Driver Sleep Detection and Alarming System using IoT

Anuruthya S.S, Athulya, Deepika R.M, Tamilarasi K

Department of Electrical and Electronics Engineering, L & T By - Pass, Sri Shakthi Nagar, Post, Sri Shakthi University, Chinniyampalayam, Coimbatore, Tamil Nadu 641062, India

***Abstract*—This journal article presents a comprehensive study on the development and implementation of a Driver Sleep Detection and Alarming System (DSDAS) utilizing Internet of Things (IoT) technology. The system aims to address the critical issue of driver drowsiness, a leading cause of road accidents worldwide. By leveraging IoT devices, such as sensors and actuators, integrated with advanced algorithms, the DSDAS continuously monitors driver fatigue levels and alerts them in real-time, thus preventing potential accidents. This article discusses the system architecture, sensor deployment strategies, algorithm design, and performance evaluation, highlighting the effectiveness and potential impact of such systems in enhancing road safety. Because of its importance, a driver drowsiness detection machine will be a crucial software for device vision and picture processing. We use a Simple code in python to detect Drowsiness and Yawn and alert the user using Dlib. We advise and put into effect a hardware machine based totally on infrared light that can be used to solve those troubles in this project.**

Keywords—IoT (Internet of Things); DSDAS (Driver Sleep Detection and Alarming System); LDR (Light Dependent Resistor); LED (Light-Emitting Diode); GPS (Global Positioning System); Raspberry; Twilio

I. INTRODUCTION

DRIVER FATIGUE IS A SIGNIFICANT FACTOR CONTRIBUTING TO ROAD ACCIDENTS, POSING A SERIOUS THREAT TO PUBLIC SAFETY. TRADITIONAL METHODS OF DETECTING DROWSINESS, SUCH AS VISUAL OBSERVATION AND MANUAL INTERVENTION, HAVE LIMITATIONS IN TERMS OF ACCURACY AND TIMELINESS. THEREFORE, THERE IS A GROWING NEED FOR AUTOMATED SYSTEMS CAPABLE OF MONITORING DRIVER ALERTNESS AND ISSUING TIMELY ALERTS TO PREVENT ACCIDENTS. IN THIS CONTEXT, IOT TECHNOLOGY OFFERS A PROMISING SOLUTION BY ENABLING THE INTEGRATION OF SENSORS, DATA PROCESSING UNITS, AND COMMUNICATION MODULES INTO VEHICLES TO CREATE INTELLIGENT SYSTEMS CAPABLE OF DETECTING AND RESPONDING TO DRIVER DROWSINESS.

Driver fatigue has been the main issue for countless mishaps due to tiredness, tedious road conditions, and unfavorable climate situations. Every year, the National Highway Traffic Safety Administration (NHTSA) and World Health Organisation (WHO) have reported that approximately 1.35 million people die due to vehicle crashes across the world. Generally, road accidents mostly occur due to inadequate way of driving. These situations arise if the driver is addicted to alcohol or in drowsiness. The maximum types of lethal accidents are recognised as a severe factor of tiredness of the driver. When drivers fall asleep, the control over the vehicle is lost. There is a need to design smart or intelligent vehicle systems through advanced technology. This paper implements a mechanism to alert the driver on the condition of drowsiness or daydreaming. A camera monitors the driver's eye blinking, eye closure, face detection, head posture, etc. with a face landmark algorithm and Euclidean distance in the behavioral-based approach. These characteristics help to measure driver fatigue and instantly alert him with the help of voice speakers and forwarding an email to a person (owner of vehicle) who can make him conscious. An email is being transmitted to a destination using an IoT module, which relies on wireless transmission. But, the proposed system is being integrated by a credit card-sized computer known as Raspberry Pi3 and Pi camera which can trace an eye movement thereby monitoring intensity of collision effects that happen at the time of accident and alerting the emergency ward of the hospitals or owners that are nearby to the accident spot along with GPS location of the accident. The car accident is the leading cause of death, killing around 1.3 million people each year. Most of these accidents are caused by driver distraction or drowsiness. Drowsiness decreases the driver's concentration, activity, alertness, and alertness, and causes the driver to make slow decisions and sometimes not make decisions. Drowsiness affects mental alertness and reduces the driver's ability to drive a vehicle safely and increases the risk of human error, which can lead to death and injury. Countless people drive long distances on the road day and night. Lack of sleep or distractions such as talking on the phone, talking to the passenger, etc. can cause an accident. To avoid these accidents, we propose a system that will warn the driver if they are distracted or drowsy. Fig: Drowsy Driver Face and brand recognition is used with the help of image processing of facial images captured by the camera to identify distractions or drowsiness. To solve the problem, we came up with the implemented solution in the form of image processing. Perform image editing. OpenCV and Dlib open source libraries are used. Python is employed as the language to implement the idea. an associate degree infrared camera is used to endlessly track the driving force' facial markings and eye movements. This project mainly focuses on the driver's eye markings. Driver. Eye characteristics are continuously tracked to detect drowsiness. Images are captured by the camera, these images are forwarded to an image processing module that performs face recognition to detect distraction and drowsiness of the driver. sThe following use cases are covered in this project. If the driver's eyes are closed for a limited period of time, the driver is considered drowsy and the corresponding audible alarm is used to warn the driver.

