PROJECT PRESENTATION
ON

STANDALONE DROWSINESS DETECTION AND ALARM MANAGEMENT BY RASPBERRY PI 3

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ABSTRACT

The aim of the project is to develop a Drowsiness Detection and Alarming System for sleepy drivers. We propose a camera module connected to a Raspberry Pi 3B+ which will continuously monitor the driver’s face, especially the eyes and determine if he is feeling sleeping or not. If the eyes are such in a condition that the Pi processes the real time data and ring an alarm to awaken the driver and hence prevent a major accident.

AIM OF PHASE 1

- Aim of the project is to develop a Drowsiness Detection and Alarming System for sleepy drivers
- Phase-1 covers the basics that are required to design such a system
- Understanding and being able to work with the hardware and software components
- Understanding the basics of image processing
- Being able to use the setup to capture images and videos.

AIM OF PHASE 2

- Phase 2 implements the main idea behind the project that is to construct a system that detect drowsiness of a driver and ring an alarm to awaken the driver and prevent a major accident.
- All the requirements of sensors and hardware were met in phase 1 and their interfacing was also done.
- Now the software behind the project which could work in harmony with hardware selected in Phase1 was to be designed
- It was decided based on whether the compiled software met the time and space complexity required for the job as the whole project was to be done on a Raspberry Pi module.
- Next, the required software, prepared in modules, had to be compiled .
- A proper testing of the compiled software module was desired .
- At last the whole system was to be tested on various subjects.

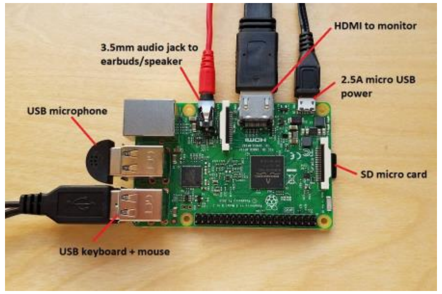
LITERATURE REVIEW

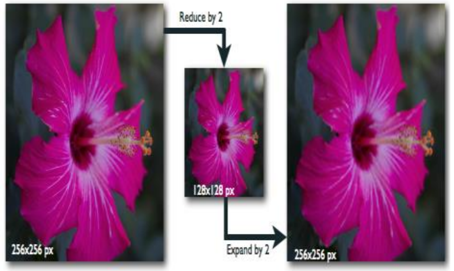
- Indications of a drowsy driver i.e; how do we know if a driver is feeling drowsy?

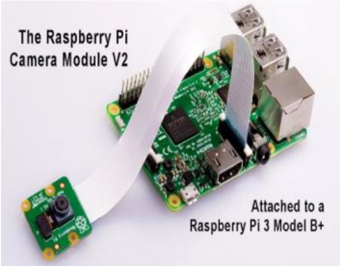
The following are indications of a drowsy driver

- Difficulty focusing, frequent blinking, or heavy eyelids
- Daydreaming; wandering/disconnected thoughts
- Trouble remembering the last few miles driven; missing exits or traffic signs
- Yawning repeatedly or rubbing your eyes
- Trouble keeping your head up
- Drifting from your lane, tailgating, or hitting a shoulder rumble strip
- Feeling restless and irritable

