Drowsiness Detection for Drivers

Submitted in partial fulfillment of the requirements

of the degree of

Bachelor of Engineering

by

Lavin Peeyus (73)

Lisha Shaji (79)

Rachel John (80)

Supervisor:

PROF. Janhavi Baikerikar

UNIVERSITY OF MUMBAI

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Don Bosco Institute of Technology
Vidyavihar Station Road, Mumbai - 400070

2020-2021

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CERTIFICATE

This is to certify that the project entitled **"Drowsiness Detection for Drivers "** is a bonafide work of

Lavin Peeyus	**73**
Lisha Shaji	**79**
Rachel John	**80**

submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of **Undergraduate** in **Bachelor of Information Technology**

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Project Report Approval for B.E.

This project report entitled **"Drowsiness Detection for Drivers"** by **Lavin Peeyus, Lisha Shaji & Rachel John** is approved for the degree of **Bachelor of Engineering in Information Technology**

External Examiner: ——————

Supervisor's Name: ——————

Date: : 30/04/2021

Place: Mumbai

DON BOSCO INSTITUTE OF TECHNOLOGY
Vidyavihar Station Road, Mumbai - 400070

Department of Information Technology

Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea / data / fact / source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Lavin Peeyus – 73
Lisha Shaji – 79
Rachel John – 80

Date: 30/04/2021

Abstract

With the expansion in population, the occurrence of automobile accidents has also seen a rise. A detailed analysis shows that, around half million accidents occur during a year, in India alone. Further, around 60% of those accidents are caused because of driver fatigue. Driver’s drowsiness or lack of concentration is considered as a dominant reason for such mishaps Driver fatigue affects the driving ability within the following 2 areas, a) It impairs coordination, b) The reaction time for judgment is longer.

If drivers might be warned before they became too drowsy to drive safely, some drowsiness-related crashes might be prevented. Through this paper, we offer a true time monitoring system using image processing & face/eye detection techniques. Keywords— Drowsiness Detection, Facial landmarks, Face detection, Eye Detection, Real-time system, OpenCV, Flask.

Keywords: *Drowsiness Detection, Facial landmarks, Face detection, Eye Detection, Real-time system, OpenCV, Flask*

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Introduction

Problem Statement

Improper and inattentive driving is one of the major causes of road accidents. Driver’s drowsiness or lack of concentration is taken into account as a dominant reason for such mishaps. If drivers might be warned before they became too drowsy to drive safely, some drowsiness related crashes might be prevented.

Hence the aim of our project is to implement a system that helps a Driver to easily access a system that detects and alerts the driver when he is drowsy to prevent facing an accident.

Scope of the Project

To prevent the driver from causing an accident, we propose to provide a system that detects whether a person is drowsy while driving, and if so, alerts him through a voice message in real time. The system also captures the image of the driver in the drowsy state and saves it to use it as proof if necessary.

Initially the system was implemented to be accessed solely through the web camera present on the driver’s device. To make the system easy to access, we implemented a web portal for the driver to register into and also be able to access the system via his Phone Camera incase of absence of a web camera on his device.

Current Scenario

Currently, no such complete system has been implemented.

Need for the Proposed System

A driver’s fatigue and drowsy state reduces his decision-making abilities to manage the car, which then leads to a mishap. Therefore, it's necessary that future set of cars setting out within the market should have a further feature to alert the driver. Notably, the utilization of those safety systems which detect drowsiness isn't widespread and is rare among drivers because they're generally available in luxury vehicles.

Summary of the results and task completed.

To prevent the driver from causing an accident, our system detects whether a person is drowsy while driving, and if so, alerts him through a voice message in real-time. The system also captures the image of the driver in the drowsy state and saves it to use it as proof if necessary.

The driver can register himself on the portal and the sign in when his journey begins, on clicking ‘Start’, the system applies facial landmark detection to detect and localize the key regions of the driver’s face followed by continuously monitoring the driver. If their eyes have been closed for a certain amount of time, we will assume that they are starting to doze off and play an alarm to wake them up and grab their attention.

Review of Literature

Summary of the investigation in the published papers

It is explained in Ref [1], two major ways to detect blinking, more importantly detect drowsiness:

1. By biological approaches like electrooculogram (EOG) electroencephalogram (EEG) or electrocardiogram (ECG) readings.

2. By image processing and computer vision methods. Following are a summary of a few scientific papers that are mainly related to the second category.

Ref. [2] depicts a noteworthy review of the role of computer vision technology applied to the event of monitoring systems to detect distraction. Authors explain the foremost methods for face detection, face tracking and detection of facial landmarks, also because the main algorithms for biomechanical, visual and cognitive distraction. Additionally, there are some algorithms detecting mixed sorts of distraction and therefore the relationship between facial expressions, key points for the event and implementation of sensors and test and training to driving monitoring systems are summarized. They proposed a algorithm that works in real time to detect the eye blinks.

In Ref. [3]. They show that recent landmark detectors, trained on datasets, show robustness against a head orientation with reference to a camera, and facial expressions, being sufficiently precise to estimate the extent of the eye opening. Also, they use a SVM classifier to detect eye blinks as a pattern of EAR values during a brief temporal window.

In Ref. [4], a blinking detection method is proposed, supported Gabor filters by measuring the space between the two arcs of the eye . First, the eye is detected by Viola-Jones' method [5]. Next, the Gabor filter extracts the pattern of the eye supported orientation angle. They apply a connected labeling method to detect the two arcs and measure the space between them compared to a threshold.

Comparison between the tools / methods / algorithms

Methodology	Gaps	Solutions Proposed
New blinking detections method by using Gabor filter.	Capturing the proposed solution from live feed.	Method of determining the openness of the eye from still images
Used a SVM classifier to detect eye blinks as a pattern of EAR values in a short temporal window.	Limitation that a fixed blink duration for all subjects was assumed, although everyone's blink lasts differently.	Simple but efficient algorithm to detect eye blinks by using a recent facial landmark detector

Manual, Visual and cognitive Distraction Detection Approaches	A limitation of the software-based methods is the fact that they cannot often be applied at night	Algorithms detecting mixed types of distraction and the relationship between facial expressions
OpenCV, dlib, and Python.	Limitations: Capturing the drowsiness of the driver during the night.	Demonstration of a complete OpenCV system to alert a driver if he is asleep for a certain amount of time.

