A PROJECT REPORT
ON

"Driver Drowsiness Detection System"

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BACHELOR OF ENGINEERING
IN
INFORMATION TECHNOLOGY
BY

Samruddhi Jagtap	**B150238551**
Suraj Kamble	**B150238560**
Ketan Sawale	**B150238618**
Roshnee Rathod	**B150238607**
Supriya Sul	**B150238632**

UNDER THE GUIDANCE OF

Prof. Shweta Patil

Department of Information Technology

STES's Sinhgad College of Engineering
Vadgaon (Bk.), Off. Sinhgad Road,Pune 411041.

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Sinhgad Institutes

CERTIFICATE

This is to certify that the project report entitled

"Driver Drowsiness Detection System"

Submitted by

Samruddhi Vijaykumar Jagtap	**B150238551**
Suraj Hanmant Kamble	**B150238560**
Roshnee Kashinath Rathod	**B150238607**
Ketan Arun Sawale	**B150238618**
Supriya Uttam Sul	**B150238632**

is a bonafide work carried out by Students under the supervision of Prof. Shweta Patil and it is submitted towards the partial fulfilment of the requirement of Savitribai Phule Pune University, for the award of the degree of Bachelor of Engineering (Information Technology).

Prof. Shweta Patil
Internal Guide
Department of IT

Prof. S. P. Potdar
H.O.D
Department of IT

External Examiner

DR.S.D.LOKHANDE
Principal
Sinhgad College of Engineering, Vadgaon

Date:

Place: Pune

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Samruddhi Vijaykumar Jagtap (B150238551)
Suraj Hanmant Kamble (B150238560)
Roshnee Kashinath Rathod (B150238607)
Ketan Arun Sawale (B150238618)
Supriya Uttam Sul (B150238632)

ABSTRACT

In today’s busy and hectic world, people are unable to get full rest and complete bedtime sleep. Due to this when they drive after a sleepless night, they end up dozing off while driving which can be very fatal. A lot of accidents are caused due to drowsy driving every year and it often goes undetected thereby leading to huge loss of lives and resources. Every year the amounts of deaths and injuries are increasing in traffic accidents due to human errors. Drowsiness and driving is a very hazardous and it is very difficult to identify. After alcohol drowsiness is the second leading cause of the road accidents. People are conscious about the risk of drinking and driving but don’t realize the dangerous of drowsiness because no instruments exist to measure the driver drowsiness. If the Driver failing to concentration on driving it reduces the driver reaction time and impair steering behavior. Driver drowsiness can cause several physical and economical losses; One way to detecting driver's drowsiness is to observe the driver with his driving, if driver not concentrating on driving alerts the driver with the alarm sound. So in this paper, we review and discuss the various detection methods for detecting driver's drowsiness and we are presenting a system that detects drowsiness while driving and alerts the driver for the same.

Keywords—Drowsiness detection, Face Detection and Tracking, Eyes Detection and Tracking

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LIST OF ABBREVIATION

ABBREVIATION	ILLUSTRATION
LSTM	Long-Short term memory
CDP	Continuous Defect Prediction
VCS	Version Control Systems
IS	Innovation Suite
SDLC	Software Development Life Cycle

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Chapter1

Introduction to Driver Drowsiness Detection

1.1 Introduction to Driver Drowsiness Detection

In recent years, driver drowsiness has been one of the major causes of road accidents and can lead to severe physical injuries, deaths and significant economic losses. Statistics indicate the need of a reliable driver drowsiness detection system which could alert the driver before a mishap happens. A driver who falls asleep at the wheel loses control of the vehicle, an action which often results in a crash with either another vehicle or stationary objects. In order to prevent these devastating accidents, the state of drowsiness of the driver should be monitored.

Today, a large number of these accidents go unnoticed because the driver does not report that he or she has fallen asleep because doing so would make them responsible for the accident and, in the worst-case scenario, result in death. To avoid tragic accidents and loss of life, it is critical to track drowsiness detection and inform the driver at the same time. It can also help to raise driver awareness of the risks involved, resulting in better driving practises. Such systems are only seen in high-end, high-priced vehicles. They include automatic braking when a vehicle is spotted by radars or ultrasonic sensors, as well as automated steering control when a car wanders a lot on a straight route. However, only a small percentage of cars have these amenities, and it will take a long time for these features to become standard in many vehicles. On the other hand, our approach is inexpensive, effective, and simple to use by a large number of people.

This disease is rapidly spreading and frequently goes undetected. It is critical to avoid drowsy driving, as it is the underlying cause of the majority of modern-day accidents. It's simply because people's lives are growing more stressful; they have a lot of work to accomplish and don't get enough rest. As a result, in order to cope with the next day's work, they often drive after a restless night's sleep, which is quite risky. It endangers not just their lives but also the lives of the people around them.

1.2 Motivation behind Driver Drowsiness Detection project

Driver drowsiness is a significant factor in the increasing number of accidents on today’s roads and has been extensively accepted. This proof has been verified by many researchers that have demonstrated ties between driver drowsiness and road accidents. Although it is hard to decide the exact number of accidents due to drowsiness, it is much likely to be underestimated. The above statement shows the significance of a research with the objective of reducing the dangers of accidents anticipated to drowsiness. So far, researchers have tried to model the behavior by creating links between drowsiness and certain indications related to the vehicle and to the driver.

Data on road accidents in India are collected by Transport Research Wing of Ministry of Road Transport & Highways. The aim of this project is to develop a prototype of drowsy driver warning system. Our whole focus and concentration will be placed on designing the system that will accurately monitor the open and closed state of the driver’s eye in real time. By constantly monitoring the eyes, it can be seen that the symptoms of driver fatigue can be detected early enough to avoid an accident. This detection can be done using a sequence of images of eyes as well as face and head movement. The observation of eye movements and its edges for the detection will be used. Devices to detect when drivers are falling asleep and to provide warnings to alert them of the risk, or even control the vehicle’s movement, have been the subject to much research and development. Driver fatigue is a serious problem resulting in many thousands of road accidents each year. It is not currently possible to calculate the exact number of sleep related accidents because of the difficulties in detecting whether fatigue was a factor and in assessing the level of fatigue.

However, research suggests that up to 25% of accidents on monotonous roads in India are fatigue related. Research in other countries also indicates that driver fatigue is a serious problem. Young male drivers, truck drivers, company car drivers and shift workers are the most at risk of falling asleep while driving. However, any driver travelling long distances or when they are tired, it is at the risk of a sleep related accidents.

The early hours of the morning and the middle of the afternoon are the peak times for fatigue accidents and long journeys on monotonous roads, particularly motorways, are the most likely to result in a driver falling asleep

There are around 466 million people worldwide with hearing loss (over 5% of the world population) and 34 million of these are children. ‘Deaf’ people have very little or no hearing ability. They use sign language for communication. People use different sign languages in different parts of the world. Compared to spoken languages they are very less in number. India has its own sign language by the name Indian Sign Language (ISL). In developing countries there are only very few schools for deaf students. Unemployment rate among adults with hearing loss are very high in developing countries. So, we wanted to make communication and learning of sign language easier so as to improve the quality of life for the disabled community.

1.3 Aim and Objective(s) of the work

- **Project aim:-**

  To design and implement a tool for avoiding road accidents due to driver drowsiness. To produce the systems that can be efficient in detecting the drowsiness level at an early stage by giving a warning to them about their lack of attention due to drowsiness or other factors. In other words, they can correct the behavior or stop driving when they in the drowsiness state. This system will need to be robust against model mismatch and disturbances and comfort constraints.

- **Project objectives:-**

To identify the current drowsiness detection by investigating flexible methods for studying the relationships between driver’s man oeuvre performances while the vehicle on the move and the physiological driver drowsiness states.

Design and development of a system that focuses on driver’s drowsiness detection and prediction through the following methods: -

- Monitoring the driver behavior by observing the vehicle man oeuvre stability and performance.
- Warning the drivers if the behavior beyond the thresholds.
- To avoid road accidents
- To Decrease death rate on road and save human lives

Chapter 2

Literature Survey

2.1 Literature Survey

Sr No.	Reference Name	Work description	Problems found
1	DrowsyDet: A Mobile Application for Real-time Driver Drowsiness Detection	Using the camera on the driver's phone as a monitor the driver.	Less time to Monitoring cause of depends on the phone battery
2	Driver Drowsiness Detection Percentage Eye closure method	Detects Eye-Blink based on different scenarios	Doesn't detect Eye when person wears Eye glasses
3	Driver Fatigue Detection	It captures every small facial expression	It doesn't give any alert, only detects drowsiness
4	Driver Drowsiness Detection Using Visual Information on Android Device	Monitors Driver, Lane and speed of the Vehicle	The use of an electrode helmet is required.
5	Drowsy Driver Detection System	Driver's state is detected using iris and pupil color	Detects Drowsiness only on behavioral factor.

2.2 SYSTEM REVIEW

This survey is done to comprehend the need and prerequisite of the general population, and to do as such, we went through different sites and applications and looked for the fundamental data. Based on these data, we made an audit that helped us get new thoughts and make different arrangements for our task. We reached the decision that there is a need of such application and felt that there is a decent extent of progress in this field too.

2.3 TECHNOLOGY USED

i) **PYTHON -** Python is an interpreted, high-level, general-purpose programming language. Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects. Python is dynamically typed AND supports multiple programming paradigms, including procedural, object-oriented, and functional programming.

ii) **MACHINE LEARNING -** Machine learning is the scientific study of algorithms and statistical models that computer systems use in order to perform a specific task effectively without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly told.

Chapter 3

RELATED WORK

3.1 What is Drowsiness

Drowsiness is a state where a person sleeps or almost likely. It alludes to a failure to keep awake or a drive to rest. Drowsiness and sleepiness considered in this paper as equivalent words. Although, in this paper sleepiness is utilized as a part of distinctive term as fatigue, which is a great tiredness because of physical and mental action. Drowsiness can likewise be depicted by the evaluation of alertness or vigilance. Attentiveness is the same as sharpness or a condition of sleep inability, while vigilance can be depicted as watchfulness or a state where one is readied for something to happen.

