DETECTION OF DRIVERS' DROWSINESS

A
PROJECT REPORT

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY
IN
ELECTRONICS AND COMMUNICATION ENGINEERING

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DECLARATION

We hereby declare that the work that has been reported in the B. Tech Project Report under the title **"Detection of Drivers' Drowsiness"** submitted to the Department of Electronics and Communication Engineering, Jaypee University of Information Technology (JUIT), Waknaghat is an authentic record of the work carried out under the supervision of **Dr. Nafis Uddin Khan.** We also assure that this work has not been submitted any where else for any other degree or diploma.

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This is to certify that the above statement made by the candidates is correct to best of my knowledge.

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Date: 30/05/2020

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ABSTRACT

Driverfatigueisconsideredoneofthevitalcauseoftheroadmishapsthatoccurthatcausesdeathsin theworld.Thustodealwithitwehavetocomeupwithasystemthatdetectsthedrivers'fatigueand alertsthem.Hereinwetriedtocomeupwithaprototypethatwouldhelpinthedetectionandalarming the driver when drowsy. This framework works by observing the eyes also identifying the mouth shape(yawns)ofthedriverandsoundinganalertwhenhe/sheissleepy.

Inthissystemwemadeuseofthenon-intrusiveapproachwhichmonitorsthesubjectinreal-time.The need is on improving the security of the driver without intruding their personal space. In this project theflickeringofaneyeaswellasthemouthshape(yawn)oftheoperatorareobserved,whereinifthe operator's eyes stayed closed for more than the threshold, or the operator is yawning or if both of themaredetectedatthesameinstancethenthedriverissupposedtobetiredandacautionissounded. The programming for this is finished using Python Language and OpenCV application is used for imageprocessingandViola–JonesAlgorithmhasbeenemployedthedetectionoffacialfeatures.

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CHAPTER 1
INTRODUCTION

As indicated by the statistics, more than one million people die annually and about and 30 to 60 million people are severely injured because of street mishaps. An investigation directed by the Central Road Research Institute (CRRI) expresses that depleted operators who portion off in the operator'sseatareanswerableforabout40%ofstreetmishapsinIndia.Inviewofthereportson300- km - Agra-Lucknow Expressway issued by the police, it has been evaluated that more than one lac conveyance that crashes every year are caused due to the sleepiness of the operators. These mishap have brought about roughly 1,760 deaths, 65,000 wounds. In the year 2009, it was evaluated that therewereabout45%ofoperatorsthathaveaconveyancewhilefeelingexhaustedandnearly25%of them have really dozed off causing mishaps. These are a some of the statistics that reveal that operator'lethargyisoneoftheimportantcauseofmishapsthattakeplaceonroads.

1.1 DrowsinessandMeasurestodetectit

Theterm"drowsy"canbecomprehendedasbeingtired,whichfurthercanbeexplainedasthestateof a person who has a tendency to fall asleep. The expression "lazy" is equal with tired, which essentially indicates a tendency to dozed off. The steps may be arranged as wakeful, non-fast eye development rest (NREM), and quick eye development rest (REM). The subsequent stage, NREM, canbepartitionedintotheaccompanyingthreesteps

The three steps can be described as follows:

StageI:Phaseincludingthechangeofawakestatetoasleepstate

Stage II: State of going intosleep

Stages III: State of being in sleep

Stage I, has been the most studied stage by the researchers, which is the lethargy phase. Various attributes that have been related to operator tiredness have been listed below :

- Occurlatearoundeveningtime(1am–5am)orduringmid-evening(2pm–5pm)
- Involve a solitary conveyance speeding offthe street
- Take place on rapidhighways
- Operator is frequentlylonely
- Operatorisfrequentlyayoungmale,14to27years
- Noslideimprintsorsignofslowingdown

According to the descriptions stated above, a Police Database used the following criterion to detect the mishaps, whose main cause was lethargy of the operator:

- Levelofalcoholinthebloodthatismorethanthespecifiedlimit
- Conveyance sped on anotherconveyance
- Notabletocontrolspeedofthevehicle
- Nosignofbadweatherconditionsandclearvisibility
- No distortion of theconveyance

Insights determined that even if we utilize these rules, it may be possible that it can't be accounted completelyformishapscausedbecauseofbeingtiredasaresultoftheintricacyinquestion;thusthis indicates that mishaps that may be ascribed to operator lethargy may be more obliterating than the measurements inform us. Henceforth, in order to stay far from these kinds of mishaps, it is essential toinferpowerfulmeasurestoperceivemotiveforcelaziness.

An operator who goes off to sleep at the any instant of time loses control of the conveyance, An activity which often brings approximately an twist of fate with either a few other car or constant objects. So the great manner to tackle this trouble is to test upon the state of the operator. The following measures have been widely used for this cause of checking the tiredness of the operator:

1. Conveyance-based measures— Measurements, such as that which includes checking of the deviations from the path position, non-steady movement of the wheels, pressure on the speedinguppedal,andmanymore,havebeenconstantlyobservedandanyalterationinthese that crosses a foreordained edge illustrates the possibility of the operator being in a state of drowsy.

2. Behavioral measures—The behavior of the operator, includes the gaping, eye closure, eye blinking, head pose, *etc.*, is monitored with the help of a camera and an alarm is put on so as toawaretheoperator,hintoflethargyareidentifiedbythesystem.

3. Physiological measures—The relationship between bodily signals such as the (electrocardiogram (ECG), electromyogram (EMG), electrooculogram (EoG) and electroencephalogram (EEG)) and operator lethargy have also been researched about to produceasystemtotacklewiththeproblemofdrowsyoperating.

These three are the main attraction to maintain an operators' lethargy detection system but , analysts haveadditionallyusedestimateswhereoperatorshavebeensolicitedtoratetheirlevelfromtiredness eitherbyexperienceorbyparticipatinginasurvey.Thepowerofsleepinessisresolveddependenton therating.

Almost all Operators' Lethargy Detection approaches have taken upon machine learning for categorizing the state of the drowsy operator. However, most of the above stated approaches are often limited to two or three models when evaluating their accuracy. With the eye state data, i.e. whether it is open, closed or partially closed, more than twenty models were developed which used

K-NearestNeighbours(KNN),SupportVectorsMachine(SVM),LogisticRegression,andArtificial Neural Networks (ANN) classifiers for classifying the eye states into awake or drowsy. On theother hand for detection of the operators' gaping it is mainly done by making use of the landmarkfeatures thathavebeenspecifiedforfaceoftheperson.

1.2 LiteratureSurvey

1.2.1 Non-intrusiveDriverDrowsinessDetectionbasedonFaceandEyeTracking

Objective:

There are many road mishaps that are credited to sleepy driving. Because of this, analysts have proposed a few techniques planned for distinguishing driver's tiredness. These strategies incorporate emotional, physiological, social, vehicle-based, and crossover strategies. In this paper we discuss the non-intrusive method of detection of driver drowsiness.

Methodology :

In this paper KamiliaKamardin, used the face and eyes to identify if the driver's eyes are opened or shut. A video dataset containing about 2 hours of driver sleepiness states captured during the day and night was studied.

On receiving the eye state data they were sent to AI models. This data was studied and classified as open or shut.. The last period of the operational arrangement is to survey the execution of the course of action models used during the investigation. To do this, the conventional disarray framework was utilized to make the positive and negative conjecture scores of each show and a short time later deduct a couple of introduction measures from those scores. Bits of knowledge concerning the disordered structure and the execution estimates concentrated on are depicted in the accompanying two fragments.

Conclusion:

To accomplish this arrangement, a few sorts of artistic works were looked into to comprehend the driver tiredness recognition environment. Nur Syazarin Natasha Abd Aziz , SurianiMohd Sam discussed an insignificant exertion plan and experimented on a mid-extend quality video dataset. After considering all the variables the accuracy of the system came out to be 70-75%. Likewise, the video feed required complex gear and taking care of intensity, any space due to which would achieve deadly outcomes. The quality of the video feed should be up to the mark, if this situation is not taken care of then deviation in results can be significant.

1.2.2 Fatigue Detection System Based on Eye Blinks of Drivers

Objective:

This paper focuses its research on detecting the drowsiness of the driver by making use of the EAR i.e. aspect ratio to decrease the accidents.. A. Aravind states that it will continue checking the eye blink of the driver and find whether he is feeling drowsy or not and if the system finds that the driver is drowsy, then an alert will be made. While driving a vehicle, it is critical for drivers to stay alert using any and all means times. This infers centering all over town as opposed to phones, explorers, and music players.

Methodology:

After checking the blinking ratio, Ayush Jaiswal states they locate the point of view extent of eyes and check status. It is checked whether the eyes are closed or open by making use of the Euclidean algorithm between the focal point of the eye, if the Eye Aspect Ratio is more than the set threshold then it is concluded that the eye is open. Here, they used the fact that an eye blink lasts 200-300 milliseconds and a drowsy person would keep blinking for 800-900 milliseconds. Finally steady the alert. If the apathetic time grows as far as possible then the alert will be made.

Conclusion:

This innovation will be a lot increasingly advantageous contrasted with the physiological signs. Aditya Agarwal discussed in this paper discussed that these structures it works with a precision of 80% which is definitely a very good alternative. Still there are a couple of limitations, such as the system is unable to detect the drivers face in low light or during night, other than that, if the driver turns his head then again it won't be able to recognize the face and eye centers and moreover, if the driver wears glasses, the system again can not detect the eyes easily. Regardless, the system has viably perceived the eye squints and laziness in sensible lightning and besides in the event that he wears a power glass. Another drawback that can be seen is that the system is not fit to recognise other parts such as yawn , head position, etc.

1.2.3 Driver Drowsiness Monitoring Based on Yawning Detection

Objective:

This paper also discuss the behavioural measures for the detection of the drowsiness of the driver. Here, it was proposed that detection of yawning i.e. the mouth geometric features can be put into use so as to make a drowsiness detecting system.

Methodology:

A camera is used to continuously record the face of the driver. Her firstly the face is detected and with the help of facial landmarks the mouth area is detected. The mouth geometrical features are then used to recognize the yawn. Yawning area is acted in two standard endeavours: in the underlying advance we separate the yawn part in the face self-governing of the mouth region. This part is in a general sense the hole in the mouth as the delayed consequences of wide mouth opening. In the second step we will use mouth region to affirm the authenticity of the recognized component. The greatest hole arranged inside the face is picked as the contender for a yawning mouth.

Conclusion:

They have applied the face identification method to more than 500 pictures with different properties. The photos are taken with various conditions, for instance, special light reflection and directional lightings. There are some restrictions, as when the driver is wearing a scarf around mouth area, different hair styles, etc. also contribute to errors in the detection of the drowsiness using this technique.

CHAPTER 2
METHODS FOR MEASUING DROWSINESS

There are numerous techniques given by the specialists to quantify operator fatigue. This specific segment gives a knowledge of the four generally used techniques, amongst which the principal approach that has been referenced is estimated either in words or via survey and the other methods from various sensors.

2.1 SubjectiveMethods

Subjectiveestimatesthatevaluatethelevelofdrowsinessrelyupontheadministrator'sownoneofa kindguessandvariousgadgetshavebeenusedtomakeanunderstandingofthisratingtoanextentof administrator lethargy. The most conventionally used dormancy scale is the Karolinska Sleepiness Scale(KSS),ascalewithninethathasverbalgrapplesforeverymovement,asexaminedinTable2.1, assessedtheKSSassessmentsofadministratorsevery5minanduseditasawellspringofviewpoint to the EoG signal accumulated. There have been many researches on this measure and int was concludedinoneofthereportthatitgivesresultoftheEEGapprovingoperatorlethargythroughboth asurveyandfromexperts.Afewanalystsmadeacomparisonaboutself-decidedKSS,thatwasbeing recordedeachtwominduringtheoperatingundertaking,withthevariationoflaneposition(VLP).

