

DROWSINESS DETECTION SYSTEM USING MACHINE LEARNING AND IMAGE PROCESSING

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Technology degree in Information Technology
by

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**DEPARTMENT OF INFORMATION TECHNOLOGY
SCHOOL OF COMPUTING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Category – 1 University by UGC
Accredited with Grade “A++” by NAAC | 12B Status by
UGC | Approved by AICTC**

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APRIL – 2024



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **KRISHNA PRIYA. R. S (40120052)** and **DIVYADHARSINI. P. S (40120030)** who carried out the project entitled **DROWSINESS DETECTION SYSTEM USING MACHINE LEARNING AND IMAGE PROCESSING** under my supervision from Jan 2024 to April 2024.

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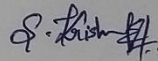
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DECLARATION

I KRISHNA PRIYA. R. S (40120052) hereby declare that the project report entitled **DROWSINESS DETECTION SYSTEM USING MACHINE LEARNING AND IMAGE PROCESSING** done by me under the guidance of **Dr. K. SUNDARA VELRANI, M.E., Ph. D., (Internal)** is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Information Technology.

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ABSTRACT

Drowsiness detection serves as a vital tool in averting accidents stemming from drowsy driving or other scenarios fraught with fatigue-related hazards. However, existing drowsiness detection models have been hampered by drawbacks such as time complexity and code intricacy. In contrast, our developed model represents a significant improvement, offering enhanced code usability and reduced detection time. With the primary aim of preventing accidents due to drowsiness in a more precise and effective manner, we introduce the Enhanced Drowsiness Detection Algorithm. This model harnesses the power of various open-source libraries including dlib, OpenCV, and Pygame. Operating by computing the distance between the eyes and comparing it against a predefined threshold, our algorithm accurately discerns drowsiness in real-time, boasting an impressive accuracy rate of 93%. Moreover, our model incorporates a user-friendly web interface facilitated by the Flask web framework, enabling seamless initiation and cessation of the drowsiness detection loop. This feature proves invaluable for users seeking to take breaks from the detection process or resume it after interruptions. Overall, our code offers a straightforward and efficient solution for real-time drowsiness detection utilizing a webcam, thereby enhancing vehicle safety and mitigating the risks associated with drowsy driving.

Keywords – Image processing, Open CV, 68 facial landmarks, EAR (Eye Aspect Ratio), Adaptive eye opening threshold, recognition and detection.

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LIST OF ABBREVIATIONS

ABBREVIATION	EXPANSION
HAR	Human Activity Recognition
CNN	Convolutional Neural Network
LSTM	Long Short Term Memory
LBPH	Local Binary Patterns Histogram
ConvLSTM	Convolutional Long Short Term Memory
LRCN	Long-Term Recurrent Convolutional Network
SWA	Steering Wheel Angles
ApEn	Approximate Entropy
EEG	Electroencephalography
ECG	Electrocardiography
ROI	Region of Interest
HRV	Heart Rate Variability
SVM	Support Vector Machine
PPG	Photo Plethysmography
ROC	Receiver Operation Curve
EDD	Enhanced Drowsiness Detection
EAR	Eye Aspect Ratio
EARTHresh	Eye-opening Threshold
NTGY	‘NO’ tilted face, Glasses ‘YES’
YTGN	‘YES’ tilted face, Glasses ‘NO’
YTGy	‘YES’ tilted face, Glasses ‘YES’

1. INTRODUCTION

One of the major safety issue while driving in the world is accidents due to drowsiness or fatigue. Drowsiness can be caused by many means such as alcohol, pills, lack of sleep or some health issues in nature. Majorly drowsiness is caused by health issues and the use of drugs. Alcohol and drug use exhibit distinct signs and tests that can be readily identified, facilitating easy prevention. In contrast, fatigue or drowsiness lacks quantifiable measures, presenting a common issue. Addressing this challenge involves emphasizing fatigue-related incidents and encouraging drivers to acknowledge fatigue when necessary. Acquiring the former is challenging and expensive, while the latter is unattainable without prior measures. Extended hours of driving can be advantageous, necessitating the implementation of drowsiness detection systems for the safety of both vehicles and drivers to safeguard his/her valuable life. Drowsy driving poses a pervasive and serious threat to the road safety, transcending geographical boundaries and affecting communities worldwide. While specific details about a recent road accidents are available, the broader impact of drowsiness-related incidents on road safety remains a cause for concern. The issue is exacerbated by factors such as extended work hours, demanding schedules, and inadequate sleep, all of which contribute to drivers operating vehicles in a state of fatigue which leads to a major problem while driving. Figure 1.1 represents a fatigued driver. Accidents related to drowsy driving are not limited to private vehicles; commercial vehicles, including trucks and buses, are also involved in such incidents. The consequences of accidents involving large commercial vehicles are particularly severe due to the potential for substantial damage and multiple casualties.



Fig. 1.1 Fatigued driver image

Every human being needs sleep, lack of sleep causes human inactiveness, improper reflex, losing of focus, gets deviated which decreases the capability to make proper decisions which is necessary for driving a vehicle. As per WHO records about 1.25 million of people were injured or dead due to accidents in a year. Some of them neglect the traffic rules, like over speeding, crossing the signals, crossing the lane, also having technical issues with the break's failure, tires. To mitigate these issues this paper focuses on the solution to reduce the fatal cases by providing a smart drowsiness detection system. This model has an accuracy of 90%. Machine learning, Computer vision are being used in this model which are the subset of AI and it allows the user to train the system and predict the output in a certain range. This technology helps to reduce the gap between human and machines.

Computer vision is the library which captures, understands the images to perform image processing. It helps in processing and extraction of the data to generate the information and also it uses other libraries which play an important role in the system. It has a Graphical User Interface (GUI) which makes the operating systems easy for users to use. Where you can simply create your own windows for generating output of a certain model. Here, we're using 2 models, drowsiness detection and face recognition of the driver for the security purpose. The outcome of this model is to alert and predict whenever the driver is drowsy, changing his track and when the vehicle is not maintained well. The aim of this project is to implement this system in the vehicle, and ensure driver's safety. Algorithms are used to process the signals and to give relevant output.

Implementing drowsiness detection systems in vehicles becomes particularly relevant in the Indian context. These systems, leveraging technological advancements like machine learning and image processing, can monitor driver behaviour and issue timely alerts when signs of drowsiness are detected. The integration of such preventive measures is crucial to enhancing road safety in India, complementing broader efforts to address the multifaceted challenges associated with drowsy driving. It emphasizes the importance of a holistic approach, combining technological solutions, awareness campaigns, and policy measures to ensure safer roads for all. This paper seeks to integrate the system into vehicles with the

primary goal of ensuring the safety of drivers. Utilizing algorithms, the signals are processed to generate pertinent outputs.

1.1 HUMAN PSYCHOLOGY

People have continually developed machines and formulated techniques to ease and protect their lives, for dull sports like journeying to work, or for greater absorbing purposes like plane journey. With the development in generation, modes of transportation stored on gain ground dominion and our dependency on it commenced largely. It has substantially changed our lives as we are aware of it. Now, we can journey to venues at a tempo that even our grandparents would not have idea viable.

In present times, almost all people on this world makes use of some type of transportation each day. few people are wealthy sufficient to possess cars while others use shuttle. However, there are a few policies and codes of behavior for people who pressure regardless of social repute. One among them is staying conscious/ alert and energetic even when we are driving.

Neglecting our duties closer to more secure travel has sanction masses of heaps of devastation to get couple with this high-quality origination anually. It can appear to be a insignificant component to most oldsters but following policies and act on the street is of maximum consequence. Even as on pavement, a motor car wields most electricity and in incautious arms, it may be ruinous and from time to time, that negligence people's lives in insecurity. One sort of carelessness isn't always admitting while we also worn-out to drive. If you want to detect and avert an unfavorable final result from such trivial, many analysts have written studies papers on the driver drowsiness detection systems. However, at instances, some factors and scrutiny made via the gadget aren't correct sufficient. Consequently, to provide statistics and any other perspective at the hassle to hand, to be able to enhance their Implementations and to similarly optimize the solution, this venture has been finished.

1.2 REAL TIME PROBLEM ANALYSIS

India has witnessed instances where drowsy driving has contributed to accidents, particularly on long stretches of highways and during extended periods of night driving. Factors such as demanding work schedules, lack of proper rest facilities for drivers, and the prevalence of night travel contribute to the elevated risk of drowsy driving incidents.

Inattentiveness, stemming primarily from drowsiness, is a key factor contributing to some of the most significant disasters, as outlined below:

- According to The Hindu Newspaper, 40% of traffic accidents in India result from drowsy drivers. In a statement, Nitin Gadkari, the Minister of Highways and Road Transportation, reported that 189,913 individuals lost their lives in car accidents in 2017.
- An internal study of 63 accidents on Mumbai Central Railway in India between 2013 and 2022 revealed that 57 out of 85 accidents occurred during clear weather in the daytime. According to the BBC, human error is responsible for 85% of plane crashes, with 12% to 24% attributed to pilot drowsiness.
- Most recently, on 2nd December, 2023, a van with 7 passengers in Punjab met with an accident due to the drowsiness of driver.