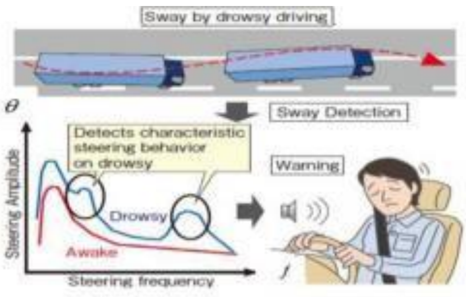


Fig.3.1.1- Drowsy Driver Characteristics

The term “drowsy” is synonymous with sleepy, which simply means an inclination to fall asleep. The stages of sleep can be categorized as awake, non-rapid eye movement sleep (NREM), and rapid eye movement sleep (REM). The second stage, NREM, can be subdivided into the following three stages

Stage I: transition from awake to asleep (drowsy)

Stage II: light sleep

Stages III: deep sleep

In order to analyze driver drowsiness, researchers have mostly studied Stage I, which is the drowsiness phase. The crashes that occur due to driver drowsiness have a number of characteristics:

- Occur late at night (0:00am–7:00am) or during mid-afternoon (2:00 pm–4:00 pm)
- Involve a single vehicle running off the road
- Occur on high-speed roadways
- Driver is often alone

3.2 Related work

Fatigued driver significantly affects the driving and increases the chances of a crash. If a dangerous situation arises it impairs our ability to respond quickly and safely, and drowsiness reduced the driver activities and he less aware of what is happening on the road. 51% youngsters feeling drowsy while they had driven and even 17% are fallen asleep according to National Sleep Foundation (NSF). More than 30% road accidents are due to driver's sleepiness or fatigue.

There are two main causes of driver fatigue:

- If Quality and quantity of the sleep is not good.
- Start the driving at the time of normally be sleeping

Finally, the driver not getting the sufficient sleep, which can lead to a great risk of a crash. The only way to recompense this is by sleeping. Or else it will have a higher problem of having a fatigue related accident.

Identification of the driver drowsy by:

1. Image is Captured from camera
2. Face detection and cropping of face
3. Morphological processes
4. Drowsiness Detection of Driver
5. Gives Alarm

For eye detection, we used facial feature prediction in the system. Facial landmarks are being used to identify and represent significant facial features like the eyes, brows, nose, and mouth.

Face alignments, head human pose, face swapping, blink recognition, and other activities have all been successfully accomplished using facial landmarks. Our goal inside the context of feature points is to use a shape prediction algorithm for detecting essential facial structures on the face. The process of detecting facial landmarks involves two steps:

1. Determine the location of the face in an image.

2. Recognize the vital facial structures here on face.

The below facial landmark index can be used to identify and access both eye regions:

- The right eye using [36, 42].
- The left eye with [42, 48].

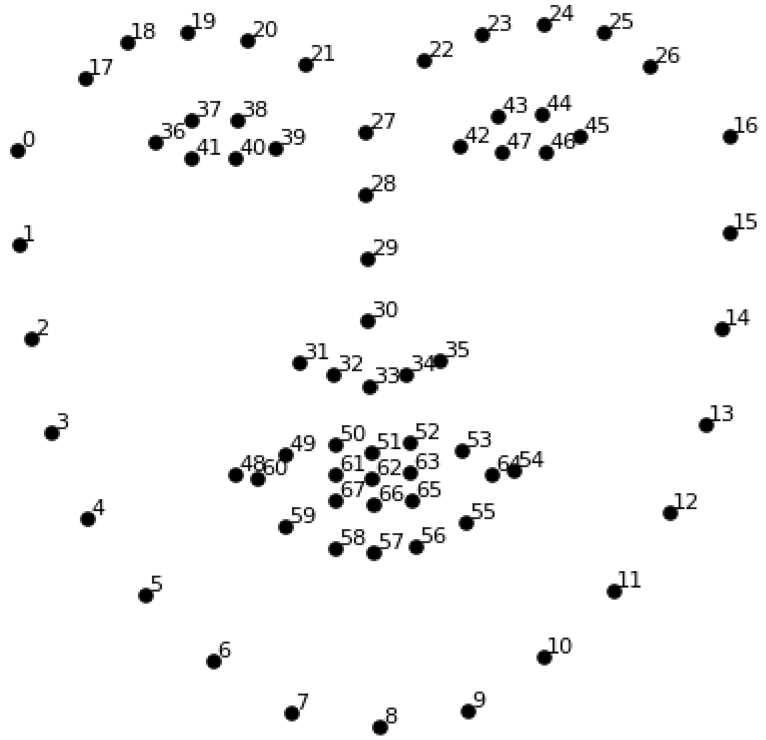


Fig 3.2.1, The 68 facial landmark coordinates (dataset)

Those remarks are part of a 68-point set that used train the dlib facial landmark predictor. It's worth noting that there are other types of facial landmark detectors, such as the 194-point model which can be trained using the dataset. The very same dlib framework can be used to build a shape predictor on the inputs training examples irrespectively of which dataset is used.

3.3 Factors cause driving drowsiness

Fatigued driver significantly affects the driving and increases the chances of a crash. If a dangerous situation arises it impairs our ability to respond quickly and safely and also drowsiness reduced the driver activities and he less aware of what is happening on the road. 51% youngsters feeling drowsy while they had driven and even 17% are actually fallen asleep according to National Sleep Foundation (NSF). More than 30% road accidents are due to driver's sleepiness or fatigue.

There are two main causes of driver fatigue:

- If Quality and quantity of the sleep is not good.
- Start the driving at the time of normally be sleeping

Finally, the driver not getting the sufficient sleep, which can lead to a great risk of a crash. The only way to recompense this is by sleeping. Or else it will have a higher problem of having a fatigue related accident.

3.4 Drowsy Detection Program

Now we discuss about the logic that we are designed for making the most effective and efficient Drowsiness System. The working of our system is shown in

This prototype program by using the computer vision libraries of OpenCV. First of all an image will be captured from camera stream and convert it into grayscale then histogram equalization will be applied on it. After then it will pass through filters for removing of noise. Then program will detect face and width to find the eyes by intensity changer because in eye region rapid change of intensity is occur. From the amount of intensity changes the program will judge either the eyes are close or open. If the eyes of driver will remain close for five consecutive image frames, then system will warn the driver.

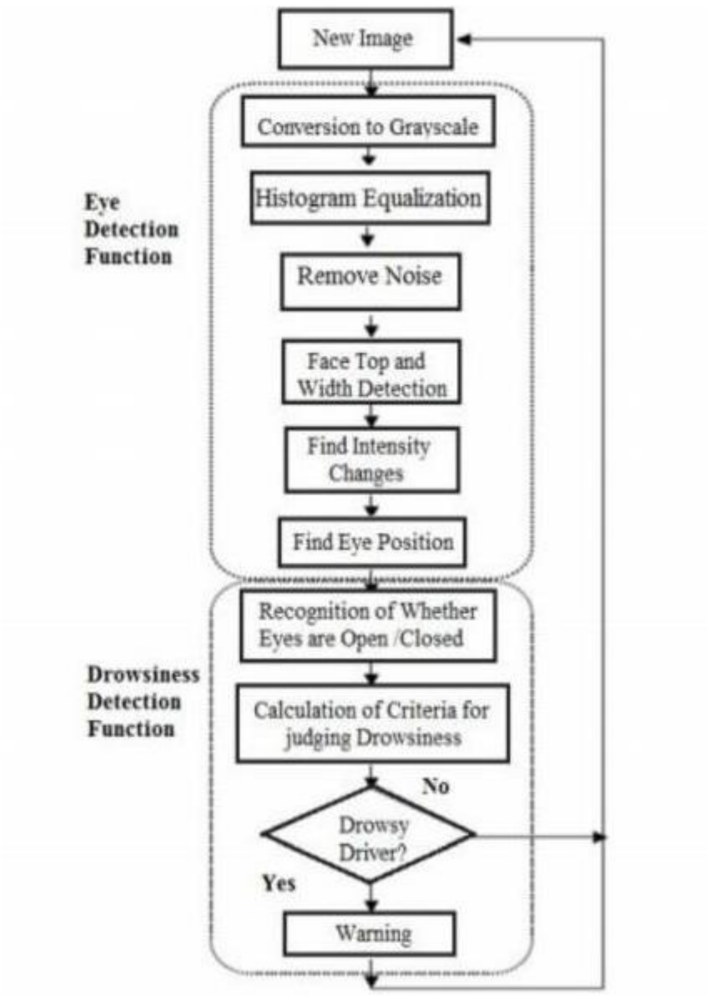


Fig.3.4.1- Flow chart of Drowsy Detection Program

If it will remain less than five consecutive frames, then system will not warn but show in display that you are drowsy. The program is designed to monitor and warn in drowsy condition as it starts. It will not take time to analyse any situation. This prototype is straightforward for checking eye and detects drowsiness on the basis of eye condition, whether the eye is close or open. The system has difficulties in finding that, whether the person is Active or not.

Chapter 4

System Requirements Specification

4.1 Software Requirements Specification

1. **IDE :** PyCharm or Anaconda

   Best Integrated Development Environment as it gives possible suggestions at the time of typing code snippets that makes typing feasible and fast.

2. **Coding Language :** Python Version 3.5

   Highly specified Programming Language for Machine Learning because of avail- ability of High Performance Libraries.

4.2 Hardware Requirements Specification

1) **Webcam**

   To continuous monitoring on driver's face.

2) **Buzzer**

   To give alarm to driver when fall asleep.

3) **RAM : 8 GB**

   As we are using Machine Learning Algorithm and Various High Level Libraries. Minimum RAM required is 8 GB.

4) **Processor : Intel i5 Processor**

   Python IDE that Integrated Development Environment is to be used and data loading should be fast hence Fast Processor is required

5) **Operating System : Windows 10**

   Latest Operating System that supports all type of installation and development Environment

Chapter 5

Requirement Analysis

5.1 Python:

Python is the basis of the program that we wrote. It utilizes many of the python libraries.

5.2 Libraries:

- Numpy: Pre-requisite for Dlib
- Scipy: Used for calculating Euclidean distance between the eyelids.
- Playsound: Used for sounding the alarm
- Dlib: This program is used to find the frontal human face and estimate its pose using 68 face landmarks.
- Imutils: Convenient functions written for Opencv.
- Opencv: Used to get the video stream from the webcam, etc.

