Driver Fatigue And Alcohol Detection, Alert And Notification System Using Image Processing And Machine Learning

Dr. S. B. Pokle, Anusha Vidyabhanu, Sharvari Saxena

Professor, Student, Student
Department of Electronics and Communication
Ramdeobaba University, Nagpur, India
poklesb@rknec.edu, vidyabhanuaa@rknec.edu, saxenasr@rknec.edu

***Abstract*—Experts say that drivers who do not take regular rests when traveling long distances face a greater danger of feeling sleepy, a condition they frequently fail to identify in time. This behaviour significantly contributes to an increase in deaths and injuries globally. Additionally, many accidents result from cases of drunk driving, where drivers lose consciousness due to alcohol consumption, leading to fatal accidents. In this research, we offer a system that is intended to determine whether the driver is affected by alcohol. If the system detects alcohol consumption, it promptly sends a notification to the registered mobile number. Furthermore, the system utilises a webcam to collect real-time data, enabling it to detect whether the driver is drowsy or not. In the event of drowsiness, the system alerts the driver and sends a notification to the registered mobile number, thereby reducing the possibilities of accidents and enhancing road safety. This system sends notifications via the internet thus decreasing the hardware of the system. Here two features, Alcohol detection and Drowsiness detection are integrated in one single system design.**

***Index Terms*—Facial landmarks, drowsiness, Eye aspect ratio (EAR), alcohol detection, driver safety, alert system**

I. Introduction

India has been witnessing a disturbingly high rate of road accidents. According to the data available until 2023, the country had one of the highest numbers of road accident fatalities globally. As per the MORTH (Ministry of Road Transport and Highways), in 2020, despite the COVID-19 pandemic and subsequent lockdowns, India witnessed approximately 4.4 lakh road accidents, resulting in over 1.5 lakh fatalities. The causes of these accidents were varied and included factors such as over-speeding, drunk driving, lack of adherence to traffic regulations. Additionally, incidents of driver fatigue and drowsiness have also been cited as contributing factors to road accidents These accidents not only lead to loss of life but also cause severe injuries and property damage[5][9].

In recent years, research on the fatigue-driving-detection system has grown in prominence. The two categories of detecting procedures are subjective and objective detection. A driver must take part in the evaluation process in the subjective detection method. This evaluation process involves self-questioning, evaluation, and questionnaire completion and is linked to the driver's subjective perceptions. The cars being driven by fatigued drivers are then estimated using this data, enabling the drivers to adjust their schedules. Moreover, there are two types of objective detection first known as non-contact and the other one is contact. When compared to the contact method, the non-contact approach is more affordable and practical due to its lack of reliance on sophisticated cameras or Computer Vision technology, which enables the device to be used in a greater number of cars[10].

We have suggested a non-contact technique for alcohol and sleepiness detection in this work. The device consists of two main parts which includes an MQ-3 sensor for alcohol detection and a camera which collects real-time data for drowsiness detection making it unnecessary for the driver to carry any on/in-body devices. The MQ3 sensor integrated in the system will first check whether the driver has consumed alcohol and will send an alert notification accordingly. Similarly, while driving, the driver's face will be monitored continuously so that the system can alert the driver in case, he feels drowsy. The drowsiness system mainly works on image processing, Facial landmark detection and eye aspect ratio [8][7].

The rest of the paper is structured as follows: Section 2 lists relevant works; Section 3 describes the suggested design and implementation of each system block; Section 4 depicts the system's work flow; Section5 includes outcomes; the final section concludes the paper; and lastly, references.

II. RELATED WORK

The problems with road safety in India and the requirement for sophisticated detection systems have prompted research on alcohol and sleepiness detection. We examine previous research in this field in this section, which sets the stage for our non-contact detection technology.

Jaekwang Oh proposed a method that uses a single eye image to detect landmarks in the eye region to estimate gaze. They show that this strategy can compete with the recently developed appearance-based techniques. Similar to the existing feature-based methods, their approach incorporates iris and eye edges and extracts more landmarks to obtain rich information. Using the HRNet backbone network, they were able to learn representations of images at various resolutions, which allowed them to extract robust features even at low resolutions[1].