This paper underscores the critical importance of adequate sleep for human functioning, emphasizing its role in preventing inactivity, compromised reflexes, and reduced decision-making capabilities - crucial factors for safe driving. With approximately 1.25 million annual injuries or fatalities attributed to accidents, often exacerbated by traffic violations and technical malfunctions, a focus on mitigating these risks is imperative. The proposed solution involves a smart drowsiness detection system, boasting a 90% accuracy rate, employing machine learning and computer vision - integral components of artificial intelligence. By narrowing the gap between humans and machines, this technology emerges as a pivotal tool in enhancing road safety and reducing fatal incidents.

2. LITERATURE SURVEY

In computer science, image processing is the use of computer algorithms to perform image processing on images. As a subcategory or field of digital signal processing, image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the buildup of noise and signal distortion during processing. Since images are defined over two dimensions digital image processing may be modelled in the form of multidimensional system.

2.1 DROWSINESS DETECTION THROUGH REGION OF INTEREST:

Region Of Interest (ROI) can detect a driver's face. As can be seen in the blue rectangle is the region of interest. The way to create an ROI area is to first obtain the green rectangle area from the Haar Cascade Classifier in the first frame, which includes height, width. Then, the rectangle is scaled up to create region of interest. There are several steps to calculate the ROI area and we have to calculate ROI for each and every region of interest.

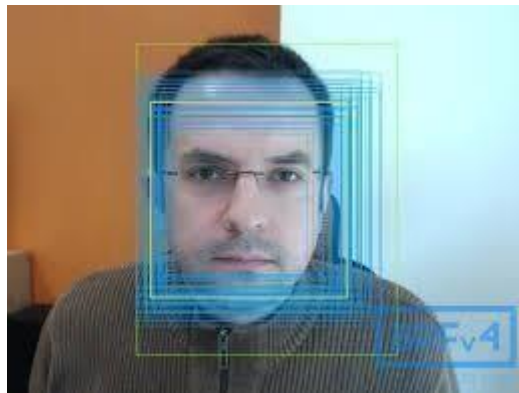


Fig 2.1 Region of Interest

DISADVANTAGES OF REGION OF INTEREST

1. It is uses extra frames or squares to detect face detection.
2. It can't find in low light.
3. Use of region of interest while Haar cascade classifier can do the same process.
4. It can't detect while using glasses in driving.

2.2 DETECTION OF DROWSINESS THROUGH LBPH:

In this algorithm the faces are detected by using Local Binary Patterns Histograms (LBPH). The first computational step in LBPH is to create an intermediate image that describes the original image in a binary format. The image is converted into matrix form and we need to take a central value of the matrix to be used as and threshold value. This value is used to define neighboring values which can be set to either 0 or 1. The values which are 1 in the matrix form are to be considered and the remaining values are discarded. The values represent each pixel. Through this the region of face can be detected.

DISADVANTAGES OF LBPH

1. It produces less accurate results
2. The computational time is high.
3. This will work only if the data samples are less.

2.3 BEHAVIOURAL BASED TECHNIQUES

The different techniques used in behavioral based parameters are:

2.3.1 EYETRACKING AND DYNAMIC TEMPLATE MATCHING

To avoid road accidents, real time driver fatigue detection system based on vision is proposed. Firstly, system detects the face of driver from the input images using HIS (Hue, Saturation, Intensity) color model. Secondly, Sobel edge operator is used to locate the eyes positions and gets the images of eye as the dynamic template for the tracking of eye. Then the obtained images are converted to HSI color model to decide that whether the eyes are close or open to judge the drowsiness or fatigue of driver. The experiments use four test videos for the tracking of eyes and face detection. The proposed system is compared with the labelled data which is annotated by the experts to study them for the proper detection of drowsiness. The average correct rate of proposed system reaches up to 99.01 % and the precision to 88.90 %.

2.3.2 MOUTH AND YAWNING ANALYSIS

Fatigue is the major reason for road accidents. To avoid the issue, Sarada Devi and Bajaj proposed the driver fatigue detection system based on mouth and yawning analysis. Firstly, the system locates and tracks the mouth of a driver using cascade of classifier training and mouth detection from the input images. Then, the images of mouth and yawning are trained using SVM. In the end, SVM is used to classify the regions of mouth to detects the yawning and alerts the fatigue. For experiment, authors collect some videos and select 20 yawning images and more than 100 normal videos as dataset. The results show that the proposed system gives better results as compared to the system using geometric features. The proposed system detects yawning, alerts the fatigue earlier and facilitates to make the driver safe.

2.3.3 FACIAL EXPRESSIONS METHOD

Laboratory condition using Finite Element Analysis is used by the researchers which is a complex system that contains the database of facial expression as a template and detect the drowsiness on the basis of results from database. Similarly, Assari and Rahmati present the hardware-based Driver Drowsiness Detection system based on facial expressions. The hardware system uses infrared light as it has given many benefits like ease of use, independent of lightning conditions of environment. The system firstly uses the technique of background subtraction to determines the face region from the input images. Then using horizontal projection and template matching, facial expressions are obtained. After that in the tracking phase, elements found earlier are followed up using template matching and then investigates the incidence of sleepiness using the determination of facial states from the changes of the facial components. Changing in the three main elements such as eye brow rising, yawning and eye closure for the certain period are taken as the initial indications for drowsiness and the system generates the alert. The experiment is performed in the real driving scenario. For testing, images are acquired by the webcam under different conditions of lighting and from different people. The results investigate that the system produces appropriate response in the presence of beard or glasses and mustache on the face of driver.

2.3.4 YAWNING EXTRACTION METHOD

Fatigue or drowsiness is the major reason for road accidents. To prevent the issue, Alioua proposed the efficient system for monitoring the driver fatigue using Yawning extraction. Firstly, face region is obtained from the images using Support Vector Machine (SVM) technique to reduce the edge required cost. The proposed method is used to localize the mouth, detection technique is used to detect facial edges, then compute vertical projection on the lower half face to detect the right and left region boundaries and then compute the horizontal projection on the resulting region to detect the upper and lower limit of mouth and mouth localized region is obtained. Finally, to detect the yawning, Circular Hough Transform (CHT) is executed on the images of mouth region to identify the wide-open mouth. If the system finds notable number of continuous frames where the mouth is widely open, system generates the alert. The results are compared with the other edge detectors like Sobel, Prewitt, Roberts, Canny. The experiment uses 6 videos representing real driving conditions and results are presented in the form of confusion matrix. The proposed method achieves 98% accuracy and outperforms all other edge detection techniques.

2.3.5 EYE CLOSURE AND HEAD POSTURES METHOD

Teyeb proposed the Drowsy Driver Detection using Eye Closure and Head postures. Firstly, video is captured using webcam and for each frame of video, following operations are performed. To detect the ROI (face and eyes), viola-jones method is used. The face is partitioned in to three areas and the top one presenting the eye area is browsed by the Haar classifier. Then to detect the eye state, Wavelet Network based on neural network is used to train the images then the coefficients learning images is compared with the coefficients of the testing images and tells which class it belongs. When the closed eye is identified in the frames then the eye closure duration is calculated, if the value exceeds the pre- defined time, then the drowsiness state is detected. Then the developed system estimates the head movements which can be mentioned as: left, right, forward, backward inclination and left or right rotation. The captured video is segmented into frames and extract the images of head and determines the coordinates of image. Then the images are compared to determine the inclined state of head and same case with other head

postures. Finally, the system combines the eye closure duration and head posture estimation to measure the drowsiness. To evaluate the system for the proper identification and detection, experiment is performed on 10 volunteers in various situations based on their appearance. And the results show that the systems achieve the accuracy of 80%. moustache for 20 days in different timings. The system performs best when the drivers are without glasses.

2.3.6 REAL TIME ANALYSIS USING EYE AND YAWNING

Kumar proposed the real time analysis of Driver Fatigue Detection using behavioral measures and gestures like eye blink, head movement and yawning to identify the drivers' state. The basic purpose of the proposed method is to detect the close eye and open mouth simultaneously and generates an alarm on positive detection. The system firstly captures the real time video using the camera mounted in front of the driver. Then the frames of captured video are used to detect the face and eyes by applying the viola-jones method, with the training set of face and eyes provided in OpenCV. Small rectangle is drawn around the center of eye and matrix is created that shows that the Region of Interest (ROI) that is eyes used in the next step. Since the both eyes blink at the same time that's why only the right eye is examined to detect the close eye state. If the eye is closed for certain amount of time, it will be considered as closed eye. To determine the eye state, firstly the eye ball color is acquired by sampling the RGB (Red, Green, Blue) components on the center of eye pixel. Then the absolute thresholding is done on the eye ROI based on eye ball color and intensity map is obtained on Y-axis that show the distribution of pixels on y-axis which gives the height of eye ball and compared that value with threshold value which is 4 to distinguish the open and close eye. After that, if the eye blink is detected in each frame, it will be considered as 1 and stored in the buffer and after the 100 frames, eye blinking rate will be calculated. Then to detect the yawning motion of the mouth, contour finding algorithm is used to measure the size of mouth for the detection of yawning. If the height is greater than the certain threshold. It means person is taking yawning.

To evaluate the performance of the proposed system, system has been measured under different conditions like persons with glasses, without glasses, with moustache and without.

$$\%d = \frac{\text{No. of closed eyes found}}{\text{No. of frames}}$$

If the value is more than the set threshold value, then system generates the alarm to alert the driver. Moreover, yawning is also considered to generate the alert. Online and offline are videos are used for experiment which are performed on two different systems. The results show that the system achieves the efficiency up to 90%.