Table no. 2.1: Karolinska sleepiness scale (KSS)

Rating	Verbal Descriptions
1	Extremely alert
2	Very alert
3	Alert
4	Fairly alert
5	Neither alert nor sleepy
6	Some signs of sleepiness
7	Sleepy, but no effort to keep alert
8	Sleepy, some effort to keep alert
9	Very sleepy, great effort to keep alert, fighting sleep

It was found out that significant lane take-offs, flickering of eye and laziness linked with bodily indications are pervasive for KSS appraisals somewhere in the range of 5 and 9. In any case, the subjectiveratingdoesn'tcompletelymatchwithconveyance-based,bodilyandbehavioralmeasures.

The sudden change in the pattern of the operator are not easy to detect since the lethargy level of the person is detected at an interval of about 5 minutes. There is one more short coming to this method andthatis,self-examinationawarestheoperator,therebyreducingtheirlethargylevel.Also,thefact cannotbeoverlookedthatitisnoteasytogetthefeedbackfromthepersonwhowasoperatinginthe real life situations. Thus, it can be said that, though the subjective measures are important and resourceful in finding the level of sleepiness during simulations, but other methods can be more useful during the real lifeconditions.

2.2 Vehicular BasedMeasures

Secondmethodthathasbeenproposedtocomputethelethargyoftheoperatorandthiscanbedoneby making use of the data collected by the measurement that includes the conveyance. It has been seen thatthesemeasurementsaremostlydoneinenvironmentsthatarecomputingwiththehelpofsensors, which includes the steering wheel, accelerator etc. After the measurements signals are sent by the sensors are then these signals are used to find the lethargy level of the operator. There were several researches, that were conducted and it was concluded from them that sleep deprivation can bring in many factors that can affect the operatingspeed.

2.2.1 SteeringWheelMovement(SWM),asthenamesuggestsemploysthemeasurementswiththe helpofsteeringanglesensoranditshasbeenoneofthemostusedconveyance-basedmeasureforthe detection of the level of operator lethargy. In this degree we mount an angle sensor on the steerage column,whichpermitsustomeasuresteeragebehavioroftheoperatingforce.Whenthemotiveforce isinadrowsystate,thenumberofmicro-correctionsonthesteeragewheelreducesincomparisonto thenormaloperating,itwasalsofoundoutinsomeoftheresearchesthatthereversalmadebyatired operator was fewer in comparison to a normal operator. In this impact to lessen the impact of path changes, numerous looks into likewise viewed as just little directing wheel developments (somewhereintherangeof0.5°and5°),whichareutilizedtoadjustthesidelongsituationinsidethe path.HencebasedonlittleSWMs,ithasgottensimplertodiscoverthelazinessstateandalongthese lines in response to this produce a caution at the necessary time. In a replicated environment, light aspect winds that pushed the car to the proper side of the road were introduced alongside a curved road to be able to create variations in the lateral role and pressure the operators to make corrective SWMs. There are many companies of cars, along with Nissan and Renault, these companies have additionallymadeuseofSWMs,thoughtheirworkisverylimited.Thishasbeenbecauseofthefact thattheycanonlyfunctionreliablyatsomeenvironmentalconditionsandalsothatthesearewaytoo subjecttothegeometricattributesofthestreetinsteadofonthemotorqualitiesofthetransport.

2.2.2 StandardDeviationofLanePosition(SDLP)isalsooneofthemeasureswithwhosehelpwe candistinguishoperator’ssleepinesstosomeextent.Itisalsotestedinacomputingenvironment,and thesoftwarethatareusedforthisprovidestheSDLPandwhenfieldexperimentsaredone,theresults aregivenwiththehelpofexternalcamera,thusprovidingthepositionofthelane.Forexample,KSS ratings of 1, 5, 8, and 9 corresponded to SDLP measurements of 0.19, 0.26, 0.36 and0.47, respectively.Anaverageof20participantshelpedinthecalculationofthegivenparticipantsthough, itwasrecordedthatforsomeoftheoperatorstheSDLPdidnotgoovertherangeof0.25mevenifthe KSS rating was 9. After conducting the above experiment, a significant deflection is seen by performing correlation analysis on a subject to subject basis. There is yet one more shortcoming of SDLP,thatisthismethodistoomuchdependentonoutsidefactorslikemarkingoftheroad,climatic and lighting conditions. In conclusion it can be seen that the conveyance based measurements of detection of lethargy is not a very reliable measure. In addition to this vehicular-based metrics aren't specificallyforlethargydetection.SDLPhaslikewisebeenbelievedtobebroughtaboutbyothersort ofrashoperating,whichincorporatesalcoholicoperatingandsoon.

2.3 BehaviouralMeasures

Tableno.2.2:List of previous works on driver drowsiness detection using behavioural measures

	Sensor used	Drowsiness Measure	Detection techniques	Feature Extraction	Classification	Positive Detection rate
1.	CCD micro camerawith Infrared Illuminator	Pupil	Ada-boost	Red eye effect, texture detection method	Ratio of eye-height and eye width	92%
2.	Camera and Infrared Illuminator	PERCLOS, eye closure duration, blink, frequency	Two Kalman filters for pupil detection	Modifies the algebraic distance algorithm for conics approx. & FSM	Fuzzy Classifier	Close to 100%
3.	CCD camera	Yawning	Gravity-center template and gray projection	Gabor wavelets	LDA	91.97%
4.	Digital Video camera	Facial action	Gabor filter	Wavelet Decomposition	SVM	96%
5.	Fire wire camera and webcam	Eye Closure Duration & Frequency of eye closure	Hough Transform	Discrete wavelet transform	Neural Classifier	95%

When a person is drowsy, it is often seen that there are a number of distinct facial expressions or characteristics that are shown by him, which sometimes includes increased number of blinking of eyes, nodding of the head and also gaping. With the help of computers, non-intrusive, behavioral approaches have been in a wide use with whose help we can undermine the abnormal activities or reactions of the operator and can make use of them to recognize languor of the operator. Thestudies thathavebeenpostedsofar,ontheuseofbehavioralmeasureshavemostlyfocusedtheresearcheson determiningtheblinkingoftheeyesanddetectionofmouthTheuseofPERCLOSiswidelyusedand acceptedasitisquitereliableandnowitisalsoputintousecommercially,someexamplesinclude products like Lexus and Seeing machine. Apart from using eye blinks and gaping researches have also been done on other facial actions like rise of the inner brow, stretching of lips, dropping ofjaws etc. (Table2.2).When using vision-based approach, the major issues and set back are often due to poor lighting conditions. The normal cameras that are used for this purpose are not suitable for working at night thus causing errors. Though to tackle this problem other researches have surfaced which usesLEDs. TheLEDsprovidesatisfactoryresultsatnightbuttheirperformanceduringthedaydoesnotprovide accurateresults.Moreoverthedatathathasbeencollectedoveryearsfortheresearchesisthatofthe people who mimic being drowsy, and data of real drowsy operator cannot be included in the researches because of the risk factor that is accompanied by it. The motion pictures or pictures are capturedbyusingmakingtheuseofCCDornetdigicamforthedurationofthedaylighthoursandthe equalmaybecompletedviatheuseofIRcameraatnight.Whenthevideohasbeencapturedwiththe helpofvarioustechniquesareusedforthedetectionoftheface,eyeormouth.Oncewehaveselected theregionofinterestfromthepicturethathasbeenextracted,featuressuchasPERCLOS,gapingrate of occurence, are found. The behavior of the person that has been extracted is then looked at and sorted as either typical, somewhat lazy, profoundly sleepy with the assistance of ordering estimates, for example, the help vector machine, fluffy classifier, and direct discriminant investigation. This being said, the question here cannot be denied that the rate of detection of the desired feature, or the success of our algorithm, after using on different people and conducting it for various occasions is reliant on the application. The PERCLOS and Eye Blink provide desired results close to 100% and 98%times,respectively.Though,thedepictedpercentageshowshighaccuracybutthefactcannotbe denied that the subject did not make use of spectacles. Similarly , many of these researches were carried out in computing environment, because of which the depicted rate of success is quite high. Thetruedetectionoflethargyhighlydecreasedonperformingthetestforreallifesituations.

2.4. Physiological Measures

Whentheoperatorsgetstired,itisobservedthattheheadbeginstoinfluenceandtheconveyancemay wanderfromthepointofconvergenceofthestreet.Thesemeasuresbecomeclearessentiallyafterthe operatorstartstorest,whichisfrequentlypastwhereitisconceivabletohinderanincident.

Be that as it may, bodily indication starts to change in earlier stages of sluggishness. Henceforth, bodily indications are progressively sensible to recognize laziness with hardly any sham positives; makingitpossibletocautionadrainedadministratorinanadvantageousmannerandalongtheselines prevent various streetmishaps.

The experiments conducted concluded this list may help in detecting the lethargy in the name of bodily signals, that is : electrocardiogram (ECG), electromyogram (EMG), electroencephalogram (EEG) and electro-oculogram (EoG) (Table 2.3). Not only this but researches have also accounted EoGsignaltofindoutaboutthesleepinessoftheoperatorwiththehelpofmovementoftheeyes.The galvanic ability complexity between the yellow-spot and the eyeball makes a galvanic field that reflects the heading of the eyes; this galvanic field is the conscious EoG signal. Pros have inspected level eye advancement by putting a nonessential Ag-Cl anode on the outer corner of each eye and a thirdcathodeatthepointofconvergenceofthetempleforreference.

Tableno.2.3: List of previous works on driver drowsiness detection using physiological signals

	Sensors	**Pre-processing**	**Feature Extraction**	**Classification**	**Classification accuracy(%)**
1.	EEG, ECG, EoG	Optimal Wavelet packet, fuzzy wavelet packet	The Fuzzy MI-based Wavelet packet algorithm	LDA, LIBLINEAR, KNN, SVM	95-97%
2.	ECG	Band Pass Filter	Fat Fourier Transform(FFT)	Neural Network	90%
3.	EEG	Independent Component Analysis Decomposition	Fast Fourier Transform	Self organizing Neural fuzzy Inference network	96.7%
4.	EEG, EMG	Band Pass Filter & Visual Inspection	Discrete wavelet transform (DWT)	Artificial neural network(ANN) back propogation algorithm(awake, drowsy, sleep)	98-99%

The pulse furthermore changes basically between the various steps of sleepiness. Subsequently, pulse, which can be handily controlled by the ECG signal, can likewise be utilized to distinguish languor. Others have estimated languor utilizing “Pulse Variability, in which the low (LF) and high (HF)frequenciesfallinthescopeof0.04–0.15Hzand0.14–0.4Hz,separately.HRVisaproportion of the beat-to-beat (R-R Intervals) changes in the pulse. The proportion of LF to HF in the ECG diminishesdynamicallyastheoperatoradvancesfromaconscioustoatiredstate.”

One of the most widely used bodily signal is the Electroencephalogram (EEG) which is useful for measuring the level of lethargy. There are many band of frequencies in the signal of EEG, which is related to calm state of mind when the person is sleeping, then we have the theta band (4–8 Hz), which corresponds to lethargy, the alpha band (8–13 Hz), which corresponds relaxation and creativity,andthebetaband(13–25Hz),thatisrelatedtoawareness.Whenthereisafallinthepower changesofthealpharateofoccurencebandandariseinthethetarateofoccurenceband,thischange indicates lethargy. It was seen that if we used EEG and EMG together we observed that it worked withhigheraccuracythantheaccuracythatwasprovidedwhenbothofthemwereusedalone.