Algorithm(s)

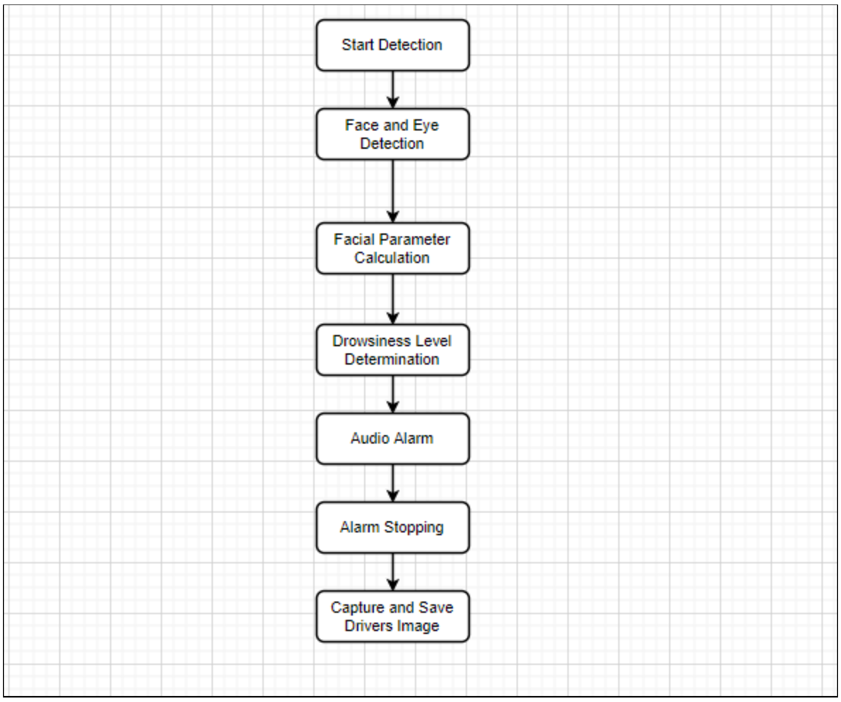


Fig1: Flow of the algorithm for the system

Analysis and Design

Methodology / Procedure adopted

This paper methodology is based on two main parts:

1. Real-time eye detection.
2. Drowsiness detection and warnings.

Facial Landmark detection

To construct our real-time drowsiness classification model, it's necessary to spot the operator’s eye on the image. based on it, we build a blink detector to acknowledge every blink and distinguish it from a nap or drowse. Typically image processing methods for computing blinks involve some combination of: (1) eye localization, (2) thresholding to seek out the whites of the eyes, (3) determining if the “white” region of the eyes disappears for a period (indicating a blink), we use a metric called eye aspect ratio (EAR), introduced by [3] . Furthermore, we use a weighted average eye aspect ratio from a neutral face. This procedure is completed to capture one’s natural EAR and subtle changes when facial features varies. The eye detection is performed with facial landmarks. Our goal is to detect important facial structures on the face using shape prediction methods. We use the dlib for facial landmark detection which uses Histograms of Oriented Gradients and Linear Support Vector Machines within the procedure. The library provides landmarks for the whole face, displayed as light green dots in Fig. 1. The landmarks are adaptive to acknowledge the form of distinct human faces.

Fig 2: Landmarks provided for the entire faces.

The EAR is calculated based on the following equation, proposed by ref. [3]:

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

One's EAR is calculated for each frame of the real-time video. Thus, a decrease in the EAR is expected when the user closes his eyes going back to a normal level when eyes are open again. This approach can be used to detect blinks as well as eye openness. In order to detect drowsiness, two methods of classification were applied, based on the approach proposed by ref. [3]. The first approach is here called threshold model. A threshold was considered so that if the user's EAR becomes lesser than this threshold for a number of frames a blink is then detected.

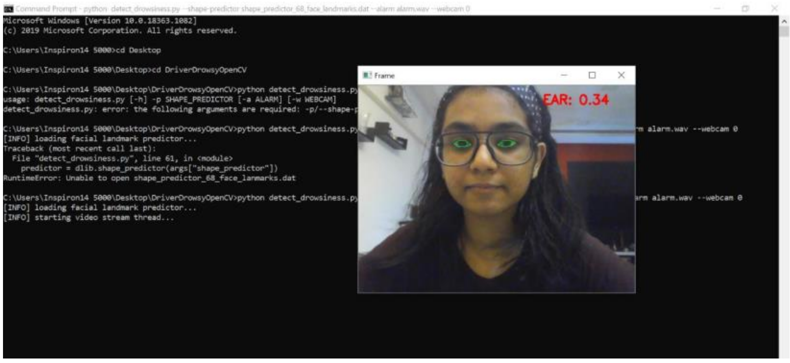


Fig 3: Eye and EAR detection

Drowsiness Detection and Warnings

Once predictions provided by SVM were considered satisfactory, real-time monitoring could be achieved.