II. Related Work

A. Driver Drowsiness and Monitoring System

Due to the large number of accidents occurring over time, the ability to detect driver's distraction and drowsiness, then alarming them in real time becomes challenging. In order to improve the system development, a few existing systems in the market have been studied and discussed. Majority of the applications are integrated with the single functionalities only. Anti-Sleep Pilot is the dashboard device that will monitor both drivers and their driving condition. It will let the driver know when it's time to take a ten-minute rest and pull over. The device continuously calculates the driver's fatigue level once driving starts and status displayed. Driver alertness is also maintained and measured through occasional reactive tests in which the device must be touched as soon as indicated. If the combination of variables approaches the limit, the visual and audible signals from the Pilot will be activated to the fact that the driver needs to take a break- the system is adaptive to light and sound, so that its monitor and warning automatically change for cabin conditions.

In industry, systems based on near-IR are the most common. The Saab Driver Attention Warning System detects visual inattention and drowsy driving. The system uses two *Corresponding Author. Miniature IR cameras integrated with Smart Eye technology to accurately estimate head pose, gaze, and eyelid status. When a driver's gaze is not located inside the primary attention zone (which covers the central part of the frontal windshield) for a predefined period, an alarm is triggered. When the cameras detect a pattern of long duration eye-lid closures, indicating the potential onset of drowsiness, a series of three warnings is initiated. This can only be canceled when the driver presses a reset button in the fascia. The system is then immediately reactivated. In this paper the author provides facts and figures of road accidents due to driver's drowsiness. Study reveals that in the United States of America near about ten million fatal accidents occur in a year. In order to find safety precautions and road accident prevention, real time driver's drowsiness monitoring must be done. Author claimed 80% correct results of the suggested structure by focusing on the facial expressions of the driver and to propose a lightweight model using an Android application.

The authors used a lightweight Convolutional-Neural-Network model to categorize facial sleepiness patterns of drivers while driving on road. With glasses, the accuracy level ranges between 85% to 88% with and without glasses along with the overall average of 83%. Driver sleepiness is one of the main reasons for road accidents and the number of such accidents can be minimized with the help of driver drowsiness monitoring systems. A lot of research has been done and a variety of alarm models and frameworks were deployed for this purpose including capturing facial and head movements along with yaw frequency. The paper itself is a survey and it presented a comprehensive comparative analysis for the detection of driver sleepiness and preventive measures adopted. The authors reviewed multiple approaches SVM (Support Vector Machine), HMM (Hidden Markov Model) and CNN (Convolutional Neural Networks) along with their positive and negative impacts and limitations associated with each approach to help researchers in finding gaps. They concluded that SVM is comparatively cheap but doesn't work best with large data sets whereas HMM and CNN have less error ratio, but they are costly. The authors presented a detailed comparison between invasive and non-invasive sleepiness detection methods. Invasive method like electrooculogram (by recording eye movements) and non-invasive method like electrocardiogram (by recording heart rhythm and activity) of the driver. The authors used a hybrid approach by combining both EOG and ECG, but this strategy has limitations associated with it as there are many other reasons for change in heart rhythm except for drowsiness only.

The authors proposed a framework to estimate in advance about the number of possible road accidents which could happen according to the road condition by using the random variable function and Taylor's series. The authors described another approach by breaking down the proposed model in four steps. Started by capturing movements of the driver from the real time video after then categorizing different sleep conditions by considering other factors like with putting glasses on or off and movements of mouth, head, and eyes. The authors are using any two conditions to get to know the sleepiness state of the driver. Another research based on measuring heart rhythm to detect driver's sleep state as heart-rate-variability (HRV) has already been used to determine the brain disorder. Therefore, the authors recommend using HRV to detect the sleep state of the driver as change in sleep state changes the involuntary physiological process of the man which directly affects HRV. But again, the reason for change in HRV may not be only the drowsiness as presence of other factors can never be ignored and this becomes the limitation of the suggested approach. Driver's face expressions recorded, and alert sent to the driver when found in drowsy state. It works by extraction of facial expressions and then running an algorithm to check and detect the drowsy position and finally alert sent to the driver to make him/her conscious.

B. Eye Blink Detection Method

For the blink detection, Mandeep and Gagandeep had proposed a method using Mean Shift Algorithm. In this algorithm, eyes are identified in each frame, and each eye blink is compared to a mean value. The system analyzes the eye opening at each blink to a standard mean value, and an alert is generated if the eye opening exceeds this value for a certain number of consecutive frames. Compared to the algorithm in this study, the system does not need to store information from previous frames because eye blinking measurements from a collective number of frames are utilized to assess drowsiness. The algorithm proposed is simple but efficient to detect eye blink. The system monitors the EAR which is the ratio between the height and the width of the eye contour in the real time. This value can represent the level of the eye opening by comparing it to the threshold value.