5.3 Operating System:

Program is tested on Windows 10.

- Laptop: Used to run our code.
- Webcam: Used to get the video feed.

Chapter 6

BLOCK DIAGRAM AND FLOW CHART

6.1 Block Diagram

As drivers become drowsy, their head begins to sway and the vehicle may wander away from the centre of the lane. The previously described vehicle-based and vision-based measures become apparent only after the driver starts to sleep, which is often too late to prevent an accident.

The Block Diagram contains Different Entity:

- **User:** The User will provide INPUT video to the system.
- **Extract video :** The input video given by user to system is extracted

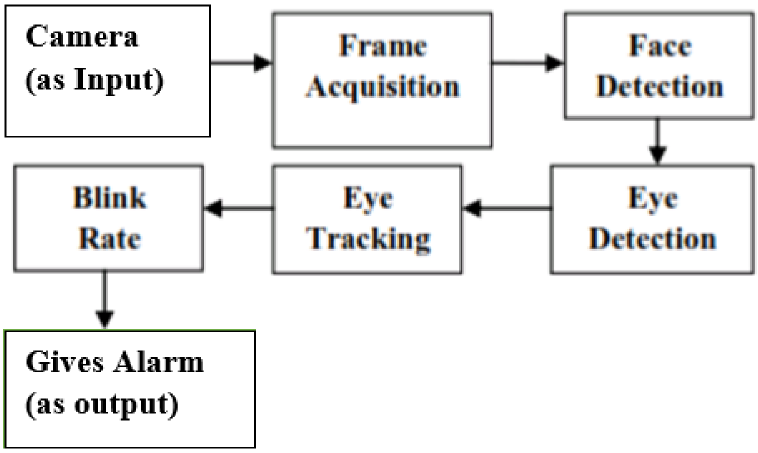


Fig. 6.1.1- Block Diagram OF Driver Drowsiness

Extraction is the process in which frames are created which are used for eye detection. The recorded video of driver face which is converted into streaming image frames, stores the image frames in a dataset to perform image pre-processing. Image pre-processing is to improve the quality of image data if any distortions which is totally enhances some image features by using geometric transformations like rotation, translation, scaling., to enhance the features of face detection. The features of eyes and mouth are extracted using LBPH technique.

We detect the features of eye (blink) and mouth (yawn) by using Haar detection method and find the parameter measures like Eye Aspect Ratio (EAR) are calculated. If the eyes are opened or closed, we check the blink rate of each eye and if blink rate of the eye exceeds the normal criteria then it alerts the warning to the system.

Finally, the driver not getting the sufficient sleep which can lead to a great risk of a crash. The only way to recompense this is by sleeping. Or else it will have a higher problem of having a fatigue related accident.

Eye shutting, head nodding, and brain activity are all examples of real-time drowsiness behaviours. We can identified exhaustion by measuring physical changes such as open/closed eyes using a video camera. This method is well suited for real-world settings because it is non-intrusive. Micro sleeps which are brief sleeps lasting 2 to 3 minutes, are also good indicators of exhaustion. Thus, by continuously monitoring the driver's eyes, the sleepy state of the driver can be detected and necessary action taken with the help of the buzzer.

When the user starts driving, the camera begins to work and continuously monitors the user's facial characteristics. After then, detection will begin using the HAAR Method. To train the classifier, the algorithm requires a large number of positive images [images with faces] and negative images [images without faces]. After that, we must extract features from it. Each feature is a single value calculated by subtracting the sum of pixels beneath the white rectangle from the total of pixels beneath the black rectangle. For eye detection, we employed facial landmark prediction. Facial landmarks are used to identify and represent important facial features. When the user falls asleep, the buzzer in front of the driver senses this and beeps.

6.2 Flow of System

The methodology in our proposed system “driver drowsiness detection alert system” is as follows:

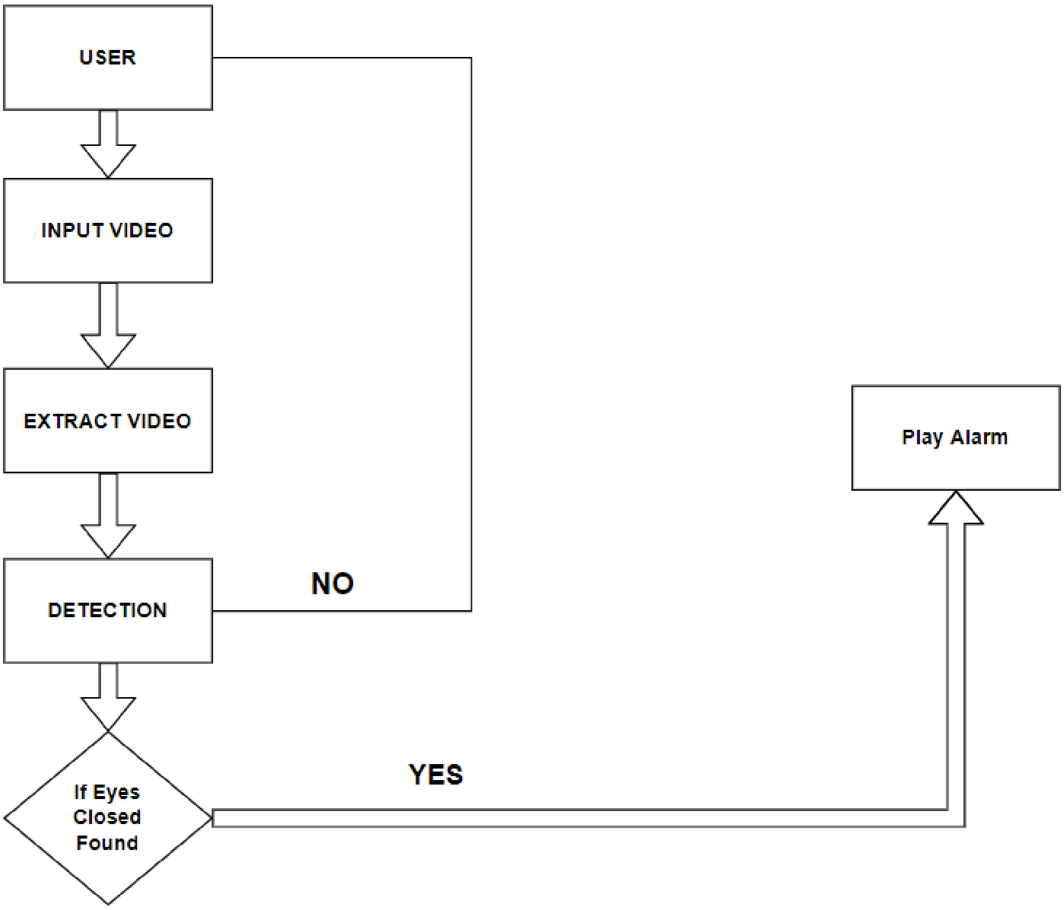


Fig.6.2.1- Flow Chart

Step 1: Image/Video extraction is used to convert input image into an array of numerical data then it is used for processing on a computer. In the first step, acquire the recorded video of a driver face as a input and is convert into image frames stored in dataset. Each of these frames are extracted and processed separately. Image extraction step mainly improves the input image which suppresses unwanted distortions in an image or enhances image features that are mainly important for processing. In this step, based on the image frame size of the pixel neighbourhood, we apply geometric transformation like rotation to enhance the features using point-based detection.

Step 2: Feature Extraction using LBPH technique Face recognition has become interesting field in research to improve the accuracy of many real-time applications. The enhanced feature extraction approach to improve human face recognition using LBPH technique is presented in this paper. We extract the features based on the landmark point-based and neighbourhood pixels of eyes & mouth to enhance the performance measures like speed to improve the recognition rate.

Step 3: Detection of eye (blink) and mouth (yawn) using Haar detection method. Haar detection method is an effective object detector method to detect the features in an image. Once we find the features extracted from 68 landmarks of face (eyes and mouth). We use Haar detection method to detect the features like eye blink and mouth yawn to a particular time limit. By using this method, we achieve accurate and faster results.

Step 4: Gives alarm beep signal to detect driver drowsiness. Based on the parameters (coordinates of eye and mouth) by using input image dataset, we could able to detect driver state weather he is sleeping state or active state. When the driver eyes blink i.e. eye open and eye close is found based on the parameters we identify, our system gives us immediate warn beep alarm. And also, when the mouth yawn i.e. mouth open and mouth close is found by parameters (dataset) then our system immediately warn an beep alarm, The results in our proposed system is implemented using OpenCV tool.

Chapter 7

SYSTEM DESIGN

7.1 System diagram

A system diagram is a visual model of a system, its components, and their interactions. The technique helps you to map out the structure of the system to be modelled. It shows the factors and relationships that are important, and helps you to start quantifying the linkages between factors.

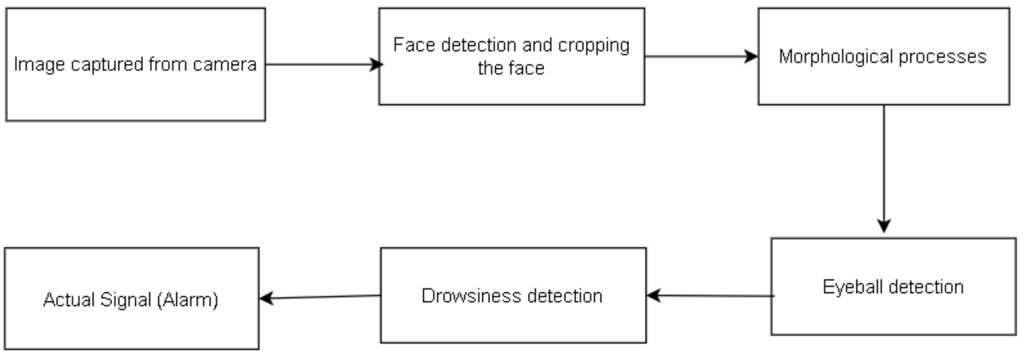


Fig 7.1- System diagram

7.2 Use case diagram

It represents the functionality of a system by utilizing actors and use cases. It encapsulates the functional requirement of a system and its association with actors. It portrays the use case view of a system.