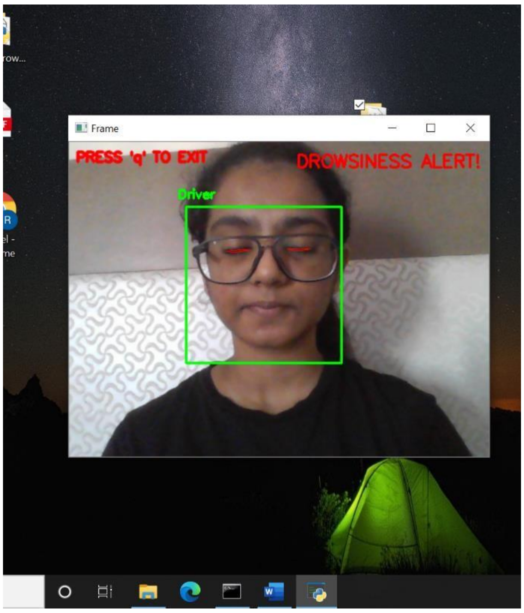


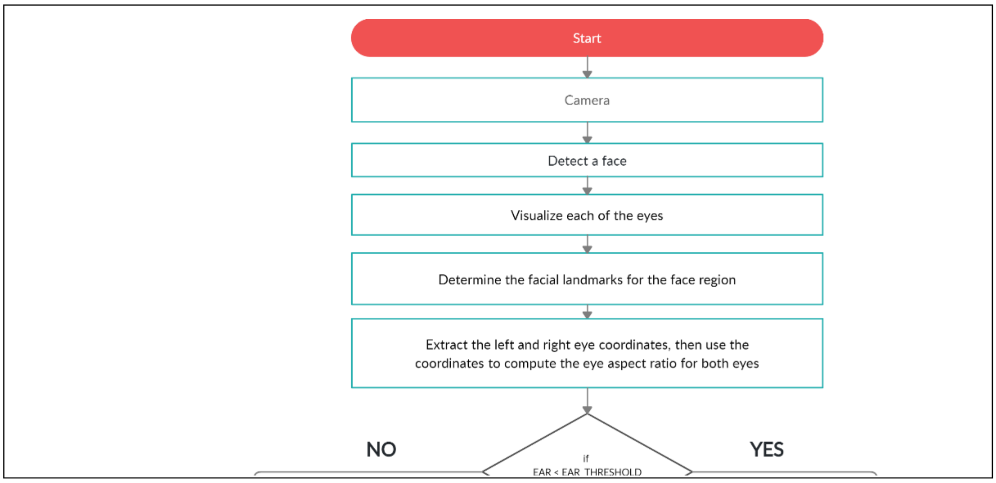
Fig 4: Drowsiness Alert

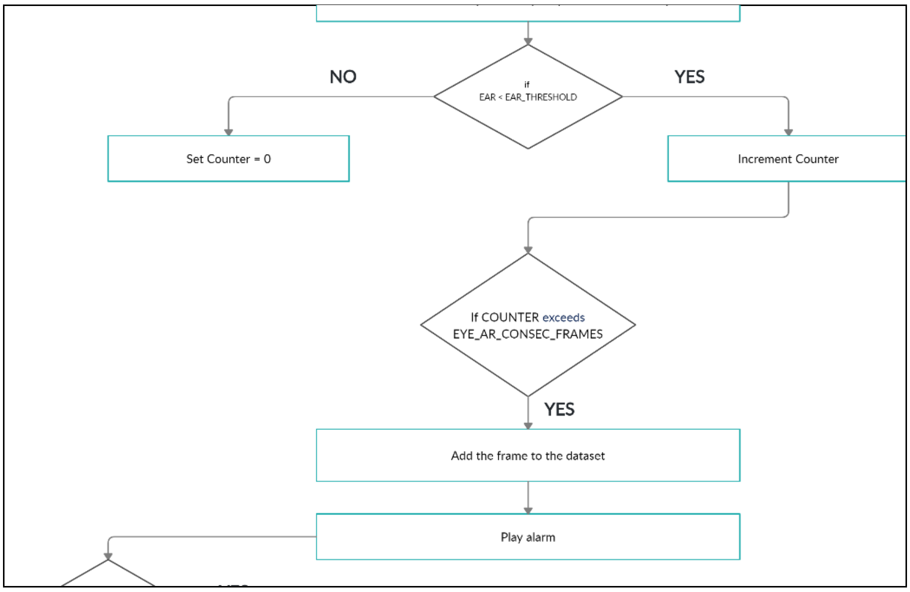
Analysis

System Architecture / Design

Our proposed system aims on creating an Alert system for Drivers when they fall asleep or feel drowsy while driving. The main advantage of this system is that it improves the safety aspect of the driver compared to the current systems.

Flow Diagram of the system





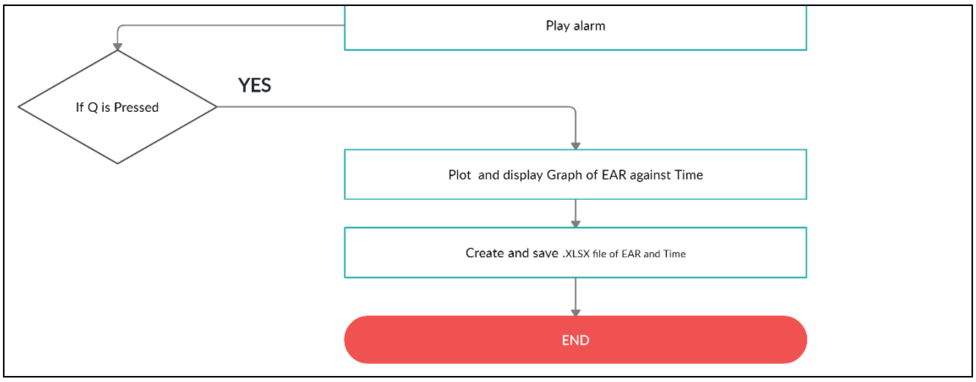


Fig 5: Complete Flow of the system

Flow Diagram of the web portal

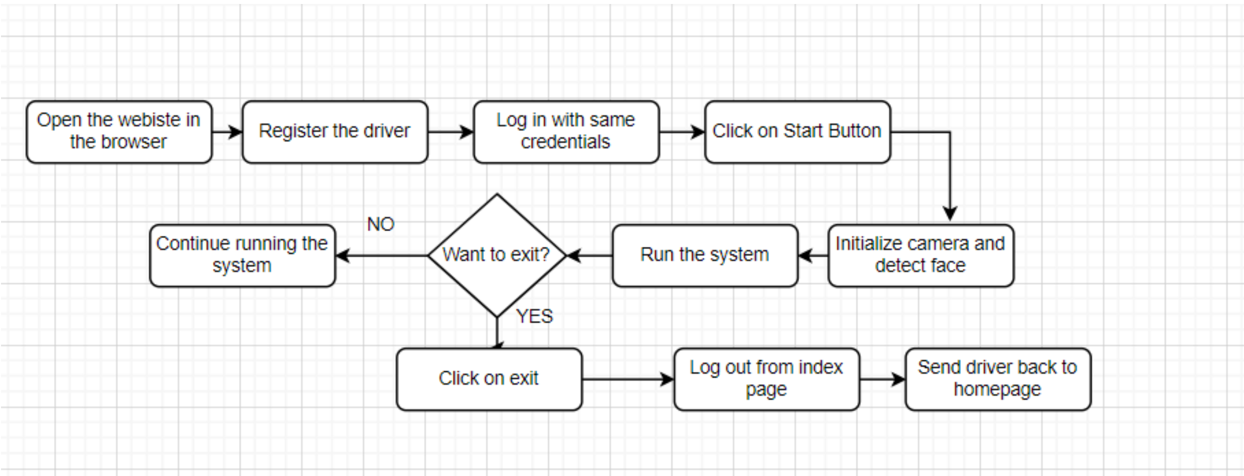


Fig 6: Complete Flow of the web portal.