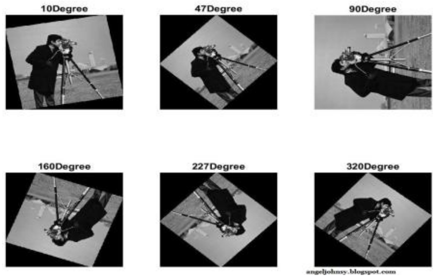
PLAN OF THE WORK

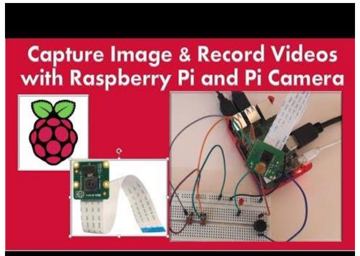


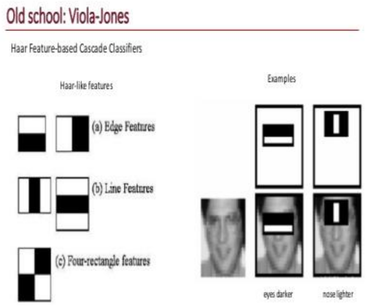


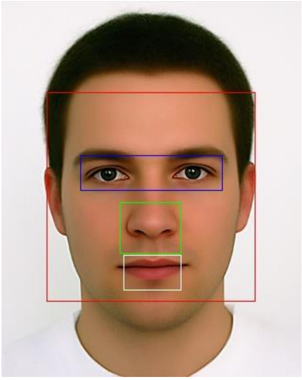


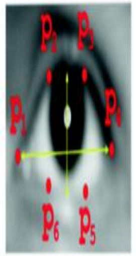
PHASE - I → FAMILIARISATION → SETUP AND INSTALLATION → UNDERSTANDING → INTERFACING





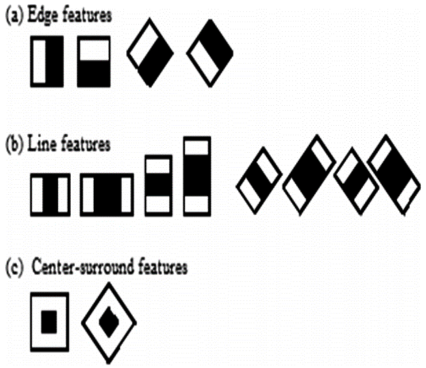


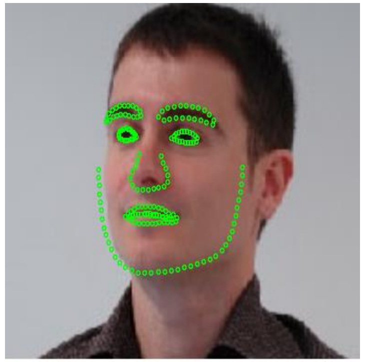


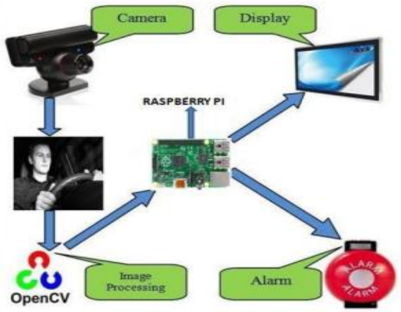


$$EAR = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

PHASE - II → USING CASCADE CLASSIFIER → DETECTING → COUNTING → CALCULATING → DEVELOPING AND IMPLEMENTING







SOFTWARE MODULES DECIDED TO BE WORKED UPON

- Face detection
- Eye detection
- Mouth detection
- Eye aspect ratio detection
- Mouth aspect ratio detection
- Yawn detection
- Blinking Frequency counter
- Yawn counter