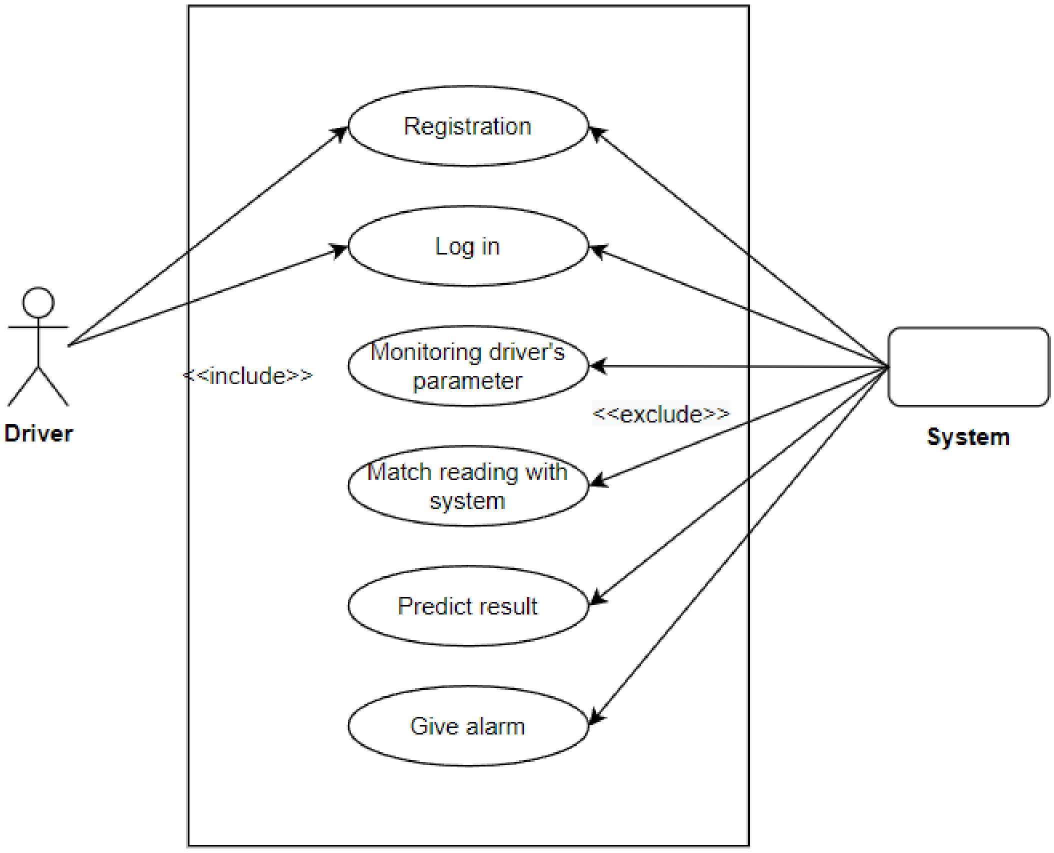


Fig 7.2- Use case diagram

7.3 Sequence Diagram

It shows the interactions between the objects in terms of messages exchanged over time. It delineates in what order and how the object functions are in a system.

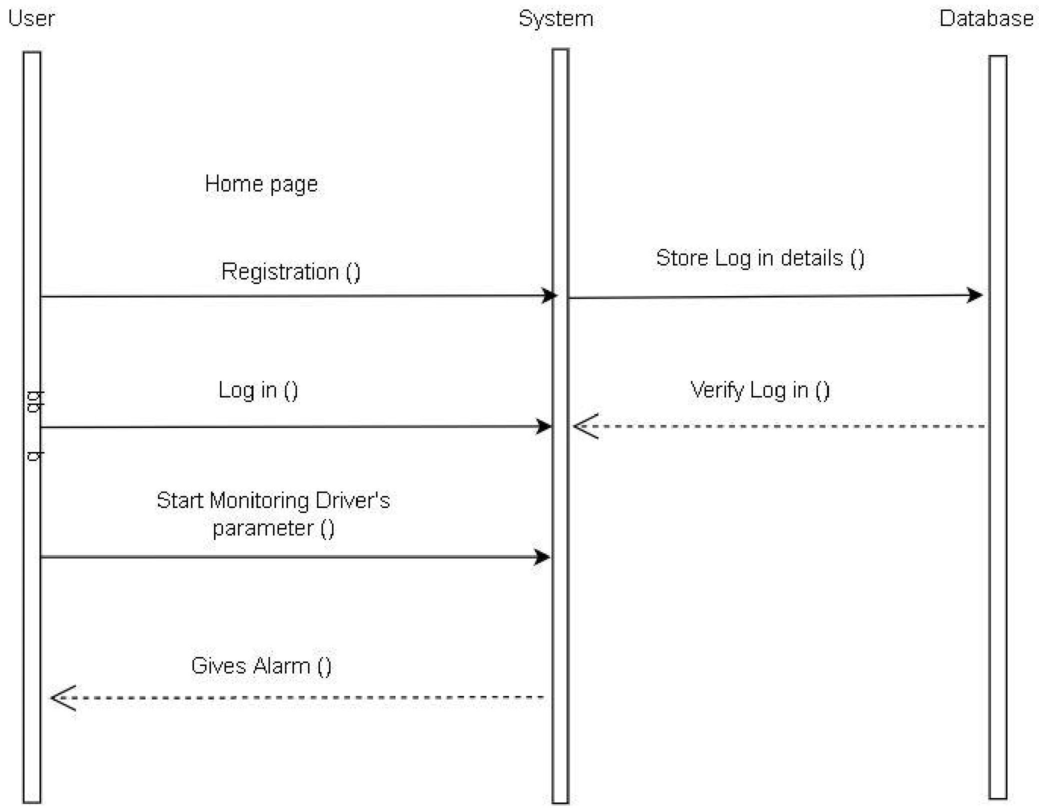


Fig 7.3- Sequence Diagram

7.4 Activity Diagram

It models the flow of control from one activity to the other. With the help of an activity diagram, we can model sequential and concurrent activities. It visually depicts the workflow as well as what causes an event to occur.

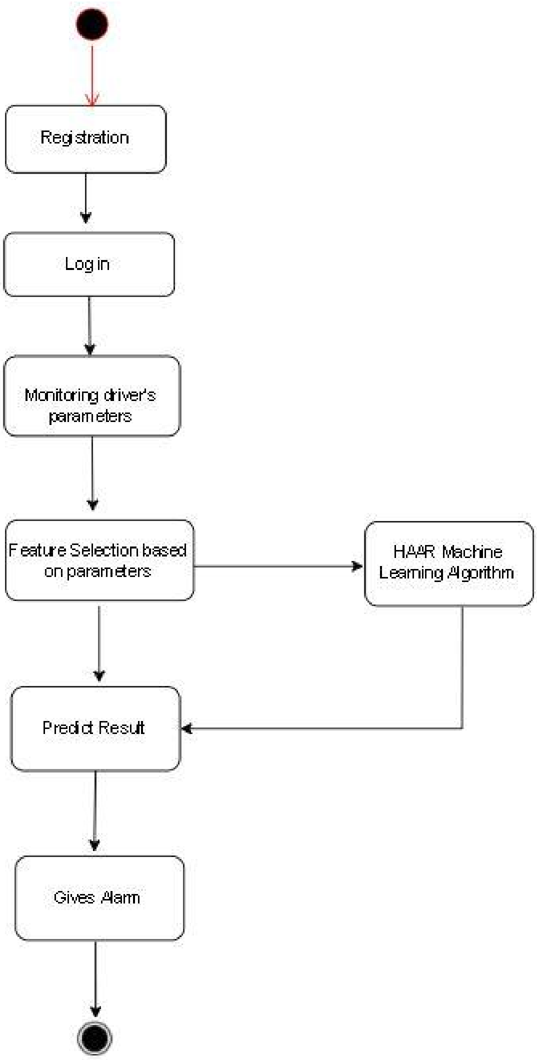


Fig 7.4- Activity Diagram

7.5 Class Diagram

Class diagrams are one of the most widely used diagrams. It is the backbone of all the object-oriented software systems. It depicts the static structure of the system. It displays the system's class, attributes, and methods. It is helpful in recognizing the relation between different objects as well as classes.

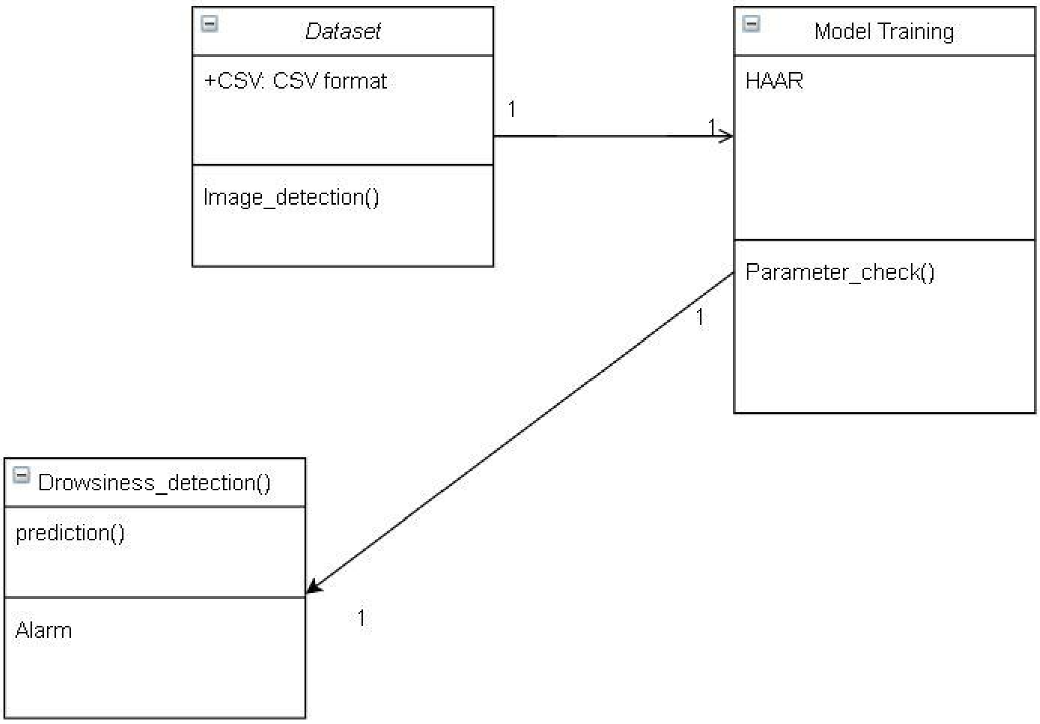


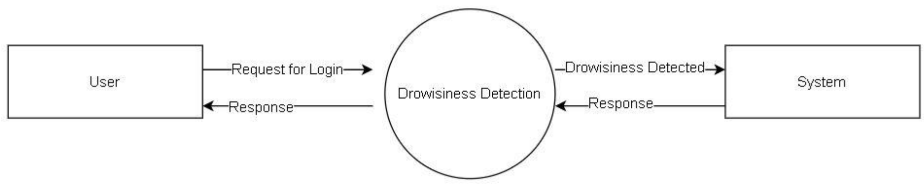
Fig 7.5- Class Diagram

7.6 Data Flow Diagram

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. The objective of a DFD is to show the scope and boundaries of a system as a whole

Level-0:

It is also known as fundamental system model, or context diagram represents the entire software requirement as a single bubble with input and output data denoted by incoming and outgoing arrows.