The research was focused on capturing eye movement with the help of cameras by using CNN which is used to identify real time patterns in images and videos. The eye movement pattern from the video helps in categorizing sleepy or non-sleepy drivers and consequently generates an alarm in order to provide protection from road accidents. The researchers provided more accuracy when compared to conventional CNN but it works with only capturing eye movement and not considering yawning and head movement. This paper covered other factors along with detection of driver's drowsiness by capturing eye-blink. Upon drowsiness detection, the system sends an alarm to make the driver alert. Location monitoring was done by GPS and driver's alcohol, temperature and heat rhythm were measured to monitor health by putting a check on vehicle speed and informing about the current status to other vehicles. The authors advocate smartly monitoring driver drowsiness without conditioning it with other factors like steering-angle, pedal-pressure and electrocardiogram etc. In fact, it used a USB camera to capture video and extract facial traces for sleep pattern monitoring by using iris area and eye closure period. Researchers presented a solution to a challenge normally faced in driver drowsiness detection that is capturing driver's different facial images like frequency of eye-closure and yawning at night or when light is low. To solve this issue, infrared cameras were used to capture facial images with adequate visibility. More than 3000 facial images were used for testing purposes and researcher claims the result was more than 90% accurate for both eye-closure and yawn frequency monitoring in low light.

C. Yawn Detection Method

On the other hand, yawn detection describes a system in which the face is found in a video frame using the Viola-Jones face detection approach. Then, from the face region, a mouth window is generated, and lips are searched using spatial fuzzy c-means (s-FCM) clustering. However, this algorithm has complex classifiers, as a result, it is impractical to install the system inside the vehicle with little processing power, and training on datasets with huge samples is required. Compared to the algorithm in this study, the system utilizes some mouth geometrical characteristics to identify yawning which is detected by the ratio of mouth height and width. The authors used an algorithm to record video and trace facial behavior like yawning, eye-closure period and frequency of eye-blink from that recorded video instead of measuring the functioning of any other device attached with the vehicle to simplify the algorithm. The authors tried to focus on driver drowsiness and to propose such an algorithm which not only detects driver's drowsiness but also finds a safe place nearby to park the vehicle there and inform the transportation authority about the problem to ensure road safety. The authors tried to enhance their previous work related to detect sleepiness with the help of machine learning. They suggested capturing face expressions and position to detect sleepiness of the driver by using a simple algorithm resulting in 88% accuracy with driver wearing no glasses and 85% with driver wearing glasses. The authors also described that their proposed algorithm is more efficient in terms of storage, model-size and complexity than the benchmark-model and is capable of implementing in real time driver's sleep detection vehicle applications.

The authors presented an approach to analyze the magnitude of relation of different facial parts to detect driver drowsiness. These facial parts include movements and changes in eyes, nose, ear, eyebrows, mouth, and face wrinkles. In analyzing the magnitude, relation of all these facial parts, the authors proposed the use of SVM classifier. In this research paper, the authors endorse the fact that use of images for driver's sleepiness detection is one of the main focus of research nowadays. Images of facial expressions and movements can be the best way to detect driver drowsiness and to ensure road safety. The researchers are using four types of CNN based image recognition and classification methods to process data containing yawn frequency along with variable mouth positioning. In this research the authors proposed a model which needs prior training as it works on two main streamlines. One is to reduce light effect from the face images with the help of contrast limited adaptive histogram equalization and second one is to extract maximum information from the eye images using the 3D SE-blocks. The researchers used a 3D-depthwise separable sensing framework instead of 3D image extraction to minimize overall cost. It comes with one limitation that face images may not always be clear as sometimes drivers may wear caps or driver's hairs may cover the face resulting in the poor visibility of extracting sleepiness patterns from driver's facial images. He proposed a framework where the Support Vector Machine algorithm was used to monitor driver sleepiness by extracting facial expressions like eye-blinking frequency for a specific period of time or mouth opening due to yawning from the pictures captured by a built-in camera in the vehicle. This proposed model sends an alert to the driver upon drowsiness detection by using Euclidean-distance function to ceaselessly monitor eyes-mouth space approaching to sleepiness.

Researchers advocated that road accidents can be avoided with driver drowsiness monitoring using MATLAB for image processing. System works on visual concepts by using a camera for face recognition and detection. After that it focuses on eye blink and then information about eyes open/close was extracted by MATLAB using Hough-transform and Viola-Jones algorithms. Eye movement observation was recorded continuously using a camera and the driver was declared sleepy if more than five frames show closed eyes consecutively. It consequently sends an alert to the driver with the help of an alarm. Authors presented a detailed analysis of recently used techniques and algorithms for driver's drowsiness monitoring/detection as drowsiness is one of the main reasons for road accidents and is more harmful than any other technical fault in vehicles. Authors used the analysis approach by dividing the latest drowsiness detection algorithms and techniques into three categories. First one is to analyze the driver's driving style, secondly driver's mental state or psychological patterns are observed. Third and last is the detailed analysis of different visual monitoring systems used to scan and then extract required information to alert drivers and ensure road safety. Specifically focusing analysis on the data sets available to work on for driver drowsiness detection and results found that there is still plenty of attention required to add more driver drowsiness images to comprehensively monitor human yawning patterns. The authors presented an approach to monitor real-time driver's sleepiness with the help of magnitude relation of driver's eye-closure along with yawn frequency and head positioning by observing the mouth and eyes movements. As the proposed model is intended for a real-time environment, therefore, to achieve accuracy it runs 15 frames/second which is justifiable. The best results showed an accuracy level of eye-movement/blinking was 97% and the results for yawn frequency was 96% and head positioning accuracy level was 63.4% detected.