2.3.7 EYE CLOSENESS DETECTION METHOD

Khunpisuth creates an experiment the calculates the drowsiness level of driver using Raspberry Pi camera and Raspberry Pi 3 model B. Firstly Pi camera captures video and to detect face regions in the images, Haar cascade classifier from Viola-Jones method is used. Several images are trained in different lights. The percentage of 83.09 % is achieved based on the case study with 10 volunteers. Blue rectangle shows the Region of Interest (ROI) that is face. Again, Haar cascade classifier is applied on the last obtained frame which reduces the size of ROI. After the face detection, drowsiness level is calculated using eye blink rate. Eye region is detected using template matching on the face and authors uses three templates to check the eye blink and eye area. CV_TM_CCOEFF_NORMED from OpenCV is considered as it gives improved results than other methods of template matching. The integration of eyes and face detection permits the checking of an eye blinking and closeness rate. If the eyes are closed, then the value of closed eye is higher than the open the eyes and opposite case if eyes are open. Authors assumed that Haar cascade classifier will work if the face is front facing position. That why authors proposed the method to rotate the tilted face back in to the front-facing position. Firstly, determines whether the head is tilt or not then calculates the degrees of rotation (angle). After the accurate detection of face and eyes, drowsiness level of driver is determined. If the drivers blink eyes too frequently, the system indicates he drowsiness. When the level reaches tone hundred, a loud sound will be generated

to alert the driver. The proposed method is compared with Haar cascade and results shows that the proposed method achieves the accuracy of 99.59 % which is comparatively high. It works in all kind of lighting conditions and able to detect the face wearing glasses.

2.4 VEHICULAR PARAMETER-BASED TECHNIQUES

2.4.1 REAL TIME LANE DETECTION SYSTEM

Road accidents have become common in the present era, causing the severe damage to the property and also to the lives of people travelling. There are many reasons of road accidents like: rash driving, inexperience, ignoring signboards, jumping signal, missing lane etc. To address the issues, Katyal et al. proposed the Drivers' Drowsiness Detection system. The system works in two phases: firstly, detects lane based on Hough transform. Secondly, detects the drivers' eyes to detect the drowsiness. For eye detection, firstly use viola jones method to detect face, then do the image segmentation, after that Otsu thresholding is done and canny edge detection is applied. The obtained results are integrated with the circle detection though transform method to detect eyes to detect the fatigue level. It will also work in low lightning conditions. Result shows that the proposed system is useful for the drivers travelling on lengthy routes, driving late night, drivers who drink and drive.

2.4.2 TIME SERIES ANALYSIS OF STEERING WHEEL ANGULAR VELOCITY

To avoid the road accidents, Zhen Hai proposed the Driver Drowsiness Detection method using time series analysis of steering wheel angular velocity. The method firstly analyses the behavior of steering below the fatigue, then temporal detection window is used as the detection feature to determine the angular velocity of steering wheel during time-series. In the temporal window, if the detection feature satisfies the variability constraints and extent constraints, then the state of drowsiness is detected accordingly. The experiment based on real testers is performed, and results shows that the proposed method outperforms the previous methods and useful in the real world.

2.4.3 STEERING WHEEL ANGLE FOR REAL DRIVING CONDITIONS FOR DDT

To avoid road accidents, Li proposed the online detection of Drowsiness Detection System to monitor the fatigue level of drivers under real conditions using Steering Wheel Angles (SWA). The data of SWA is collected from the sensors attached on the steering lever. The system firstly extracts the features of Approximate Entropy (ApEn) from fixed sliding windows on time series of real time steering wheel angles, then the system linearizes the features of ApEn using the deviation of adaptive linear piecewise fitting method. After that the system calculates the warping distance between the series of linear features of sample data. Finally, system determine the drowsiness state of drivers using warping distance according to the designed decision classifier. The empirical analysis uses the data collected in 14.68 hrs. driving under real road conditions and evaluated on two fatigue levels: drowsy and awake. Results show that the proposed system is capable for working online with an accuracy of 78.01 % and useful for the prevention of road accidents caused by drivers' fatigue.

2.4.4 AUTOMATIC DETECTION OF DRIVER FATIGUE

To address the issue of drivers' fatigue, an online detection of drivers' fatigue using the Steering Wheel Angles (SWA) and Yaw Angles (YA) information in the real driving conditions is proposed. The system firstly investigates the operation features of SWA and YA in the different states of fatigue, after that calculates the ApEn (Approximate Entropy) features on time series of shot sliding window, then using the dynamic time series of non-linear feature construction theory and taking features of fatigue as input, designs a 2-6-6-3 multi-level Back Propagation (BP) neural network classifier to determine the fatigue detection. For empirical analysis, 15 hours long experiment is performed in real road conditions. The experts evaluated the retrieved data and categorized in three categories of fatigue: drowsy, very drowsy, and awake. Each category states the level of drowsiness of the driver. And the experiment achieves the average accuracy of 88.02% in fatigue detection and 19 valuable for the engineering applications.

2.5 DROWSINESS DETECTION THROUGH PHYSIOLOGICAL APPROACH

Physiological measures have much of the time been utilized for drowsiness discovery as they can give an immediate and objective measure. Conceivable measures are EEG, eyelid closure, movements of eye, heart rate, size of pupil, skin conductance and creation of the cortical. Among these procedures, the systems that are best, in light of precision are the ones in view of physiological experience of human. There are two ways for implementing this procedure. Measurement of changes in physiological signs for example, waves of human brain, blinking of eyes and heart rate; and physical changes measurement for example, drooping stance, leaning of the head of driver and the open/close conditions of the eyes.

2.5.1 EEG-BASED DRIVER FATIGUE DETECTION

EEG is a technique for measuring the electrical action created by the nerve cells of the human brain, basically the cortical movement. The fundamental inception of the EEG is the neuronal action in the cerebral cortex; however, some action likewise starts from the thalamus and from subcritical parts of the human brain. The EEG speaks to the summation of excitatory and inhibitory postsynaptic possibilities in the nerve cells. The movement is because of the synchronous actuation of the nerve cells. The drivers' fatigue detection system using EEG signals is proposed to avoid the road accidents usually caused due to drivers' fatigue. The proposed method firstly, finds the index related to different drowsiness levels. The system takes EEG signal as input which is calculated by a cheap single electrode neuro signal acquisition device. To evaluate the proposed method, data set for simulated car driver under the different levels of drowsiness is collected locally. And result shows that the proposed system can detect all subjects of tiredness.

DISADVANTAGES:

1. High cost
2. Sensors Required
3. Can't see behind objects
4. Takes longer time

2.5.2 WAVELET ANALYSIS OF HEART RATE VARIABILITY & SVM CLASSIFIER

Li and Chung proposed the driver drowsiness detection that uses wavelet analysis of Heart Rate Variability (HRV) and Support Vector Machine (SVM) classifier. The basic purpose is to categorize the alert and drowsy drivers using the wavelet transform of HRV signals over short durations. The system firstly takes Photo Plethysmography (PPG) signal as input and divide it into 1- minute intervals and then verify two driving events using average percentage of eyelid closure over pupil over time (PERCLOS) measurement over the interval. Secondly, the system performs the feature extraction of HRV time series based on Fast Fourier Transform (FFT) and wavelet. A Receiver Operation Curve (ROC) and SVM classifier is used for feature extraction and classification respectively. The analysis of ROC shows that the wavelet-based method gives improved results than the FFT-based method. Finally, the real time requirements for drowsiness detection, FFT and wavelet features are used to train the SVM classifier extracted from the HRV signals. The performance of classification using the wavelet-based features achieve the accuracy of 95%, sensitivity to 95% and specificity to 95%. The FFT-based results achieve the accuracy of 68.85. The results show that waveletbased methods perform better than the FFT-based methods.

2.5.3 PULSE SENSOR METHOD

Mostly, previous studies focus on the physical conditions of drivers to detect drowsiness. That's why Rahim detects the drowsy drivers using infrared heart-rate sensors or pulse sensors. The pulse sensor measures the heart pulse rate from drivers' finger or hand. The sensor is attached with the finger or hand, detects the amount of blood flowing through the finger. Then amount of the blood's oxygen is shown in the finger, which causes the infrared light to reflect off and to the transmitter. The sensor picks up the fluctuation of oxygen that are connected to the Arduino as microcontroller. Then, the heart pulse rate is visualizing by the software processing of HRV frequency domain. Experimental results show that LF/HF (Low to high frequency) ratio decreases as drivers go from the state of being awake to the drowsy and many road accidents can be avoided if an alert is sent on time.

2.5.4 WEARABLE DRIVER DROWSINESS DETECTION SYSTEM

Mobile based applications have been developed to detect the drowsiness of drivers. But mobile phones distract the drivers' attention and may cause accident. To address the issue, Leng proposed the wearable-type drowsiness detection system. The system uses self designed wrist band consists of PPG signal and galvanic skin response sensor. The data collected from the sensors are delivered to the mobile device which acts as the main evaluating unit. The collected data are examined with the motion sensors that are built-in in the mobiles. Then five features are extracted from the data: heart rate, respiratory rate, stress level, pulse rate variability, and adjustment counter. The features are moreover, used as the computation parameters to the SVM classifier to determine the drowsiness state. The experimental results show that the accuracy of the proposed system reaches up to 98.02 %. Mobile phone generates graphical and vibrational alarm to alert the driver.