Level-1:

In 1-level DFD, a context diagram is decomposed into multiple bubbles/processes. In this level, we highlight the main objectives of the system and breakdown the high-level process of 0-level DFD into subprocesses.

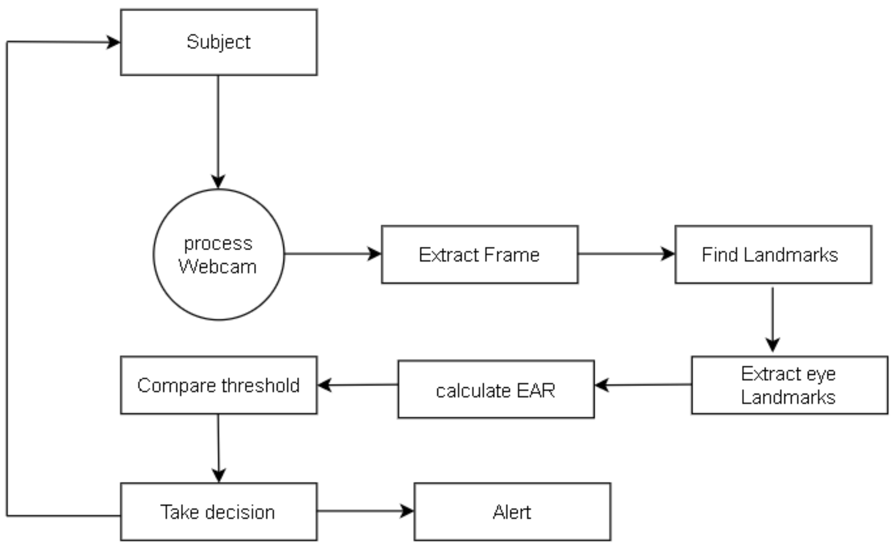


Fig 7.6 -Data Flow Diagram

7.7 Object Diagram

It describes the static structure of a system at a particular point in time. It can be used to test the accuracy of class diagrams. It represents distinct instances of classes and the relationship between them at a time.

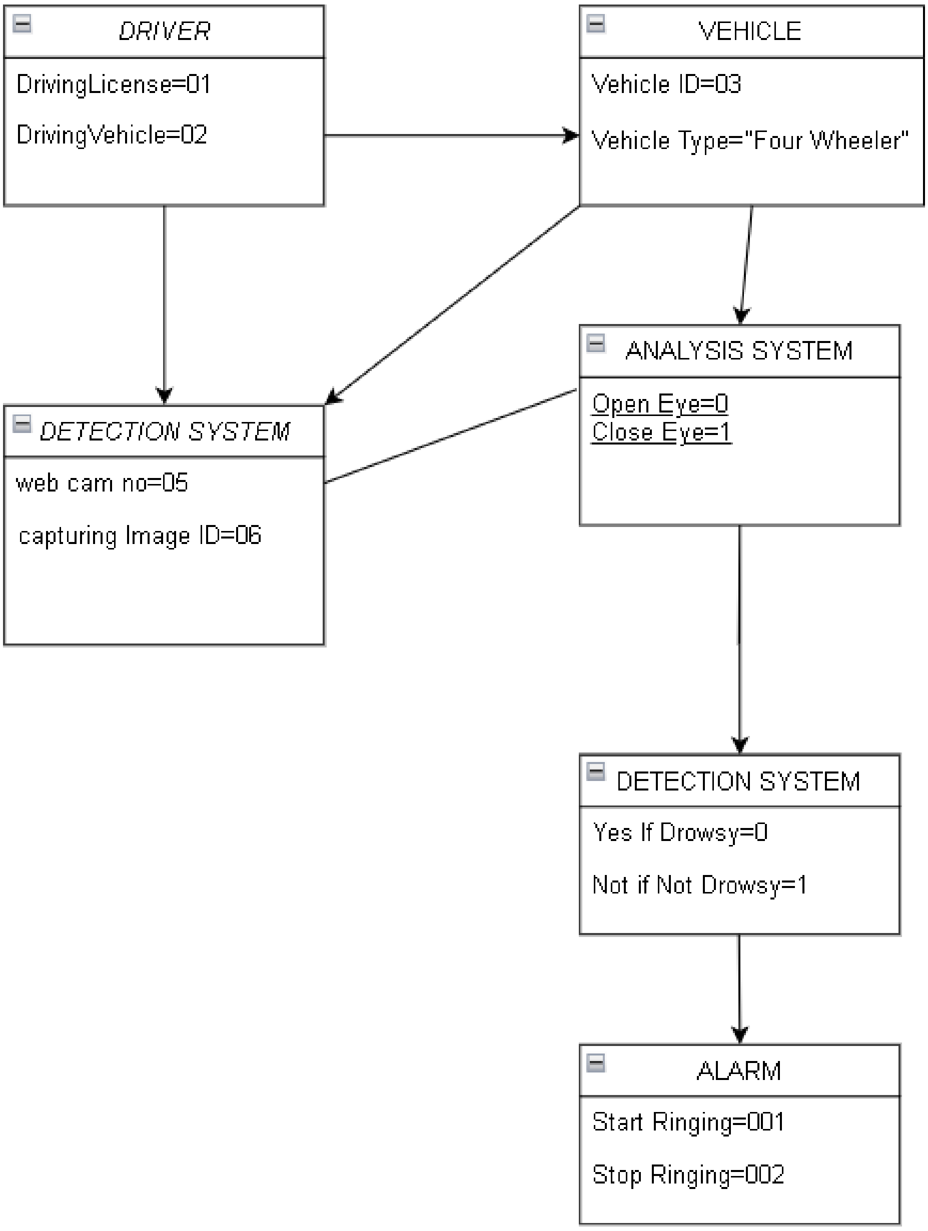


Fig [7.7]-Object Diagram

7.8 Package Diagram

It is used to illustrate how the packages and their elements are organized. It shows the dependencies between distinct packages. It manages UML diagrams by making it easily understandable. It is used for organizing the class and use case diagrams.

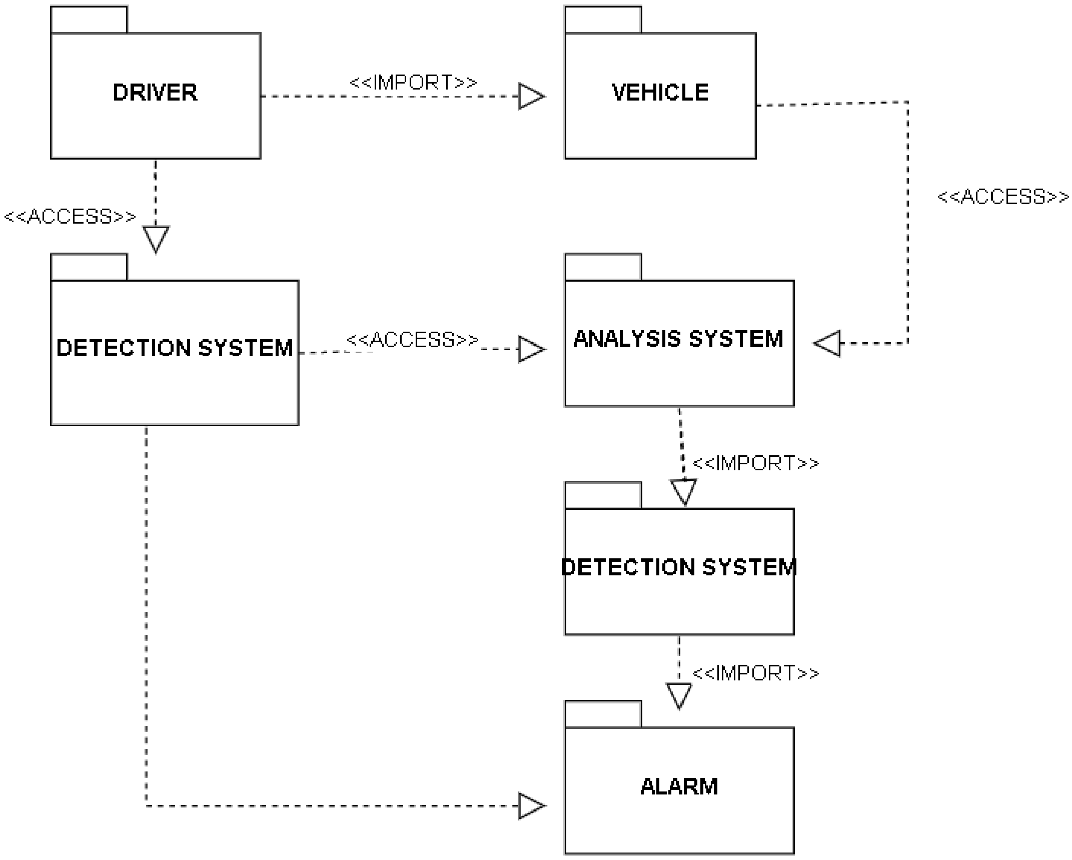


Fig 7.8- Package Diagram

Chapter 8

Methods for movement and drowsiness measurement

8.1 Methods for movement measurement

8.1.1 Driver's Head Movement

The objective is to detect the driver's state based on his/her head movement. For this, driver's head movements during normal and drowsy driving need to be compared and analysed.

