A Project/Dissertation Report

on

Face Recognization System

B. Tech CSE

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Under The Supervision of

Mr. Lalit Sharma Sir

Submitted By :-

Sourabh Suman

(18021011403)

(18SCSE1010156)

Shivam Shardul

(18021011404)

(18SCSE1010157)

SCHOOL OF COMPUTING SCIENCE AND ENGINEERING DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING GALGOTIAS UNIVERSITY, GREATER NOIDA INDIA OCTOBER, 2021.

ABSTRACT

In this project we are going to develop a face recognition AI model using Machine Learning and Deep Learning. In order to achieve the above task, we are going to use the algorithm which works by taking image as input from the camera then detecting the face in the image and creating a region of interest (ROI) then detect the eyes from the ROI and feed it to the classifier, the classifier will categorize whether the eyes are open or closed then calculate the score to check the drowsiness of the driver and beep the alarm if the limit exceeds. The main objective of developing this project is to reduce the accidents that happen on the road due to drowsiness. The major benefit of the project is that it warns the driver of drowsiness and the risk of a microsleep; compliance with driver warnings helps to avoid crashes caused by fatigue. (Flair, n.d.)

Keyword: facial expression, facial recognition, deep learning, convolution neural network

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Chapter 1

Introduction

1.1 Formulation of Problem

The development of technology allows introducing more advanced solutions in everyday life. This makes work less exhausting for employees, and also increases the work safety. Vision-based systems are becoming more popular and are more widely used in different applications. These systems can be used in industry, transportation, airport security and in the end-user complex products such as cars. Such complex systems could also be used to detect vehicle operator fatigue using vision-based solutions. (Damian Sałapatek, 2017)

Fatigue is such a psychophysical condition of a man, which does not allow for a full concentration. It influences the human response time, because the tired person reacts much slower, compared to the rested one. Appearance of the first signs of a fatigue can become very dangerous, especially for such professions like drivers. Nowadays, more and more professions require long-term concentration. People, who work for transportation business (car and truck drivers, steersmen, airplane pilots), must keep a close eye on the road, so they can react to sudden events (e.g., road accidents, animals on the road, etc.) immediately. Long hours of driving cause the driver fatigue and, consequently, reduces her/him response time. (Damian Sałapatek, 2017)

1.2 Tool and Technology Used

According to the results of the study presented at the International Symposium on Sleep Disorders, fatigue of drivers is responsible for 30% of road accidents. The British journal “What Car?” presented results of the experiment conducted with the driving simulator and they concluded that a tired driver is much worse dangerous than a person whose alcohol in blood level is 25% above the allowed limit. Driver fatigue can cause a microsleep (e.g., loss of concentration, a short sleep lasting from 1 to 30 seconds), and falling asleep behind the wheel. Therefore, there is a need to develop a system that will detect and notify a driver of her/him bad psychophysical condition, which could significantly reduce the number of fatigue-related car accidents. However, the biggest difficulties in development of such a system are related to fast and proper recognition of a driver’s fatigue symptoms. (Damian Sałapatek, 2017)

Due to the increasing number of vehicles on the road, which translates into the road accidents directly, equipping a car with the fatigue detection system is a must. One of the technical possibilities to implement such a system is to use vision-based approach. With the rapid development of image analysis techniques and methods, and a number of ready Component-on-the-Shelf solutions (e.g., high resolution cameras, embedded systems, sensors), it can be envisaged, that introducing such systems into widespread use should be easy. Car drivers, truck drivers, taxi drivers, etc. should be allowed to use this. (Damian Sałapatek, 2017)

