three-, four-rectangles, Viola and Jones used two-rectangle features.

Haar-Cascade algorithm:

Step 1: Load the required XML classifiers

Step 2: Load our input video in grayscale mode

Step 3: Find the faces in the image. If faces are found, it returns the positions of detected faces as Rect (x,y,w,h)

Step 4: Get the locations and create a ROI (Region of interest) for the face and apply eye detection on this ROI

Step 5: End

2. Face landmark shake predictor

Facial landmark prediction (FLP) algorithm:

Every Human Face has 68 distinct points on his face. The position on each of these 68 facial points is stored in a matrix. So, with the help of this algorithm, the positions of both left eye and right eye can be obtained.

VI. MATERIALS

Figure 1 displays the basic block diagram for driver drowsiness detection based on image processing. It consists of three key stages, i.e. input, process and output. The key idea of this system is to conduct real-time video monitoring on the driver's face from a camera and is able to accurately measure the level of driver drowsiness. The input stage includes a Raspberry Pi camera sensor to take a video of the eyes and the face of the drivers. The process stage includes Raspberry Pi 3 software using Open CV and Python for image processing using Haar Cascade and Eye Aspect Ratio algorithms. Output is the identification of drowsiness and buzzer rings as a way to warn the driver. Also, alert is send to the driver's acquaintances through SMS and email. The location of the Pi camera in the vehicle is on the dashboard in front of the steering wheel. The driver will not be disturbed as the prototype in a small size.

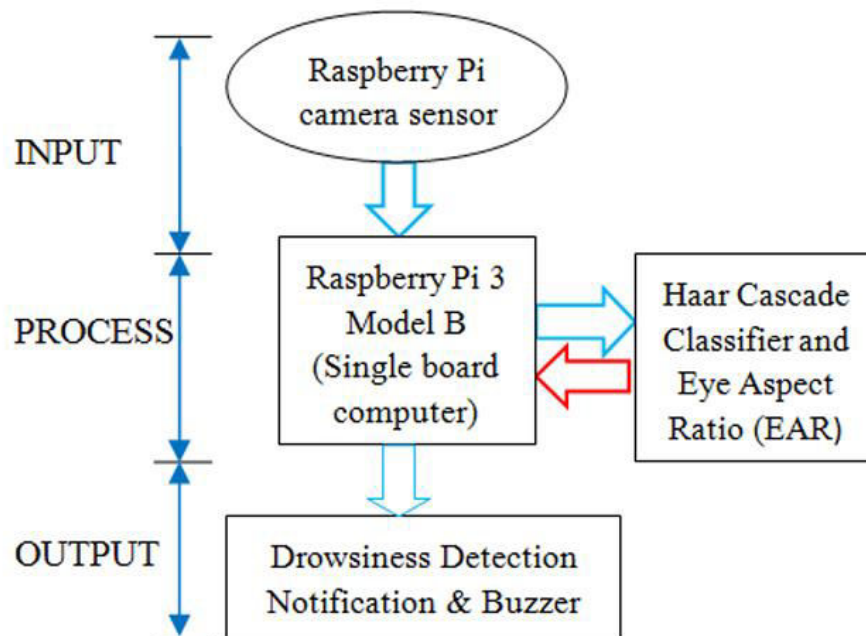


Fig: 1 Block Daigram of the device implemented

HARDWARE APPARATUS :

The key tools for designing prototype-based image processing are the Raspberry Pi 3 Model B and the Raspberry Pi 8 Mega Pixel camera sensor. Figure 2 shows the Raspberry Pi 3 Model B, built by the Raspberry Pi Foundation. Although retaining the common board style, the Raspberry Pi 3 Model B brings a more powerful processor that is 10 times faster than that of the Raspberry Pi first generation. It is also fitted with wireless LAN and Bluetooth networking, making it the perfect solution for strong wired designs.

It is capable of capturing 3280 x 2464 pixel images and support 1080p30, 720p60 and 640x480p60/90 videos. Its small size and light (with a weight of just over 3 g) make it suitable for portable applications. It can be connected to the Raspberry Pi via a short ribbon cable.