A. Collecting Drivers' Head Movement

The 'Collecting Drivers' Head Movement' process of the figure 8.1.1.1 is the collecting process for the driver's head movement, state and the circumstance during the real driving situations.

The driver's state and the circumstance were recorded through the WebCam, and the head movements were collected by IR sensors. For this, the "IR Sensing Module" which can gather the driver's head movement and "State Recorder" which can record the driver's state and circumstance were implemented.

B. Categorizing Drivers' Head Movement

This process, which is placed on the middle of the figure 8.1.1.1 classify the driver's head movement based on the moves of the driver's state and circumstance which were delivered from former stage. In this stage, the application named 'State Player' was implemented to analyze the driver's state and circumstance. By using this application, the user can directly categorize the driver's state.

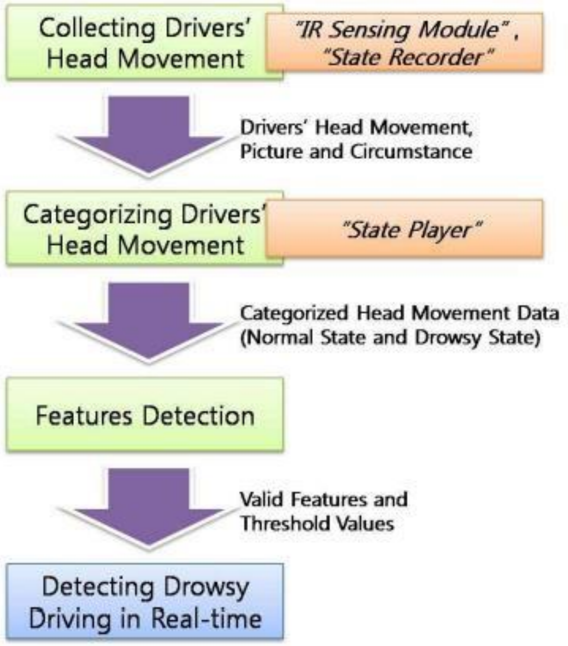


Fig. 8.1.1.1- Analysing Driver's Head Movement

8.1.2 Facial Action Classifiers

The facial action coding system (FACS) is arguably the most widely used method for coding facial expressions in the behavioural sciences. The system describes facial expressions in terms of 46 component movements, which roughly correspond to the individual facial muscle movements. FACS provides an objective and comprehensive way to analyse expressions into elementary components, analogous to the decomposition of speech into phonemes. Because it is comprehensive, FACS has proven useful for discovering facial movements that are indicative of cognitive and affective states. Here we investigate whether there are action units (AUs).

State	Value	Indicators in Image
Alert	0	Fast eye blinks, often reasonably regular; apparent focus on driving with occasional fast sideways glances; normal facial tone
Slightly Drowsy	1	Increase in duration of eye blinks & possible increase in rate of eye blinks
Moderately Drowsy	2	Disruption of eye focus; significant increase in eye blink duration; disappearance facial tone

Significantly Drowsy	3	Discernible episodes of almost complete eye closure; eyes are never fully open; significant disruption of eye focus
Extremely Drowsy	4	Significant increase in frequency of eye closure episodes; longer duration of episodes

Table 1, Drowsiness level based on facial expression

The facial action detection system was designed as follows:

First faces and eyes are detected in real time using a system that employs boosting techniques in a generative framework. The automatically detected faces are aligned based on the detected eye positions and cropped. The system employs 72 Gabor-spanning spatial scales and 8 orientations. The outputs of these filters are normalized and then passed to a standard classifier.

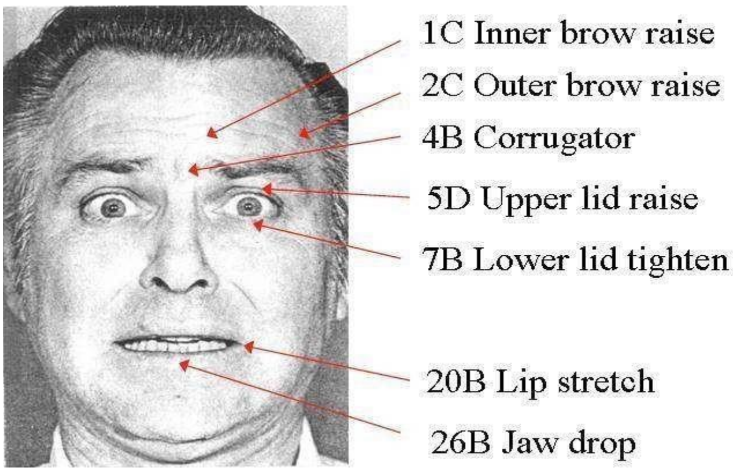


Fig.8.1.2.1- facial action decomposition from Facial Action Coding System

Facial expression training data

The training data for the facial action classifiers came from two posed datasets and one dataset of spontaneous expressions. The facial expressions in each dataset were FACS coded by certified FACS coders.

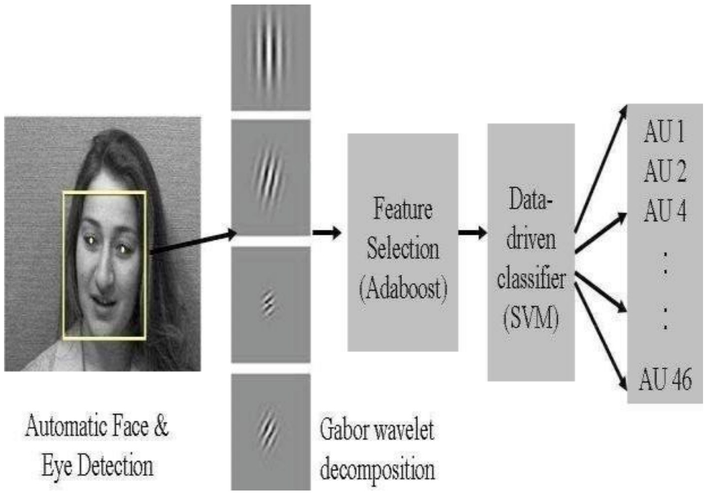


Fig. 8.1.2.2- Overview of fully automated facial action coding system

8.2 Methods for Measuring Drowsiness

8.2.1 Subjective Measures

In Subjective measures the driver drowsiness can be calculated based on the driver's individual estimation, regarding subjective measures various tools have been used to rating the driver sleepiness.

Subjective measures that evaluate the level of drowsiness are based on the driver's personal estimation and many tools have been used to translate this rating to a measure of driver drowsiness.

i. **Epworth sleepiness scale (ESS):**

The Epworth sleepiness scale (ESS) is one of the subjective measurement methods for measuring sleepiness of the driver. This method especially used to calculate the driver sleepiness at the daytime. This method is based on a subjective approach. In this approach it contains a set of short questionnaire, asked driver to rate their prospect of drowsiness in different daily life situations. If the score is higher, then the individual driver daytime sleepiness is also higher. The Epworth sleepiness scale (ESS) does not provide a diagnostic solution, but it can specify the essential for medical assistance. ESS test not influencing the behavior of the driver and not constantly attention to his sleepiness therefore ESS used as a research tool to find the road crashes and driver drowsiness.

Scale	Use
0	No chance of Drowsiness
1	Slight chance of Drowsiness
2	Moderate chance of Drowsiness
3	High chance of Drowsiness

Table 2- ESS

ii. **Karolinska Sleepiness Scale (KSS)**:

Karolinska Sleepiness Scale (KSS), is one of the tools and most regularly used tool for measuring the driver drowsiness. Karolinska Sleepiness Scale (KSS) contains totally nine different graded rating scale and it is orally measuring self-assessment scale to measuring the drowsiness. Karolinska Sleepiness Scale (KSS) scale from extremely alert to very sleepy. In this scale every few minutes about his or her driving situation. Few years back KSS is one of the most frequently used method to measure the drowsiness. It is very sensitive to different variations.

Scale	Use
1	Extremely alert
2	Very alert
3	Alert
4	Fairly alert
5	Neither alert nor sleepy
6	Some signs of sleepiness
7	Sleepy, but not effort to keep alert
8	Sleepy, more effort to keep alert
9	Very sleepy, great effort to keep alert, fighting sleep

Table 3- KSS

KSS is a long-time interval. It is recorded for every 15 minutes it cannot record immediate variations caused by the driver in various situation. This is an intrusive measure and driver continuously interacts with the superior and reports his or her status it could cause interference. It is an intrusive method used to measure sleepiness of the driver.

8.2.2 Behavioural Measures

The drowsy driver's behaviour like head pose, frequently yawning, eye closure, eye blinking etc. are observed to detect the driver drowsiness through camera and alert the driver if any one of these indications is detected in the driver. To measure abnormal behaviour of the driver different behavioural approaches to determine driver drowsiness one is eye blinking and EAR, MAR.

A drowsy person displays a number of characteristic facial movements, including rapid and constant blinking, nodding or swinging their head, and frequent yawning. Computerized, non-intrusive, behavioural approaches are widely used for determining the drowsiness level of drivers by measuring their abnormal behaviours. Most of the published studies on using behavioural approaches to determine drowsiness, focus on blinking. EAR, MAR. This measurement has been found to be a reliable measure to predict drowsiness and has been used in commercial products such as seeing Machines and Lexus. Some researchers used multiple facial actions, including inner brow rise, outer brow rise, lip stretch, jaw drop and eye blink, to detect drowsiness. However, research on using other behavioural measures, such as yawning and head or eye position orientation.