Theapproximationofbasicbodilyindicationsisconstantlywillingtonoiseduetotheprogressthatis related to operating, which will wipe out noise, unique pre-handling methods, for instance, low bypass channel, superior differentiators, were applied(Table2.2).

A successful automated sifting plan could expel the unwanted stuffs in an idyllic manner. Numerous quantifiable highlights remain separated after organized sign making use of exclusive detail extractionmethods,includingDiscreteWaveletTransform(DWT)andFastFourierTransform(FFT).

The unwavering high-quality and accuracy of operator lethargy identified by means of utilizing bodily indications is extremely excessive contrasted with exclusive techniques. But interfering conceptofestimatingphysicalsymptomsstaysandifficultytobetendedto.Toclearupthis,experts haveusedwirelessdevicestogaugebodilyalertsinalessintrusivewaythroughplacingtheelectrode depotsattheframeandacquiringsignalsusingfaroffimprovementslikeZigbee,Bluetooth.Experts have proceeded with the aid of estimating physical signals in a uninterfering manner; with the aidof setting terminals at the guiding wheel or at the operator's seat. The indications obtained were then prepared in machine based superior cellular phone gadgets and the operator became alarmed on schedule. The precision of a non-meddling agenda is moderately much less due to improvement antiques and errors that happen because of irrelevant terminal contact. Be that because it may, specialists are considering to utilize this in view of its ease of use. Assessments are brought about approvenon-intrusiveagenda.Theaccompanyingdeskportraysandthinksaboutthepointsofhobby and impediments of the techniques Table2.4.

Table2.4: Advantages and limitations of various measures

	Measures	**Parameters**	**Advantages**	**Limitations**
1.	Subjective measures	Surveys	Subjective	Cannot be run in real time
2.	Vehicle based measures	Deviation from the lane position. Loss of control over the steering wheel movements	Non-intrusive	Reliability issues
3.	Behavioural measures	Yawning, Eye closure, Eye blink, Head pose	Non-intrusive, Ease of use	Light issues
4.	Physiological measures	Statistical & energy features derived from ECG, EoG, EEG	Reliable, Accurate	Intrudes personal space

2.4 HybridMeasures

The techniques expressed above have their own points of interest and set-backs while the lethargy level of the operator is being resolved.

For instance the vehicular-based strategy come into utilization When a nonappearance of cautiousness impacts conveyance manipulate. In spite of the fact that it has regularly been seen that sway on the parameters of the conveyance was experienced when the operator was drowsy, along these lines this reality utilizes vehicular based strategies unsafe.

Whileweseethatthebehavioraltechniqueisbyalongshothelpfulandproficientforthediscoveryof tiredness. In any case, in this likewise we may see that when we are testing in the ongoing, there are numerousissuesoflightingconditions,inthismanneragaintheunwaveringqualityoftheframework getssketchy.

We continue forward to the bodily measures, it was exhibited that these are strong and definite considering the way that they give the real internal state of the operator. Among each and every bodily constraint investigated, ECG can be assessed in a fewer intruding manner. EEG indicators needdifferentcathodestobeputonthecraniumandtheterminalsusedforevaluatingEoGsignalsare putneartheeyewhichcanblockoperating.Non-noticeablebodilysensorstoevaluatethelethargyof operators are required to get conceivable soon. The upsides of bodily measures and the growing availability of non-intruding approximation equipment make it invaluable to solidify bodily indications with social and conveyance-basedmeasures.

But cross range systems uses specific sensors have not been tried in a certifiable circumstance, it's miles fascinating to examine the capacity to recognize lethargy with the usage of a mixture of physical indicators with diverse approximations.

CHAPTER 3
IMAGE PROCESSING

Image processing can be described as to develop a virtual system that performs operations on virtual image. An image is basically nothing but two dimensional image which can be defined by A(a, b), whereaandbaretwocoordinatesandAistheamplitudeofcoordinate.Atthiscoordinateorpointit shows grey level of the image. When a, b, A are at finite distinct quantities, it is defined as a virtual image, comprising limited number of essentials having specific position and values of these essentials can be specified aspixels.

3.1 WhyweuseImageProcessing:

The data that we collect or generate is mostly raw data and can not be used in application directly. Hence, we need to analyze it first, perform pre-processing before using it. One of themajor reason is that the collected data would not be of same size, dimensions. Therefore, before feeding themtothemodelfortrainingweneedtoresizeorpre-processthemtoastandardsize.Thisisoneof themajorreasonweuseimageprocessingtoanycomputervisionapplication.

3.2 Working andComponents

The input to the digital system is a digital image, that image is being processed with different algorithms in order to produce image as an output. Adobe photoshop in one of the application whichisextensivelyusedfordigitalimageprocessing.

3.2.1 Components of ImageProcessing:

1. Image sensors: to obtain digital image we need two essentials, firstly a physical device whichis diffused to power radiated through the object we demandtopictureandsecondlyapictureprocessingtool.

2. Specializedimageprocessingtool:itiscomposedofconverteraswellastool which executes basic procedures onimages.

3. Computer:itisbasicallyusedtoaccomplishmandatoryimplementation.

4. Software: it allows user to compose codes to be utilized the specialized module.Italsoallowstheintegrationofthesemodules.
5. Image displays: these are nothing but color TV monitors, compelled by yields of picture and realistic presentationcards.
6. Hardcopydevices:itisusedforrecordingimageinmaximumresolution.

7. Networking: it can be defined as default function in systems because of the hugemeasureofinformationitacquirestofulfilitspurpose.

3.2.2 Fundamentalsteps

There are two classes of steps engaged with picture handling

a. Whentheoutputofthesystemareimages.
b. Whentheoutputareattributesfromtheimage.

This can be further be explained as follows:

1. Imageacquisition:Itgenerallyincludespreparing,like,scalingoftheimage.

2. Image boosting: It is one of the least difficult and most engaging zones of advanced picture handling.Itisgenerallyusedtofeatureareaofenthusiasmforthepicture.

3. Imagehandling(color):Itmanagesshadingmodelsandtheirexecutioninpicturepreparing.

4. Multiresolution management: These are the premise of representing picture in different level of goals.

5. Imagerestoration:Itisanobjectiveapproachwhichisusedtoenhancetheformofanimageinlight of scientific model of picturehandling.

6. Compression: It uses methods to diminish the capacity required to spare a picture or data transmissiontotransmit.Theoutputisintheformofbitstreamdata.Ithastwoapproaches:

i. Lossless Compression: It prevents the data from being destroyed. We can retrieve the originaldatafromthecompresseddataasitallowsreconstruction.
ii. Lossy Compression: It is called as irreversible pressure, practices inaccurate estimates to display the image. With the help of these methods we can reduce size of an image for storing, handling andtransmitting.

7. Extraction method: It manages separating picture parts which are helpful in the portrayal of shape andlimitofapicture,forthemostpartutilizedinrobotizedapplications.

8. Illustration:Itfollowstheyieldofthedivisionstepthatincorporatescrudepixelinformation,limit ofapicture.Attheendoftheday,tochangeoverinformationtoframereasonableforpreparing.

9. Recognition:Accordingtothedescriptorsandlandscapesitassignslabel..

3.3 ImageDigitization

To obtain a virtual image, firstly we have to change over persistent detected information into advanced structure utilizing examining and quantization. An image can be nonstop in terms of amplitude as well as x and y coordinates. To obtain virtual image we need to do conversion of function from both the axis as well as amplitudes.

Sampling may be defined as converting the continuous waveform into samples(or digitizing coordinates values). While Quantization is defined as converting amplitude values into discrete quantities. Also we need to convert gray level values into discrete form.

3.4 Digital ImageDefinition

The2Dpicturef(c,d)isseparatedintoAlinesandBsegments.Thecrossingpointofcandd arrangesisnamedaspixel.Thecoordinates[a,b]hasrelegatedvalueswith{a=0,1,2,….,A-1}and {b=0,1,2,… … ,B-1}. In numerous pictures F(a,b) has different capacities which incorporates depth(d), shading and time.

A virtual picture F[a,b] denotes 2D discrete space is gotten from a simple picture f(c,d) in a 2D constant space through examining process that is every now and again denoted as digitization.

3.4.1 Processing anImage:

1) First level - It comprises basic procedures to process an image like to lessen clamor, differentiate upgrade, and picture refining. This procedure is portrayed by both info and yield arepictures.
2) Second level- It comprises subdivision, removing unnecessary variables to frame reasonable for preparing and order of picture. Input to the system are images but output is in the form of attributes.
3) Final level- To perform works normally connected with vision. It joins all recognized object fromtheimagewhichisusedforimageanalysis.

3.4.2 Representing DigitalImages

Theexaminingproceduremightbeseenasdividingthex-yplaneintoamatrixwiththedirections of the focal point of every network being a couple of components from the Cartesian items, set of all arranged pair of componentsZ.

The consequence of testing and quantization is network of genuine numbers. Accept that a picture F(a,b)isinspectedwiththegoalthatthesubsequentcomputerizedpicturehasAlinesandBColumns. The estimations of the directions (a,b) presently become discrete amounts in this mannerthe estimationofthedirectionsatinceptionbecome(a,b)=(0,0)..Itdoesn'timplythatthesearethereal estimationsofphysicaldirectionswhenthepicturewasexamined

The following Coordinates an incentive along the first mean the picture along the principal column. Accordinglythecorrectsideofthenetworkspeakstoacomputerizedcomponent,pixel.Thegridcan bespokentointheaccompanyingstructurealso.

$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & f(0,2) & \dots & f(0,N-1) \\ f(1,0) & f(1,1) & f(1,2) & \dots & f(1,N-1) \\ . & . & . & & . \\ . & . & . & & . \\ . & . & . & & . \\ f(M-1,0) & f(M-1,1) & f(M-1,2) & \dots & f(M-1,N-1) \end{bmatrix}$$

Consequently F(a,b) is an advanced picture if dim level (that is, a genuine number from the arrangementofgenuinenumberR)toeachunmistakablepairofdirections(a,b).Thisutilitariantask isthequantizationprocedure.Intheeventthatthedimlevelsarelikewisewholenumbers,Zreplaces R, and a computerized picture become a 2D work whose facilitates and the adequacy esteem are numbers. Because of handling stockpiling and equipment thought, the quantity of dark levels normally is a number intensity of2Q=2*S^3.

At that point, the number b, of bits required to store an advanced picture is M=B*A* S

WhenA=BTheconditionbecomeb=B^2*S^2.Whenapicturecanhave2kdarklevels,itisalluded toas"k-bit".Apicturewith255potentialdarklevelsiscalleda"9-piecepicture.

CHAPTER 4
TOOLS REQUIRED

4.1 Python

Python is an extensible, cross-platform, free and open source programming language with dynamic semantics. It has many in built functions of data structures which is favourable for the Rapid Application Development(RAD) which is software for iterations. It is for the use as a glue language or scripting which is used for the binding of already existing functions. This language's uncomplicated and easy to handle libararies, functions and syntax focuses on simple reading which indeeddecreasesitsmaintainingcostfortheprograms.Thislanguageevensupportsmodulesaswell aspackagesthathelpswithcodereuseandprogrammodularity.Thislanguageisplatformfreeasthe interpreterisofbinaryformandisfreelyspreadover.

It's often preferred by coding professionals as it provides highly efficient results because of its edit-test-debug cycle have no compilation step therefore it is tremendously of high speed. Fixing of the errors in this language's programs are even simple as the segmentation fault is not created or caused by the bug. Instead, it raises exception whenever, interpreter discovers an error. Whenever any code isnotabletocatchtheexceptionthentheprintingofastacktraceisdonebytheinterpreter.Asource level correction allows checking of local and global variables, setting breakpoints, stepping through the code a line at a time and so on. The detection and correction code for checking of error is been written by this language only. While even adding few print statement make easy to debug the error: thefastedit-test-debugcyclehelpsinmakingtheabovemethodmoreeffective.