In order to identify EEG data for Drowsiness Detection, Adinath Joshi's work uses algorithms and Deep Learning architecture, such as Convolutional Neural Networks (CNNs). The primary metrics of video-based methods involve the identification of physical characteristics; however, their applicability is restricted by issues like brightness restrictions and real-world obstacles like driver focus. The degree of eyelid closure is the primary metric used in video-based techniques; however, practical issues like driver distraction and brightness limitations limit their effectiveness[2].

Garcia's work offers a computer vision-based, non-intrusive method for sleepiness detection. An infrared (IR) camera is mounted in front of the driver in the dashboard to identify his face and gather indicators of sleepiness from the closure of his eyes. Three stages make up the system that is being shown. Preprocessing is the first step, which involves normalization and face and eye detection. In order to enable the system to function under outdoor illumination settings, the second stage carries out the detection and characterization of pupil location and combines it with adaptive lighting filtering. PERCLOS is calculated in the last step using eye closure data[3].

A study by Alshaqaqi et al. addressed driver fatigue, a significant contributing factor to traffic accidents worldwide. They unveiled the Advanced Driver Assistance System (ADAS), which uses artificial intelligence (AI) and visual data to identify tiredness automatically. Their program measures PERCLOS, a known sign of tiredness, by examining the driver's face and eyes[4].

The Nimmy James system offers a special way to stop intoxicated individuals. An alcohol sensor is integrated into the car's steering system. The sensor detects the amount of alcohol in the driver's breath whenever the ignition is turned on, and if the driver is intoxicated, it instantly turns off the automobile. From zero to extremely high concentrations, the sensor in this device provides a current that has a linear connection to the alcohol molecules. The pic microcontroller receives the sensor's output and compares it. The buzzer sounds and the relay cuts off automatically when the measured value crosses the threshold [2][5].

I. Chatterjee et al. proposed a non-invasive method for assessing driver fitness using computer vision techniques. They monitor real-time video from a smartphone camera inside the vehicle to detect drowsiness and impairment by tracking eye blinks, head and body alignment, and generate a severity score. Alarms are triggered for issues, and in serious cases, the smartphone's location is shared with family and authorities [6].

The main goal of Rohith Chinthalachervu's research is the identification of driver drowsiness and an effective response to the finding. The physiological method is one of the techniques that helps keep the driver awake and distracted from his tiredness. A small number of techniques also deal with large amounts of data and costly sensors. As a result, this research creates a system that can accurately and properly identify sleepiness in real time. This device uses a webcam to record and capture the driver's facial expressions. Several image processing algorithms are used to identify every movement in every frame. The landmark points on the face are used to determine the EAR, Mouth Opening Ratio, and Nose Length Ratio[7][11].

III. PROPOSED DESIGN

Now-a-days every car is equipped with Real Time Driver Fatigue Detection, Smart Rescue, and a notification system to alert and save the driver in the event of an accident. In addition, there are projects available for driver alcohol detection to determine whether the driver is drunk before driving [4][5]. But in our system, we have integrated above mentioned two different systems into one i.e. the alcohol detection system as well as the driver fatigue detection system besides this we have also reduced the hardware of the notification subsystem that is used to send alerts so that our overall system becomes compact, reliable and affordable.

The alerting system works on the basis of image processing, with the webcam positioned in front of the driver and continuously streamed live. Afterwards, the face that was spotted is captured for additional processing and analysis to determine whether the driver appeared active, fatigued, or drowsy.

The buzzer will go off to warn the driver of his possibility of becoming sleepy, allowing him to regain consciousness and drive safely. Thus, the possibility of an accident is reduced. In addition, a message is sent to the registered mobile number if driver found fatigued, enabling the recipient to alert the driver by phone.