Stage of Drowsiness	Behaviour examples
1	Eye moving fast, many movements shown
2	Eye moving slower, mouth open little
3	Mouth mumbling, touching face, fixing the seating
4	Head shaking, yawning, blinking slower
5	Eye closed, head nodding

Table 4- STAGE OF DROWSINESS AND BEHAVIOR

Visual behaviours were measured by an eye mark camera with a sampling rate of 60.1 Hz. The number of eye blinks and the percentage closure of eyes (EAR, MAR) over 10 s were calculated from the recorded data.

8.3 Eye Blink

8.3.1 Eye Blink method

Based on individual access of drivers face we can detect whether the driver is sleepy or not. All we can do is so by following steps which are included as follows:

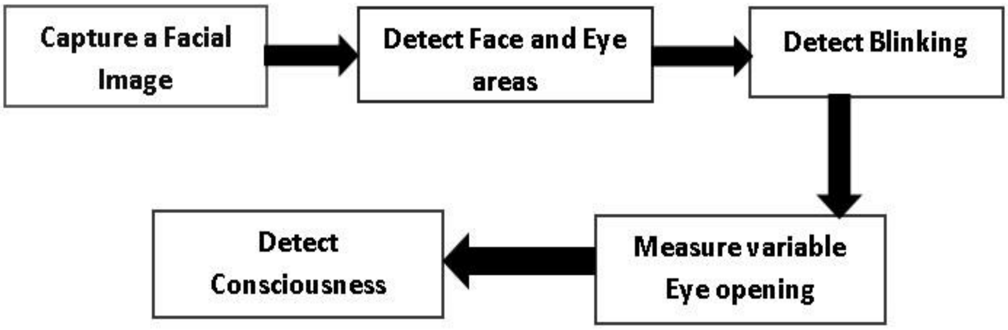


Fig 8.3.1.1- procedure for detecting driver's drowsiness

Above Fig 8.3.1.1 can be divided as per below.

A. Capturing the facial image

Generally, the illumination intensity changes extremely in cars. In daytime, it is sometimes very bright, while at night it is completely dark. Therefore, our imaging system should adapt to wide range of conditions. We adopted a pulsed infrared light projection method for our system.

B. Detecting the face and eye area

To detect the eye area from the images, our system uses a 68 facial landmark. Those remarks are part of a 68-point set that was used to train the dlib facial landmark predictor. It's worth noting that there are other types of facial landmark detectors, such as the 194-point model which can be trained using the dataset. The very same dlib framework can be used to build a shape predictor on the inputs training examples irrespectively of which dataset is used.

C. Detecting the upper and lower eyelids for detecting blinks

For detecting the upper and lower eyelids included in the eye area. First, this method slices the captured image into several vertical sections. Then, it detects candidate points on the upper and lower eyelids in each section. The method decides the candidate points A and B for the upper and lower. Then, we search for a pair of points that attain a maximal and a minimal derivative respectively outwards starting from the centre point C, which is the darkest point.

Next, the candidate points of the upper and lower eyelids are grouped respectively. Then, the two groups are estimated to represent the upper and lower eyelids respectively. Finally, we compute the average values of the distance between the upper and lower eyelid points of the five sections, which we call "eye gap." Using this method, we can detect the upper and lower eyelids robustly. The method is little affected by the shapes around the eyes of individual people. The detected blinks are almost identical to the actual opening and closing movements of the eyelids.

D. Detecting eye-blinks

When the eyes are open, the eye gap is large, and when a blink starts, the eye gap decreases quickly. After the eyes are shut completely, the eye gap increases gradually. It is necessary to measure blink periods precisely to detect driver's drowsiness. Therefore, it is necessary to determine the start point and the end point of a blink precisely to measure eyelid closure time of a blink. However, the patterns of blink waveforms and eye gaps vary by individual drivers. Moreover, period of blinks also varies. Therefore, a method using a uniformly fixed threshold for detecting blinks or a threshold depending to individual shape of eyes unusable for robust detection of eye blinks.

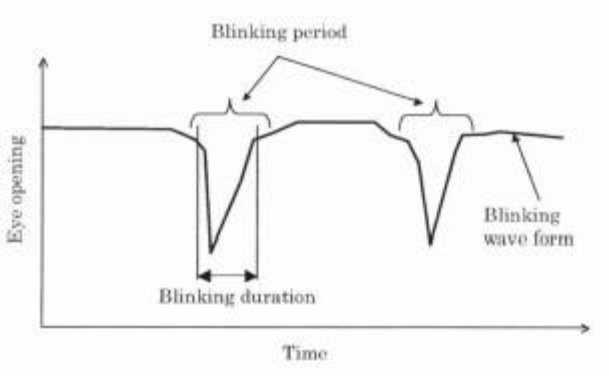


Fig 8.3.1.2- A model of blinking waveform A1

Fig. 8.3.1.2 shows a blink detection method that is little affected by individual differences. The method is robust because it uses zero-cross points of blink waveform delivered from second order derivative of the waveform to determine start and end points of blinks. The circuit for this process can be composed of a D/A converter, a low pass filter, two differential calculus operation circuits, and so on.

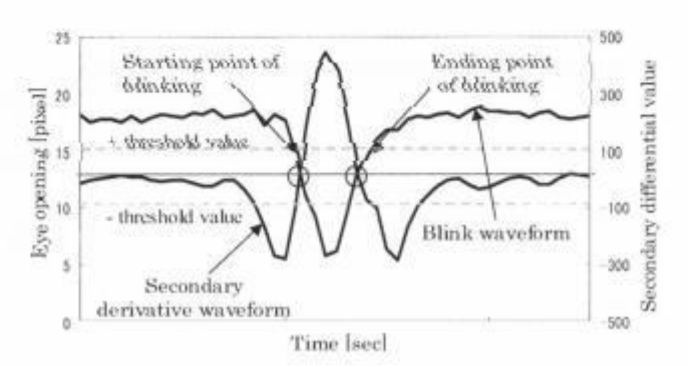


Fig 8.3.1.3- A model of blinking waveform A2

8.3.2 Eye Blink detection method

The eye-detection is done by the usage of the camera where they can be able to save the eye for the upcoming considering. The online images are obtained and thus the camera is able to detect the eye in the rectangle position. The primary goals are to analyse eye blinking and monitor it every 5-10 minutes. Thus, if the eye is matched to 0 means the eye is in the closed state in other constrain if it is non-zero it represents that the driver's eye is fully closed and it is been used for calculation of equation 1 is the calculation of average eye blinking. Here d is the drowsiness in percentage and CE is the number of the closed eye found by number of frames.

Chapter 9

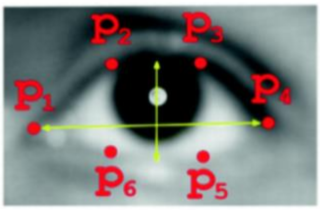
Feature Extraction

9.1 Feature Extraction

As briefly alluded to earlier, based on the facial landmarks that we extracted from the frames of the videos, we ventured into developing suitable features for our classification model. While we hypothesized and tested several features, the four core features that we concluded on for our final models were eye aspect ratio, mouth aspect ratio, pupil circularity, and finally, mouth aspect ratio over eye aspect ratio.

1) **Eye Aspect Ratio (EAR)**

EAR, as the name suggests, is the ratio of the length of the eyes to the width of the eyes. The length of the eyes is calculated by averaging over two distinct vertical lines across the eyes as illustrated in the figure below.



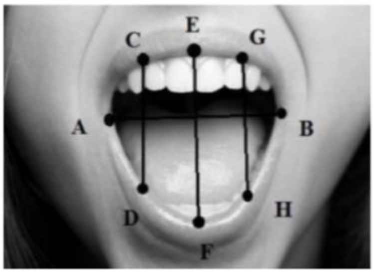
$$\text{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

Fig, 9.1.1- Eye Aspect Ratio

Our hypothesis was that when an individual is drowsy, their eyes are likely to get smaller and they are likely to blink more. Based on this hypothesis, we expected our model to predict the class as drowsy if the eye aspect ratio for an individual over successive frames started to decline i.e. their eyes started to be more closed or they were blinking faster.

2) **Mouth Aspect Ratio (MAR)**

Computationally similar to the EAR, the MAR, as you would expect, measures the ratio of the length of the mouth to the width of the mouth. Our hypothesis was that as an individual becomes drowsy, they are likely to yawn and lose control over their mouth, making their MAR higher than usual in this state.



$$MAR = \frac{|C-D|+|E-F|+|G-H|}{3|A-B|}$$

Fig, 9.1.2 - Mouth Aspect Ratio

Chapter 10

PROPOSED ALGORITHM

10.1 HAAR Cascade Algorithm

A Haar classifier, or a Haar cascade classifier, is a machine learning object detection program that identifies objects in an image or video.

I. **Calculating Haar Feature:**

The first step is to collect the Haar features. A **Haar feature** is essentially calculations that are performed on adjacent rectangular regions at a specific location in a detection window. The calculation involves summing the pixel intensities in each region and calculating the differences between the sums.

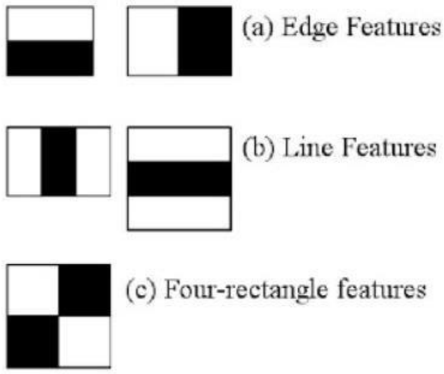


Fig 10.1.1- Types of HAAR features

II. **Creating Integral Images**

Without going into too much of the mathematics behind it, integral images essentially speed up the calculation of these Haar features. Instead of computing at every pixel, it instead creates sub rectangles and creates array references for each of those sub-rectangles. These are then used to compute the Haar features.

It's important to note that nearly all of the Haar features will be **irrelevant** when doing object detection, because the only features that are important are those of the object.