4.1.1 Comparing Python to OtherLanguages

Other interpreted languages than Python are JavaScript, Java, Smalltalk, Perl, or Tcl. Comparisons to Scheme, C++ and Common Lisp can also be enlightening. The differences usually deals with the issues on language only. In general, the choosing of a coding language is usually affected by the real-world problems which are testing, cost and training

Java

Itisseenthatthislanguage'scodesareusuallyrunninginhighspeedotherthanpythoncodes, but time to develop them is also less as Python language's program are typically much smaller in comparison to the same code written in this language. The difference rises because of the Python's built-in high-level data types and the dynamic typing. For example, no time is wasted in a Python program declaring the types of arguments or variables, and Python's powerful dictionary types and polymorphiclist,forwhichrichsyntacticsupportisbuiltstraightintothelanguage,isalmostusedin every Python program. Because of the run-time typing, Python's run time works harder than Java's. Forexample,whenevaluatingtheexpression(x+y),itmustfirstlyinspect theobjectsxandytofind out their type, which is not known at compile time. It then starts the appropriate addition operation, which can be an overloaded user-defined method. Java, on the other side, can perform floatingpoint or an efficient integer addition, but requires variable declarations for x and y, and not allow overloading of the + operator for instances of user-defined classes. Some of the reasons why Python is much better characterized as a combining language, while Java is better suited as a low-level implementation language. Together these two languages make a very good combination to work with. Thus the developing of the components can be done in Java and then can be combined with Python to form applications; Python is also used as a prototype components until their design canbe "hardened" in a Javaimplementation.

JavaScript

The "object-based" subset in Python which is as similar in JavaScript . Same as this language and not like the other languages such as java, programming styles which are easy to write and read as well as both similar in JavaScript and python, both involves simple language for function definition as well

defining of class. But JavaScript have this very advantage or feature better than the other language whereas in Python we have a feature of code reusability in which we reuse the big functions, with the help of polymorphism as well as class declaration and calling of functions via objects.

Perl

Python and Perl go hand in hand with their background as both have long out grown Unix scripting as well as sports same features, but having a contrasting concepts. Python lays much more stress common which are designing of extensible short programs and object-oriented programming, which further encourages the coders to write a code which is easily understood or read by anyone (basicEnglishlanguage)byprovidinganelegantbutnotcomplexcrypticnotation.Ontheotherhand, Perl emphasize more on supporting common application-oriented tasks, e.g. having built-in regular expressions,reportgeneratingfeaturesandfilescanning.Asaresult,PythonisclosetoPerlbutdoes notbeatitasPythonhavemoreofpracticalApplicationsratherthanthePerllanguage.

Tcl

Similar to Python, Tcl is also usable language in which the coding professional can write full-fledged programs to extend the original Application. However, this language, stores all data in string form and execution of lengthy code is much slower than Python and is really weak on data structure.Large codes which are written in Tcl language which are ‘typical’ codes, these uses Tcl extensions that is usually written in C/C++ whereas on the other hand for this same code is written in pure python form. So it is obvious with this that debugging and writing a pure python code is easier rather than the debugging the C/C++ components. One of the best feature of the Tcl is the Tk tool kit which is even adopted by the Python through the standard GUI component which is interface to Tk. Modular namespace feature which is helpful in writing large program is missing in this language.

Smalltalk

The biggest difference between Python and Smalltalk is Python's have more "mainstream" syntax, which gives it a upper edge on programmer training. Similar to Smalltalk, Python has dynamictypingaswellasbinding,andeverythinginPythonisanobject.However,thedifferencelies withPythonbuilt-inobjecttypesfromuser-definedclasses,andwhichfurthercurrentlydoesn'tallow inheritancefrombuilt-intypes.Smalltalk'sstandardlibraryofcollectiondatatypesismorerefinedor clear , whereas that of Python's library has more facilities for dealing with Internet and WWW realities such as email, FTP andHTML.

Python has an extremely different philosophy regarding the distribution of code and development environment. Where Smalltalk traditionally comprises of both the environment and the user's program,whichhasamonolithic"systemimage".Pythonisstoringbothstandardmodulesaswellas usermodulesinindividualfileswhichcaneasilyberearrangedoutsidethesystem.Thereismorethan one option for attaching a Graphical User Interface (GUI) to a Python program, since the GUI is not built into thesystem.

C++

Java and C++ are similar in comparison to java where Java code is typically 3-5 times larger than equivalent Python code, which is often 5-10 times shorter than equivalent C++ code. Python is as a glue language which is used to combine components written in C++.

4.2 OpenCV(OpenSourceComputerVisionLibrary)

OpenCV stands for Open Source Computer Vision Library and it is a software used in machine learning and source computer vision library. It is built for providing a suitable structure for computer vision applications as well as for increasing the use of machinery much more in the commercial products. It is a product which is BSD-licensed, which makes it easy for businesses to make changes and also utilize the program.

The libraries of this software have many optimized algorithms, it includes many functions such as comprehensive set of both state-of-the-art computer vision and classic for machine learning algorithms. These algorithms is of great use to identify the objects, detect and recognize the face, tracking movement or images, classification of human actions in videos, extraction of 3D models of objects,stitchingofimagestogethertoproduceahighresolutionimageofanentirescene,removalof red eyes from images taken using flash, production of 3D point clouds from stereo cameras, finding similar images from an image database, following eye movements, recognizing scenery and establishingmarkerstooverlayitwithaugmentedreality,etc.Ithasmorethanthousandsofpeopleof user community and the number of downloads exceeding 18 million. These libraries are used extensivelyinresearchgroups,manycompaniesandbygovernmentalbodies.

This software have interfaces in different languages such as C++, Java etc. It supports any operating systems such as Windows, Linux, Androidand Mac. A full-featured OpenCL and CUDAinterfaces are being developed right now. There are over 500 algorithms and about 10 times as manyfunctions that support or compose those algorithms. OpenCV is written in C++ and has a templated interface that works smoothly with STLcontainers.

4.2.1 WhyOpenCV?

1. Specifications

This software is mainly created to be used in image processing algorithms. Each and every function and data structure has been designed with an Image Processing application in mind. Meanwhile, MATLAB, is quite generic and not specific as OpenCV.

2. Speedy

MATLAB is just way too slow and OpenCV is fast. MATLAB basically developed by Java whichisslowerthanPythonasOpenCVusesPython.FurtherJavawasdevelopeduponC.therefore runningaMATLABcodeiswaytoslowasfirstthecomplexcodeisbeingtranslatedtojavaandthen to C language which is long conversion process as well as time consuming. Therefore, MATLAB is not efficient inuse.

So by using this feature we directly write out code in C/C++ which directly execute our machine learningcodeandthisislesstimeconsumingandoutoutputsgenerallyfastwhichgivesusrealtime resultfasterratherthanjustwastingtimeininterpretingthecodeandwastingtimeonconvertingjust like MATLABcodes.

After even we are done with the execution of image processing and done with real-time execution inbothMATLABaswellasOpenCVbutthenagainfaceproblemofverylowspeedinMATLABas there are just 4-5 frames in comparison to OpenCV code in which it gives out 30 frames per second. Though we pay the price for speed – we deal with a more cryptic language, but it’s definitely worth. We can perform some really complex mathematics on images using C and still get with good speeds for ourapplication.

3. Efficient

MATLAB uses just way too much system resources. With OpenCV, we can get away with as little as 10mb RAM for a real-time application. Although with today’s computers, the RAM factor isn’tabigthingtobeworriedabout.However,ourdrowsinessdetectionsystemistobeusedinsidea carinawaythatisnon-intrusiveandsmall;soalowprocessingrequirementisvital.

Thus OpenCV is a better choice than MATLAB for a real-time drowsiness detection system as it is faster as well as efficient.

4.3 Pygame

This function or file is basically created for making computer based games and it consists of basically Python Functions. It basically adds functionality on top of the excellent SDLlibrary which allowstheusertocreatefullyfeaturedgamesandmultimediaprogramsinthepythonlanguage.This functionorfilerunsonnearlyplatformlikecommandprompt,Anaconda,jupyternotebookandmany more, and it even supports every operating system and is highly portable. It is free of cost. Released under the LGPL licence, thus helping in creating open source, freeware, shareware, and commercial games withit.

The advantages of pygame are listed below:

- Multi core CPUs can be usedeasily
- UsesoptimizedAssemblyandCcodeforcorefunctions
- Runs with many Operatingsystems
- It'sportable.
- No GUI require to use allfunctions
- Small amount ofcode.
- The core is simple, and extra functions like GUI libraries, and effects are developed separately outside ofpygame.

4.4 CMake

CMaketask is to of building up of the operating system and the main feature is it build up with compiler independent manner as it is an extensible, open-source system. It is not same as the many different platform independent system, it is main feature is that it works with the native build environment. Standardbuildfiles(e.g.,makefilesonUnixandprojects/workspacesinWindows

MSVCwhicharegeneratedbysimple configurationfilesplacedineachsourcedirectory(calledCMakeLists.txtfiles)whichareusedinthe usual way. CMake can generate a native build environment that will compile source code, generate wrappers, create libraries and build executables in arbitrary combinations. CMake supports out-of- place builds and in-place builds and it supports multiple builds from a single source tree. It also supports static and dynamic library builds. Another good feature of CMake is that it also generates a cache file that is designed to be used with a graphical editor. For example, when CMake runs, libraries,itlocatesfiles,executablesandmayencounteroptionalbuilddirectives.Theinformationis then gathered into the cache, which can be changed by the user before the generation of the native build files. CMakeisbasicallydesignedtosupportapplicationsdependentandcomplexdirectoryhierarchieson severallibraries.Forexample,CMakesupportstheprojectswhichareconsistingofmultipletoolkits (i.e.,libraries),andinthateachtoolkitmightcontainseveraldirectories,andtheapplicationdepends onthetoolkitsplusadditionalcode.CMakeisalsousedforhandlingthesituationswhereexecutables mustbebuiltinordertogeneratecodewhichisthencompiledandalsolinkedintoafinalapplication. As CMake is an open source, and having a simple, extensible design, CMake can be extended as necessary support new features and also using CMake is simple. This build process is further controlled by creating one or more CMakeLists.txt files in each directory (including subdirectories) which further makes up a project. Each CMakeLists.txt consists of one or more commands. Each command has the form COMMAND (args…) where COMMAND is the name of the command,and args is a white-space separated list of arguments. CMake provides many pre-defined commands,but ifyouneedtoaddyourowncommands,youcan.Inaddition,tothistheadvancedusercanaddother make file generators for a particular compiler/OS combination. (While Unix and MSVC++ is supportedcurrently,odevelopersareworkingonaddingothercompiler/OSsupport.).

4.5 LibrariesUsed:

1. IMUTILS:

Achainoffunctionswhichisusedtoperformmanyoperationssuchasfundamentaloperations

whileprocessingimage.Thosefunctionsincluderotation,translation,resizing,and

displaying matplotlib images using the help of OpenCV library.

2. DLIB

It stands for Digital Library and it is a modern C++ toolkit which is used for making real world data analysis and application. It is used in both industry and as well as in an academia in a wide range of domains including robotics, mobile phones, embedded devices and high performance large computing environments

3. NUMPY

Itisusedforthenumerical computationinPython,anditstandsforNumericalpython.Itisdesigned and based on powerful n-dimensional arrayobject.