Chapter 2

Literature Survey

2.1 Regression-Based Fusion Model

In 2008, Hong Su et. al. described 'A Partial Least Squares Regression-Based Fusion Model for Predicting the Trend in Drowsiness'. They proposed a new technique of modeling driver drowsiness with multiple eyelid movement features based on an information fusion technique—partial least squares regression (PLSR), with which to cope with the problem of strong collinear relations among eyelid movement features and, thus, predicting the tendency of the drowsiness. The predictive precision and robustness of the model thus established are validated, which show that it provides a novel way of fusing multi-features together for enhancing our capability of detecting and predicting the state of drowsiness. (Chisty, 2015)

2.2 Camera based Drowsiness Reference

In June, 2010, Bin Yang et. al. described 'Camera based Drowsiness Reference for Driver State Classification under Real Driving Conditions'. They proposed that measures of the driver's eyes are capable to detect drowsiness under simulator or experiment conditions. The performance of the latest eye tracking based in-vehicle fatigue prediction measures are evaluated. These measures are assessed statistically and by a classification method based on a large dataset of 90 hours of real road drives. The results show that eye-tracking drowsiness detection works well for some drivers as long as the blinks detection works properly. Even with some proposed improvements, however, there are still problems with bad light conditions and for persons wearing glasses. As a summary, the camera-based sleepiness measures provide a valuable contribution for a drowsiness reference, but are not reliable enough to be the only reference. (Chisty, 2015)

2.3 Infrared illumination for an intelligent vechile

In 2011, M.J. Flores et. al. described ‘Driver drowsiness detection system under infrared illumination for an intelligent vehicle’. They proposed that to reduce the amount of such fatalities, a module for an advanced driver assistance system, which caters for automatic driver drowsiness detection and also driver distraction, is presented. Artificial intelligence algorithms are used to process the visual information in order to locate, track and analyze both the driver’s face and eyes to compute the drowsiness and distraction indexes. This realtime system works during nocturnal conditions as a result of a near-infrared lighting system. Finally, examples of different driver images taken in a real vehicle at nighttime are shown to validate the proposed algorithms. (Chisty, 2015)

2.4 Computer Vision Technology

In June, 2012, A. Cheng et. al. described 'Driver Drowsiness Recognition Based on Computer Vision Technology’. They presented a nonintrusive drowsiness recognition method using eye-tracking and image processing. A robust eye detection algorithm is introduced to address the problems caused by changes in illumination and driver posture. Six measures are calculated with percentage of eyelid closure, maximum closure duration, blink frequency, average opening level of the eyes, opening velocity of the eyes, and closing velocity of the eyes. These measures are combined using Fisher’s linear discriminated functions using a stepwise method to reduce the correlations and extract an independent index. Results with six participants in driving simulator experiments demonstrate the feasibility of this video-based drowsiness recognition method that provided 86% accuracy. (Chisty, 2015)

2.5 Visual Analysis of Eye State and Head Pose

In 2013, G. Kong et. al. described ‘Visual Analysis of Eye State and Head Pose for Driver Alertness Monitoring’. They presented visual analysis of eye state and head pose (HP) for continuous monitoring of alertness of a vehicle driver. Most existing approaches to visual detection of non-alert driving patterns rely either on eye closure or head nodding angles to determine the driver drowsiness or distraction level. The proposed scheme uses visual features such as eye index (EI), pupil activity (PA), and HP to extract critical information on non-alertness of a vehicle driver. A support vector machine (SVM) classifies a sequence of video segments into alert or non-alert driving events. Experimental results show that the proposed scheme offers high classification accuracy with acceptably low errors and false alarms for people of various ethnicity and gender in real road driving conditions. (Chisty, 2015)

2.6 HMM based Dynamic modelling

In June, 2014, Eyosiyas et. al. described ‘Driver Drowsiness Detection through \HMM based Dynamic Modeling’. They proposed a new method of analyzing the facial expression of the driver through Hidden Markov Model (HMM) based dynamic modeling to detect drowsiness. They have implemented the algorithm using a simulated driving setup. Experimental results verified the effectiveness of the proposed method. (Chisty, 2015)