The alcohol detection system will determine whether or not the driver is drunk. If the driver is drunk, the system will send a message to the registered mobile number, allowing them to prevent any future mishaps.

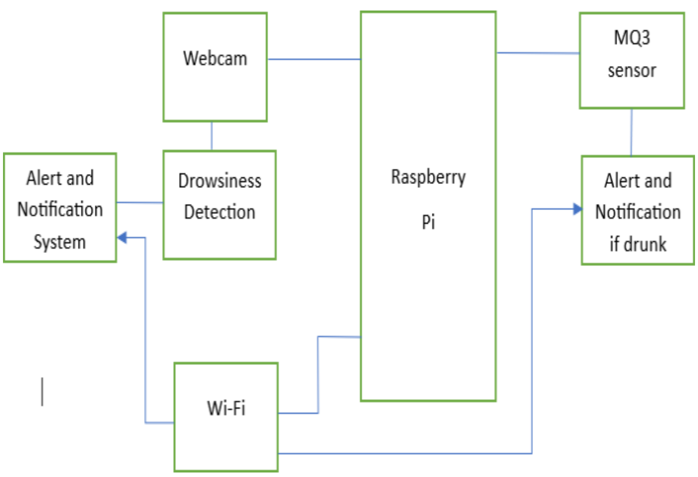


Fig. 1 System Block Diagram

TABLE I. Drowsiness Detection

A webcam captures continuous footage to detect the driver's tiredness. The driver's facial expression is captured during this streaming and is converted to grayscale using image processing and Dlib(library) for frontal face detection, making face detection easier. The identified face is then assigned a numerical value, and the facial landmark system is utilised to identify various elements of the face, such as the eyes, brows, lips, and lower jaw, allowing the eye indices to be sliced to locate the eyeballs. The Eye Aspect Ratio (EAR) is then calculated to detect the state of drowsiness, and a threshold value of frames is utilised to assess whether there is fatigue or blinking. If EAR > 0.20, then driver is active; else if EAR is between 0.15 and 0.20, then the driver is fatigued; else for other values of EAR, driver is sleepy. One can adjust the sensitivity based on their needs.
Formula for calculating EAR is as follows:

$$EAR = (|P2—P6| + |P3—P5|) / 2|P1—P4|$$

Fig. 2 below displays the 68 index facial landmarks assigned to a face, and Fig. 3 displays the eye indices that were obtained by slicing through NumPy arrays.

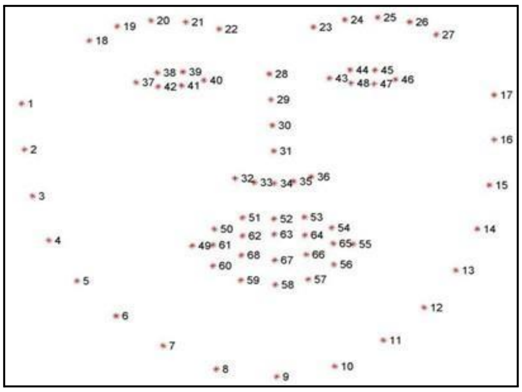


Fig. 2 Facial Landmarks

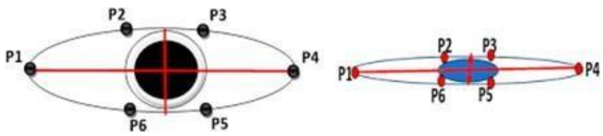


Fig. 3 Eye Indices

TABLE II. Raspberry-Pi 4

The Raspberry Pi 4 is a versatile, credit card-sized computer that is well-known for its small size and powerful features. Compared to its predecessors, The Pi 4 has more processing power and performance due to its quad-core ARM Cortex-A72 processor and up to 8GB of RAM. It is appropriate for a variety of projects thanks to its diverse connectivity choices, which include Bluetooth, Wi-Fi, USB ports, and HDMI. The Raspberry Pi 4 can be a key component of a drowsiness detection project by integrating with sensors such as cameras to track eye patterns and facial movements. The Pi 4 can analyse these inputs to identify indicators of drowsiness in people, using machine learning techniques and image processing to generate alerts that avert accidents. Its compact form factor, computing capabilities, and accessibility make it an ideal platform for such applications, enabling real-time monitoring and timely intervention to ensure safety[12].