The variables, tables, computation or list can be implemented in a program by using Python traditional

approaches but instead of that we prefer to use Numpy since, which is much more memory efficient as well as faster than traditional approaches of Python language. Numpy package performs various operations,whichcanbeusefulformathematicalandlogicaloperationstobeperformed.Itisanarray of a multidimensional array which is used to store values of many datatype in an array. Thesearrays areindexedlikesequences,startingwithzero,tablesetc.

CHAPTER5
VIOLA JONES ALGORITHM

Withextraordinaryprogressioninadvancementsourcellphoneshavehadtheoptiontoutilizeahumanface as a secret word to open the gadget. Before utilizing face locks unique finger impression scanner were created.Muchthesameasfingerprints,facesareoneofakindwithahugenumberoffeaturesthatseparate one from the other. It may not generally be clear to us people, however machines assess each little bit of information,whichthusincreasestheprecision.

Like other information based models, Facial Detection isn't 100% accurate. Despite the fact that, it has arrivedataphasewhereitismonetarilysatisfactoryinourdaybydaylives.Installedinourgadgets,facial discovery can be utilized from multiple points of view, from essentially opening your smartphone to sendingcashandgettingtoindividualinformation.

5.1 The Viola-JonesAlgorithm

The Viola-Jones algorithm is an object-recognition framework, which was developed by Paul Viola andMichaelJonesintheyear2001.Thisalgorithmallowsitsusertodetectfeaturesofapictureinthe real-time.Despiteofthefactthatitwasproposedalmosttwentyyearsago,Viola-Jonesalgorithmstill can be seen as powerful tool and its applying it for the detection of the faces in real time scenarios proves itsusefulness.

Viola-Jones has many features some them are listed below:

- Ithasahighrateofdetection

- Itisabletodifferentiatebetweenfacialandnon-facialimages

- Thenumberoffalsepositivesislowandtruepositivesarehigh

- Itcanbeappliedintherealtime

5.2 Thealgorithmconsistsof4stages:

1. Haar FeatureSelection

2. CreatinganIntegralImage

3. AdaboostTraining

4. CascadingClassifiers

TheViola-Jonesalgorithmwasmostlyproposedtodetectthefacesfromthefronti.e.frontalfaces,so frontalfacedetectionhasbeenproventobeofhighaccuracybecauseofthisfactthesidewayface,or the face showing the upper or lower part of the face often give unsatisfactory results. Before recognizing a face, the image is turned over into grayscale, this is done because of the fact that it is simpler to work on it and there's lesser information to process. The Viola-Jones calculation initially recognizesthefaceonthegrayscalepictureandafterwarddetectstheareaontheshadedpicture.

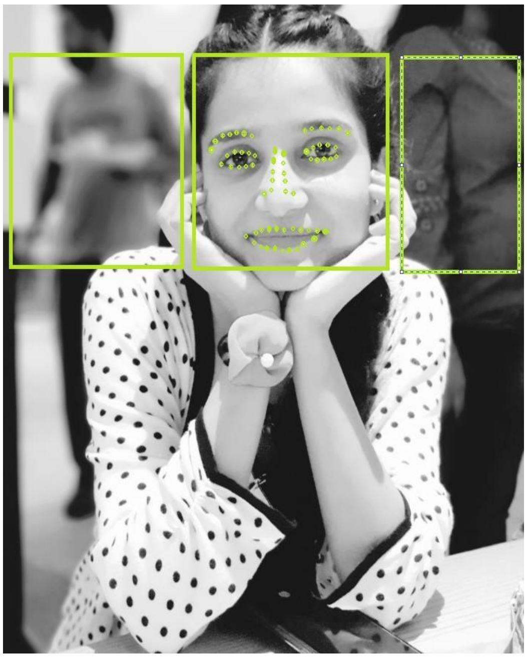
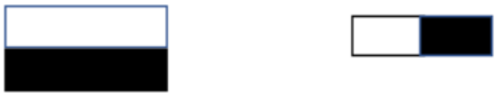


Fig 5.1: Detecting faces from a given picture

Viola-Jones outlines a box and scans for a face inside the container. This basically scans for the haar-like features. The rectangle green colouredbox shifts to the right side after checking every tile in the image. With small advances, various boxes identify face-like features and the information of those cases set up, enables the calculation to figure out where the face is.

5.2.1 Haar-likeFeatures

The Haar features and Haar wavelets were developed by Alfred Haar, a Hungarian mathematicianof the nineteenth century, and thus the name Haar features. The features in the figure represnts a box with a white side and a black side, this is the manner by which the machine figures out what the componentis.Ithasbeenseenthatforcertainpartsidentificationtherewillbeonesidethatishaving a light color in comparison to the other, for instance the edge of eyebrow. Now and then the center partmightbelighterincolorthantheencompassingboxes,thatisdecipheredasanose.



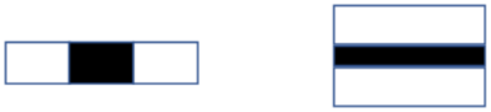


Fig.5.2(a): EdgeFeature **Fig 5.2(b):** LineFeature

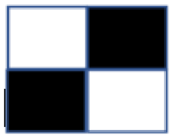


Fig. 5.2(c): Four Rectangle Features

Thesefeaturesallowsthemachinetointerpretthepicture.Forthedetectionoftheeyebrowsandnose there are two features that are extensively for detection of these particular features these are the horizontalandtheverticalfeaturesthathavebeendipictedintheimagesshownbelow.

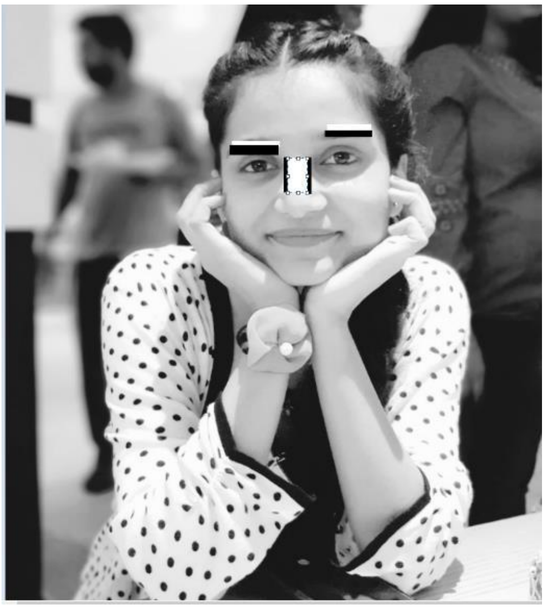
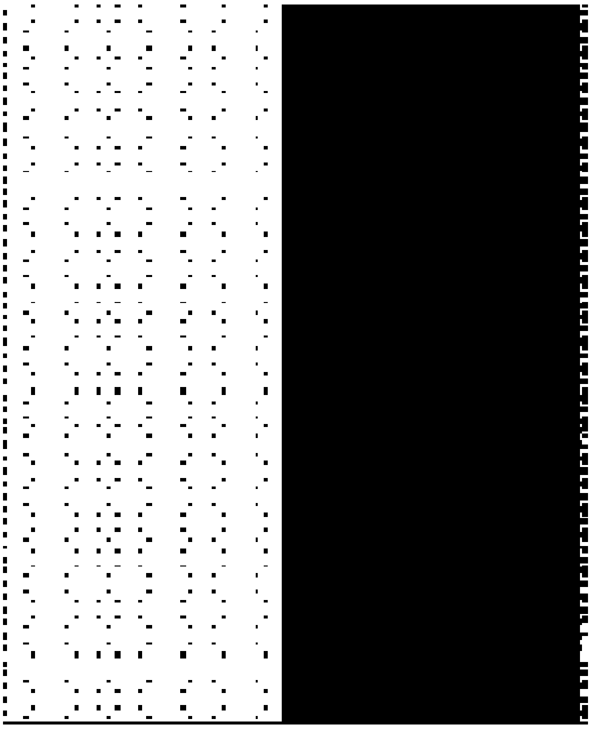


Fig 5.3: Detection of faces by Haar Features

Furthermore, when the pictures are examined, each component has its very own estimation. It can easily be taken out by finding the difference between the White region and the Black region. For instance, for the picture given :



0.2	0.3	0.4	0.5
0.2	0.2	0.5	0.4
0.1	0.1	0.4	0.7
0.1	0.2	0.7	0.8
0.1	0.2	0.5	0.4
0.2	0.3	0.6	0.6
0.1	0.1	0.4	0.7
0.1	0.2	0.5	0.7

Fig 5.4: Example image

Ifthesehaar-likefeaturesweremadeintoanarraylikestructure,theneveryblockwoulddepictapixel. Todemonstratethis,a4x8gridischosen,butwhiledealingwithreallifeexamples,therewouldbea largenumberofpixelsandthismeansthatabiggergridisneededforaparticularfeature.Thedarkness of the feature is depicted by the numbers in the box. The value of the grid represents that the pixelis darker.Thus,weseethatwehaveanumberwithhighervalueontherightsidewhereasthevalueon theleftsideissmaller.Ifwetakethesumofthevaluesofthetwocolumnsintheleft,whicharewhite in colour, and then subtract them from the sum of the columns on the right side, the value of the particularfeaturecanbecalculated.

Thus for the given example it can be calculated as follows:

(0.4+0.5+0.4+0.7+0.5+0.6+0.4+0.5+

0.5+0.4+0.7+0.8+0.4+0.6+0.7+0.7)-

(0.2 + 0.2 + 0.1 + 0. 1+ 0.1 + 0.2 + 0.1 + 0.1 +

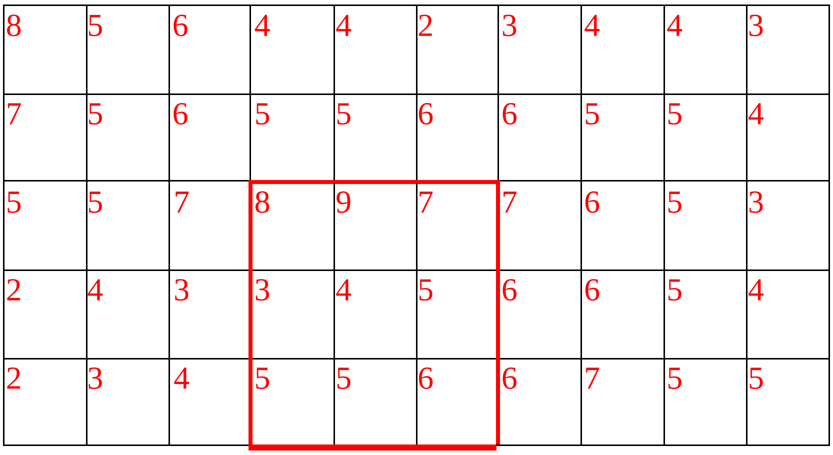
0.3+ 0.2 + 0.1 + 0.2 + 0.2 + 0.3 + 0.1 + 0.2)

B - W= 8.8- 2.7

= 6.1

5.2.2 IntegralImage

Intheendweneedtocalculatethevalueofafeature.Again,inactualpractice,thecalculationsthat havetobecarriedoutareintensiveinnaturebecauseofthefactthatthenumberofpixelswouldbe muchlargerforalargeimagecontainingmorefeatures.. Withthehelpofintegralimagetheselargecalculationscanbedonewitheaseandinafastermanner thusallowingustounderstandwhetherornotafeaturefromanumberoffeaturescanfitthepointof reference.