2.7 Low-Cost 3-D Sensors

In August 2014, García et. al. described ‘Driver Monitoring Based on Low-Cost 3-D Sensors’. They proposed a solution for driver monitoring and event detection based on 3-D information from a range camera is presented. The system combines 2-D and 3-D techniques to provide head pose estimation and regions-of-interest identification. Based on the captured cloud of 3-D points from the sensor and analyzing the 2-D projection, the points corresponding to the head are determined and extracted for further analysis. Later, head pose estimation with three degrees of freedom (Euler angles) is estimated based on the iterative closest points algorithm. Finally, relevant regions of the face are identified and used for further analysis, e.g., event detection and behavior analysis. The resulting application is a 3-D driver monitoring system based on low-cost sensors. It represents International Journal of Computer Science Trends and Technology an interesting tool for human factor research studies, allowing automatic study of specific factors and the detection of special event related to the driver, e.g., driver drowsiness, inattention, or head pose. (Chisty, 2015)

2.8 Motorist Doziness Discovery System and Ways

According to the experts it has been observed that when the motorists don't take break they tend to run a high threat of getting drowsy. Study shows that accidents do due to sleepy motorists in need of a rest, which means that road accidents occurs further due to doziness rather than drink- driving. Attention help can advise of inattentiveness and doziness in an extended speed range and notify motorists of their current state of fatigue and the driving time since the last break, offers malleable perceptivity and, if a warning is emitted, indicates near service areas in the COMAND navigation system.

2.9 Perpetration of the Motorist Doziness Discovery System

In this we aremaking buses more intelligent and interactive which may notify or repel stoner under inferior conditions, they may give critical information of real time situations to deliver or police or proprietor himself. Motorist fatigue performing from sleep diseases is an important factor in the adding number of accidents on moment's roads. In this paper, we describe a real- time safety prototype that controls the vehicle speed under motorist fatigue. To advance a system to descry fatigue symptoms in motorists and control the speed of vehicle to avoid accidents is the purpose of such a mode. In this paper, we propose a motorist doziness discovery system in which detector like eye blink detector are used for detecting doziness ofdriver.However, buzzer will start buzzing and also turns the vehicle ignition out, If the motorist is plant to have sleep.

2.10Detecting Motorist Doziness Grounded on Detectors

Experimenters have tried to determine motorist doziness using the following measures vehicle- grounded measures; behavioural measures and physiological measures. A detailed review on these measures will give sapience on the present systems, issues associated with them and the advancements that need to be done to make a robust system. This paper reviews the three measures as to the detectors used and bandy the advantages and limitations of each. The colorful ways through which doziness has been experimentally manipulated is also bandied. A number of road accidents might also be avoided if an alert is transferred to a motorist that's supposed drowsy.

2.11 Motorist Doziness Discovery System

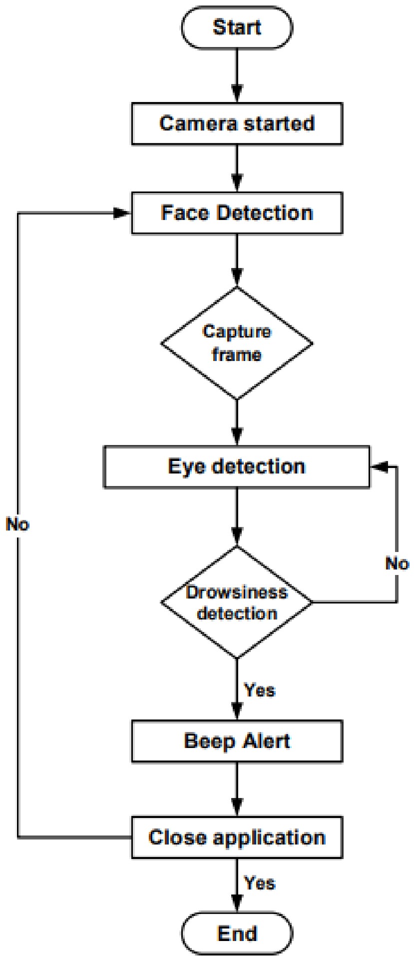
One of the major cause of business accident is Motorist ‘s doziness. It's a serious trace safetyproblem.However, some of these crashes could be averted, If motorists could be advised before they came too drowsy to drive safely. In order to reliably descry the doziness, it depends on the donation of timely warnings of doziness. To date, the effectiveness of doziness discovery styles has been limited by their failure to consider individual differences. Grounded on the type of data used, doziness discovery can be accessibly separated into the two orders of protrusive andnon-intrusive styles. During the check,non-intrusive styles descry doziness by measuring driving geste and occasionally eye features, through which camera grounded discovery system is the stylish system and so are useful for real world driving situations (5). This paper presents the review of was doziness discovery ways that will be used in this system like Circular Hough Transform, FCM, Lab Color Space etc.

