Driver's Drowsiness Alert System

Mitesh Chopra[1], Atharva Chavan[2], Ayush Tanwar[3], Prof. Odilia Gonsalves[4]

[1,2,3]*Student, Department of Information and Technology, Atharva College of Engineering, Mumbai, Maharashtra, India.*
[4]*Professor, Department of Information and Technology, Atharva College of Engineering, Mumbai, Maharashtra, India.*

---***---

Abstract – *A standard camera is used where real time sequence of frames are captured and by algorithms and mathematical formulas it is detected if the driver is yawning or actually sleeping. Facial expressions like the eyes and the mouth are captured through image processing techniques and a threshold value is obtained with the help of Eye aspect ratio (EAR). This threshold value tells us whether the driver is sleeping and he needs to be warned with continuous beeps so the driver is alerted followed by an automatic e-mail send in the form on an alert message to the concerned team or to his loved ones to further call the driver to wake him up preventing any fatal mishaps or loss to human life and also avoiding collision with any other stationary objects.*

***Key Words*: Image Processing, Facial Expressions, Eye Aspect Ratio, Automatic e-mail**

1. INTRODUCTION

No matter how fast the new sophisticated technologies are emerging day by day we cannot ignore the fact that human are not actually machines and rely on the few fundamentals and principles of life like eat good food , drink plenty of water and most important is adequate sleep which many of us ignore these days due to hectic lifestyles and busy routines .Various studies show that a healthy human body requires a sleep of about 7-9 hours per night, failing to which causes concentration problems
, risk of heart diseases , high blood pressure, hormone imbalance , weight gain and memory loss . Along with it fatigue and drowsiness of the driver are the main causes of vehicle accidents now a days because of lack of sleep.

About 40% of highway accidents are caused by drivers who fall asleep while driving vehicles says a study by Central Road Research Institute (CRRI) on the 300km Agra-Lucknow Expressway. An alert-based system is made here which beeps continuously when the driver tends to sleeps or actually sleeps while he is driving the vehicle on a regular day by extracting those useful facial landmarks like the eyes and the mouth from the whole face to detect closed eyes with yawn value also followed by an immediate e-mail send to the team or to the driver's operator subsequently to either escalate the issue with his management or call him directly for accident warnings. So, other vehicles and people on the road are safe along with the driver himself with such a system. Other additional feature which are included are real time screen recorder to obtain CCTV like footage to keep track on the activities of the driver, radio for entertainment purpose and emergency options such as nearest fuel station, nearest automobile repair center etc.

Problem Statement

There are thousands of unfortunate deaths that occur in our country due to the fatigue and drowsiness of the driver. The main drawback of such existing system is that they are limited to foreign and other developed countries in luxurious vehicles and not budget cars or trucks where majority of such dreadful mishaps happen. Our proposed system is simple and relatively cheap. It can be easily adopted and installed in the vehicles by transport agencies or even in the low-end budget cars for personal safety. Automatic e-mail alert messages give an edge as your operator or loved ones can call you as a warning being notified by the e-mail instantly.

2. LITERATURE REVIEW

In this paper, author Maninder Kahlon and Subramaniam Ganesan have used driver drowsiness detection algorithm to determine the state of eyes of the driver, and depending upon that drowsiness is detected [1]. The live image was captured with a camera and then processed with the help of image processing tools. Viola-Jones algorithm has been used to detect facial part like eyes from the image. The image gets converted from RGB to Grayscale and then, to a binary image. With the help of a median filter, noise is reduced. The drowsiness is detected based on the black to white pixel's ratio and comparison with the threshold value. The system takes two or three consecutive states of eyes to give an accurate result. The system gives a warning when drowsiness is detected or the driver is not looking straight.

In this paper, Melissa and other co-authors have mentioned different reasons for drowsiness and factors causing it. As drowsiness is one of the reasons that cause accidents. The system is developed to detect the drowsiness of the driver [4]. The drowsiness can be detected by the level of distraction, blinking and yawns. The camera has a range for capturing the area, therefore, the face outside the range is difficult to detect. In this case, blinking and the shape of the eyes are taken into consideration for having efficiency in the system. The frequency of blinking is determined by the number of times eyes are closed at a particular time. For the shape of eyes, PERCLOS is used to decide the percentage of eyelids closed. The camera captures the image, then the region of interest is acquired. The image is processed to detect drowsiness. If drowsiness is detected alarm is ringed for alerting the driver.

The author Amit Chakraborty has given a tutorial for image processing and image pattern recognition [5]. There are different methods for image recognition but the sequence remains the same which involves image processing, development of a classifier algorithm, training, testing and deployment. It also consists of image processing techniques such as thresholding, contouring and template matching. They are important factors during the programming of the system. Steps involved in image pre-processing are binarization, changing color spaces, geometric transformation, smoothing, edge detection, morphological transformation. Tesseract, image segmentation, hough transforms, contour detection are required for character recognition. Post-processing includes validating, exception handling, etc. For object recognition, TensorFlow and OpenCV are used.