D. Gaze Detection Method

Lastly, the gaze detection explained that the face detection was done using the Viola-Jones algorithm. The eye area is next localized using the integral projection function, followed by pupil detection and gaze classification. The pupil position and eye corner location information are utilized to identify the direction in which the subject is looking. The distance from pupil boundary to eye corner line segment is measured to find whether the driver is distracted or not. Compared to the algorithm in this study, the system is able to handle the head movement while this algorithm is done only for frontal face images. Researchers proposed a framework to optimize gaze detection using data transfer learning with the help of deep-learning models. It used a small camera to capture images of eyes and mouth and then extract the required information from the center of the eyes and mouth. Researchers proposed a framework for eye gaze detection with the use of Convolutional-Neural-Network. Model and claimed better accuracy results when it comes to road safety. Along with this claim, the paradigm for the possible execution of proposed algorithms, real time eye gaze controlled autonomous vehicles can be used. The authors described that real time road safety applications must deal with some challenges, like driver drowsiness, glass, and lighting reflections. Therefore, the chance to get false results may increase when the driver does not move his head and gaze at an object with only eye movement and gaze detection based only on head movement will not be sufficient and accurate. It presented a deep learning gaze detection without prerequisite of driver standardization with the help of an infrared small sensor.

III. Literature Review

Drowsiness of the driver can be determined with different aspects using vehicle- based. Psychological, and behavioral measurements implemented though different predictive algorithms as discussed in the following sections.

Face and Eye Detection by Machine Learning (ML) and Deep Learning (DL) Algorithms

Jabbar et al proposed the Convolutional Neural Network (CNN) technique of the ML algorithm to detect microsleep and drowsiness. In this paper, detection of driver's facial landmarks can be achieved through a camera that is then passed to this CNN algorithm to properly identify drowsiness. Here, the experimental classification of eye detection is performed through various data sets like without glasses and with glasses in day or night vision. So, it works for effective drowsiness detection with high precision with android modules. The algorithm of Deep CNN was used to detect eye blink and its state recognition as provided by Sanyal and Chakrabarty . Saleh et al. developed an algorithm of LSTM and Recurrent Neural Networks (RNN) to classify driver's behaviors through sensors. Ed-Doughmi et al. analyzed the driver's behaviors through the RNN algorithm. It specially focuses on construction of real-time fatigue detection to prevent roadside accidents. This system formulates a number of drivers' faces, which works on multilayered 3D CNN models to identify drowsy drivers and provide a 92 percentage acceptance rate.

FPGA-Based Drowsiness Detection System

A low-intrusive drowsiness detection system using field-programmable gate array (FPGA) has been designed by Vitabile et al. This system focuses on bright pupils of eyes which are detected by IR sensor light source embedded in a vehicle. Due to this visual effect, the retinas identified up to 90%, which helps to find drivers' eyes for analyzing drowsiness through a number of frames for avoiding serious mishaps. Navaneethan et al implemented a real-time system to track human eyes using cyclone II FPGA.

Eye Recognition System Based on Wavelet Network Algorithm

Jemai et al introduced a technique for drowsy warning systems using wavelet networking. That network tracks eyes with the help of classifying algorithms like Wavelet Network Classifier (WNC) that relies on Fast Wavelet Transform (FWT), which specifically leads to binary way decisions (conscious or not). The physiological aspects are heart beat rate and electrocardiogram that are repeatedly extracted through wavelet transformation with regression technique for fatigue detection, designed by Babaeian et al. This principle worked on heart rate data classification through a wavelet network which can find an average way of drowsiness alert system.

Fatigue and Collision Alert System Using Smart Technique

Chen et al implemented a smart glass to detect fatigue. The rear light of the vehicle is automatically flashed with a message being sent using the IoT module or cloud environment. Kinage and Patil proposed a system to detect drowsiness using eye blinking sensors and any accidents or collisions that happened; then, the vibration sensor was integrated with a heart rate measurement sensor for forwarding alert messages to the authorized user. So, it is also attached to the GPS and GSM device for tracking the location and transmission of messages. Siva Reddy and Kumari introduced a system to control the cause of unconditional mishaps using an Arduino board with sensors which operated through the camera. But, it is an efficient system with less estimation cost for construction of it. Jang and Ahn implemented a system to detect an alcohol addict and drowsy drivers through sensors, where these elements are integrated with the Raspberry Pi controller module. So, the IoT modules are also used to send messages for any abnormal driver activities, which are properly invigilated with the help of a webcam (image processing) and controller unit. A new process has been developed for regular vigilance of facial detection and eye blink state, which predicts the driver's drowsiness. In addition to extra sensors, voice recognition applications and machine learning methods are used to enhance the process of alert.