8	5	6	4	4	2	3	4	4	3
7	5	6	5	5	6	6	5	5	4
5	5	7	8	9	7	7	6	5	3
2	4	3	3	4	5	6	6	5	4
2	3	4	5	5	6	6	7	5	5

Fig 5.5: Regular Image

Theblockshowninredcolourdepictstheparticularfeaturethatisneededbyus,andourobjectiveisto findoutthevalueofthisparticular.Herewewouldnotusethemethodofjustsummingupthenumbers represented in the box because doing so would largely increase the calculation which is not a good practicethustotacklethisproblemweusetheideaofanintegralimage.

Nowwehavetousethedatathatisfilledintheregularimageandwithitshelpwewillfindthevalueof the boxes of our integral image. To do so this we add the values in the boxes on the left and fill the valueasshowninthefigure.

8	5	6	4	4	2	3	4	4	3
7	5	6	5	5	6	6	5	5	4
5	5	7	8	9	7	7	6	5	3
2	4	3	3	4	5	6	6	5	4
2	3	4	5	5	6	6	7	5	5

Regularimage

Integralimage

Thegreencolouredboxindicatedintheimageisfilledwiththesumofthenumbersthatarefilledinthe integralimage.Onrepeatingthisprocessforeachofthegroupofboxesoftheregularimageandfilling theintegralimagewecangetthesequencegoingthroughthegridanditappearliketheimagesgiven below.Thusthecalculatedvalueoftheexamplediscussedearliercanbeshownas:

8	5	6	4	4	2	3	4	4	3
7	5	6	5	5	6	6	5	5	4
5	5	7	8	9	7	7	6	5	3
2	4	3	3	4	5	6	6	5	4
2	3	4	5	5	6	6	7	5	5

Regularimage

8	13	19	23	27	29	32	36	40	43
15	25	37	46	55	63	72	81	90	97
20	35	54	71	79	94	110	125	139	149
22	41	63	83	95	115	137	158	177	191
24	46	72	97	114	140	168	202	226	245

Integralimage

Nowitisfurthersimplifiedaswejusthavetotakethefourcornersofthefeatureandtakingthefigure inaccountwehavetoaddtherectanglesinbluecolourandsubtractthegreens.

→ 168–114 + 79–110 = 23

The idea of using an Integral image arises because Haar-like features which are being used are basicallyrectangles,andtheintegralimagegivesustheabilitytolocatethefeaturewithinthepicture inaneasierwayasweareawareofthesumvalueofaparticularboxandtofindthedifferencebetween tworectanglesintheregularimage,wejustneedtosubtracttwosquaresintheintegralimage.Thusif welookatthefactthat,ifwearegivenaverylargeimagesay,1000x1000pixelsimagein,themethod used to find the value of the integral image takes very less time and calculations are also easy thus making it a favorableoption.

Before we start the detection of the face we first have to train the classifiers. This can be considered as a typical example of machine learning wherein we are training the given machinebyfeedingindatatorecognizethefeatures.Weareprovidingthedata,andatthesametime trainingit,whichallowsmachinetolearnfromthedatathathasbeenfedtomakeprediction.Thusthe algorithm is determining and recognising the features which can be classified and also those that cannotbeclassifiedbysettingaminimumthreshold.

Thealgorithmcompressesthepictureto24x24andsearchesthegivenimageforthefeaturesthathave been trained. For this purpose many images of faces are required so as to percept the features in varyingformsanddifferently.Thisisthereasonwhyalotofdatacontainingthefacialimageisneeded tobeabletotrainthealgorithm.ViolaandJonesusedabout5000picturesfortheiralgorithmandthis toowasdonemanually.Tomakeitsimpleroftenthemirrorimageofthealreadyfedimagecanalsobe usedandthiswouldbeanewpieceofdatafor thesystem.

Forthetrainingofthesystem,apartfromtheimagesofthefacenegativeimages,suchasthenon-facial images are also fed for the training of the system, this is done so as to allow the system to learn and differentiatebetweenthegiveninformation.ForthispurposeViolaandJonesfedtheiralgorithmwith 9,544 images that were not of the faces. Some of the images were chosen in such a manner that they were comparable to the images of the faces, but the algorithm will be able to differentiate it and recognizethefeaturesthatareexpectedtobepresentonafaceandothers,whicharenotfacialfeatures can beavoided.

5.2.3 Adaptive Boosting(AdaBoost)

Thealgorithmistrainedanddecidesforitselfwhetherthepicturesuppliedbyusisfalsepositiveortrue negativeandthisishowthealgorithmcanimproveitsaccuracy.Onemployingthismethodoffeeding inpositiveimages,negativeimages,falsepositivesandtruenegativeswemakeabetterandaccurate model.Thismakesthetrainingquitecomplicatedastherecanbedifferentcombinationsanddifferent possible ways for getting the features and a check has to kept while looking for these from all the pictures.

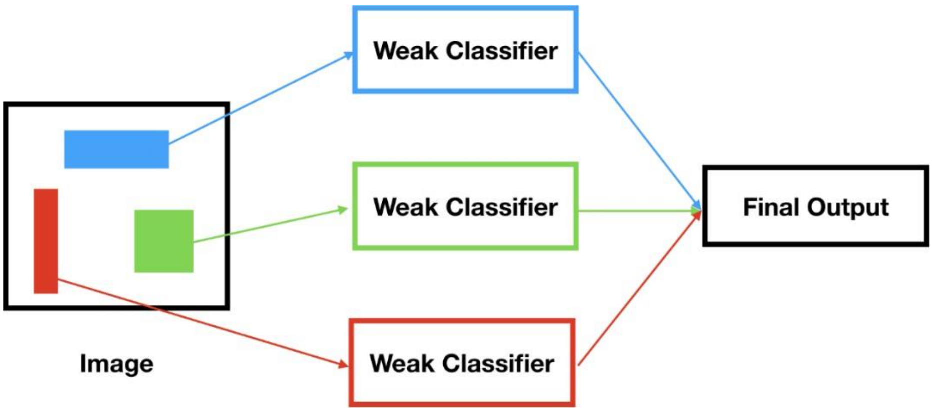


Fig 5.6: Image Classification

Wecomeupwithanequation,thatcouldallowustodeterminewhetherwesuccessfullygotafeature or not as shown in the figure, say with f1, f2 and f3 as the features and a1, a2, a3 as the respective weightsofthefeatures.HerewerefertoallthefeaturesasaweakclassifierandtheF(X),whichonthe left hand side of the equation is referred as a strong classifier. As the name suggests a single weak classifierisnotofmuchhelpalonesotherearisesaneedofgettingastrongclassifier,whichitselfaset oftwoormoreweakclassifiers.Onadditionoftheweakclassifiertoourequationitstartstobecome strongerthanbefore,andthisiswhatwecallanensemble.Afterthishasbeendoneweneedtoensure thatthemostimportantfeatureshouldcomeupinthefirstplace,butforthisweneedtosearchforthe mostimportantfeature,whichcanbedonewiththehelpofAdaptiveBoosting.

Example:Ifwetaketenimagesoutofwhichfiveofthemareofthefaceandotherfivearethepictures otherthantheface.Thenwesearchforthemostimportantfeatureandthusaccordinglywewilluseit topredictanddetect.Theresultthatcameoutwasthatitgaveus3picturesthatweretrueoutof5,and 2outof5truenegatives.Thepredictioncameoutrightforthesepicturesbuttherewere someerrors as well: 3 false positives and 2 false negatives. So it didn’t find the feature on the 2 images they are actuallyfaces.Butitalsopointedoutfeaturesin3non-facialpictures.

$$F(x) = a1f1(x) + a2f2(x) + a3f3(x) ......$$

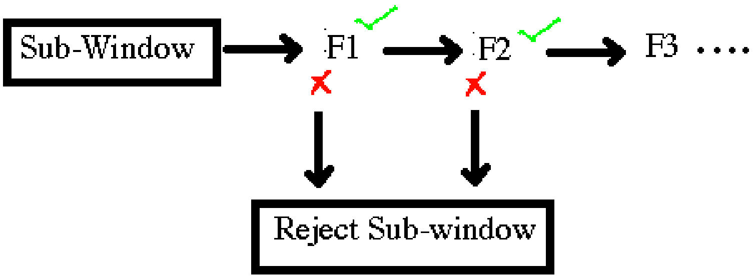


Fig 5.7: Selection of Features and cascading

After this, adaptive boosting uses another feature, the one to best complement our current strongest feature. It overlooks the feature that is second best, and finds such a feature that complements the feature that is considered the best. So it builds the significance of the pictures that it got off-base as falsenegatives,andfindsthefollowingbestelementthatwouldfitthesepictures,asitwere,increasing theweightofthesepicturesonthegeneralcalculation.Alongtheselines,asnewfeaturesareincluded, we would boil down to one picture toward the end that would be given a higher weight. When the calculationisstreamlinedandcanascertainallpositivesandnegativeseffectively,weproceedonward to the following stage:cascading.

5.2.4 Cascading

We use cascading to increase the speed and make our model more accurate. Thus to accomplish this taskwetakeasub-windowandinthissub-windowwefindafeaturethatismostimportantandsearch whetherthisparticularfeatureispresentinsidethegivensub-windowornot.Oncheckingthis,ifwe find out that the required feature is not present in the sub-window, then we stop looking for it inthat particular sub-window and reject it. But if it happens to be present in that sub-window, then we start oursearchforthesecondfeatureinthesamesub-window.Againifthesecondfeatureisnotavailable initthenthatsub-windowisalsodiscarded.Thisprocessiscontinuedforseveralroundsandwekeep onselectingthesub-windowswithdesiredfeaturesandalsokeeponrejectingtheoneswithoutthem.. Evaluatingitdoesnotrequirealargeamountoftimebutsincethisprocesshastobefinishedforalarge numberoffeaturesthisincreasesthetimetaken.Forthispurposewerequirecascading,asitincreases the speed of the processto very large extent which allows the system to provide the result at a much fasterrate.

CHAPTER 6
DROWSINESS DETECTION ALGORITHM

Following steps were used in the detection of drowsiness of the driver.

Firstly, we used a web cam, for capturing the video and face detection was initiated.

When the face was detected, facial landmark were applied and thus moving on to the step of extraction of the eye regions and the mouth region:

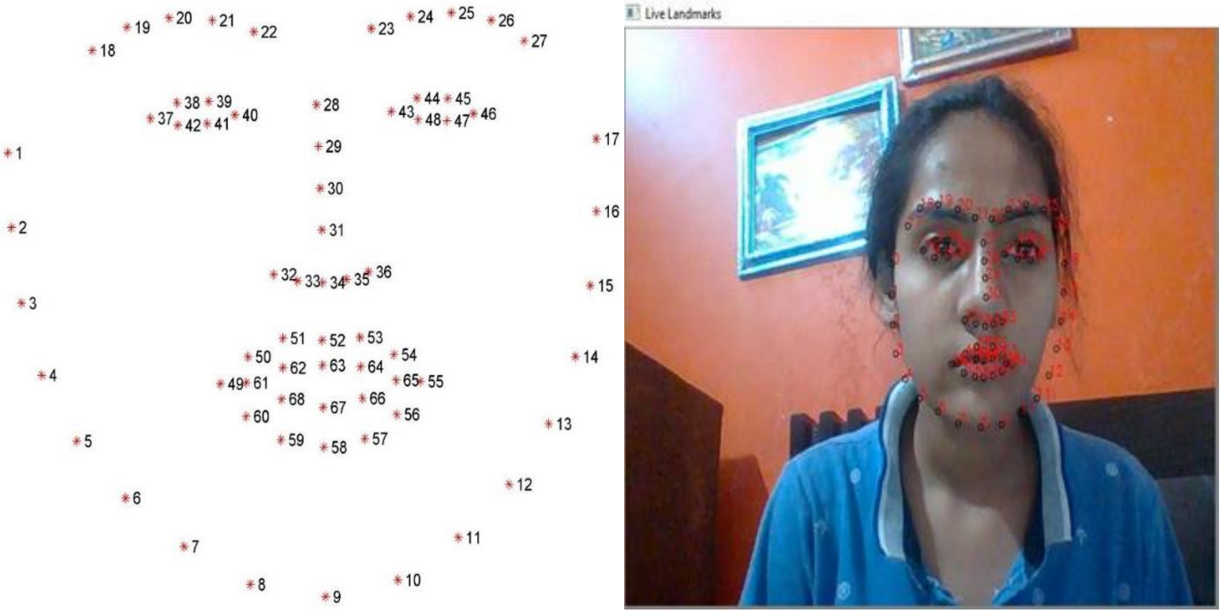


Fig 6.1: Applying the 68 facial landmark coordinates

Now that we have the eye and the mouth region, the eye aspect ratio was calculated to find out whether the eyes are open or closed:

$$\text{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

On calculation of the eye aspect ratio and comparing it with asset figure the system decides whether or not the eyes are closed, and if the eyes have been closed for a time more than the specified threshold an alarm is sounded :