Implementation

Implementation Plan *for Sem – 8*

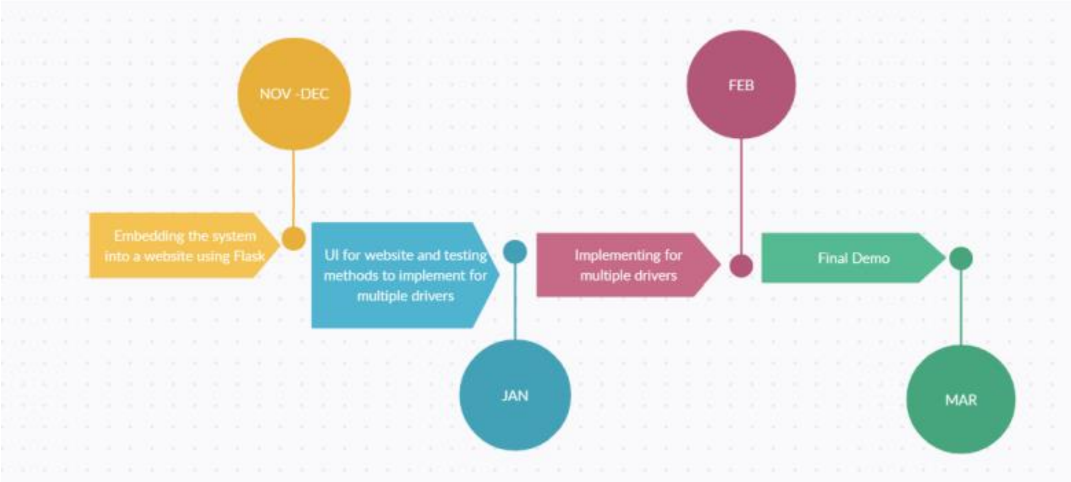


Fig 7: Implementation plan

Contribution breakdown

Group Members	Task Assigned
Lavin Peeyus	Determining threshold for the system, Research on Database for the system, Creating Database for the system Running the system on phone camera, multiple testing via phone camera.
Lisha Shaji	Research on UI, Coding for Layout and UI for the website, testing the system via web camera, Coding to capture images of the Driver after detecting drowsiness.
Rachel John	Research on software requirements ,Coding for the detection system, Determining EAR and MAR for the system, Coding for displaying plot of EAR and MAR vs Time, Code to embed the system into the website, multiple testing via web camera.

Testing

Stages of testing the system were as follows:

1. Test for initializing the web camera on the system.
2. Test for detecting and localizing eyes of the driver.
3. Test for detecting mouth of the driver.
4. Test for detecting the face and creating a box around the detected face and labelling it as Driver.
5. Test for Blink Detection for the driver.
6. Test for determining eye aspect ratio and eye aspect ratio threshold to check for drowsiness.
7. Test for determining number of frames for the given threshold to check drowsiness.
8. Test for Registration of Driver on the web portal.
9. Test for running the system via web portals index page.
10. Test for initializing camera on phone.
11. Test for capturing image of Driver when detected as drowsy.
12. Test for displaying plot of EAR vs MAR after the driver exits the system.

Results and Discussion

We have proposed a real time system that begins with the driver registering himself on the web portal created with Html, Css, Jquery and Flask. The driver can then sign in with his credentials and click on ‘Start’.

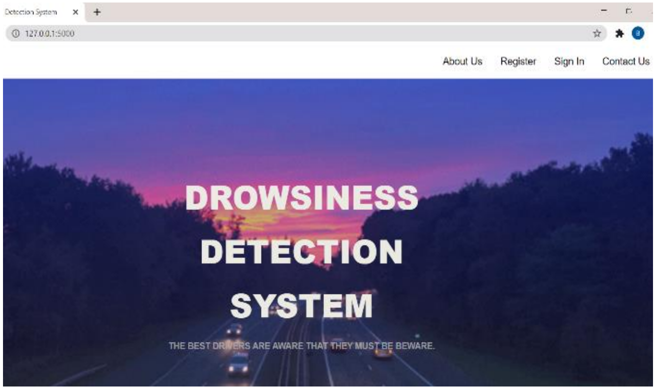


Fig 8: UI of the website.

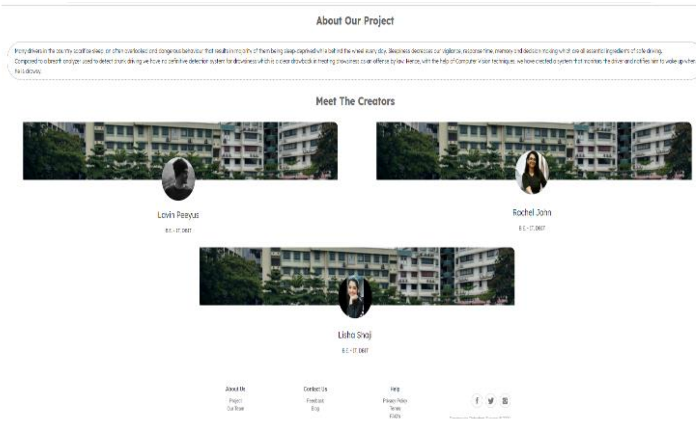


Fig 9: UI of the website.

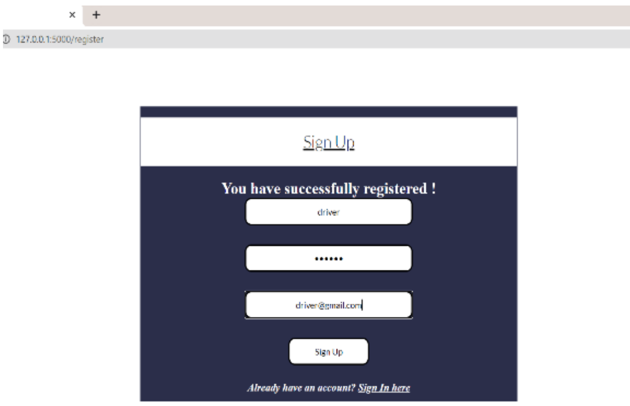


Fig 10: Registration page with success message.