Chapter 3

Project Design

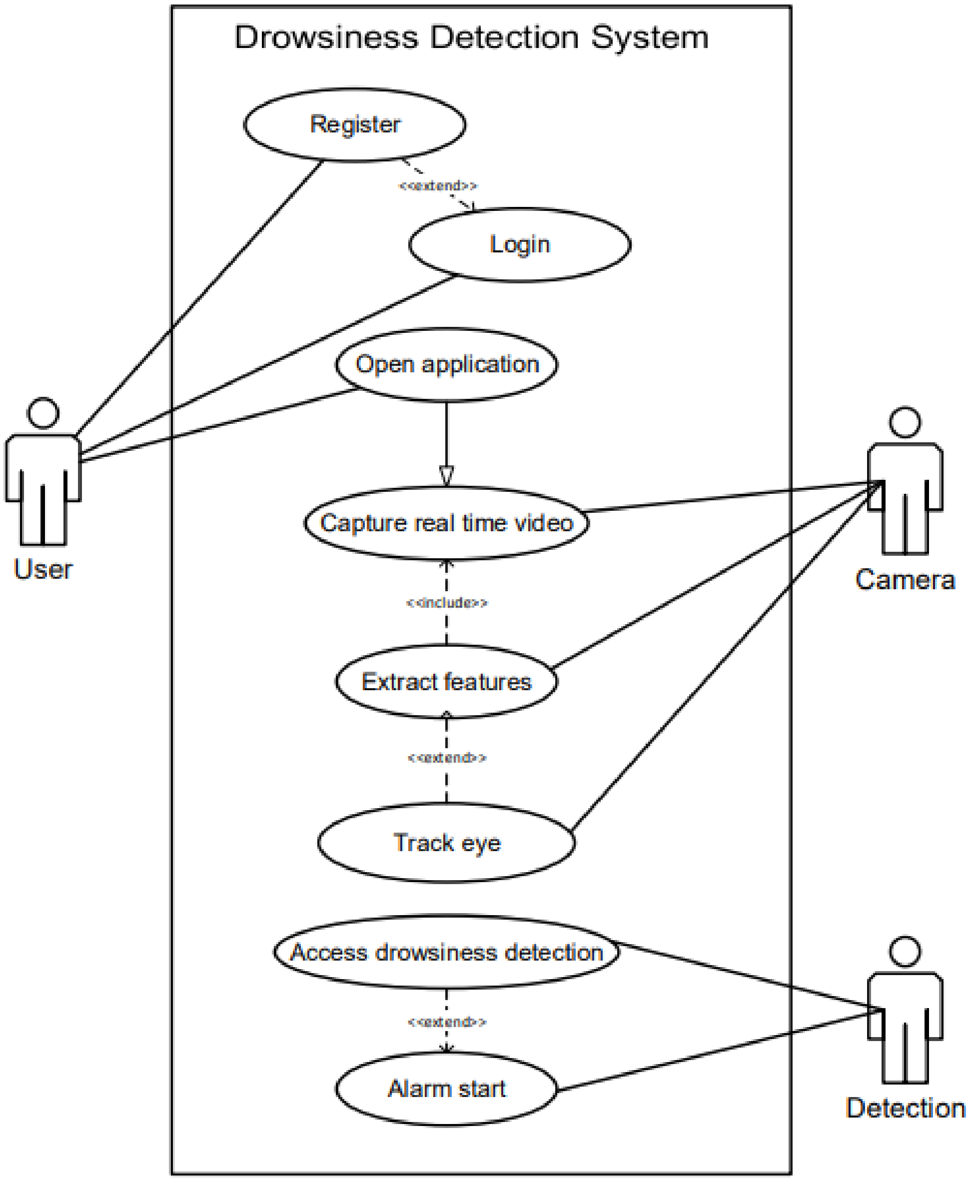
3.1 Data Flow Diagram (Ghimire, 2020)