Fig: 2 Raspberry Pi 3

The Raspbian Operating System is a free, Debian-based operating system optimized for Raspberry Pi hardware. It includes a collection of simple programs and utilities running the Raspberry Pi. Python is a programming language that can be used to develop a computer program for Raspberry Pi when IDLE is an application that generates and runs Python programs. Python IDLE software with Open CV computer vision extensions is used to code the Haar Cascade and EAR algorithms. In order to start the execution of the program, the following libraries, such as NumPy, Open CV, and pi camera, need to be installed. The Open CV is released under a BSD license and is free for academic and commercial use. It has C, C++, Python and Java interfaces, and it supports Windows, Linux, Mac OS, IOS and Android. It is designed for computational efficiency and has a strong focus on real- applications. It is an open-source computer vision project that aims to provide a platform for the development of computer vision algorithms with a collection of libraries and applications. It provides I / O libraries for easy acquisition and manipulation of video data from multiple camera inputs

VII. RESULT

Results and analysis are provided in this segment. The key results of the Haar Cascade algorithm and the EAR formula are analysed on the basis of the various experimental studies. The EAR was determined on the basis of the equation (4) for each consecutive video frame and the EAR threshold was set in the code. The numerator of this equation calculates the distance between vertical eye landmarks while the denominator calculates the distance between horizontal eye landmarks. The EAR values for both eyes were then determined and the average EAR values for both eyes were shown on the screen. As described above, when eyes closed, the EAR result would be approximately 0 while, when eyes open, the EAR is always any number that is greater than 0. Figure 11 demonstrates the real-time measurement of the EAR during open and closed eyes. It is also seen that the EAR value appeared on the screen as seen in Figure which was 0.268 when the eyes opened (not drowsy). Meanwhile, the EAR value was small (0.127) when the eyes closed (indicate sleepiness). The notification of drowsiness warnings is also shown in Figure.



Fig: 3 Normal Face

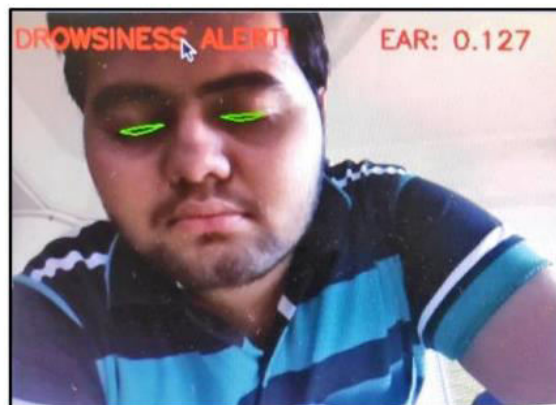


Fig: 4 Drowsiness Detected

Example in real time EAR calculation during (a) eyes opened (EAR=0.268) and (b) eyes closed (EAR=0.127). A notification of drowsiness detection was popped out in the screen during eyes closed.

VIII. CONCLUSION

In conclusion, all the objectives set at the beginning of the project have been successfully achieved. The development of image processing tasks based on Haar Cascade Classifier and Eye Aspect Ratio (EAR) algorithms on Raspberry Pi to predict sleepiness has been successfully developed and executed throughout this project. This project was conducted to propose a hardware platform prototype using the Raspberry Pi 3 Model B and the Raspberry camera sensor to operate image processing to detect driver drowsiness. These two main algorithms have been coded using Open CV and Python. In order to evaluate the performance of the Haar Cascade Classifier algorithm, five subjects were selected to perform a set of specific experiments. It pointed out that the Haar Cascade classifier was unable to find the face and eyes while the subjects shifted or wore glasses and shades. As for eye blink detection; the resultant EAR value was approximately 0.269 when the eyes opened, whereas when the eyes closed, the EAR was 0.119. Although it was not possible to obtain zero average EAR value, the sudden drop in average EAR indicates that the driver was in a state of sleepiness. As a mechanism to alert the driver, the warning message of drowsiness appeared on the screen, and the buzzer immediately rang in less than 1 second after the eyes had been closed. The device was able to send SMS and email to another subject after the driver's somnolence was identified.

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