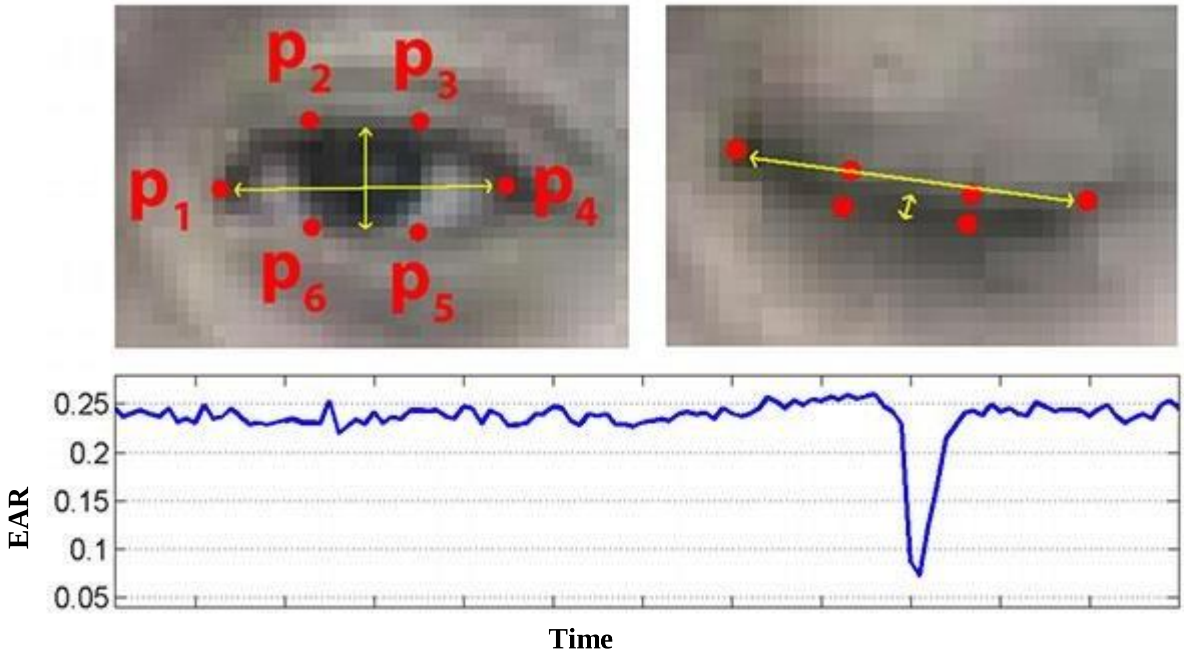


Fig 6.2: Eye landmarks depicting open and close eye respectively and plot of eye aspect ratio versus time

ThegraphindicatesthattheEARisconstantwhichindicatesthateeyesareopenandthenthereisa rapid drop in the graph which indicates that the EAR decreased to zero, which means that the eyes have beenclosed.

Todetectthedrowsinessusingtheconceptofeyeaspectratio,wewillobserveandlimitourstudyon thefactthattheEARisfalling,whichwouldcausethesystemtosoundanalarm.

The algorithm was run on a machine and some results were found out. Some of the experimental results have been shown as follows.

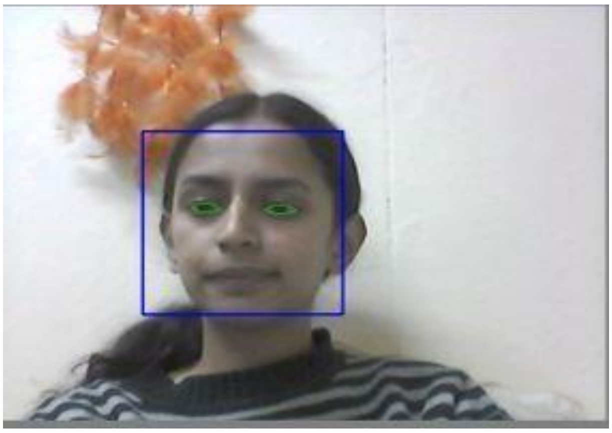


Fig 6.3(a): Person A: Face andeyesdetected

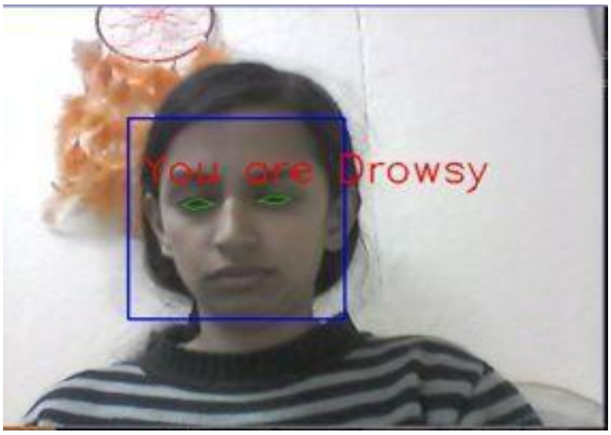


Fig 6.3(b): Person A: Detection ofdrowsiness

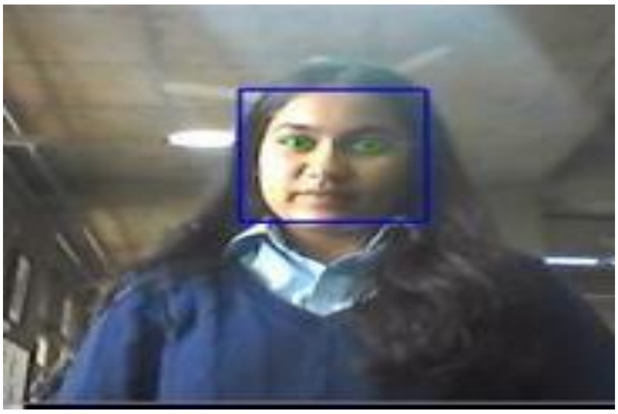


Fig 6.3(c): Person B: Face andeyesdetected

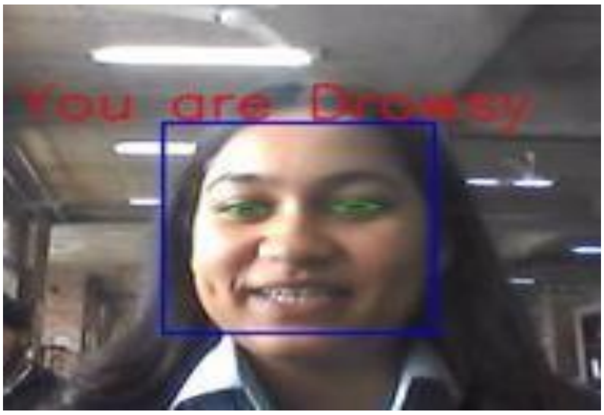


Fig 6.3(d): Person B: False DrowsinessDetected

Similarly we detect the mouth region using landmark feature and sound an alarm if the mouth opens more than a particular threshold value, such that if the person is talking he is not mistaken for yawning.

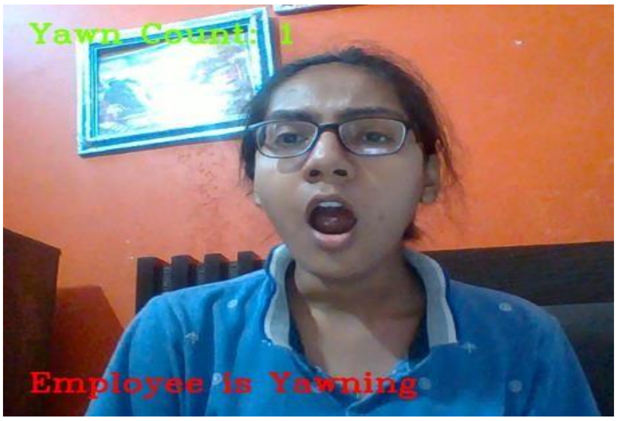


Fig 6.3(e): Yawningdetected

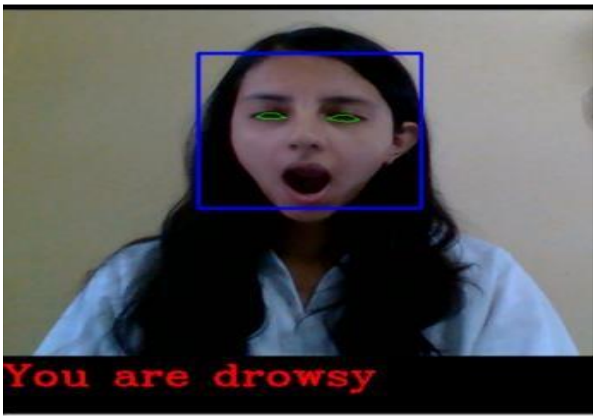
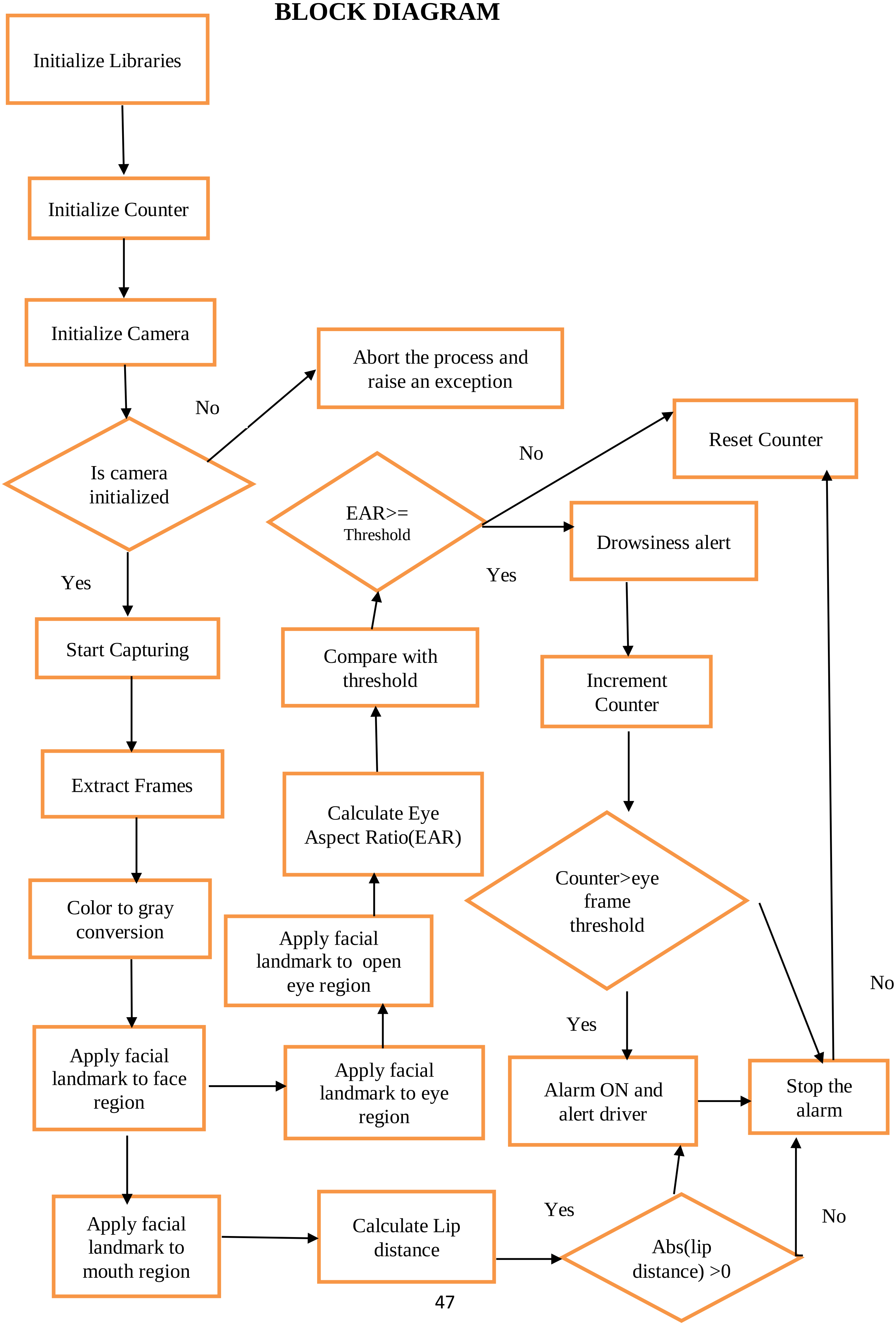