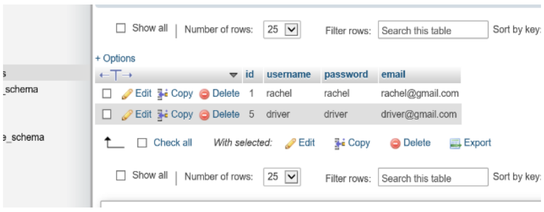


Fig 11: Credentials saved in database.

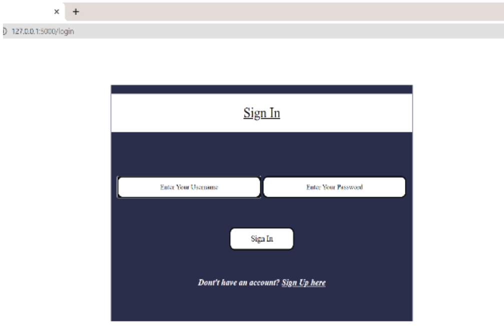


Fig 12: Login page.

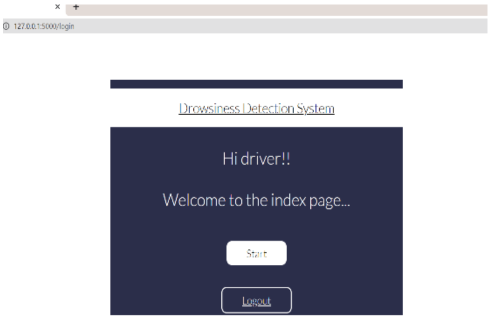


Fig 13: Index page after login.

When the start button is activated, the driver is presented with two options,

a. To monitor using Webcam
b. To monitor using phone cam.

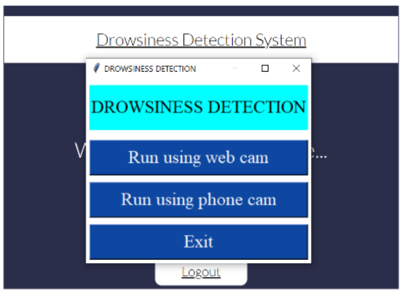


Fig 14: Dialog box for Webcam and Phone cam.

When the first option is selected, we instantiate our video stream using the webcam provided and then the facial landmarks produced by dlib is used to detect and localize the eye and mouth region of the driver specifically.

Dlib facial landmarks: The next step is to acquire the facial landmarks. The basic idea of this technique is to locate 68 specific points on face such as corners of the mouth, along the eyebrows, on the eyes, and so forth. It is a pre-trained detector available in the dlib 1library that is able to find these 68 co-ordinates on any face.

Fig 15: Pre-defined 68 co-ordinates of face defined in dlib library

EAR and MAR calculation: Eye aspect ratio can be calculated using equation (1)

$$\boxed{\mathrm{EAR} = \frac{||p2\ - p6||\ + ||p3 - p5\ ||}{2\ \times ||p1\ - p4||}}$$

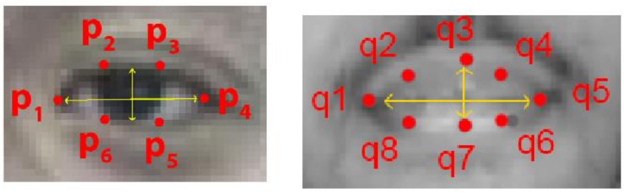
Equation (1)

where, p1, p2, ..., p6are 6 eye landmark shown in Figure 15a. Similarly mouth aspect ratio (MAR) can be calculate using equation (2)

$$\boxed{\mathrm{MAR} = \frac{||q2\ - q8||\ + ||q4 - p6\ ||}{2\ \times ||q1\ - q5||}}$$

Equation (2)

where, q1, q2, ..., q8are 8 mouth landmark shown in Figure 15b.



(a) Each eye is represented by $6(x, y)$-coordinates facial landmark of eye region starting from left corner in clock wise direction.

(b) Mouth is represented by $8(x, y)$-coordinates facial landmark of mouth region starting from inner lip left corner.in clock wise direction

Fig 16: Representation of points for MAR and EAR calculation

Drowsiness Detection: The system continuously monitors the driver's states such as sleepiness, yawning and if the driver falls asleep or yawns more than 4 seconds, the systems alert the driver to switch back to normal state. After the driver's journey is completed, he can exit from the system. Upon exit, the images of the driver are captured if the system had caught him in a drowsy state and is saved in the 'dataset' folder. Along with this, a MAR and EAR graph Vs. Time is also plotted to make get a clear idea of the working of the system.

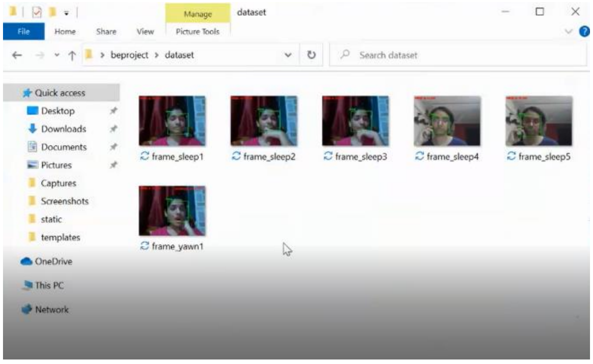


Fig 17: Captured Drowsy Image of Driver in Dataset folder.

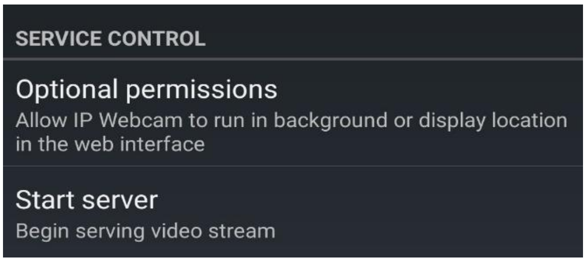


Fig 18: Start Server option on IP webcam interface.

When the second option is selected, we have used an Android Application named IP Webcam. Once we click on 'Start Server' on the application, the system monitors the driver with the same procedure as mentioned above through this application.