2.5.5 WIRELESS WEARABLES METHOD

To avoid the disastrous road accidents, Warwick proposed the idea for drowsiness detection system using wearable Bio sensor called Bio- harness. The system has two phases. In the first phase, the physiological data of driver is collected using bio-harness and then analyzes the data to find the key parameters like ECG, heart rate, posture and others related to the drowsiness. In the second phase, drowsiness detection algorithm will be designed and develop a mobile app to alert the drowsy drivers.

2.5.6 DRIVER FATIGUE DETECTION SYSTEM

Chellappa presents the Driver fatigue detection system. The basic of the system is to detect the drowsiness when the vehicle is in the motion. The system has three components: external hardware (sensors and camera), data processing module and alert unit. Hardware unit communicates over the USB port with the rest of the system. Physio- logical and physical factors like pulse rate, yawning, closed eyes, blink duration and others are continuously monitored using somatic sensor. The processing module uses the combi- nation of the factors to detect drowsiness. In

the end, alert unit alerts the driver at multiple stages according to the severity of the symptoms.

2.5.7 HYBRID APPROACH UTILIZING PHYSIOLOGICAL FEATURES

To improve the performance of detection, Awai's proposed the hybrid method which integrates the features of ECG and EEG. The method firstly extracts the time and frequency domain features like time domain statistical descriptors, complexity measures and power spectral measures from EEG. Then using ECG, features like heart rate, HRV, low frequency, high frequency and LF/HF ratio. After that, subjective sleepiness is measured to study its relationship with drowsiness. To select only statistically significant features, t-tests is used that can differentiate between the drowsy and alert. The features extracted from ECG and EEG are integrated to study the improvements in the performance using SVM. The other main contribution is to study the channel reduction and its impact on the performance of detection. The method measures the differences between the drowsy and alert state from physiological data collected from the driving simulated-based study. Monotonous driving environment is used to induce the drowsiness in the participants. The proposed method demonstrated that combining ECG and EEG improves the performance of system in differentiating the drowsy and alert states, instead of using them alone. The analysis of channel reduction confirms that the accuracy level reaches to 80% by just combining the ECG and EEG. The performance of the system indicates that the proposed system is feasible for practical drowsiness detection system

2.6 CURRENT EXISTING SYSTEM

The current drowsiness detection systems include the usage of the devices that detect the respiration rate, heart rate, blood pressure, etc. These devices can cause the driver to be uncomfortable for driving. Cannot be assured that he drivers wear these devices all the time while driving. May get lost or improper functioning which may lead to low accuracy in the result. The existing system does not produce good results in low light conditions. If the light conditions are dark or too low it is unable to detect the face and eyes of the driver which results in lower accuracy.

3. METHODOLOGY

3.1 STUDY OF DROWSINESS

Sleep represents the inherent cyclical state of rest for both the mental and physical health. During this phase, individuals eyes will be closing often, experiencing partial or complete unconsciousness, thereby diminishing their responsiveness to external stimuli. Sleep is not a discretionary activity; rather, it is an essential and unavoidable process vital for bodily rejuvenation and energy restoration. The term "microsleep" or "drowsiness" denotes short and brief description of sleep intrusion that may occur at any moment, often triggered by fatigue or prolonged cognitive effort. These microsleep episodes, lasting a few seconds, entail the brain entering a swift and uncontrolled sleep state, posing significant hazards, 2 particularly in contexts like driving or situations requiring concentrated attention. Indicators of diminished wakefulness in drivers include frequent yawning, repetitive blinking, difficulty in opening eyes, an inability to concentrate, head deviation, a wandering mind, sensations of fatigue, and impaired vision.

3.2 REQUIREMENT ANALYSIS

3.2.1 HARDWARE REQUIREMENTS

1. Processor: Intel Corei3.
2. RAM: 8 GB RAM
3. Hard Disk: 100 GB
4. Web cam / In-built laptop camera
5. Sound system

3.2.2 SOFTWARE REQUIREMENTS

Anaconda Navigator: Anaconda navigator is a graphical consumer interface (GUI) this is blanketed within the anaconda distribution, permitting you to effortlessly release packages and control conda applications, environments and channels without the use of command- line commands. Navigator can look for applications in anaconda. Org or the nearby anaconda repository. It's miles to be had for windows, macOS and Linux.

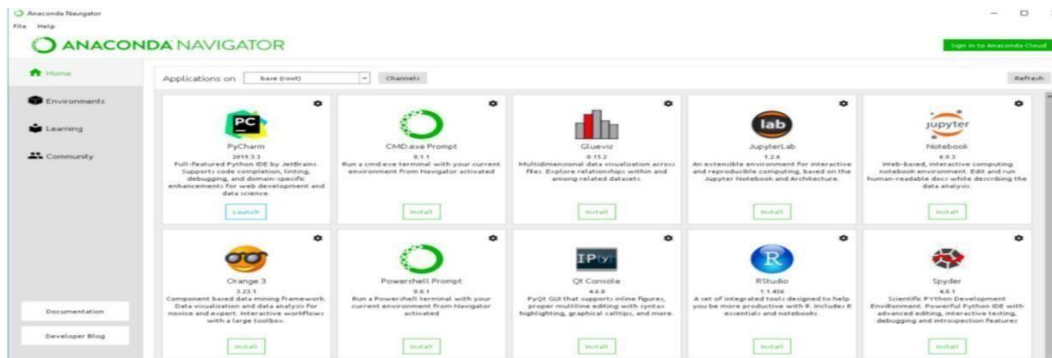


Fig 3.1 Anaconda home tab

Jupyter Notebook: The jupyter notebook expands the console-primarily based approach to interactive computing in an approximate. new route, dispensing a bendy internet- primarily based application to capture the whole computing method: enlarging, logging and applying code, as well as speaking outcomes.

The jupyter pocket book combines two elements:

- 1.A web application
- 2.Notebook documents

Python 3: Python is the basis of the program that we wrote in the system. It utilizes many of the python libraries

3.2.3 FUNCTIONAL REQUIREMENTS

D-lib: D-lib is a toolkit for growing actual-world device gaining knowledge of and records analysis packages. It is used to become aware of the face and to mark the facial landmarks which may be used for a wide array of functions. The frontal face detector on the d-lib works properly.

Open CV: OpenCV is a library the usage of which we will broaden actual-time computer vision programs. It in particular used for photo processing, video seize and assessment in conjunction with capabilities like face detection and object detection. OpenCV is the big open-supply library Used for laptop imaginative and prescient and also system gaining knowledge of and image processing and now it plays a prime function in actual-time operation which can be very critical in current systems.

Operating System: An operating system, or "os" is software program that interacts with the hardware and permits one-of-a-kind applications to run. Every laptop pc, pill, and cellular telephone consists of an operating system that gives simple functionality for the device. Common desktop jogging structures consist of home windows, os x, and Linux.

Pygame: Pygame is an open-source cross-platform library for the improvement of multimedia packages like video games made using python. It uses the clean direct media layer library and several different famous libraries to abstract the most common features. It includes cg and sound libraries and it's intended for use with python.

NumPy: NumPy is a library that deals with massive multi-dimensional arrays and matrices. It does high-stage mathematical paintings on these mathematical systems. The NumPy array is a widespread data shape for handling images, filter kernels and function factors.

SciPy: SciPy is an open-source python library that is used to clear up scientific and mathematical problems. It is constructed at the NumPy extension and allows the user to control and visualize statistics with a large range of excessive-level commands.

Imutils: Imutils are a sequence of functions used to make fundamental photo processing functions which incorporates translation, rotation of images, resizing images, skeletonization, and displaying matplotlib pictures much less complex with OpenCV and each python 2.7 and python .3. It also helps in sorting contours and detecting edges.



Fig 3.2 Functional Requirements

3.3 PROPOSED MODEL

The drowsiness detection system assesses the driver's alertness by analyzing the eyes and facial landmarks. Initially, face recognition is conducted to identify eye blinks, allowing the system to recognize the driver's eyes. Subsequently, the system calculates the speed of eye blinks and generates an appropriate output. The Enhanced Drowsiness Detection (EDD) algorithm, utilizing the HAAR cascade method with OpenCV, is employed for human face detection. Leveraging the fact that human eyes appear darker and the nose brighter, the HAAR cascade technique is applied to extract facial information. This method accurately identifies the eye's position in the human dimension. The system continuously monitors the driver's face until activity ceases, employing the mean shift method to determine the image centre for image distribution, contributing data on a plane. Attaining the detailed section of the image requires determining the position and radius of the image. For eye detection, the open-source library Dlib is employed, enabling the identification of blinks and the calculation of the eye aspect ratio. The system sets a threshold of 0.3 for the eye aspect ratio, considering the eyes open when the threshold remains constant. If the threshold is reduced below 0.3, the system interprets it as a drowsy state.

3.3.1 IMPLEMENTATION PLAN OF THE PROPOSED MODEL

Positive and negative images are captured and fed into the system for processing. The Haar cascade, an object detection algorithm proposed by Viola and Jones in the paper "Fast Object Detection Using a Boosted Cascade of Simple Features" in 2002, is employed in machine learning. The system is trained using sets of positive and negative images, and this training involves uploading data into the system. Once trained, the system can then detect various objects in different images. OpenCV provides pre-trained cascade algorithms categorized based on the images they were trained on, aligning with our specific model requirements. The dataset is divided into training and testing sets, allocating 80% for training and the remaining 20% for testing. To enhance user-friendliness, a Graphical User Interface (GUI) is incorporated using tkinter.