Fig. 4 Rpi

TABLE III. Alert Buzzer

A buzzer is a piezoelectric, electromechanical, or mechanical audio signalling device. It is an item meant to warn the person or people. In this paper, it serves as a warning when the driver experiences fatigue or when the driver is drunk.

TABLE IV. MQ-3 Sensor

The MQ-3 sensor is a type of gas sensor, specifically designed to measure the amount of alcohol vapour present in the atmosphere. This sensor is frequently found in automotive, industrial safety, and breathalyser applications. Utilising a tin dioxide (SnO_2) sensitive layer, which alters its electrical conductivity in response to the amount of alcohol in the air, it functions on the basis of a semiconductor sensor. Because of its extreme sensitivity to alcohol, the MQ-3 sensor is a crucial part of systems designed to measure alcohol concentrations. There are four pins in total: ground, digital output, analogue output, and Vcc. It has the ability to produce digital and analogue output. Because Raspberry Pi can only receive digital input.
Dout is the only pin used here for ease. The MQ-3 sensor's VCC pin is connected to the Raspberry Pi's PIN2, or common VCC for accessibility, the Raspberry Pi's PIN15 is connected to the MQ-3 sensor's Dout pin and finally the GND of MQ-3 sensor is connected to Raspberry Pi PIN9.
Features of MQ-3 sensor-

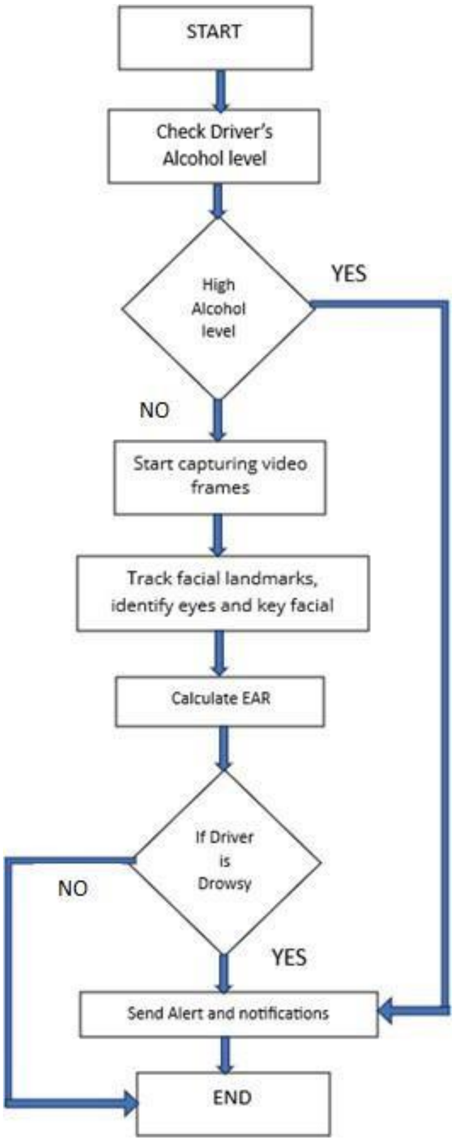
- Highly sensitive to alcohol vapour in the air, making it an efficient tool for alcohol detection.
- Provides analogueand digital output.
- Power Supply: 5 Volts.
- Cheap cost
- Stable
- Long life
- On-board power indication