In this paper, Guan Zhiwei and other co-authors have worked on the trajectory tracking controller using the Model Predictive Control algorithm [7]. The model predictive control has three important steps which are predictive model, moving optimization and feedback correction. CarSim software is used for vehicle model building, simulation condition setting and external interface setting. Simulink software is used for the simulation model of the controller. Simulation is verified by a trajectory tracking controller on a given trajectory. The simulation results demonstrate that the trajectory controller based on the model predictive control can track the vehicle route fast and steadily. The controller can be used in the vehicle to improve the safety and reliability of driving.

In this paper, Anmol and other co-authors have developed the system for face recognition, emotion recognition and drowsiness detection. For face recognition, K Nearest Neighbor (KNN) algorithm is used whereas for emotion recognition Convolutional Neural Network (CNN) based on Facial Expression Recognition System (FER) is used [2]. The drowsiness is detected by an algorithm with the help of blinking of eyes. In face detection, the system captures the image and then take the name as input to create a dataset. After that, the system is trained to detect the face and name. The system with the help of the KNN algorithm detects the face and displays the name. For emotion recognition, the system captures the face in window size and then with the help of a database labels the emotion. The drowsiness is detected with the help of computer vision. The face is detected then the morphology and image enhancement process are applied. The facial landmark precisely detects the measure of the eye- opening. The eye aspect ratio's threshold is used for drowsiness detection.

3. DESIGN METHODOLOGY

The system which is implemented will only require a camera and a decent computing system for it to work. As the eye blinking rate of human is very fast (approximately 30-400ms) a relatively good camera is required to capture the eyes and the face of the driver. The software that the system is based on is Python, which is an open-source free programming language means it will be cheap and can be easily modified and upgraded at any time with libraries available. The program detects drowsiness in real-time which saves time and energy during processing. The working of the system can be divided into two parts: A) Facial feature detection in which the program will detect eyes and mouth of the driver using a camera and B) Drowsiness detection using Eye Aspect Ratio and the integral difference of the mouth landmarks.

3.1 Facial features detection

The OpenCV is one of the most important libraries in the Image Processing domain and we have made the best use of it. We have used the state-of-the-art Facial Landmark feature of OpenCV to detect the face of the driver. The pre- trained facial landmark feature which is in the dlib library of OpenCV will plot a 68(x, y) points on the face of any given input image. The landmark marks eyes, nose, mouth and jaw with those 68 points. We are going to use the points of Left Eye, Right Eye and Mouth (Upper Lips and Lower Lips) to detect the driver's fatigue. The landmarks of those features are 37-42, 42-48 and 49-68 respectively.

The camera which will record the face must be place at front of the driver for more accurate results. The camera should be able to record at a minimum 30 frames per second at 720p HD resolution for best optimal results. Once everything is in place, the program takes input frames and starts plotting the landmarks points of eyes and mouth consecutively.

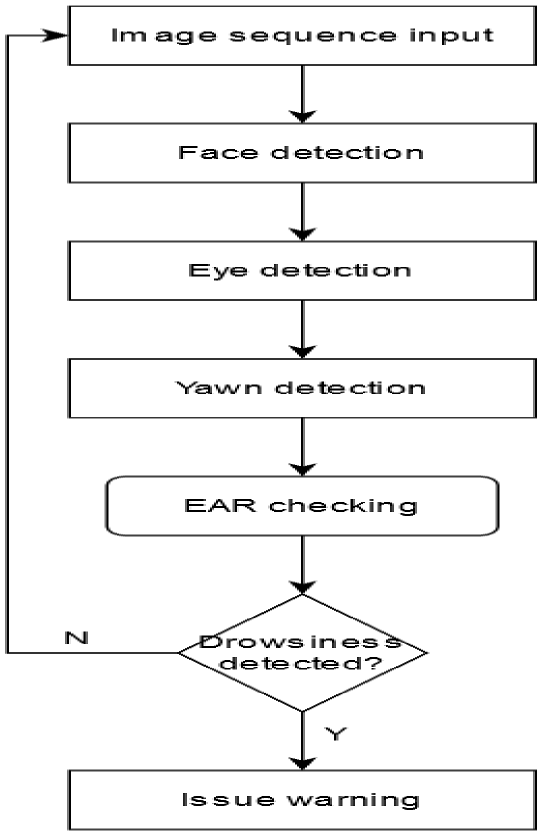

Fig 1: System Flowchart

3.2 Drowsiness detection

3.2.1 Eye Aspect Ratio (EAR)

The plotted frame will be used to calculate the drowsiness of the driver using 2 mathematical equations, Eye Aspect Ratio and sum difference between the lips of the mouth. The EAR was derived by Tereza Soukupova and Jan Cech in 2016 [6]. The EAR is calculated using this equation:

$$EAR = \frac{||p2 - p6|| + ||p3 - p5||}{2||p1 - p4||}$$

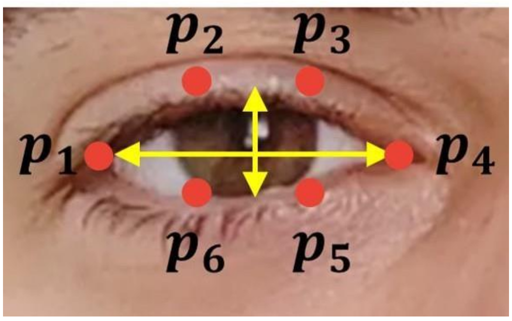

Fig 2: Eye Landmarks

Where *p1…p6* are eye landmark locations marked on the input video frame. The EAR value is constant when the eye is open but falls down to zero if the eye is closed. So, if we have a pre-determined threshold of the EAR, we can compare the calculated EAR over a small period of time to find out if the driver's eyes are closed or not.

The EAR will be calculated for both Left and Right eyes. Once both eyes EAR is calculated we will take the average of both and compare it with the pre-determined threshold. If the EAR is less than the threshold for over 30 frames the alarm will ring to alert the driver.

3.2.2 Yawn Detection

The eyes are not the only factor that shows the drowsiness state of the driver. When the driver is getting sleepy, he/she will usually yawn. We can use that action to determine whether the driver is getting drowsy or not. It also adds an extra factor in increasing the accuracy of the system to detect the fatigue.

The landmark feature also plots the mouth with points 49-68. Those points are divided into 2 parts: Upper Lip and Lower Lip. Since the landmark points are arrays, we have to use the numpy library to calculate the mathematical functions that we require. The Upper Lip is formed by points 50-53 and 61-64. The Lower Lip is formed by 56-59 and 65-68. The idea here to figure out driver fatigue is to calculate the difference between Upper Lip and Lower Lip an in order for us to do that we need to have two single line arrays of both Upper Lip and Lower Lip. So we will use *np.concatenate* on 61-64 with respect to arrays 50-53. We will do the same for arrays 65-68 with respect to 56-59. The command *np.concatenate* connects the arrays into 1 single array. Once it is done, we will calculate the difference of both Upper Lip and Lower Lip using *np.mean* with *axis=0.* After that we will calculate the distance between the two with simple algebra. To check for drowsiness, we will compare the final calculated result with the pre-determined threshold. If the calculated yawn is higher than that of the threshold it means the driver is yawning and he/she is getting more drowsier, the alarm will be ring to alert the driver of the same.

4. RESULT OF IMPLEMENTATION

The system was built and implemented on Python 3.6.4. The testing was done on dynamic images for real-time facial recognition. An in-built HD camera was used to detect the faces. Following are the snapshots of the working system detecting the faces and drowsiness.

4.1 Facial feature detection

Once the camera is started the landmark feature detects the eyes and mouth and marks the points on it. The output number of the calculated EAR and YAWN is shown on the screen.

Fig 3: Real-time detection of Eyes and Mouth

Once the eyes are closed and the calculated EAR drops below the EAR_THRESHOLD, the driver is alerted through a beep alarm and on-screen message along with an email on his registered email address.

4.2 Drowsiness detection

Following are the snapshots of drowsiness detection.

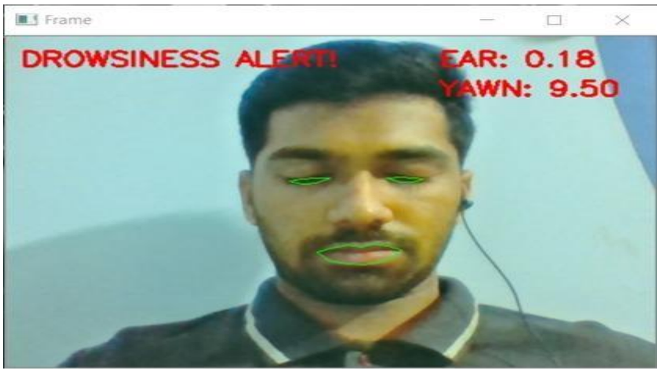

Fig 4: Real-time Drowsiness detection

Fig 5: Real-time Yawn detection

The yawning is detected when the driver opens its mouth wide due to which the calculated YAWN is greater than the YAWN_THRESHOLD so the driver is alerted through a beep alarm and an e-mail.