In the existing system, the fatigue of the driver is calculated through the eye or facial movements, deep learning, FPGA-based, ECG or EEG or EOG, vehicle steering movement, etc. But the implementation of the IoT-based technique helps to smartly control the various issues of driver drowsiness by the automatic buzzing of alarm, easily tracing the mishap location, and warning to the owner by sending emails or messages.

Drowsy Alert System Designed Using Electroencephalography (EEG), Electrocardiography (ECG), Electrooculogram (EOG), and Electromyogram (EMG) Algorithm

Budak et al designed a drowsy detection system through EEG technique which is designed with various components like AlexNet method, VGGNet method, and wavelet transform algorithm. This process effectively analyzes the state of sleepiness using the brain indicator signal (EEG), camera, and sensors that are activated with the help of machine learning methods to alert drowsy drivers. Hayawi and Waleed proposed a method to observe drowsiness through a signal of Heart Rate Variability (HRV) which is obtained using EEG sensors. Hayawi and Waleed established an intrusive method for measuring eyeball movement using EOG technique to construct a fatigue alert system that is also embedded with an Arduino controller board with Nearest Neighbors (KNN) classifier to improve the percentage of accuracy. Song et al proposed a system to identify the fatigue of drivers through the movement of muscular skin of eyes which is processed using EMG sensors with the help of a human machine interface. Similarly, the closure of eyelids and muscle part movements are also observed through the EMG sensors signals that function with the help of ESP8266 to provide or monitor the drowsy data on the Internet, which is designed by Artanto et al. Ma et al designed a driving fatigue detection system by measuring the EEG signals. It provided a robust platform for detecting drowsiness which is based on a deep learning process to find the accuracy of fatigue through EEG signals. But the deep learning process is structured through a principal component analysis network (PCANet) that preprocesses EEG data to create accuracy of detection. This process was tested in small sample size and offline mode, but it violates the accuracy in a large population of samples in real-time situations. Due to that reason, the IoT module is used to test online or offline in large sample sizes. Ma et al proposed an efficient application for the detection of driver fatigue through facial expression. Here, the facial movement is observed by deep learning of multi block local binary patterns (MB-LBP) and AdaBoost classifier. But it is also used to accurately and quickly detect drowsiness with the help of a fuzzy inference system. When the driver wears a glass, then the accuracy of detection is decreased. So IoT modules are used to make it more intelligent and to improve accuracy level of fatigue detection.

IV. Components Description

The proposed system is made up of the following primary components.

ARDUINO NANO:

The Arduino Nano plays a crucial role in a driver detection and monitoring system as a compact and powerful microcontroller board that integrates sensor data, processes information, and enables wireless communication. It reads data from various sensors such as GPS, accelerometer, and heart rate sensors, processes the information to detect driver fatigue, distraction, or hazardous conditions, and transmits the data wirelessly to a remote server or mobile device. Additionally, it triggers an alert system to notify the driver or fleet management of potential risks, manages power consumption, and optimizes battery life, making it an ideal choice for fleet management, vehicle tracking, and driver safety applications due to its small size, affordability, and flexibility.

USB CABLE:

A USB cable, short for Universal Serial Bus, is a common type of cable used to connect electronic components to computers or other digital devices. It enables data transfer and power supply between devices, making it an essential tool in today's interconnected world.

CONNECTING WIRES:

Connecting wire allows the electric current from one point to another point without resistivity. Resistance of the connecting wire should always be near zero. Copper wires have low resistance and are therefore suitable for low resistance.

BATTERY:

The nine-volt battery, or 9-volt battery, is an electric battery that supplies a nominal voltage of 9 volts. Actual voltage measures 7.2 to 9.6 volts, depending on battery chemistry. Batteries of various sizes and capacities are manufactured; a very common size is known as PP3, introduced for early transistor radios.

BUZZER:

A buzzer plays a crucial role in a driver detection and monitoring system as an audible warning device that alerts the driver of potential hazards or dangerous conditions. When the system detects driver fatigue, distraction, or other hazardous conditions, the buzzer sounds an alarm to immediately grab the driver's attention, prompting them to take corrective action or pull over to rest. The buzzer's loud and piercing sound ensures the driver is alerted even in noisy environments, serving as a vital component in preventing accidents and ensuring road safety.

GEAR MOTOR:

A gear motor plays a significant role in a driver detection and monitoring system as an actuator that controls the movement of a mechanical component, such as a warning light or a display screen. When the system detects a hazardous condition, the gear motor is triggered to rotate the mechanical component, drawing the driver's attention to the warning or alert. The gear motor's precise control and high torque output enable smooth and reliable movement, ensuring the warning mechanism is effectively deployed, and the driver is alerted in a timely and conspicuous manner, enhancing road safety and preventing accidents.