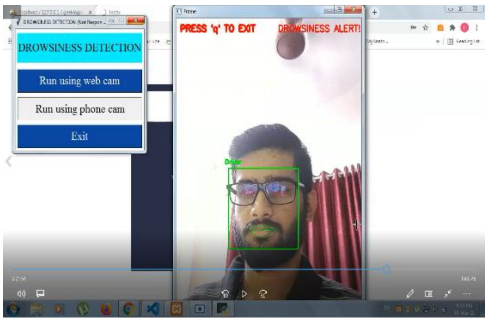


Fig 19: Using IP webcam application to detect drowsiness.

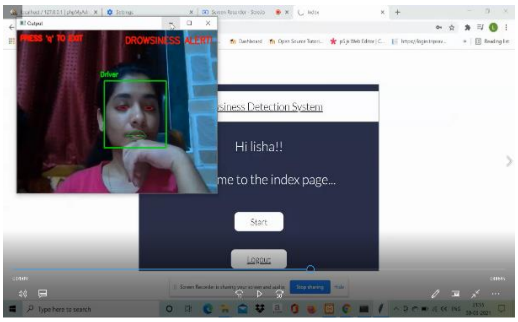


Fig 20: Using laptop webcam to detect drowsiness.

Conclusion & Future Work

Hence, we implemented a complete Drowsiness Detection and alert system for safety of drivers and as a prevention to reduce the rising number of road accidents. We have successfully implemented the concept by adding face recognition which makes the system accessible for multiple drivers.

As a future scope, this methodology can be further implemented as a service provided by ride-hailing applications under Driver Security. A thorough through survey and multiple testing can also be done to determine the average threshold to be used for better and accurate results according to different categories such as age and hours of sleep undergone.

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Acknowledgements

It gives us immense pleasure to present our report on the topic 'Drowsiness Detection for Drivers'.

We would like to take this opportunity to thank our guide Prof. Janhavi Baikerikar for her constant support and for helping us and giving us proper insights and guidance.

We would also like to thank our Faculty and panel members for their insights and suggestions that helped us improve our project.

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Drowsiness Detection for Drivers

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***Abstract*— With the expansion in population, the occurrence of automobile accidents has also seen a rise. A detailed analysis shows that, around half million accidents occur during a year, in India alone. Further, around 60% of those accidents are caused because of driver fatigue. Driver's drowsiness or lack of concentration is considered as a dominant reason for such mishaps Driver fatigue affects the driving ability within the following 2 areas, a) It impairs coordination, b) The reaction time for judgment is longer. If drivers might be warned before they became too drowsy to drive safely, some drowsiness-related crashes might be prevented. Through this paper, we offer a true time monitoring system using image processing & face/eye detection techniques.**

Keywords*— Drowsiness Detection, Facial landmarks, Face detection, Eye Detection, Real-time system, OpenCV, Flask.

I. Introduction

One of the most prevailing problems across the globe nowadays is the booming number of road accidents. Even in recent years, there has not been much improvement in the reduction of road accidents. One of the many reasons behind the rise of such road accidents is the driver's fatigue and drowsy state. Exhausted drivers who doze off at the wheel are responsible for about 40% of road accidents, says a study by the Central Road Research Institute (CRRI) on the 300-km Agra-Lucknow Expressway. Driver's drowsiness or lack of concentration is taken into account as a dominant reason for such mishaps. If drivers might be warned before they became too drowsy to drive safely, some drowsiness related crashes might be prevented. To prevent the driver from causing an accident, we propose to provide a system that detects whether a person is drowsy while driving, and if so, alerts him through a voice message in real-time. The system also captures the image of the driver in the drowsy state and saves it to use it as proof if necessary. The driver can register himself on the portal and the sign in when his journey begins, on clicking 'Start', the system applies facial landmark detection to detect and localize the key regions of the driver's face followed by continuously monitoring the driver. If their eyes have been closed for a certain amount of time, we will assume that they are starting to doze off and play an alarm to wake them up and grab their attention.

II. Literature Review

It is explained in [1], two major ways to detect blinking, more importantly detect drowsiness:

By biological approaches like electrooculogram electroencephalogram (EEG) or electrocardiogram (ECG) readings.
By image processing and computer vision methods. Following are a summary of a few scientific papers that are mainly related to the second category. [2] depicts a noteworthy review of the role of computer vision technology applied to the event of monitoring systems to detect distraction. Authors explain the foremost methods for face detection, face tracking and detection of facial landmarks, also because the main algorithms for biomechanical, visual, and cognitive distraction. Additionally, there are some algorithms detecting mixed sorts of distraction and therefore the relationship between facial expressions, key points for the event and implementation of sensors and test and training to driving monitoring systems are summarized. They proposed an algorithm that works in real time to detect the eye blinks.
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III. Methodology

This paper methodology is based on two main parts:

a. Real-time eye detection.
b. Drowsiness detection and warnings.

A. *Real-time eye detection.*

To build our real-time drowsiness system, it is necessary to spot the persons eye on the image and then based on it, we can begin to build the blink detector to acknowledge every blink and then distinguish it from a nap or drowse.

Typically, image processing methods for computing blinks involve some combination of: (1) eye localization, (2) thresholding to seek out the whites of the eyes, (3) determining if the "white" region of the eyes disappears for a certain period such that it indicates a blink, so we use a metric called eye ratio (EAR), introduced by [3] . This procedure is completed to capture one's natural EAR and subtle changes when facial features vary. Our goal is to detect important facial structures like eyes and mouth on the face using the shape prediction method. We use the dlib for facial landmark detection which uses Histograms of Oriented Gradients and Linear Support Vector Machines within the procedure. The library provides landmarks for the whole face, displayed as light green dots in Fig. 1. The landmarks are adaptive to acknowledge the form of distinct human faces.

Fig 1: Localizing Facial landmarks for the entire face.

The EAR is calculated based on the following equation, proposed by ref. [3]:

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

Fig 2: Formula to calculate EAR value.

Using this the EAR is calculated for each frame of the video stream. Thus, a decrease in the EAR is expected when the person closes his eyes and then going back to a normal level when eyes are open again. This approach can be used to detect blinks. In order to detect drowsiness, two methods of classification were applied, based on the approach proposed by ref. [3].