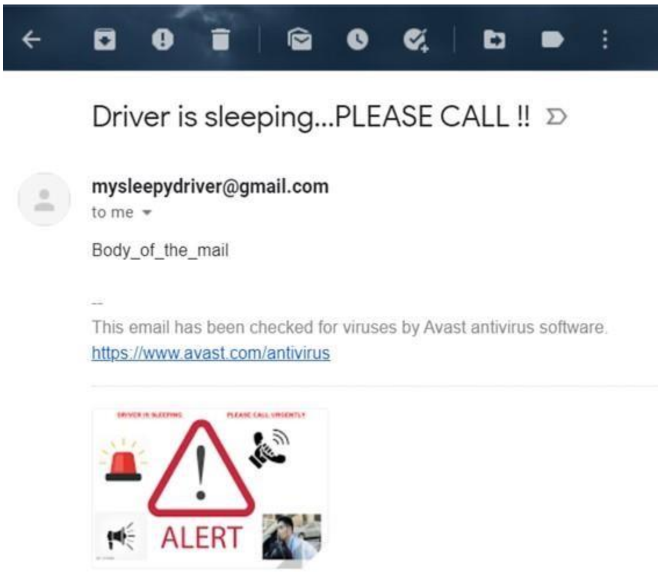

Fig 6: Automatic e-mail received after sleep detection

GUI of the system

Fig 7: Graphical User Interface

5. CONCLUSION

The drowsiness system takes live image from the camera to detect the difference between the open and closed eyes of the driver has been successfully implemented. To detect the drowsiness, facial landmarks are used to extract eye landmarks and then verified using EAR thresholds. If EAR<EAR_THRESHOLD, it is an indication that driver is drowsy and then the system gives warning signal to driver. The system is able to detect state of eyes with or without glasses on. It also uses an additional factor of Yawning along with EAR to detect the drowsiness more accurately.
The proposed system can successfully detect fatigue and alert the driver as accurately as possible. The system that we have implemented is more advanced and cost effective than the existing ones as we have taken more than one factor into consideration for detecting driver's fatigue.

ACKNOWLEDGEMENT

We express our deep gratitude to **Prof. Odilia Gonsalves**, our project guide for her exemplary guidance, monitoring and constant encouragement to push us beyond our limits throughout the course of this project. We would like to thank her for providing idealistic solutions and give fresh dimensions to the completion of this project. Regular virtual meetings and doubt solving sessions made it easy for us. We are overwhelmed to offer our gratitude to Head of the Information Technology department **Prof. Deepali Maste** for her moral support which motivated us throughout the hardships to complete the project on time in this pandemic. Special thanks to the principle of Atharva College of Engineering **Prof. Shrikant Kallurkar** and the entire administrative staff to provide us with well-furnished libraries along with necessary reference papers. Well-equipped IT labs and other infrastructure provided us with a perfect environment to deliver the best of us.

REFERENCES

[1] Maninder Kahlon and Subramaniam Ganesan, "Driver Drowsiness Detection System Based on Binary Eyes Image Data" IEEE, 2018.

[2] Anmol Uppal, Shweta Tyagi, Rishi Kumar, Seema Sharma, "Emotion recognition and Drowsiness detection using Python," IEEE, 2019.

[3] M. Sugur, B. Hemadri and P. Kulkarni, "Drowsiness Detection Based On Eye Shape Measurement," International Journal of Computer and Electronics Research, vol 2(2), 2013.

[4] Melisaa Yauri Maccha, Brian Menesis-Claudia, Natalia Vargas-Cuentas, Avid Roman-Gonzalez, "Design of a Driver Drowsiness Detection System Through Image Processing using MATLAB," IEEE, 2018.

[5] Amit Chakraborty, "Image Processing and Image Pattern Recognition", IEEE, 2018.

[6] Tereza Soukpov'a and Jan Cech. "Real-Time Eye Blink Detection using Facial Landmarks." 21st Computer Vision Winter Workshop Luka Cehovin, Rok Mandeljc, Vitomir Struc (eds.) Rimske Toplice, Slovenia, February 3-5, 2016.

[7] Guan Zhiwei, Ding Jianfeng, Du Feng, "Simulation Research on Trajectory Tracking Controller Based on MPC algorithm," IEEE, 2017.

[8] OpenCV. Open Source Computer Vision Library Reference Manual, 2001.

[9] B. Bhowmick and C. Kumar, "Detection and Classification of Eye State in IR Camera for Driver Drowsiness Identification", in Proceeding of the IEEE International Conference on Signal and Image Processing Applications, 2009.

[10] Z. Tian et H. Qin, "Real-time Driver's Eye State Detection", in Proceedings of the IEEE International Conference on Vehicular Electronics and Safety, October 2005.

[11] Belhassen Akrout and Walid Mahdi, "Yawning detection by the analysis of variational descriptor for monitoring driver drowsiness", International Image Processing, Applications and Systems (IPAS), 5-7 Nov. 2016.