FIG 1 : FACE DETECTION

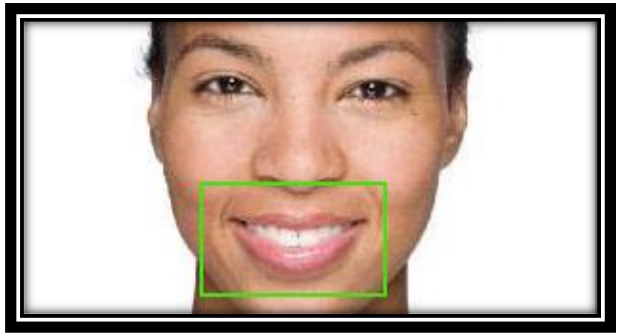


FIG 2 : MOUTH DETECTION

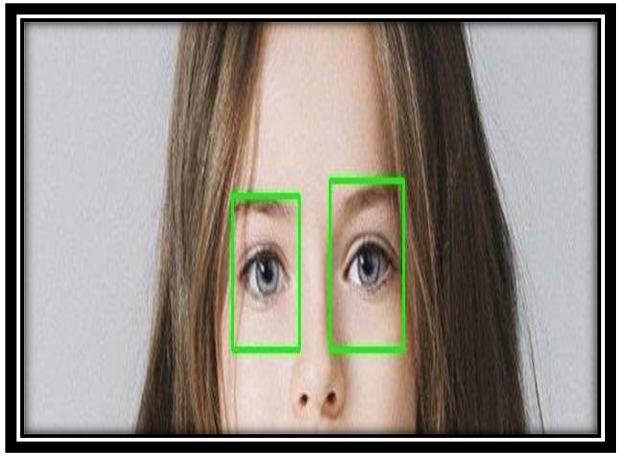
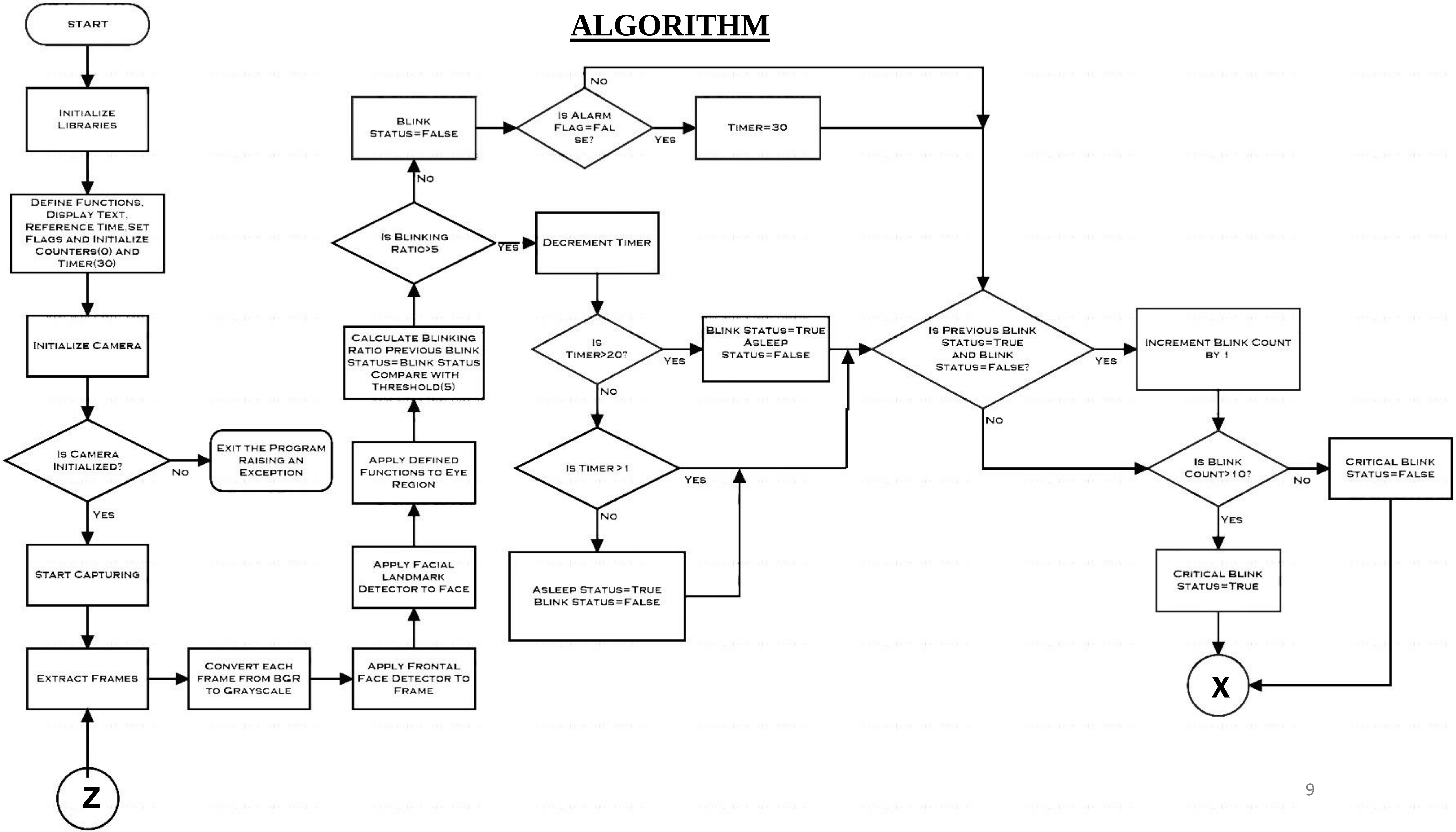
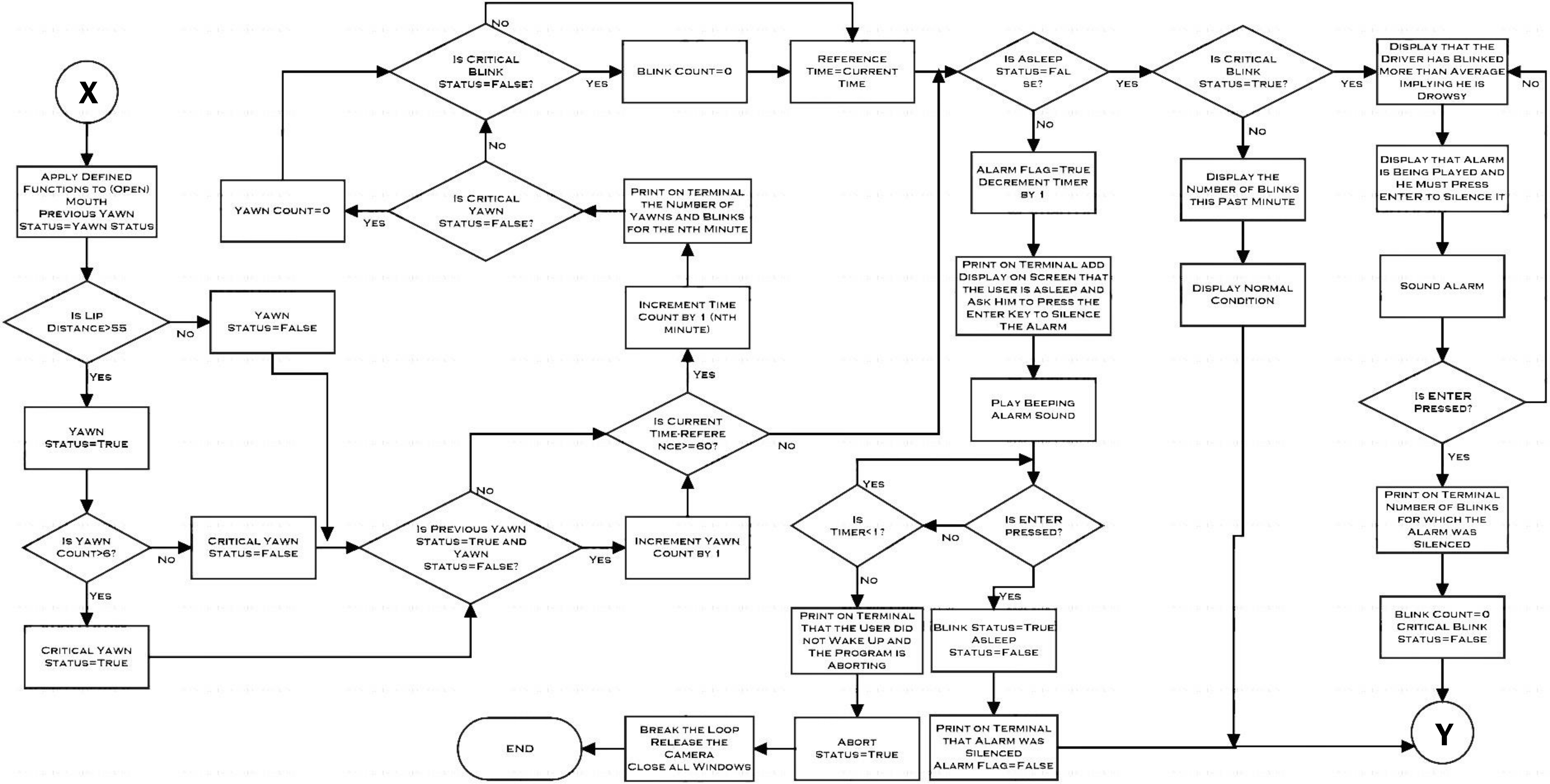