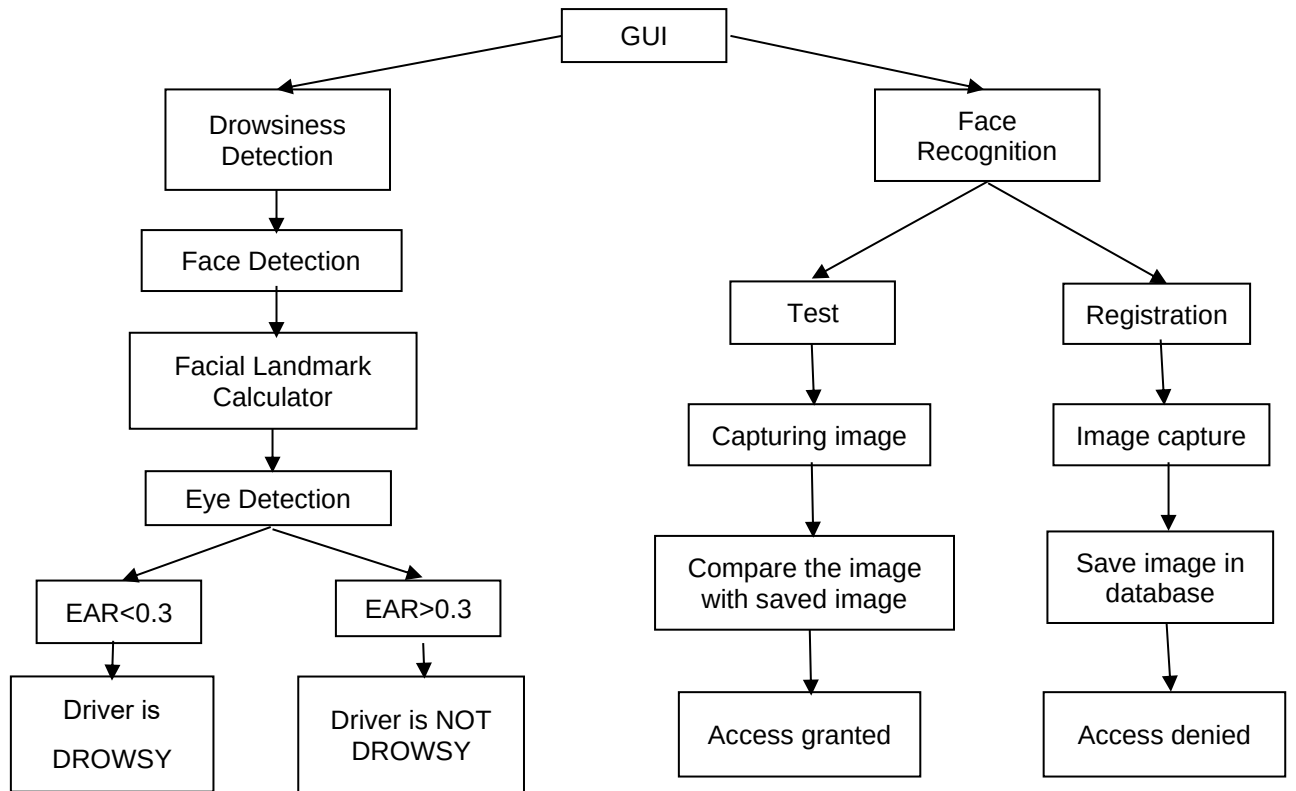


Fig 3.3 Component process flow

3.3.2 DROWSINESS DETECTION AND PREDICTION BASED ON FACIAL LANDMARKS

The methodology proposed in this study draws inspiration from preceding research techniques. However, a drawback is identified in the fixed eye-opening threshold applicable to all drivers, introducing inaccuracies for individuals with either larger or smaller eyes. To address this limitation, we enhance the method by introducing the adaptive eye-opening threshold (EARThresh) personalized for each and every driver. The proposed method's model is depicted in below Figure 3.4.

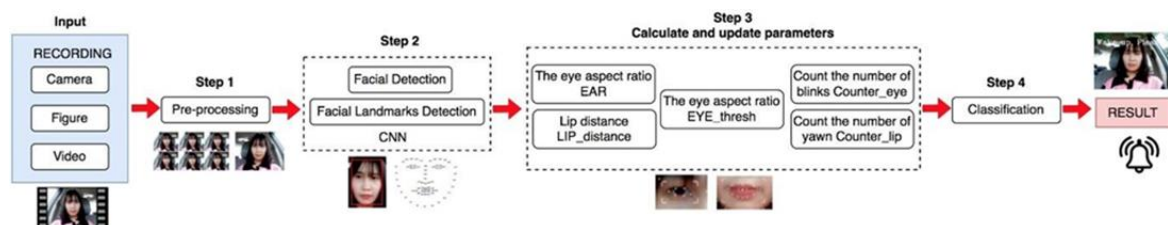


Fig 3.4 System architecture for EDD(Enhanced Drowsiness Detection)

Initially, both EAR (Eye Aspect Ratio) and EARThresh values are calculated for each driver. Subsequently, the level of drowsiness of the drivers is determined by comparing EAR and EARThresh. This iterative process is repeated throughout the driving duration. Importantly, yawning frequency is not relied by this method, ensuring accuracy even in scenarios where drivers wear masks or engage in conversation while driving.

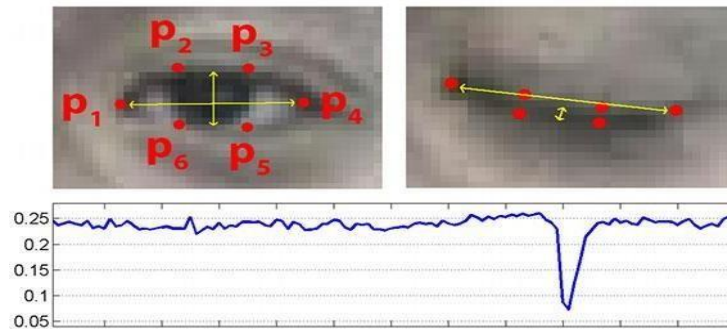


Fig 3.5 Eye landmarks and EAR

The second module is face recognition system. Here we're using object detection techniques in which features of faces will be captured. Positive and negative images are taken and we feed the data to the system. Haar cascade is an object detection set of rules which is utilized in gadget learning proposed via Paul viola and Michael jones the paper "fast object detection the usage of a boosted cascade of easy functions" in 2002. On this set of rules, the device is skilled by means of taking a couple of photos of the users. Right here we will be taking a fixed of high-quality photographs and a set of terrible photos which we are able to be importing the information in the device. It's far then used to detect different objects present in the other pictures. Here, OpenCV offers pre-trained haar cascade algorithms, that are organized into classes relying at the pictures which they are educated on as consistent with our required model. Right here the given dataset is split into testing and training out the model. We will consider 80% of data for training and remaining 20% of data into testing purposes. To represent the system and make the user easy to use, we are adding GUI (Graphical user interface) for the quality of appearance using tkinter.

3.3.3 FACIAL LANDMARKS IDENTIFICATION

Kazemi and Sullivan devised a method for precise facial landmark estimation using a labelled image training dataset. This real-time detection system identifies 68 key positions as the important facial points to be noted on human faces for facial landmarks detection, as depicted in following Figure 3.6

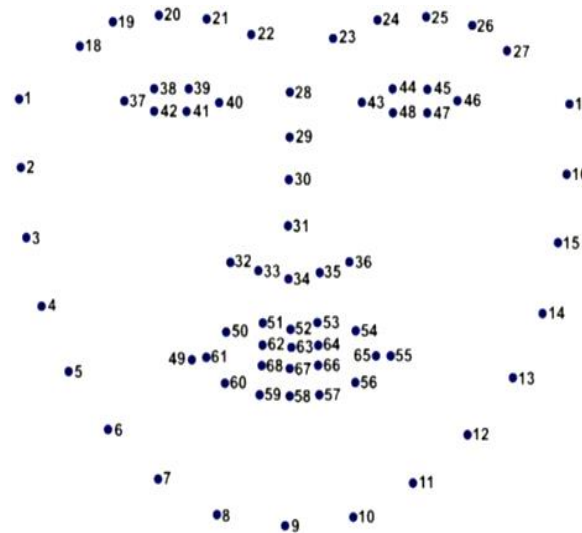


Fig. 3.6 Human face having 68 landmarks

Table 3.1 – Areas of 68 landmarks on human face

Facial Components	Point Region
Left jaw line	1 – 8
Chin	9
Right jaw line	10 – 17
Left eyebrow	18 – 22
Right eyebrow	23 – 27
Bridge of nose	28 – 31
Bottom of nose	32 – 36
Left eye	37 – 42
Right eye	43 – 48
Outer edge of lips	49 – 60
Inner edge of lips	61 - 68

In this model, we exclusively utilize 32 out of 68 facial points, specifically coordinates of both the mouth and eyes, to calculate the mouth-opening (lip distance) and Eye Aspect Ratio (EAR) for eye-opening that is described in the above table.