Fig 6.3(f): Yawning and small EARdetected

BLOCK DIAGRAM



CHAPTER 7
CONCLUSION

A real-time detection of the blinking of the eye and yawning algorithm was presented and following steps were followed:

- Capturingofthevideousingawebcam.
- Captured video was divided into frames and each frame was analysed and the face detected using the haar features .xmlfiles.
- This was followed by detection of eyes and mouth. Further calculation were done and thresholdvalueswereset,exceedingwhichcausedthealarmtoset,thusalertingthedriver.

7.1 Limitations:

The proposed method have some shortcoming as discussed below:

1. Alarm Delay:- At the point when the level of drowsiness of the person surpasses a specific threshold,analertisdeliveredbythesystem.Thereissomeamountofdelaybetweenthedetectionof the drowsiness of the person and sounding of the alarm. In any case, progressively, drowsiness is a continuousphenomenonthusthepostponementisn'tunreasonablyrisky.

2. Reliance on surrounding light: Even if the system detects the face, because of the poor lighting conditionstheeyesandmouthofthedrivercannotbedetectedsatisfactorilyandthesystemisunable to distinguish the features properly. To deal with this problem one can make use of infrared backlights to avoid poorly litenvironment.

3. Hardwarerequirements:-OurprojectwasrunninginaPCwithadesignof1.6GHzand1GBRAM Pentium double centre processor. The system runs fine on higher setups, but, when a system has a mediocre or low design, the system may not be efficient and drowsiness identification will bereally

slow. This issue was resolved by utilizing the dedicated equipment in real time applications, so therefore there are no issues of slow discovery or edge buffering.

4. Errorduetospectacles:-Whenthedriveriswearingspectaclesthesystemthenneglectstoidentify eyes which is therefore the biggest disadvantage of our system. This is the only issue with not any specific solution and is a difficulty for practically each and every eye recognition system structured up untilnow.

7.2 Future works:-

Inthenearfuturesystemcanbemadetodecreasethespeedoftheavehicleonitsownorcompletely stops it whenever fatigue level of a driver crosses a threshold value. Instead of the model being designedi.e.thresholddriverfatiguemodelitissuggestedtodesignacontinuousscaledriverfatigue detection system which is better as it observes the state of the driver continuously and whenever the thresholdvalueisexceeded,asignalmaybegeneratedwhichisattachedtothebreakingsystemthus stopping the motion of thevehicle.

7.2.1 Hardwarerequirements

To stop the vehicle automatically, dedicated hardware components are required for the linking ofthe image acquisition processing and display Interface support with the hydraulic braking system which aincludestimer,relay,alinearactuatorandsteppermotor.

7.2.2 Function

When the drowsiness state of the driver is detected, a signal can be initiated which further communicateswiththerelaythroughtheparallelporti.e.paralleldatatransfer.Thisrelayswitcheson delaytimerandthistimerinturnstartsthesteppermotorforadefinitetimeperiod.Thesteppermotor isconnectedtoalinearactuator.Thenthisactuatorchangesrotationalmovementtolinearmovement. Thelinearmovementthuscanbeusefulindrivingtheshaftwhichisturnhasitsconnectionwiththe hydraulic braking system. With the shaft movement, the brake is applied which would make the vehicle’s speed less. As it helps in decreasing the speed of the vehicle the chances of accident occurrence is also decreased thus reducing the chance of accidents.

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APPENDIX

```
'''Thisscriptdetectsifapersonisdrowsyornot,usingyawningdetectionandeyeaspectratio calculations.
Uses webcam video feed asinput.'''


#Import necessary libraries
from scipy.spatial import distance
from imutils import face_utils
import numpy as np
import pygame #For playing sound
import time
import dlib
import cv2

#Initialize Pygame and load music
pygame.mixer.init()
pygame.mixer.music.load('alert.wav')

#Minimum threshold of eye aspect ratio below which alarm igstriggerd
EYE_ASPECT_RATIO_THRESHOLD = 0.3

#Minimumconsecutiveframesforwhicheyeratioisbelowthresholdforalarmtobetriggered
EYE_ASPECT_RATIO_CONSEC_FRAMES =50

#COunts no. of consecutuve frames below threshold value
COUNTER = 0

#Load face cascade which will be used to draw a rectangle around detected faces.
```

```
face_cascade                    =                    cv2.CascadeClassifier("C:\\Users\\Dell\\Desktop\\python
 files\\HAAR\\haarcascade_frontalface_default.xml")


#Thisfunctioncalculatesandreturneyeaspectratio
defeye_aspect_ratio(eye):
   A  =  distance.euclidean(eye[1],eye[5])
   B  =  distance.euclidean(eye[2],eye[4])
   C = distance.euclidean(eye[0],eye[3])


   ear  =  (A+B)  /  (2*C)
   return ear


#Load face detector and predictor, uses dlib shape predictor file
detector = dlib.get_frontal_face_detector()
predictor = dlib.shape_predictor('shape_predictor_68_face_landmarks.dat')


#Extract indexes of facial landmarks for the left and right eye
(lStart,  lEnd)  =  face_utils.FACIAL_LANDMARKS_IDXS['left_eye']
(rStart, rEnd) = face_utils.FACIAL_LANDMARKS_IDXS['right_eye']


def getting_landmarks(im):
   rects = detector(im,1)
   if len(rects) >1:
      return"error"
   iflen(rects)==0:
      return"error"
   return  np.matrix([[p.x,p.y]  for  p  in  predictor(im,rects[0]).parts()])
def annotate_landmarks(im,landmarks):
   im = im.copy()
   for  idx,point  in  enumerate(landmarks):
      pos        =        (point[0,0],point[0,1])
      cv2.putText(im,str(idx),pos,
              fontFace=cv2.FONT_HERSHEY_SCRIPT_SIMPLEX,
                fontScale=0.4,
                color=(1,2,255))
        cv2.circle(im,pos,3,color=(0,2,2))
    return im

def    top_lip(landmarks):
    top_lip_pts = []
    for          i          in          range(50,53):
        top_lip_pts.append(landmarks[i])
    for          i          in          range(61,64):
        top_lip_pts.append(landmarks[i])
    top_lip_all_pts      =      np.squeeze(np.asarray(top_lip_pts))
    top_lip_mean = np.mean(top_lip_pts, axis=0)
    return int(top_lip_mean[:,1])

def              bottom_lip(landmarks):
    bottom_lip_pts = []
    for          i          in          range(65,68):
        bottom_lip_pts.append(landmarks[i])
    for                i                in                range(56,59):
        bottom_lip_pts.append(landmarks[i])
    bottom_lip_all_pts      =      np.squeeze(np.asarray(bottom_lip_pts))
    bottom_lip_mean = np.mean(bottom_lip_pts, axis=0)
    return int(bottom_lip_mean[:,1])

def mouth_open(image):
    landmarks = getting_landmarks(image)
    if landmarks == "error":
        return image,0
    image_with_landmarks    =    annotate_landmarks(image,landmarks)
    top_lip_center = top_lip(landmarks)
    bottom_lip_center = bottom_lip(landmarks)
    lip_distance = abs(top_lip_center - bottom_lip_center)
    return image_with_landmarks,lip_distance



#Start webcam video capture
cap = cv2.VideoCapture(0)
yawns = 0
yawn_status = False



while(True):


    #Read each frame and flip it, and convert to grayscale
    ret, frame = cap.read()
    frame = cv2.flip(frame,1)
    gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)

    image_landmarks, lip_distance = mouth_open(frame)

    prev_yawn_status = yawn_status


    #Detect facial points through detector function
    faces = detector(gray, 0)

    #Detect faces through haarcascade_frontalface_default.xml
    face_rectangle = face_cascade.detectMultiScale(gray, 1.3, 5)



    #Draw rectangle around each face detected
    for (x,y,w,h) in face_rectangle:
        cv2.rectangle(frame,(x,y),(x+w,y+h),(255,0,0),2)
```

```
#Detect facial points
for face in faces:

    shape = predictor(gray, face)
    shape = face_utils.shape_to_np(shape)

    #Get array of coordinates of leftEye and
    rightEyeleftEye = shape[lStart:lEnd]
    rightEye = shape[rStart:rEnd]

    #Calculate aspect ratio of both eyes
    leftEyeAspectRatio = eye_aspect_ratio(leftEye)
    rightEyeAspectRatio = eye_aspect_ratio(rightEye)

    eyeAspectRatio = (leftEyeAspectRatio + rightEyeAspectRatio) / 2

    #Usehulltoremoveconvexcontourdiscrepenciesanddraweyeshapearoundeyes
    leftEyeHull =cv2.convexHull(leftEye)
    rightEyeHull = cv2.convexHull(rightEye)
    cv2.drawContours(frame, [leftEyeHull], -1, (0, 255, 0), 1)
    cv2.drawContours(frame, [rightEyeHull], -1, (0, 255, 0), 1)

    #Checking if the person is yawning, has small eye ratio or both
    if (lip_distance> 25)or(eyeAspectRatio< EYE_ASPECT_RATIO_THRESHOLD):
        yawn_status = True
        COUNTER += 1
        if (COUNTER >= EYE_ASPECT_RATIO_CONSEC_FRAMES):
            continue

            cv2.putText(frame, "You are drowsy", (50,450),cv2.FONT_HERSHEY_COMPLEX, 1,
(0,0,255),2)
        #Playing an alert sound
```

```
            pygame.mixer.music.play(-1)


        else:
            #Stoping the alert sound
            pygame.mixer.music.stop()
            yawn_status = False
            COUNTER = 0



    #Show video feed
    cv2.imshow('Detection', frame )
    if(cv2.waitKey(1) & 0xFF == ord('q')):
        break

#Finally when video capture is over, release the video capture and
destroyAllWindowscap.release()
cv2.destroyAllWindows()
```

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