The first approach is here called threshold model. A threshold was considered so that if the user's EAR becomes lesser than this threshold for a number of frames then a blink is then detected.

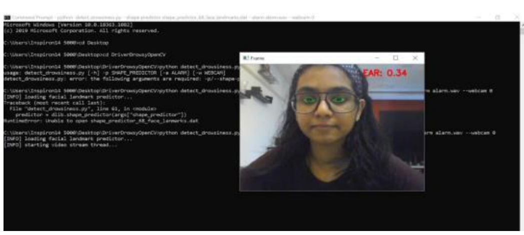


Fig 3: Localizing eye region and Determining EAR threshold value.

B. Drowsiness Detection and Warnings

Once predictions provided were considered satisfactory, real-time monitoring could be achieved.

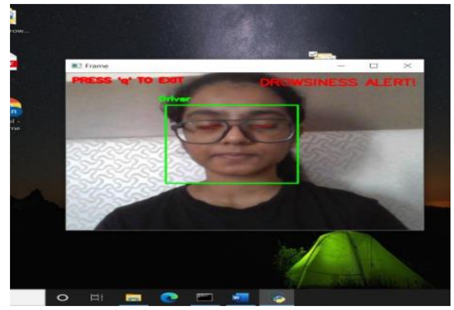


Fig 4: Detecting Drowsiness based on the threshold value and number of frames.

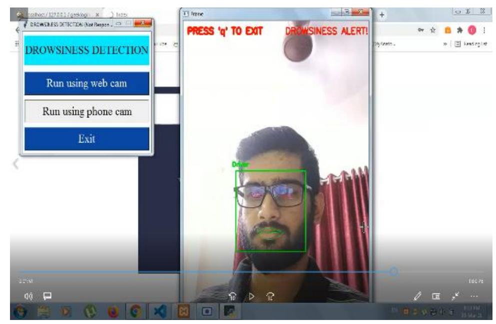


Fig 5: Using IP webcam application to detect drowsiness.

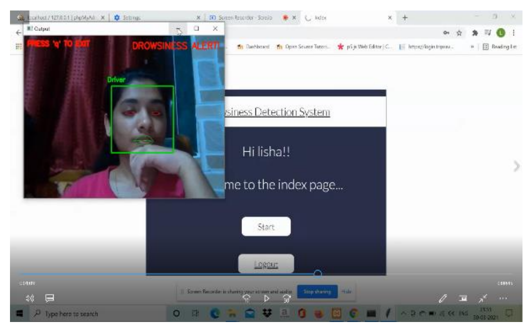


Fig 6: Using laptop webcam to detect drowsiness.

IV. Proposed Work

We have proposed a real time system that begins with the driver registering himself on the web portal created with Html, Css, Jquery and Flask. The driver can then sign in with his credentials and click on 'Start'.

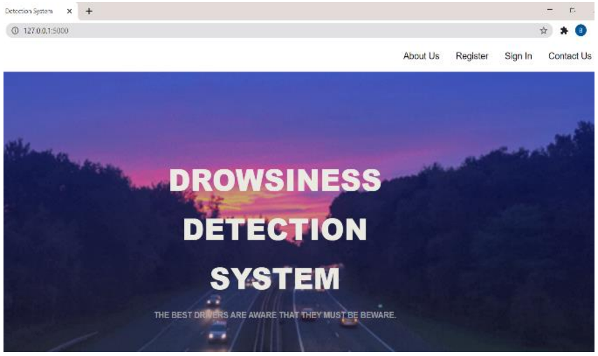


Fig 7: UI of the website.

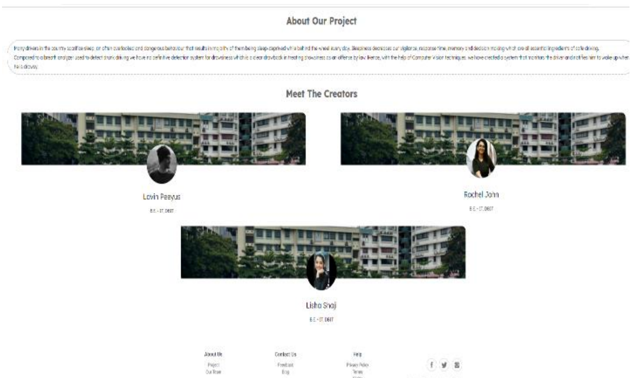


Fig 8: UI of the website.

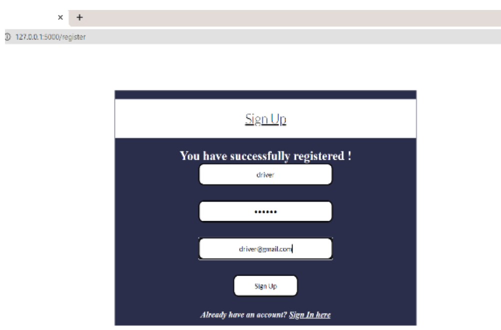
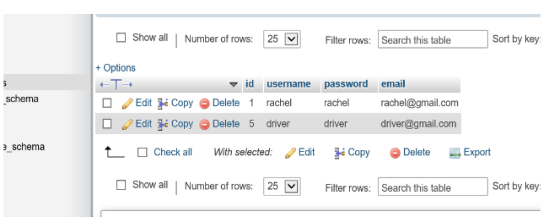


Fig 9: Registration page with success message.



id	username	password	email
1	rachel	rachel	rachel@gmail.com
5	driver	driver	driver@gmail.com

Fig 10: Credentials saved in database.

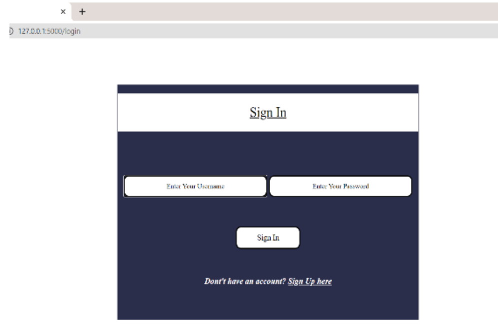


Fig 11: Login page.