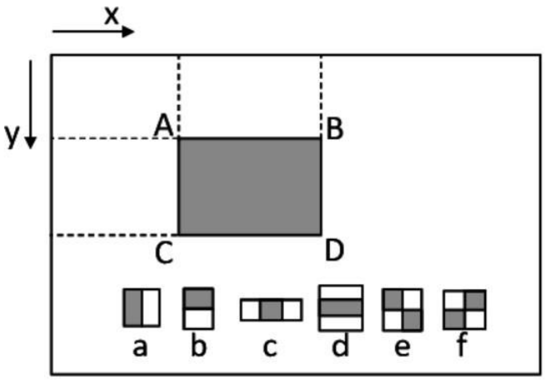


Fig 10.1.2- Creating Integral Images

III. Adaboost Training

Adaboost essentially chooses the best features and trains the classifiers to use them. It uses a combination of **"weak classifiers"** to create a **"strong classifier"** that the algorithm can use to detect objects.

Weak learners are created by moving a window over the input image, and computing Haar features for each subsection of the image. This difference is compared to a learned threshold that separates non-objects from objects. Because these are "weak classifiers," a large number of Haar features is needed for accuracy to form a strong classifier.

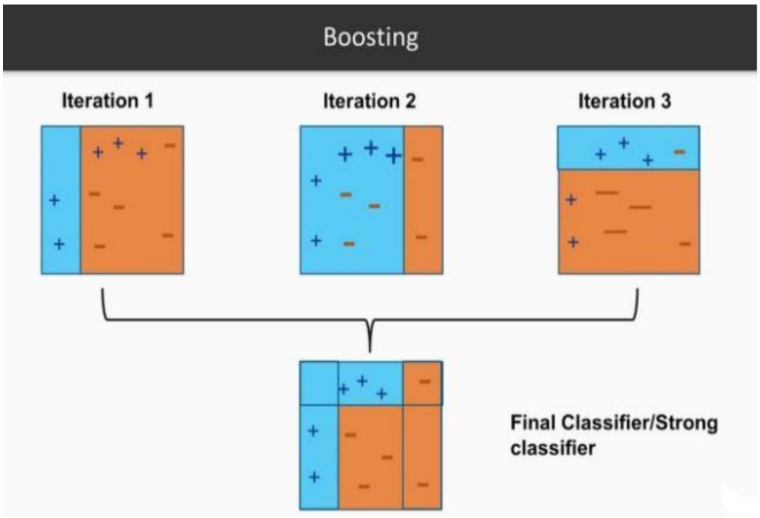


Fig 10.1.3- Representation of a boosting algorithm.

Ⅳ. Implementing Cascading Classifiers

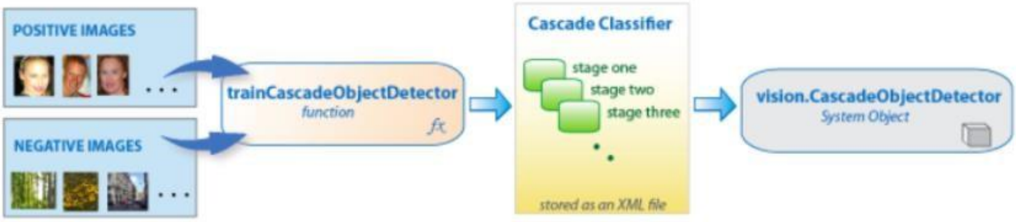


Fig 10.1.4- A flowchart of cascade classifiers.

The cascade classifier is made up of a series of stages, where each stage is a collection of weak learners. Weak learners are trained using boosting, which allows for a highly accurate classifier from the mean prediction of all weak learners.

Based on this prediction, the classifier either decides to indicate an object was found (positive) or move on to the next region (negative). Stages are designed to reject negative samples as fast as possible, because a majority of the windows do not contain anything of interest.

It's important to maximize a low false negative rate, because classifying an object as a non-object will severely impair your object detection algorithm. A video below shows Haar cascades in action. The red boxes denote "positives" from the weak learners.

Haar cascades are one of many algorithms that are currently being used for object detection. One thing to note about Haar cascades is that it is very important to reduce the false negative rate, so make sure to tune hyperparameters accordingly when training your model.

Chapter 11

Project Plan

11.1 Project Estimate

- **Cost Estimate:** The initial cost estimate of project before beginning the implementation process is INR 10000. This cost may vary. This estimate is subject to change according to the availability and need of a particular item.
- **Time estimate:** The initial time estimate for the complete implementation of the primary objectives is 45-50 days depending on the schedule of the developers. The secondary objectives require an additional 25 days to be completed. Also, depending on the stage of development, the testing and debugging would require an additional 15 days.

11.2 Analysis Model

We are using waterfall model for our project.

1. **Requirement gathering and analysis** − All possible requirements of the system to be developed are captured in this phase and documented in a requirement specification document.
2. **System Design** − The requirement specifications from first phase are studied in this phase and the system design is prepared. This system design helps in specifying hardware and system requirements and helps in defining the overall system architecture.
3. **Implementation** − With inputs from the system design, the system is first developed in small programs called units, which are integrated in the next phase. Each unit is developed and tested for its functionality, which is referred to as Unit Testing.
4. **Integration and Testing** − All the units developed in the implementation phase are integrated into a system after testing of each unit. Post integration the entire system is tested for any faults and failures.

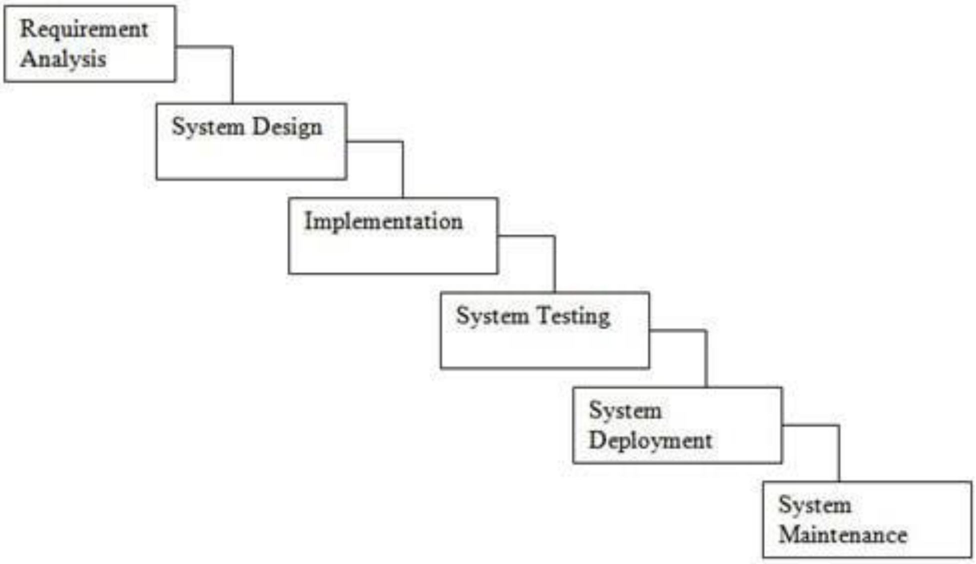


Fig. 11.2.1- Waterfall Model

5. **Deployment of system** − Once the functional and non-functional testing is done; the product is deployed in the customer environment or released into the market.
6. **Maintenance** − There are some issues which come up in the client environment. To fix those issues, patches are released. Also to enhance the product some better versions are released. Maintenance is done to deliver these changes in the customer environment.

11.3 Test Cases

TC No	Description	Input	Expected Result	Actual Result	Status
1	Eye state detection (open/closed)	Face	Detect whether eye is open or closed	Detects eye is open or closed	PASS
2	Eye state detection	Face + Glasses	Detect whether	Detect Eye	PASS

	while wearing glasses		eye is open or closed even driver wears glasses	State while wearing glasses	
3	yawning detection	Mouth	Detect yawning	Detect yawnin g	PASS
4	Wearing obstacle (Hat)	Face + Obstacl e	Detects Face even there are obstacles	Detects Face even there are obstacle	PASS

Chapter 12

SIMULATION RESULTS

Fig 12.1- Eye and Mouth Detection

Fig 12.1 reveals that EAR is used to make the eye detection decision. The eye state is characterised as "closed" if the distance is zero or close to zero; otherwise, the eye state is classified as "open.". MAR is used for mouth detection.

Fig 12.2- Drowsiness Detection

Fig 12.2 displays the detection of drowsiness. It detects tiredness and beeps the buzzer if the person is asleep.

Fig 12.3- Yawning Detection

Fig 12.3 displays the detection of yawning and beeps the buzzer.

Chapter 13

OTHER SPECIFICATION

13.1 ADVANTAGES

1. Detects drowsiness
2. Decreasing road accidents
3. System implemented without using database storage
4. No wires, cameras, monitors or other devices are to be attached or aimed at the driver.
5. Due to the non-obstructive nature of these methods, they are more practically applicable.

13.2 APPLICATION

1. This project can be used in the areas where camera as well as use of eyes detection happens.
2. The working of Driver Drowsiness detection can be used in Airplane, so that pilots can get regular alerts.
3. If enhanced, the project can be used in online student examination, through which we can prevent cheating as well as can keep eye on the student through giving smart alerts.
4. We are using whole face detection in this project, in the future for security purpose we can use this project.
5. Make the system work in real-time environment.

Chapter 14

Conclusion and Future Scope

14.1 Conclusion

Drowsy driving is becoming the serious issue. In our India, many accidents on highways are happening. To prevent these accidents, there is the need of system that can alerts us, it should check whether the driver is drowsy or not. The enhanced system can prevent such road accidents and many lives can be saved. We have reviewed the various methods available to determine the drowsiness state of a driver. We discussed the various ways in which drowsiness can be manipulated in a simulated environment. The various measures used to detect drowsiness include subjective, vehicle-based, physiological and behavioural measures. Although the accuracy rate of using physiological measures to detect drowsiness is high, these are highly intrusive. However, this intrusive nature can be resolved by using contactless electrode placement. Hence, it would be worth fusing physiological measures, such as ECG, with behavioural and vehicle-based measures in the development of an efficient drowsiness detection system. In addition, it is important to consider the driving environment to obtain optimal results.

14.2 Future Scope

- This project can be used in areas where camera as well as use of eyes detection happens.
- The working of Driver Drowsiness detection can be used in Airplane, so that pilots can get regular alerts.
- If enhanced, the project can be used in online student examination, through which we can prevent cheating as well as can keep eye on the student through giving smart alerts
- We are using whole face detection in this project, in the future for security purpose we can use this project.
- Make the system work in real-time environment.

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