RELAY:

A single channel 5V relay plays a crucial role in a driver detection and monitoring system as an electromagnetic switch that controls the power supply to external devices or systems. When the Arduino Nano detects a hazardous condition or driver fatigue, it sends a signal to the relay, which then switches off the power supply to the vehicle's ignition system, alarm, or other external devices, thereby preventing accidents or ensuring safety. The relay acts as a switch, isolating the high voltage circuit from the low voltage control circuit, and its 5V operating voltage makes it compatible with the Arduino Nano, allowing for seamless integration and control, and enabling the system to take prompt action in emergency situations.

EYE BLINK SENSOR:

An eye blink sensor plays a vital role in a driver detection and monitoring system by tracking the driver's eye blinks to detect fatigue, drowsiness, or distraction. The sensor uses infrared or optical technology to monitor the driver's eye movements and blink rate, and sends the data to the Arduino Nano or other microcontroller. If the sensor detects abnormal blinking patterns, such as slow or infrequent blinks, it triggers an alert or warning system to notify the driver to take a break or rest, preventing potential accidents caused by driver fatigue or distraction, and ensuring safer driving conditions.

CONNECTOR:

Connectors play a vital role in a driver detection and monitoring system by enabling secure and reliable connections between various components, such as sensors, microcontrollers, and actuators. They ensure seamless data transmission and power supply, facilitating communication between the system's components and enabling the accurate detection of driver fatigue, distraction, or other hazardous conditions. Robust and durable connectors withstand the rigors of vehicular environments, maintaining consistent performance and preventing signal degradation or loss, thereby guaranteeing the system's overall reliability and effectiveness in promoting road safety.

V. PROPOSED METHODOLOGY

When the Pi camera model V2 is successfully integrated with Raspberry Pi3, it continuously records each movement of the driver’s face. This proposed work specially focuses on behavioral measures of the driver with severity measurement of collision in following sections. The EAR is accurately calculated due to the use of Raspberry Pi3 model B and Pi camera modules to make a persistent recording of face landmarks that are localized through facial landmark points. But the Raspberry Pi3 model B and Pi camera modules are securely processed due to the operating system of the controller and predictable secure shell (SSH) keys. The use of SSH host keys provides secure network communications and helps to prevent unauthorized communications or file transfers. The IoT-based application is being developed through the integration of some IoT modules like wireless sensors, GPS tracker, Pi camera, and smart code for detecting drowsiness of the driver. So the above modules are properly integrated with the Raspberry Pi controller module that intelligently controls and smartly warns a drowsy driver. The successful integration of IoT modules is robustly used to prevent the cause of mishaps and also warns the drowsy driver to avoid careless driving. The Internet of Things (IoT) is helping to manage various real-time complexities like handling complex sensing environments and also provides a very flexible platform to control multiple connectivities. The IoT module is a very reliable way of capturing images of the drowsiness of the driver as well as sending an alert message to the owner for awareness.

DROWSY EYES AND FACE DETECTION:

The step by step methods for detection of drowsy drivers in the scenario are previously explained in Figure 4, and the various steps are as follows:

(i)Step 1: video recording

(ii)Step 2: face detection

(iii)Step 3: eye detection

(iv)Step 4: drowsiness detection (combination of steps 2 and 3)

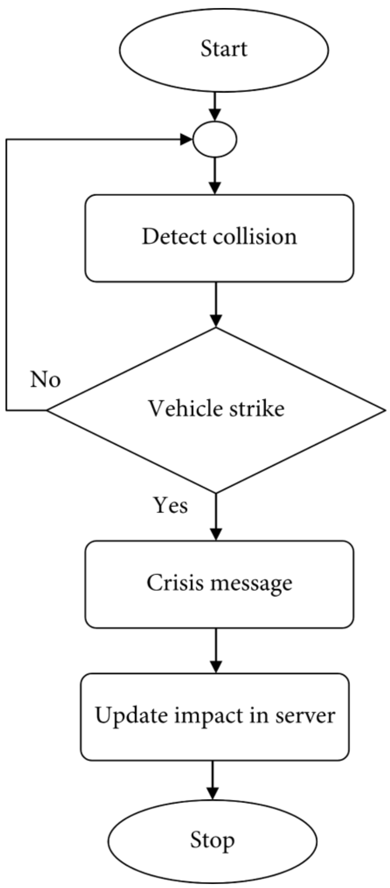

Fig. 1. Flow chart for driver sleep detection and alarming system

The Raspberry Pi3 camera is an 8-megapixel video camera which captures continuous video streams in good quality. Recorded video stream is converted into a number of frames which are forwarded to the face detection step. The face detection is analyzed by face landmark algorithm, which can detect eye, mouth, and nose from facial appearance. Actually, this detection technique works with Python-based library packages like OpenCv. OpenCv is used for real-time image processing which is implemented by computer vision algorithms. When facial features are successfully detected, the next step, like eye detection of drowsy drivers, is possible to focus through facial landmark predictor algorithms. So, it can convert that image frame format to gray scale level, where detected eye areas are traced by six coordinates as depicted in Figure 5 Now, it is needed to calculate EAR which measures the distance between vertical and horizontal eye landmark points by using a Euclidean distance (ED) method as in Equation (1). The calculation of the distance of the eyelid section is made as

$$iED\left(X_i, Y_i\right) = \sqrt{\sum_{n=1}^{n} \left(Y_i - X_i\right)^2}, \qquad (1)$$

where ED(X,Y) is denoted as a Euclidean distance between and ; these are two Cartesian coordinate points. So it is represented in Python program which is explained below:

(i) $A = \text{dist. euclidean}(\text{eye}[2], \text{eye}[6])$

(ii) $B = \text{dist. euclidean}(\text{eye}[3], \text{eye}[5])$

(iii) $C = \text{dist. euclidean}(\text{eye}[1], \text{eye}[4])$

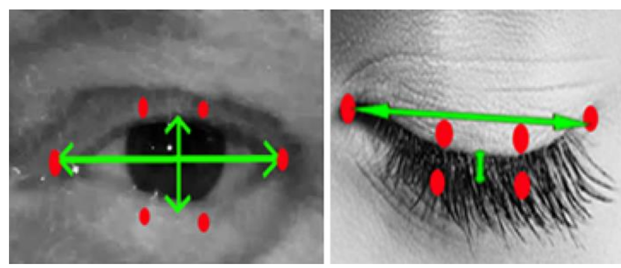

Fig. 2.Eye landmarks (6 coordinates) of opening and closing eye.

From the above statement, dist is an object of distance package that belongs to the scipy library file which is invoked as a Euclidean . Here, there are two coordinate points of an eye landmark. The variables are used for calculation of the EAR value of an eye. In order to find the EAR by using detected eye landmark coordinate values from ever video frames, it is being computed as

$$\text{EAR} = \frac{\|x_2 - x_6\| + \|x_3 - x_5\|}{2\,\|x_1 - x_4\|}, \qquad (2)$$

where x1, x2, x3, x4, x5, and x6 are 6 landmark coordinates which are shown in Figure 2(b). The EAR value of the left and right eyes is averaged during synchronous eye blink. The threshold value of EAR remains constant when both eyes continue to be open, where values will be randomly changed during eye blink. The threshold range of EAR is above 0.25 that means the driver’s eyes are unlatched. If any drowsiness of the driver is detected from video frames, it happens due to a drop of its threshold value below 0.25. When the number of frames is more than 30, then the voice speaker is turned on and mail is sent. So, the Raspberry Pi3 is programmed to operate a speaker by using a software which can convert text-to-speech (TTS) conversion technique.

Driver Drowsiness and Monitoring System is an automobile application that has the purpose to alert the driver when signs of drowsiness or distraction are detected. Based on Fig. 2, this system comprises a camera-based driver drowsiness and monitoring system aimed at the driver's face, which enables a real-time evaluation of the driver's presence and state. For the hardware part, the system will use Raspberry Pi 4 as the main component to make a compact embedded system. All the algorithms will be implemented in it. Webcam is installed on the car dashboard for video feed purposes to track features of the driver (8FPS). Portable speaker will be used as an alarm device. When the system detects drowsy or distracted driver conditions, it makes a sound alert from the speaker. Image’s processing algorithm is developed in Python and OpenCV to detect the drowsiness sign based on rate of eye blinking, eye closing period and rate of yawning while gaze detection to estimate where the driver is looking for the distraction sign.

VI . OUTPUT

Our current project develops a system for detecting drowsiness of the driver.

The system uses eye aspect ratio and mouth aspect ratio to detect blinks and yawning respectively and also a ML model is trained to draw the result based on them to achieve the main objective of the project i.e., Driver’s Drowsiness. The framework has reached a stable state in which all bugs have been eliminated. The results are discussed in the testing section and are found satisfactory.

Our project provides a way through which a number of road accidents might be avoided if an alert is sent to a driver that is deemed drowsy. Our model is not only useful to the person who will install it in their vehicle but also for the other cars, trucks, buses and humans moving around it.

In conclusion, drowsiness detection systems have the potential to significantly improve driver safety and reduce the risk of accidents caused by drowsy driving. However, it's important to choose the right system and understand its limitations. By following the tips outlined in this article, you can find the best drowsiness detection system for your needs and stay safe on the road.