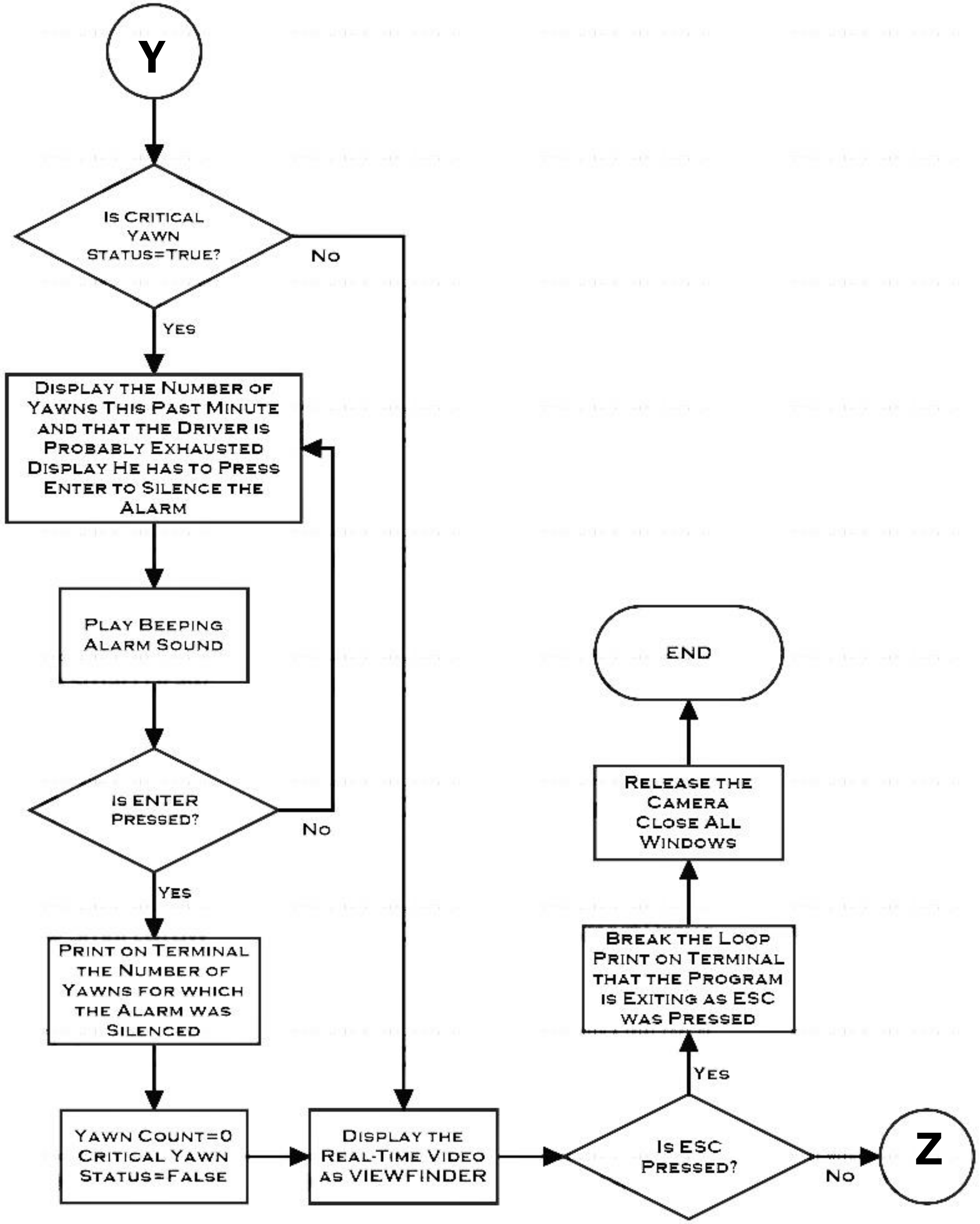
FIG 3: EYE DETECTION

ALGORITHM



START
INITIALIZE LIBRARIES
DEFINE FUNCTIONS, DISPLAY TEXT, REFERENCE TIME,SET FLAGS AND INITIALIZE COUNTERS(0) AND TIMER(30)
INITIALIZE CAMERA
IS CAMERA INITIALIZED?
NO
EXIT THE PROGRAM RAISING AN EXCEPTION
YES
START CAPTURING
EXTRACT FRAMES
Z
CONVERT EACH FRAME FROM BGR TO GRAYSCALE
APPLY FRONTAL FACE DETECTOR TO FRAME
APPLY FACIAL LANDMARK DETECTOR TO FACE
APPLY DEFINED FUNCTIONS TO EYE REGION
CALCULATE BLINKING RATIO PREVIOUS BLINK STATUS=BLINK STATUS COMPARE WITH THRESHOLD(5)
IS BLINKING RATIO>5
NO
BLINK STATUS=FALSE
IS ALARM FLAG=FALSE?
NO
YES
TIMER=30
YES
DECREMENT TIMER
IS TIMER>20?
YES
BLINK STATUS=TRUE ASLEEP STATUS=FALSE
NO
IS TIMER > 1
YES
NO
ASLEEP STATUS=TRUE BLINK STATUS=FALSE
IS PREVIOUS BLINK STATUS=TRUE AND BLINK STATUS=FALSE?
YES
INCREMENT BLINK COUNT BY 1
NO
IS BLINK COUNT>10?
NO
CRITICAL BLINK STATUS=FALSE
YES
CRITICAL BLINK STATUS=TRUE
X


X
Apply Defined Functions to (Open) Mouth
Previous Yawn Status=Yawn Status
Is Lip Distance>55
No
Yes
Yawn Status=False
Yawn Status=True
Is Yawn Count>6?
No
Yes
Critical Yawn Status=False
Critical Yawn Status=True
Yawn Count=0
Yes
Is Critical Yawn Status=False?
No
Is Critical Blink Status=False?
No
Yes
Blink Count=0
Reference Time=Current Time
Print on terminal the number of Yawns and Blinks for the nth Minute
Increment Time Count by 1 (nth minute)
Yes
Is Current Time-Reference>=60?
No
Is Previous Yawn Status=True and Yawn Status=False?
No
Yes
Increment Yawn Count by 1
Is Asleep Status=False?
Yes
No
Alarm Flag=True
Decrement Timer by 1
Print on Terminal add Display on Screen that the User is Asleep and Ask Him to Press the Enter Key to Silence the Alarm
Play Beeping Alarm Sound
Is Enter Pressed?
No
Yes
Is Timer<1?
Yes
No
Print on Terminal that the User did not Wake Up and the Program is Aborting