A data flow diagram shows the way information flows through a process or system. It includes data inputs and outputs, data stores, and the various subprocesses the data moves through. You can use these diagrams to map out an existing system and make it better or to plan out a new system for implementation.



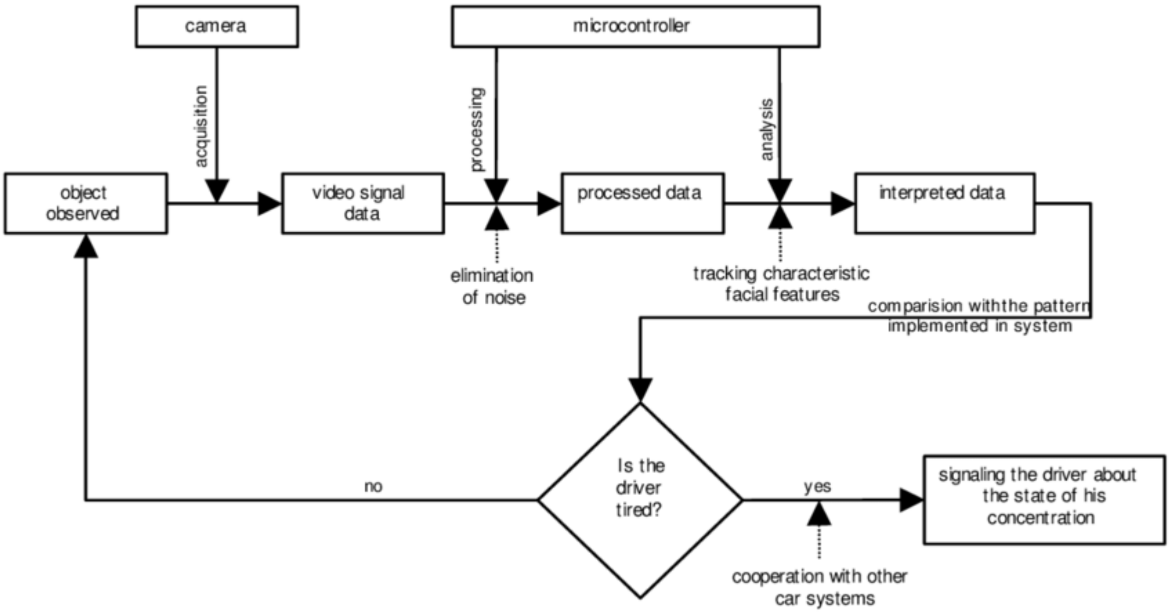
3.2 Use Case Diagram (Ghimire, 2020)

A use case diagram is a graphical depiction of a user's possible interactions with a system. A use case diagram shows various use cases and different types of users the system has and will often be accompanied by other types of diagrams as well. The use cases are represented by either circles or ellipses.



3.3 Block Diagram (Damian Sałapatek, 2017)

A block diagram is a diagram of a system in which the principal parts or functions are represented by blocks connected by lines that show the relationships of the blocks. They are heavily used in engineering in hardware design, electronic design, software design, and process flow diagrams.