3.3.4 DETECTION OF BLINK

To ascertain facial region positions, facial feature detection is employed, encompassing the mouth, nose, eyebrows, eyes and ears. Specific facial structures are extracted based on the index of particular face parts. Blink detection focuses on eye features, with each eye represented by six coordinates, as depicted in Figure 3.7, originating from the eye at it's left corner and proceeding clockwise direction around the surrounding area.

$$EAR = \frac{(|p_2 - p_6| + |p_3 - p_5|)}{(2|p_1 - p_4|)} \dots\dots(1)$$

In accordance with Soukupova and Cech, Equation (1) is formulated to represent the eye-opening value, where $p_1, \dots, p_6$ denote features on a two - Dimensional face. The given numerator in Equation (1) computes the vertical distance between eye feature points, while the calculated denominator value is the horizontal distance. The balancing of the denominator is appropriate here, given horizontal points of single set compared to the vertical points of two sets. The value of eye-opening distance remains relatively stable in the eye open state but rapidly decreases to zero(0) during blinks. The above approach eliminates the necessity for image processing techniques, relying instead on eye-opening values to identify blinking actions.

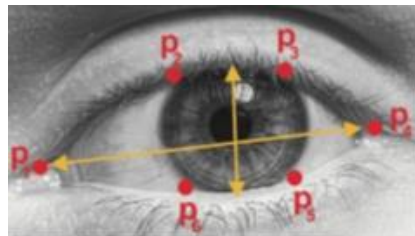


Fig. 3.7 Landmarks on eyes

3.3.5 DETECTION OF YAWNING

Yawning is characterized by the act of opening the mouth. Just like the process of detecting blinks, facial features are utilized to identify the opening of the mouth. The value of mouth-opening, serving as a parameter to gauge the degree of mouth opening, the calculation is done by subtraction of the mean of all points in the lower mouth to the mean of all points in the upper mouth, as defined in Equation (2).

$$LIP_{Distance} = | LIP_{Top} - LIP_{Low} | \quad \dots\dots(2)$$

If the computed mouth-opening value derived from the frames exceeds a pre-established threshold for mouth opening, it is recognized as yawning. An alarm is activated when an individual yawns for a duration surpassing a predefined threshold, with adjustments made for slight variations attributed to talking and eating.

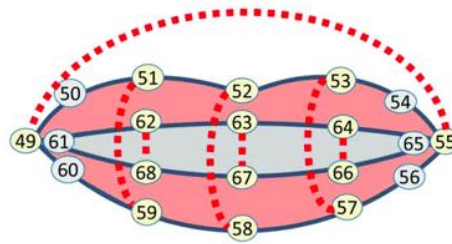


Fig 3.8 Landmark on lips

3.4 MODULES AND ANALYSIS

The modules the proposed system contain are:

1. Data pre-processing
2. Feature Extraction
3. Training the system

3.4.1 DATA PRE-PROCESSING

In the realm of face recognition systems, the efficacy of image processing during the preprocessing stage is paramount for ensuring accurate, most precise and reliable outcomes, especially when confronted with challenging environmental factors such as uncontrolled and varying lighting conditions. The images undergo

rigorous testing with the proposed algorithm, where preprocessing serves as the foundational stage in the development of any proficient face recognition system for the better solution.

The significance of preprocessing lies in its ability to enhance the quality and suitability of facial images for subsequent stages of analysis. Under uncontrolled and challenging lighting conditions, traditional face recognition systems may encounter difficulties in extracting meaningful features, leading to compromised performance. In response to these challenges, a novel and innovative preprocessing approach has been introduced. This novel preprocessing approach aims to address the specific intricacies posed by uncontrolled lighting conditions, acknowledging the dynamic nature of light in real-world scenarios. Unlike conventional methods, this new technique adapts to the nuances of challenging lighting environments, ensuring that facial features are extracted with precision and robustness. By doing so, it lays a solid foundation for subsequent stages of the face recognition pipeline.

The proposed preprocessing method is designed to mitigate the impact of adverse lighting conditions, allowing the face recognition algorithm to operate more effectively and deliver reliable results thus providing accurate system solution. This innovation is particularly crucial in scenarios where conventional systems might falter, such as in surveillance applications where lighting conditions can be unpredictable.

As a testament to the effectiveness of this preprocessing technique, the images are rigorously tested, and then it is validated for its capability to improve the performance of the face recognition system. This approach not only contributes to the accuracy of facial feature extraction but also showcases adaptability to diverse and challenging real-world settings. Ultimately, the integration of this novel preprocessing methodology represents a significant stride in advancing the robustness and applicability of face recognition systems under adverse lighting conditions.

3.4.2 FEATURE EXTRACTION

In our quest to develop an effective classification model for facial analysis, we strategically focused on harnessing information extracted from facial landmarks within video frames. This approach allowed us to capture dynamic facial expressions and movements, laying the groundwork for a sophisticated model. Through a series of hypotheses and rigorous testing, we systematically explored various facial features, aiming to identify those with the most significant impact on our classification objectives.

Amidst this exploration, four core features emerged as paramount for the success of our final models. The eye aspect ratio, a measure of the geometric relationship between key points around the eyes, became a cornerstone in gauging alertness and attention levels. Simultaneously, the mouth aspect ratio, capturing proportions around the mouth area, provided crucial insights into facial expressions indicative of drowsiness or attentiveness.

Our model's robustness was further augmented by the inclusion of pupil circularity, a feature that delves into the symmetry and regularity of pupil shape. This not only contributed to the model's ability to discern subtleties in eye movements but also enriched its understanding of overall alertness. Lastly, the ratio of mouth aspect to eye aspect emerged as a distinctive feature, offering a nuanced perspective on the interplay between facial components.

Eye Aspect Ratio (EAR) :

The EAR or Eye Aspect Ratio, is defined as the ratio of the length to the width of the eyes. The calculation involves averaging the measurements along two horizontal and two vertical lines across the eyes. Our hypothesis posited that when an individual is drowsy, their eyes tend to become smaller, and they are likely to blink more frequently and in the faster rate. Building on this hypothesis, our model was anticipated to predict the drowsy class if the EAR for an individual across successive frames decreased, indicating a trend of their eyes closing or blinking at a faster rate with which we can detect drowsiness.

3.4.3 TRAINING THE SYSTEM

In the intricate process of face recognition, the pivotal phase involves the training of the face recognizer to glean insights and patterns from a carefully curated dataset. To facilitate this learning process, we have meticulously crafted a labelled dataset, aptly named "dataset," tailored for our face recognition system. The utilization of OpenCV in Python is instrumental in this endeavour.

In the initial stages, the face identifier is trained using the pre-categorized dataset. The training process is executed through the execution of the "Trainer_in_the_same_folder.py" file, strategically located in the designated directory. Following the completion of the training, a dedicated folder named "Trainer" is created within the same directory. This folder serves as the repository where the trained face identifier is securely stored, ready to be employed for subsequent recognition tasks.

For the training and evaluation of our drowsiness detection system, we utilized the "shape_predictor_68_face_landmarks" dataset, meticulously trained based on the comprehensive ibug 300-w dataset, known for its extensive coverage of facial landmarks. This dataset integration enhances the accuracy of our drowsiness detection model, allowing it to discern subtle facial nuances associated with drowsiness or alertness. This approach, combining a specialized face recognition dataset and a curated dataset for drowsiness detection, reflects our commitment to leveraging advanced techniques and robust datasets to improve the performance and reliability of our facial analysis systems. The combination of Python, OpenCV, and well-structured datasets is fundamental to our efforts in building sophisticated solutions in facial recognition and drowsiness detection.

3.4.4 DEEP NEURAL NETWORKS FOR DROWSINESS PREDICTION

Taking advantage of deep learning techniques, we apply deep neural networks with MobileNet-V2 and ResNet-50V2 for driver drowsiness detection. A detailed description of the network architectures and an analysis of their advantages is presented as follows.

MOBILENET-V2 NETWORK

MobileNet-V2 is a significant improvement over MobileNet-V1, enhancing image recognition capabilities on mobile devices including classification, object detection, and semantic segmentation. Figure 3.9 illustrates the MobileNet-V2 network architecture. Overall, MobileNet-V2 models are faster with the same accuracy across the entire latency spectrum, using 2 times fewer operations, 30% fewer parameters, and being 30–40% faster than MobileNet-V1. MobileNet-V2 has the advantages of being fast, lightweight, and having high accuracy, which makes it suitable for training with limited datasets. MobileNet-V2 is trained on datasets such as ImageNet, COCO, and VOC, and has been applied in object classification such as Fruit Image Classification and Flower Classification with accuracy up to 85.12% and 96%, respectively. With these advantages and practical results, we decided to choose MobileNet-V2 for drowsiness prediction. Besides, we would like to apply this network to build a mobile application for driver drowsiness detection while driving.

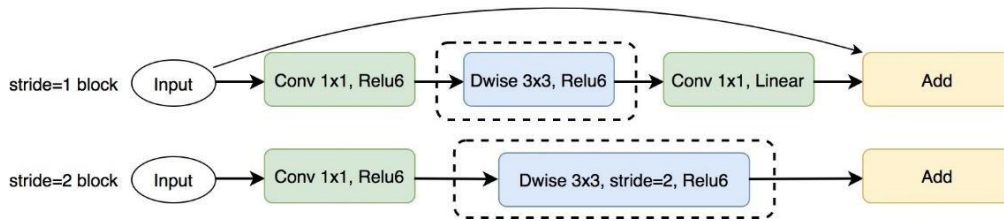


Fig 3.9 Illustration of MobileNet-V2 network architecture.