Blink Status=True
Asleep Status=False
Abort Status=True
Print on Terminal that Alarm was Silenced
Alarm Flag=False
Break the Loop
Release the Camera
Close all Windows
END
Is Critical Blink Status=True?
Yes
No
Display the Number of Blinks this Past Minute
Display Normal Condition
Display that the Driver has Blinked More than Average Implying he is Drowsy
No
Display that Alarm is Being Played and He Must Press ENTER to Silence It
Sound Alarm
Is ENTER Pressed?
Yes
Print on Terminal Number of Blinks for which the Alarm was Silenced
Blink Count=0
Critical Blink Status=False
Y


Y
Is Critical Yawn Status=True?
No
Yes
Display the Number of Yawns This Past Minute and that the Driver is Probably Exhausted Display He has to Press Enter to Silence the Alarm
Play Beeping Alarm Sound
Is ENTER Pressed?
No
Yes
Print on Terminal the Number of Yawns for which the Alarm was Silenced
Yawn Count=0 Critical Yawn Status=False
Display the Real-Time Video as VIEWFINDER
Is ESC Pressed?
No
Z
Yes
Break the Loop Print on Terminal that the Program is Exiting as ESC was Pressed
Release the Camera Close All Windows
END

ADDITIONAL SOFTWARE REQUIREMENTS

- Dlib
- Cmake
- Haar cascade
- Shape predictor
- Imultis
- Scipy
- Ipython
- Matplotlib

TESTING OF THE SYSTEM ON A SUBJECT AFTER COMPLETION OF THE PROJECT

NAME OF SUBJECT- ARITRA BAG

OCCUPATION- STUDENT

AGE- 22

RESULTS

- The system ran successfully meeting our expectations.
- The individual modules were tested first and the obtained output was satisfactory and fulfilling.
- Then the overall system was tested which was also fruitful.
- Though we experienced some glitches in the raspberry pi system due to its slower processing speed and low physical memory space this obstacle could be overcome with a processor of higher speed and more ram capacity.
- The system ran smoothly on windows system without any glitches