Fig. 5 MQ-3 sensor

TABLE V. Notification System

The Raspberry Pi's built-in Wi-Fi module greatly expands the features of the drowsiness detection system for drivers. With the help of the internet, the Raspberry Pi can communicate with other devices and networks by sending instant alerts or notifications because of its wireless connectivity feature. If the system determines that the driver is sleepy or drunk, the Raspberry Pi, which has the Wi-Fi module installed, quickly sends alerts to recipients that have been pre-approved, a monitoring station, or a central control hub. These notifications, which can come in the form of emails, SMS messages, or app alerts, notify relevant authorities or worried parties about the drowsiness or drunk condition of the driver in time to allow for timely intervention or other necessary actions to ensure driver safety. The Wi-Fi module plays a critical role in enabling prompt and smooth communication, making sure that the alerts are received by the appropriate parties on time, and thereby making a significant contribution to averting potential accidents caused by sleepy or drunk drivers.

IV. WORKFLOW



A sophisticated safety application, the Raspberry Pi drowsiness and alcohol detection system combines the capabilities of the MQ3 sensor for alcohol detection and image processing for drowsiness detection. The MQ3 sensor, which continuously measures the amount of alcohol vapour in the surrounding air, is where the project workflow starts. The Raspberry Pi initiates the alert system when it detects the presence of alcohol. The Pi notifies designated recipients using other communication modules or Wi-Fi connectivity. The Raspberry Pi then processes and examines the data from the mounted camera. To detect indicators of sleepiness in the subject of observation, the Pi simultaneously records and analyzes facial expressions and eye movements using image processing techniques (EAR) via a linked camera. If drowsiness is recognized through image processing, an alert is generated by the buzzer, and a notification is sent out to monitoring entities, signalling the need for a break or caution. This thorough flow ensures that timely alerts are sent out in emergency situations, greatly improving overall safety and preventing accidents.

V. RESULT

We have developed a real-time drowsiness and alcohol detection system that enhances driver safety by monitoring the driver's face and eyes for signs of drowsiness and also checking for alcohol using an MQ-3 sensor. We establish a seamless connection between the camera, MQ-3 sensor and the Raspberry Pi, enabling video and image capture for analysis.Firstly, our integrated MQ-3 sensor will be used to detect the consumption of alcohol. If the driver has consumed alcohol, then it will send a notification to the intended recipient as shown in Fig. 7.

Fig. 7 Alcohol Notification

We have collected a diverse dataset representing various driver states, used for training and testing our machine learning model. We also extract essential features like facial landmarks and eye movement patterns to improve accuracy.

Our system calculates EAR (eye aspect ratio) and triggers visual and auditory alerts when drowsiness is detected, ensuring real-time driver notification to prevent accidents. Additionally, we design a notification system to alert external devices for prompt communication with relevant stakeholders. We have used the Pushbullet application to send notifications.

If a person's blink analysis indicates prolonged eye closure, the status is set to "SLEEPING", as shown in Fig. 8 and an instant notification is sent to the intended device.When the blink analysis detects occasional drowsiness, the status is set to "Drowsy" and displayed in red. If the person's eyes remain open and active, the status is set to "Active" and displayed as shown in Fig. 9 and Fig. 10.

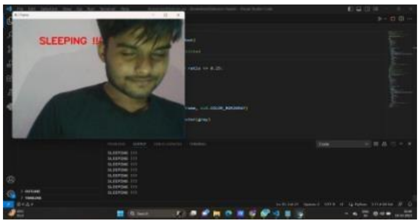


Fig. 8 Sleeping

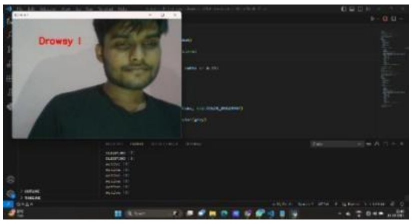


Fig. 9 Drowsy

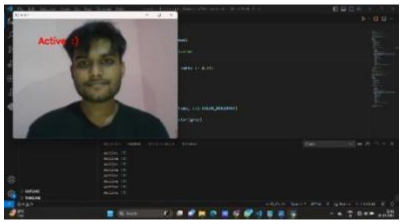


Fig. 10 Active

Fig. 11 Drowsiness Notification

VI. CONCLUSION

The proposed system effectively enhances driver safety by integrating facial and eye monitoring with an MQ-3 sensor. Through machine learning, it accurately identifies drowsiness and alcohol consumption, issuing alerts to prevent accidents. In order to reduce hardware, we opt for sending email notifications instead of using GPS/GSM technology. As a future scope of the project, the system's capabilities could be extended to include stress analysis, thereby offering additional means to mitigate distractions while driving.