ResNet NETWORK

ResNet won the ImageNet Large Scale Visual Recognition Competition in 2015 for image classification, object localization, and object detection. The main challenge in training deep learning models is that the accuracy decreases with the depth level of the networks. ResNet converges very quickly and can be trained with hundreds or thousands of layers. At the same time, ResNet is easy to optimize and can achieve accuracy gains from greatly increased depth, producing better results. ResNet-50V2 was trained on ImageNet and CIFAR-10 datasets. The ResNet-50V2 network architecture is shown in Figure 3.10. The results show that ResNet-50V2 performs better and gives better results than ResNet50 and ResNet101 on the same ImageNet dataset. ResNet-50V2 applies the transfer learning technique with

ImageNet pre-trained weights, which are used in object classification, such as COVID-19 and pneumonia detection from chest X-ray images and video classification with accuracy up to 94–98%. Taking advantage of ResNet-50V2, we choose this architecture as the training model for drowsiness detection of driver that is described below.

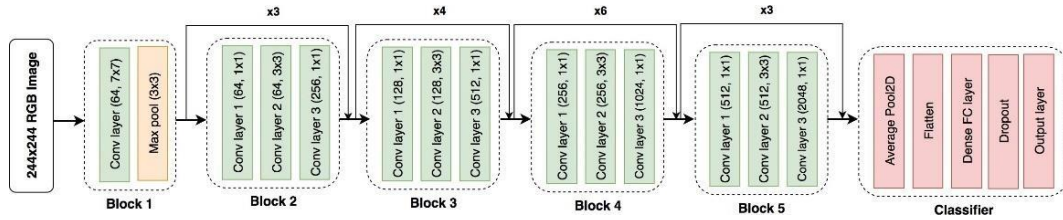


Fig 3.10 Illustration of ResNet-50V2 network architecture.

3.5 FLOW OF METHODOLOGY

In the first module i.e., Drowsiness detection System. This system detects whether the driver is drowsy or not by considering eyes and facial landmarks. The first step to it is to perform face recognition in order to detect blink of an eye, where the system recognizes the driver's eyes and then calculates the speed of eye blink and provides an appropriate output. HAAR cascade method uses OpenCV to detect the human faces. Human eye is dark in color and the nose is bright in color. Hence haar cascade technique is used for extracting the face information using OpenCV. This method recognizes the position of the eye on the human dimension. In the system the face is monitored continuously till he/she stops the functioning of it. The mean shift method is used for finding the center of image for image distribution, where the data is contributed on a plane. To achieve the dense part of the image, we must obtain the position and radius of the image. Eye detection, Dlib is the opensource library used for detecting the blink and also calculating the eye aspect. ratio where the eye aspect ratio has the threshold of 0.3 if the threshold is constant than system consider as the eyes are open, if the threshold value is decreased from 0.3 than system will consider as the drowsy state.

3.6 DATA COLLECTION

The dataset is either collected or generated according to our proposed model. The effectiveness of machine learning hinges entirely on the quality and quantity of the data; a larger dataset enhances the system's intelligence. Various algorithms can be employed for model training, and having ample data contributes to increased training and accuracy. Distinct datasets are utilized to train new models. In the case of the initial model, a drowsiness detection system, image data is sourced from Kaggle, an open-source platform offering datasets. The dataset for this model comprises two categories: images depicting open eyes and images depicting closed eyes.

In the second model, the face recognition system is designed for security applications to detect the driver's face. The dataset consists of captured facial images of individuals for authentication purposes. Live images can also be used to train the model, enhancing system accuracy. The model collects and stores images of various drivers in categorized folders, serving as labeled datasets. The dataset's pivotal role is evident in training the model, influencing accuracy, efficiency, reliability, and overall system capabilities. The system's ability to generate precise results is contingent on the size and quality of the uploaded data.

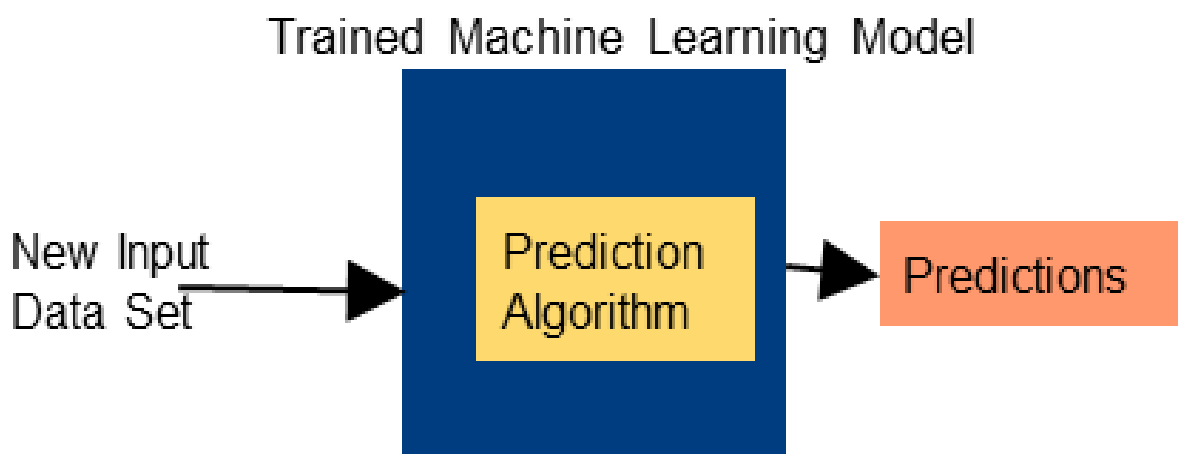


Fig 3.11 Working of a dataset

4. RESULTS AND DISCUSSION

In this application, the system states the combination of two different models: face recognition and drowsiness detection. The purpose is to ensure the safety and security of the driver. Firstly, the application loads a user interface window. In this screen the user is able to enter their details. Here the user indicates the driver. The driver is requested to enter the details such as;

- Name
- Email
- Driver License Number
- Date of Birth

The details will be stored for the emergency purpose where the driver plays the vital role for the application. The picture example for the first user interface screen is shown in below figure 4.1



Fig. 4.1 User Interface for entering details

The model retrieve user data through the input console, such as Name, Email, License Number, and Date of Birth as mentioned above. When the driver click the submit button, the data will be displayed on the output console below the same interface. All the details that are entered by the driver which is stored in the database is displayed for the concern to check their details for the confirmation. They can even enter their details again if the displayed details were wrong. Now the user will be given by an option to start the detection. Here the start detection is an option provided as a clickable button as shown in figure 4.2.



Fig. 4.2 User interface after entering details

After entering the details successfully, user will be clicking on start detection button for enabling the Drowsiness Detection model. Once the user starts the model the output screen will be displayed as shown in figure 4.3 where the camera captures the face of the driver to detect whether he/she is drowsy or not. Once the screen starts displaying the image that captures shows the face with pointing the 68 - facial points with green colour.

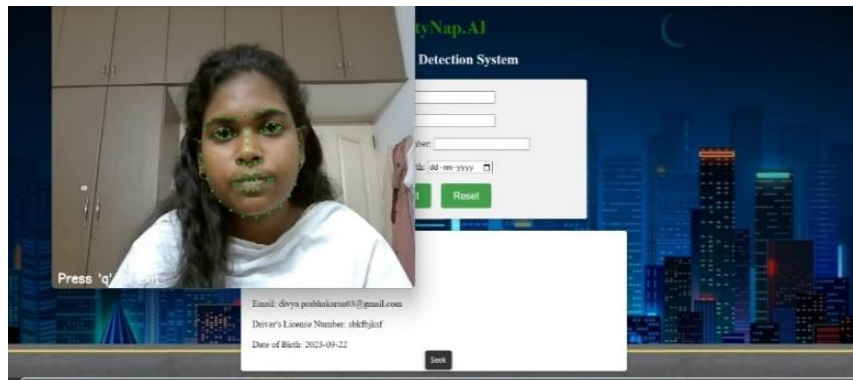


Fig. 4.3 Output window and face detection

The drowsiness of the driver has been detected using the specified 68 face points in the real – time while the driver is driving. The eye points and lip points are the important points for the detection of drowsiness of driver. Even if all the 68 facial points are displayed. Once the model detects the drowsiness, it displays an alert message to user as ***“ALERT : Drowsiness detected! Wake Up plz”*** as shown in following figure 4.4.

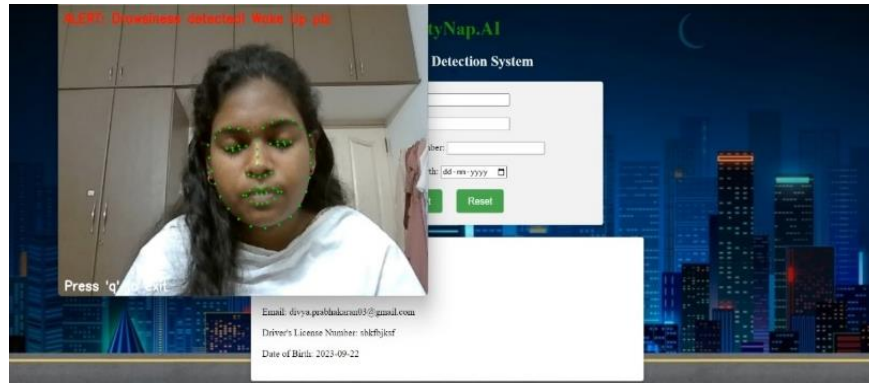


Fig. 4.4 Output window and drowsiness detection

5.1 TEST CASES AND TEST RESULTS

The model has been analysed by a custom set of test cases and conditions and obtained the expected results. The cases and conditions are based on face state and glasses which is mentioned in table 2.