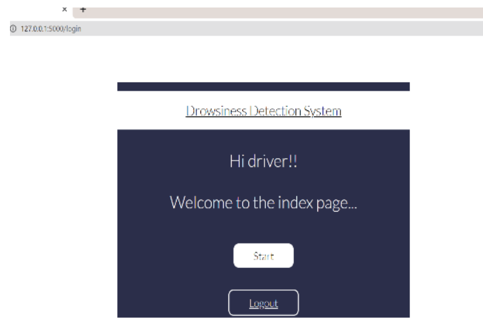


Fig 12: Index page after login.

When the start button is activated, the driver is presented with two options,

a. To monitor using Webcam
b. To monitor using phone cam.

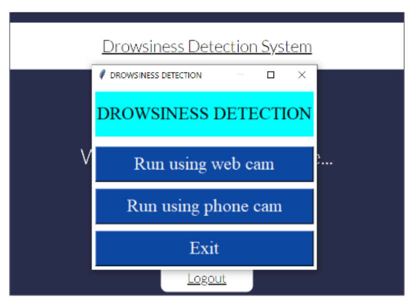


Fig 13: Dialog box for Webcam and Phone cam.

When the first option is selected, we instantiate our video stream using the webcam provided and then the facial landmarks produced by dlib is used to detect and localize the eye and mouth region of the driver specifically.

Dlib facial landmarks: The next step is to acquire the facial landmarks. The basic idea of this technique is to locate 68 specific points on face such as corners of the mouth, along the eyebrows, on the eyes, and so forth. It is a pre-trained detector available in the dlib 1library that is able to find these 68 co-ordinates on any face.

Fig 14: Pre-defined 68 co-ordinates of face defined in dlib library

EAR and MAR calculation: Eye aspect ratio can be calculated using equation (1)

$$\boxed{EAR = \frac{||p2 - p6|| + ||p3 - p5||}{2 \times ||p1 - p4||}}$$

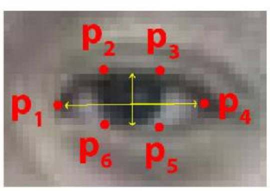
Equation (1)

where, p1, p2, ..., p6are 6 eye landmark shown in Figure 15a. Similarly mouth aspect ratio (MAR) can be calculate using equation (2)

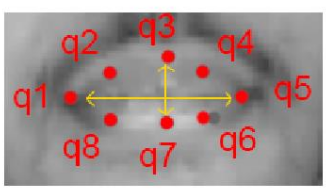
$$\boxed{MAR = \frac{||q2 - q8|| + ||q4 - p6||}{2 \times ||q1 - q5||}}$$

Equation (2)

where, q1, q2, ..., q8are 8 mouth landmark shown in Figure 15b.



(a) Each eye is represented by $6(x, y)$-coordinates facial landmark of eye region starting from left corner in clock wise direction.



(b) Mouth is represented by $8(x, y)$-coordinates facial landmark of mouth region starting from inner lip left corner.in clock wise direction

Fig 15: Representation of points for MAR and EAR calculation

Drowsiness Detection: The system continuously monitors the driver's states such as sleepiness, yawning and if the driver falls asleep or yawns more than 4 seconds, the systems alert the driver to switch back to normal state. After the driver's journey is completed, he can exit from the system. Upon exit, the images of the driver are captured if the system had caught him in a drowsy state and is saved in the 'dataset' folder. Along with this, a MAR and EAR graph Vs. Time is also plotted to make get a clear idea of the working of the system.

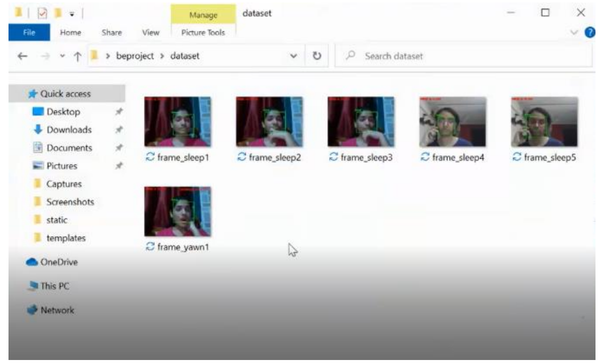


Fig 16: Captured Drowsy Image of Driver in Dataset folder.

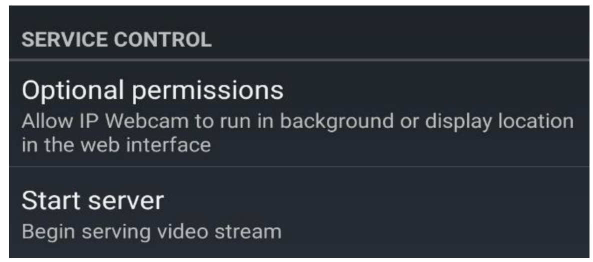


Fig 17: Start Server option on IP webcam interface.

When the second option is selected, we have used an Android Application named IP Webcam. Once we click on 'Start Server' on the application, the system monitors the driver with the same procedure as mentioned above through this application.

V. Future Work

As a future scope, this methodology can be further implemented as a service provided by ride-hailing applications under Driver Security. A thorough through survey and multiple testing can also be done to determine the average threshold to be used for better and accurate results according to different categories such as age and hours of sleep undergone.

VI. Conclusion

Hence, we implemented a complete Drowsiness Detection and alert system for safety of drivers and as a prevention to reduce the rising number of road accidents. We have successfully implemented the concept by adding face recognition which makes the system accessible for multiple drivers.

Acknowledgement

It gives us immense pleasure to present our report on the topic 'Drowsiness Detection for Drivers'. We would like to take this opportunity to thank our guide Prof. Janhavi Baikerikar for her constant support and for helping us and giving us proper insights and guidance.

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Plagiarism Report

RESULTS

100% Completed: 100% Checked

11% Plagiarism

89% UNIQUE

Sentence Wise Result | Matched Sources | Document View

UNIQUE	Often during transportation some unexpected events such as temperature fluctuations, humidity cha...
UNIQUE	Destruction of valuable products or items during shipment could cost a lot of loss to the sender as we...
UNIQUE	In order to prevent unwanted events and to overcome some shortcomings in process of delivering go...
UNIQUE	A smart real time-based system that would offer to locate and track goods from origin to destination,...
UNIQUE	the delivery process occurs and simultaneously alerts to the client, transportation companies or other...
UNIQUE	The main goal of our project is to design an IOT system with the help of different sensors that can be ...