TEST RESULTS

Face Detection

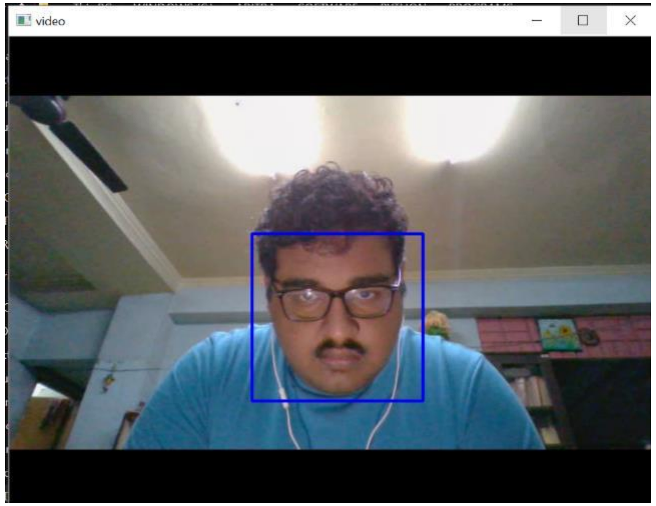


FIG 4 : IMPLEMENTATION OF FACE DETECTION

Eye Detection

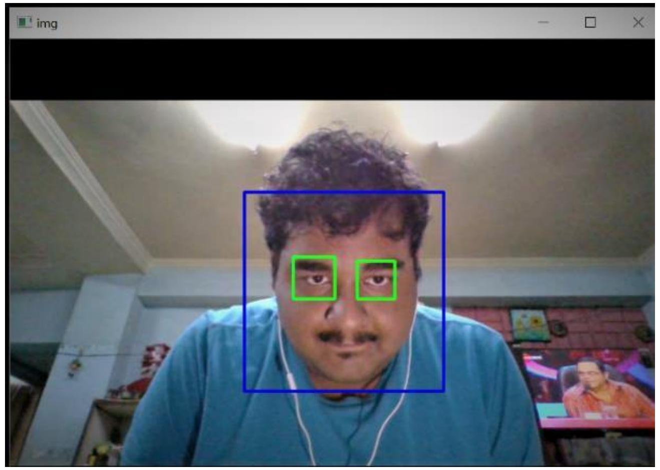


FIG 5 : IMPLEMENTATION EYE DETECTION

Blink Detector

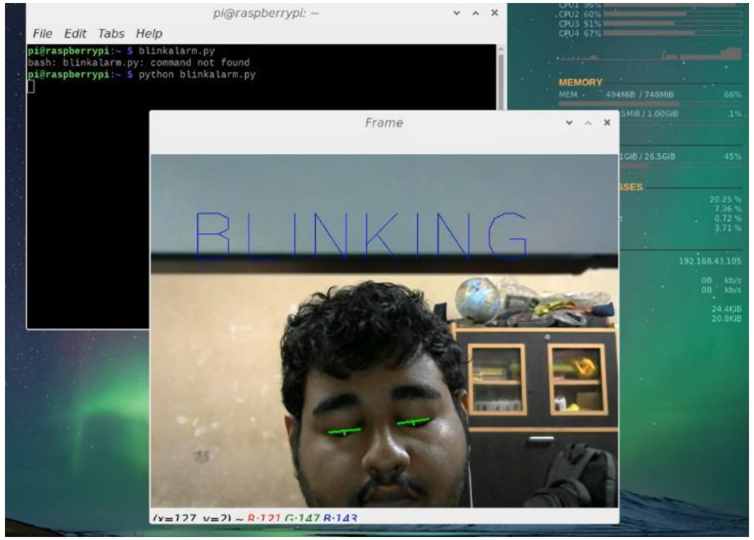


FIG 6 : IMPLEMENTATION OF BLINK DETECTOR

Yawn Detector and Counter

FIG 7 : IMPLEMENTATION OF YWAWN DETECTOR AND COUNTER

FINAL STATUS OF THE PROJECT WORK

- Successful installation of Raspbian, OpenCV, and other required libraries and software.
- Successful development of algorithm for basic image processing like edge detection, shifting, color space change, etc.
- Successful connection of the camera module and enabling it to capture images and videos.
- Successful implementation of the drowsiness detection and alarm management system on the Raspberry Pi.
- Successful implementation of the system on Windows with minimum modifications thus implying the logic is correct and of universal nature.
- Successful testing of all the scenarios considered and thus the system is ready for real world use.