References

[1] Oh, J.; Lee, Y.; Yoo, J.; Kwon, S. Improved Feature-Based Gaze Estimation Using Self-Attention Module and Synthetic Eye Images. Sensors 2022, 22, 4026. https://doi.org/10.3390/s22114026

[2] Drowsiness Detection using EEG signals and Machine Learning Algorithms Adinath Joshi, Atharva Kamble, Akanksha Parate, Siddhesh Parkar, Digambar Puri and Chandrakant Gaikwad ITM Web Conf., 44 (2022) 03030 DOI:https://doi.org/10.1051/itmconf/20224403030

[3] Garcia, I. & Bronte, Sebastian & Bergasa, Luis & Almazán, Javier & Yebes, José. (2012). Vision-based drowsiness detector for real driving conditions. IEEE Intelligent Vehicles Symposium, Proceedings. 618-623. 10.1109/IVS.2012.6232222.

[4] B. Alshaqaqi, A. S. Baquhaizel, M. E. Amine Ouis, M. Boumehed, A. Ouamri and M. Keche, "Driver drowsiness detection system," 2013 8th International Workshop on Systems, Signal Processing and their Applications (WoSSPA), Algiers, Algeria, 2013, pp. 151-155, doi: 10.1109/WoSSPA.2013.6602353.

[5] James,Nimmy Jamesmmy, C. Aparna, and Teena P. John. "Alcohol detection system." IJRCCT 3.1 (2014): 059-064.

[6] Chatterjee, Isha and A. Sharma, "Driving Fitness Detection : A Holistic Approach For Prevention ofDrowsy and Drunk Driving using Computer Vision Techniques," 2018 South-Eastern European Design Automation, Computer Engineering, Computer Networks and Society Media Conference (SEEDA_CECNSM), Kastoria, Greece, 2018, pp. 1-6, doi: 10.23919/SEEDA-CECNSM.2018.8544944

[7] Chinthalachervu, Rohith & Teja, Immaneni & Kumar, M. & Harshith, N. & Kumar, T.. (2022). Driver Drowsiness Detection and Monitoring System using Machine Learning. Journal of Physics: Conference Series. 2325. 012057. 10.1088/1742-6596/2325/1/012057.

[8] A. V. Sant, A. S. Naik, A. Sarkar and V. Dixit, "Driver Drowsiness Detection and Alert System: A Solution for Ride-Hailing and Logistics Companies," 2021 IEEE Pune Section International Conference (PuneCon), Pune, India, 2021, pp. 1-5, doi: 10.1109/PuneCon52575.2021.9686546.

[9] Rajasekar .R, Vivek Bharat Pattni, S. Vanangamudi, "Drowsy Driver Sleeping Device and Driver Alert System", International Journal of Science and Research (IJSR), ISSN (Online): 2319-7064

[10] A. Ravi, T. R. Phanigna, Y. Lenina, P. Ramcharan and P. S. Teja, "Real Time Driver Fatigue Detection and Smart Rescue System," 2020 International Conference on Electronics and Sustainable Communication Systems (ICESC), Coimbatore, India, 2020, pp. 434-439, doi: 10.1109/ICESC48915.2020.9156021.

[11] Fouzia, R. Roopalakshmi, J. A. Rathod, A. S. Shetty and K. Supriya, "Driver Drowsiness Detection System Based on Visual Features," 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT), Coimbatore, India, 2018, pp. 1344-1347, doi: 10.1109/ICICCT.2018.8473203.

[12] https://opensource.com/resources/raspberry-pi