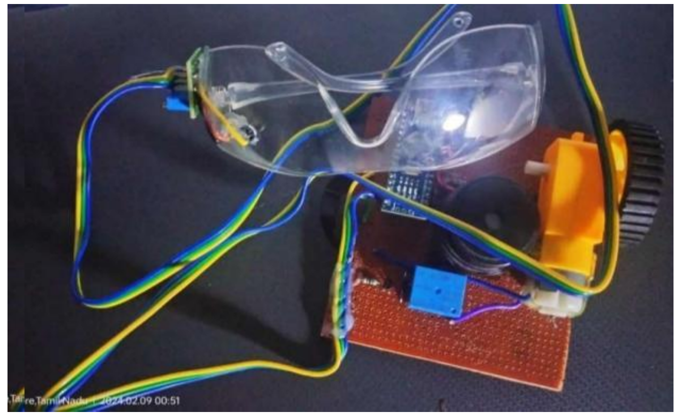

Fig. 2. Output of our proje

VII . CONCLUSION

This research provides a robust method for detecting drowsiness of drivers and collision impact (severity) systems in the present time. This method generally combines two different systems in one integrated system. But, the existing techniques are based on psychological or vehicle-based approaches to detect drowsiness of drivers and also, the severity of collision is separately measured, but such technique is highly intruding as well as fully turns on the physical environment. So, the proposed system is used to construct a non intruding technique for measuring drowsiness of the driver with severity of collision due to braking or mishap. This system’s main components are the Raspberry Pi3 model B module and Pi camera module that are used for persistent recording of face landmarks that are localized through facial landmark points then to calculate EAR. However, if the calculated EAR value increases from the threshold range, then the eyes are kept open and no change in the state of the system occurs. Similarly, if the EAR value falls from the threshold range, then the system urgently alerts using a speech speaker and warning e-mail to the authority (owner) for extra supportive alertness to the driver. In addition, measurement of collision severity (impact) is made through implementation of sensors with the GPS module to properly track the location of accidents thereby alerting the nearer medical service center to serve emergency diagnosis.

Several approaches to developing a model for detecting driver drowsiness that can be used effectively have been investigated. To identify the most effective method and review the current advancements in the area of DDDS, sixty-eight research publications from various sources, including IEEE, Google Scholar, ScienceDirect and ResearchGate, have been selected. Thirty-one papers have been shortlisted out of sixty-eight studies that discuss face detection techniques, hybrid measures and deep learning algorithms. A total of 26,344 articles have been published that help the research community to build an efficient driver drowsiness detection system, of which 12,395 articles are based on hybrid models, e.g., DDDS. Figure 5 shows the publication trends from 2012 to 2021 in

DDDS and hybrid model-based driver drowsiness detection systems (HMDDDS). These publication trends reveal that the research community has shown intense interest in building an efficient DDDS to reduce accidents and protect people's precious lives.

Drowsy driving is one of the leading causes of traffic accidents all over the world. Driving in a monotonous manner for an extended amount of time without stopping causes tiredness and catastrophic accidents. Drowsiness has the potential to ruin many people's lives. As a result, a real-time system that is simple to create and configure for early and accurate sleepiness detection is required. In this study, a real-time vision-based system called Driver Drowsiness Detection System has been developed utilizing machine learning. In this study, the Haar Cascade classifier was used to recognize the driver's face characteristics and functions present in OpenCV library to detect the region of the face. The following step is to examine the open/close state of the eyes, followed by sluggishness depending on the sequence of ocular conditions. The non-intrusive and cost-effective nature of this vision-based driver tiredness detection is its distinguishing attribute.

The suggested approach employs four convolutional layers and one fully linked layer. Convolution layer.1 receives key pictures that are 128 X 128 pixels in size (Conv2d 1). The input image is convolved using 84 3*3 filters in Conv2d 1.The.architecture includes convolution, batch normalization, non-linear. transformation ReLU, and Max pooling over 2 x 2 cells, followed by 0.25 percent dropout. Conv2d 1 requested that 840 parameters be used. In batch normalization, 336 parameters are utilized. The output of convolution layer 1 is sent to convolution layer 2. (Conv2d).The input is convolved using 128 5x5 filters in Conv2d 2.With stride 2 and 0.25 percent dropout over 2 2 cells, convolution, batch normalization, non-linear transformation ReLU, and MaxPooling were used. A total of.268927 parameters were required by Conv2d 2. Batch normalization 2 necessitates the use of 512 parameters. Convolution layer 3 receives the output of convolution layer 2. (Conv2d 3). The input is convolved in Conv2d 3 with 256 5*5 filters. Conv2d 3 required 819456 parameters after convolution, batch normalization, and non-linear transformation. 0.25 percent dropout after ReLU, MaxPooling over 2 2 cells with stride 2. 1024 parameters are required for batch normalization 3. Conv2d 4's convolution layer-3 output is sent on to Conv2d 4's convolution layer-4. In Conv2d 4, the input is convolved with 512 filters of size 5x5 filters each. After convolution, Batch Normalization, and non-linear transformation, Conv2d 4 required 3277312 parameters. 0.25 percent dropout, ReLU, and Max Pooling across 2 x 2 cells with stride 2. Batch normalization 4 needed a total of 2048 parameters. 8388864 parameters are required for the dense 1 completely connected layer. A CNN model with 12,757,874 trainable parameters was proposed by the researchers. Because the classifier's output is two states, the output layer only has two outputs. For optimization, the Adam method is applied. For classification, the softmax classifier is used. The deep features derived from input eye images are the 256 outputs of the fully linked layer in our proposed CNN.

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