The test cases are,

1. NTGY – ‘NO’ tilted face, Glasses ‘YES’
2. YTGN – ‘YES’ tilted face, Glasses ‘NO’
3. YTGy - ‘YES’ tilted face, Glasses ‘YES’

Table 4.1 – Test cases and Test results

Test ID	Test Case Title	Test Condition	System Behaviour	Expected Result
T01	NTGY	Straight face, Good light, With glasses	Not drowsy	Not drowsy
T02	YTGN	Tilted face, Good light, With no glasses	Drowsy	Drowsy
T03	YTGy	Tilted face, Good light, With glasses	Drowsy	Drowsy

5. CONCLUSION

In our pursuit of enhancing driver safety, we have meticulously measured key parameters to develop two distinct yet complementary models. The first model addresses the critical issue of drowsiness detection, incorporating an alert system designed to safeguard the driver. When signs of drowsiness persist for more than 3-4 seconds, the system triggers an alarm, prompting the driver to remain alert or take a break. This proactive approach holds immense potential to prevent road accidents and reduce fatalities resulting from drowsiness-related incidents.

Simultaneously, our second model harnesses the power of facial recognition to fortify the security of the vehicle. By detecting the driver's face, this system provides secure access, mitigating the risk of unauthorized use or theft. The integration of facial recognition technology not only enhances vehicle security but also adds an additional layer of authentication, ensuring that only authorized individuals can operate the vehicle.

The implementation of the drowsiness detection system is envisaged on a broader scale, envisioning its deployment in every vehicle. This strategic approach aims to significantly mitigate the occurrence of road accidents attributed to driver fatigue, contributing to an overall reduction in the loss of human lives.

As we witness the exponential growth of AI techniques, the potential for making our systems more intelligent and responsive to real-time demands becomes increasingly apparent. By introducing diverse models and leveraging a spectrum of algorithms, we can optimize our solutions to yield the best possible results. This is particularly relevant in countries like India, where road accidents are unfortunately common, often resulting from minor lapses in attention. Embracing intelligent systems equipped with drowsiness detection and facial recognition capabilities holds the promise of not only curbing road accidents but also safeguarding vehicles from theft, making our roadways safer and more secure.

5.1 OPEN CHALLENGES

Looking ahead, as we strive to enhance our existing drowsiness detection models, the possibilities for improvement are significant. By harnessing advanced features, we can substantially improve both the accuracy and efficiency of our systems. One pivotal addition that warrants consideration is the incorporation of zoom-in capabilities. Zoom-in capabilities would empower our system to predict drowsiness with even greater accuracy by honing in on specific regions of interest, such as the eyes. The eyes are well-established as crucial indicators of drowsiness, with subtle changes in movement and behavior providing invaluable insights into the driver's alertness level. By directing the focus of our detection algorithms towards these critical features, we can extract more nuanced data and make more precise predictions regarding the driver's state of alertness. This refinement is particularly pertinent in light of the continuous evolution of technology and AI techniques. As our understanding of machine learning and computer vision advances, so too does our ability to extract meaningful insights from complex data sources. By leveraging zoom-in capabilities, we can capitalize on these advancements to elevate the overall efficiency of our drowsiness detection systems. In essence, incorporating zoom-in capabilities represents a strategic investment in the ongoing refinement of our models. By sharpening our focus on the most pertinent indicators of drowsiness, we can enhance the accuracy of our predictions and, by extension, improve the overall safety of the driving experience. Some of the major advancements can be given as open challenges that are mentioned below.

1. Specialized Eye Capture:

- Transitioning to capturing only the eyes of the driver allows for more focused data processing, reducing computational load and potentially improving processing speed.
- By concentrating on the eyes, which are critical indicators of drowsiness, the system can achieve higher accuracy in detecting signs of fatigue or distraction.

- This specialized approach ensures that the system prioritizes the most relevant facial features for drowsiness detection, optimizing resource utilization and enhancing overall performance.

2. Integration of Additional Safety Features:

- Verification of seat belt usage adds an extra layer of safety by ensuring that drivers are properly restrained, reducing the risk of injury in the event of a collision.
- Addressing security-related concerns could involve features such as detecting unauthorized access to the vehicle or alerting authorities in case of theft or vandalism.
- Implementing a vehicle maintenance system helps drivers stay proactive about vehicle upkeep, reducing the likelihood of mechanical failures that could lead to accidents.
- These safety-oriented components not only enhance the safety aspect of the system but also contribute to a more comprehensive approach to improving the overall driving experience.

3. Refinement of Drowsiness Detection with Mouth Aspect Ratio (MAR):

- Incorporating mouth region detection and MAR calculation enhances our drowsiness detection system's ability to discern driver fatigue by analyzing patterns of frequent yawning. This feature provides a deeper understanding of fatigue indicators, particularly valuable for capturing subtle signs of drowsiness that may not be immediately apparent through other metrics alone.
- Implementing a predefined threshold for MAR values allows our system to issue timely alerts upon detecting signs of drowsiness. By establishing clear criteria for MAR levels associated with fatigue, we can proactively notify drivers to take preventive measures, such as resting or alternating drivers, thereby reducing the risk of accidents caused by drowsy driving.
- The integration of MAR analysis adds a layer of sophistication to our drowsiness detection model, enhancing its ability to accurately identify and respond to driver fatigue. By combining multiple indicators, including eye

movements, facial expressions, and now mouth activity, our system becomes more comprehensive and effective in ensuring road safety. This refinement underscores our commitment to advancing technology for the protection and well-being of all road users.

4. Night Vision Camera Upgrade:

- Upgrading cameras with night vision capabilities ensures reliable drowsiness detection even in low-light conditions, such as during nighttime driving or in poorly lit environments.
- Night vision cameras enhance the system's ability to operate effectively in challenging lighting situations, maintaining consistent performance regardless of external factors.
- This upgrade significantly improves the system's reliability and ensures that drowsiness detection remains effective in all driving conditions, further enhancing overall safety for drivers.

5. Continuous Improvement and Innovation:

- The future trajectory involves ongoing optimization and integration of advancements in technology to make the system more robust, accurate, and attuned to various aspects of driver safety.
- By continuously expanding the feature set and embracing innovations, such as AI-driven improvements or sensor technology enhancements, the system can evolve into a comprehensive safety ecosystem for drivers.
- This commitment to continual improvement sets the stage for a safer and more secure driving experience, demonstrating a dedication to enhancing road safety through technological innovation.

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APPENDICES

Sample Code

app.py :

```
from flask import Flask, jsonify
from threading import Thread
from imutils import face_utils
import dlib
import cv2
from pygame import mixer
import threading
import sys

thres = 6

mixer.init()
sound = mixer.Sound('sound file\\alarm.wav')

dlist = []

detector = dlib.get_frontal_face_detector()
predictor = dlib.shape_predictor("shape_predictor_68_face_landmarks.dat")

cap = cv2.VideoCapture(0)

def dist(a,b):
    x1,y1 = a
    x2,y2 = b
    return ((x1-x2)**2 + (y1-y2)**2)**0.5

# Define a flag variable to stop the detection loop
detection_running = False

def detect_faces():
    global detection_running

    while detection_running:
        # Getting out image by webcam
        _, image = cap.read()
        # Converting the image to gray scale
        gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)

        # Get faces into webcam's image
        rects = detector(gray, 0)
```

```

# For each detected face, find the landmark.
for (i, rect) in enumerate(rects):
    # Make the prediction and transform it to numpy array
    shape = predictor(gray, rect)
    shape = face_utils.shape_to_np(shape)

    # Draw on our image, all the finded coordinate points (x,y)
    for (x, y) in shape:
        cv2.circle(image, (x, y), 2, (0, 255, 0), -1)

    le_38 = shape[37]
    le_39 = shape[38]
    le_41 = shape[40]
    le_42 = shape[41]

    re_44 = shape[43]
    re_45 = shape[44]
    re_47 = shape[46]
    re_48 = shape[47]

    dlist.append((dist(le_38,le_42)+dist(le_39,le_41)+dist(re_44,re_
48)+dist(re_45,re_47))/4<thres)
    if len(dlist)>10:
        dlist.pop(0)

    # Drowsiness detected
    if sum(dlist)>=4:
        try:
            sound.play()
            cv2.putText(image, "ALERT: Drowsiness detected! Wake Up
plz", (10, 30), cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 0, 255), 2)
        except:
            pass
    else:
        try:
            sound.stop()
        except:
            pass

    # Show the image
    cv2.putText(image, "Press 'q' to exit", (10, 470),
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (255, 255, 255), 2)
    cv2.imshow("Output", image)

    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

```

```

from flask import Flask, jsonify, render_template
from threading import Thread

app = Flask(__name__)

# Define a flag variable to stop the detection loop
detection_running = False

# Define a function to start the detection loop
def start_detection():
    global detection_running
    detection_running = True
    detect_faces()

# Define a function to stop the detection loop
'''def stop_detection():
    global detection_running
    detection_running = False'''

@app.route('/')
def home():
    return render_template('index.html')

@app.route('/start')
def start():
    # Start a new thread to run the detection loop
    thread = Thread(target=start_detection)
    thread.start()
    return jsonify({'message': 'Detection loop started successfully!'})

'''@app.route('/stop')
def stop():
    # Stop the detection loop
    stop_detection()
    return jsonify({'message': 'Detection loop stopped successfully!'})'''

if __name__ == '__main__':
    app.run(debug=True)

```

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