BUDGETING FOR THE PROJECT WORK

MATERIALS	QUANTITY	APPROXIMATE PRICE (in Rs.)
Raspberry Pi 3B+	1	3,500
Raspberry Pi Case	1	500
SanDisk MicroSD Card	1	400
Pi Camera v1.3	1	700
Mobile charging brick with MicroUSB Cable	1	100
TOTAL		5,200

CHALLENGES FACED

- Slow processing speed of python resulted in increased time response of our software module.
- Slow processing speed of raspberry pi processor and low ram space resulted in increased time for detection and glitches in the overall system.
- Installation of dlib on windows interface.
- The limit for number of blinks in a minute was set at 10 from common knowledge that the average person blinks 10-11 times a minute. However, the same could not done in case of the number of yawns as there is no such specific information on the number of times a person would yawn in a minute.
- For the sake of simplicity, system exists in case the driver fails to wake up. In the practical world, this could be the trigger for an auto-pilot system for self-driving cars. However, the development of such a self-driving system is complex and expensive and is beyond the scope of this project.
- Errors are generated when there are more people in the frame as their yawns and blinks are also counted.
- The threshold values for lip distance and blinking ratio were set manually through trial and error, where detection was mostly accurate. There is not generalized metric to determine these as the facial features are unique for each individual.
- The system can run without the requirement of a screen or GUI. For this the keyboard can be entirely replaced with a button connected to the GPIO pins. However, as most modern vehicles have a Visual Display Unit for SMART technologies, the added GUI would help the driver interpret the data and his actions in a more understandable manner. Further, the displayed instructions would help him take him take decisions easily rather than memorizing what to do like what button to press to silence alarms

ADVANTAGES AND DISADVANTAGES

- The overall system is relatively compact.
- The system can run complex programs on relatively weak hardware thus can be implemented in small standalone devices.
- The system can detect yawns and blinks accurately and can distinguish between a blink and asleep condition.
- The system is highly interactive.
- Not only does the system display warnings, but also plays different sounds for different situations thus two ways for alarming.
- It allows for the system to take its own action in case the driver does not wake up.
- Videos coming out of the camera directly have color, brightness and contrast issues that need to be fixed first for more efficient working of the drowsiness detection system.
- Low end specifications of the Raspberry Pi lead to slow performance and a few crashes during high load tasks. This greatly affects its ability to capture and process frames in real time which can hamper its whole purpose. Hopefully this can be improved with better SBCs such as the Raspberry Pi 4 which has far more powerful Cortex A72 cores and 4GB of Ram.
- Minimization of costs led to problems in arranging for cooling and fanning of the Raspberry Pi, resulting in overheating and thus slow performance when running continuously for hours.
- For operation at lowlight or night the system requires external lighting arrangements or an infrared camera.
- The system tends to include the blinks and yawns of others if too many faces are present in the frame, leading to errors.

DIFFERENCES AND IMPROVEMENTS OF THE IMPLEMENTED SYSTEM OVER EXISTING ONES

- None of the existing systems take into account both yawns and blinks and cannot distinguish between a blink and asleep condition.
- Most of the existing systems are not as interactive in nature as this one- they do not have the means to silence alarms and take actions in case the system fails to wake up the driver.
- Existing systems do not play different alarms for the different events. For any alarm management system, being able to audibly distinguish the different scenarios is crucial.
- None of the existing systems work with a time reference. This is fundamental for any alarm management system. For example- A driver was initially yawning excessively and the state was broken by the sound of the alarm and the actions required to silence it. Now, say after 2 hours of driving, he yawns again. But without the periodic cleaning of the yawn counter, this single yawn, which is not related to his previous state, would trigger the alarms again. A sudden alarm for unnecessary situations may distract or startle him, which may cause him to lose control of the vehicle and lead to an accident.
- The implemented system provides both a visual interface as well as a command line interface to displace warnings and actions taken along with the date stamp that the existing systems lack and this gives the driver a much clearer understanding of his condition and allows him to see the event log.

SCOPE FOR THE FUTURE

- Use a more powerful SBC like the Raspberry Pi 4
- Use an infrared camera
- Develop a pan and tilt face tracking system
- Develop the auto pilot system for the driverless mode

FIG 8 : PROPOSED SYSTEM WITH FACE RACKING

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THANK YOU