Chapter 4

MODEL IMPLEMENTATION

Driver Drowsiness Detection System

In this Python project, we will be using OpenCV for gathering the images from webcam and feed them into a ***Deep Learning*** model which will classify whether the person's eyes are 'Open' or 'Closed'. The approach we will be using for this

Python project is as follows :

Step 1 – Take image as input from a camera.

Step 2 – Detect the face in the image and create a Region of Interest (ROI).

Step 3 – Detect the eyes from ROI and feed it to the classifier.

Step 4 – Classifier will categorize whether eyes are open or closed.

Step 5 – Calculate score to check whether the person is drowsy.

Driver Drowsiness Detection Dataset

The dataset used for this model is created by us. To create the dataset, we wrote a script that captures eyes from a camera and stores in our local disk. We separated them into their respective labels 'Open' or 'Closed'. The data was manually cleaned by removing the unwanted images which were not necessary for building the model. The data comprises around 7000 images of people's eyes under different lighting conditions. After training the model on our dataset, we have attached the final weights and model architecture file "models/cnnCat2.h5".

Now, you can use this model to classify if a person's eye is open or closed.

The Model Architecture

The model we used is built with Keras using **Convolutional Neural Networks (CNN)**. A convolutional neural network is a special type of deep neural network which performs extremely well for image classification purposes. A CNN basically consists of an input layer, an output layer and a hidden layer which can have multiple layers. A convolution operation is performed on these layers using a filter that performs 2D matrix multiplication on the layer and filter.

The CNN model architecture consists of the following layers:

- Convolutional layer; 32 nodes, kernel size 3
- Convolutional layer; 32 nodes, kernel size 3

- Convolutional layer; 64 nodes, kernel size 3
- Fully connected layer; 128 nodes

The final layer is also a fully connected layer with 2 nodes. A Relu activation function is used in all the layers except the output layer in which we used Softmax.

Project Prerequisites

The requirement for this Python project is a webcam through which we will capture images. You need to have Python (3.6 version recommended) installed on your system, then using pip, you can install the necessary packages.

1. **OpenCV –** pip install opencv-python (face and eye detection).
2. **TensorFlow –** pip install tensorflow (keras uses TensorFlow as backend).
3. **Keras –** pip install keras (to build our classification model).
4. **Pygame –** pip install pygame (to play alarm sound).

Steps for Performing Driver Drowsiness Detection

The contents of the zip are:

- The “haar cascade files” folder consists of the xml files that are needed to detect objects from the image. In our case, we are detecting the face and eyes of the person.
- The models folder contains our model file “cnnCat2.h5” which was trained on convolutional neural networks.
- We have an audio clip “alarm.wav” which is played when the person is feeling drowsy.

- “Model.py” file contains the program through which we built our classification model by training on our dataset. You could see the implementation of convolutional neural network in this file.
- “Drowsiness detection.py” is the main file of our project. To start the detection procedure, we have to run this file.

Let’s now understand how our algorithm works step by step.

Step 1 – Take Image as Input from a Camera

With a webcam, we will take images as input. So to access the webcam, we made an infinite loop that will capture each frame. We use the method provided by OpenCV, **cv2.VideoCapture(0)** to access the camera and set the capture object (cap). **cap.read()** will read each frame and we store the image in a frame variable.

Step 2 – Detect Face in the Image and Create a Region of Interest (ROI)

To detect the face in the image, we need to first convert the image into grayscale as the OpenCV algorithm for object detection takes gray images in the input. We don’t need color information to detect the objects. We will be using haar cascade classifier to detect faces. This line is used to set our classifier **face = cv2.CascadeClassifier(‘ path to our haar cascade xml file’)**. Then we perform the detection using **faces = face.detectMultiScale(gray)**. It returns an array of detections with x,y coordinates, and height, the width of the boundary box of the object. Now we can iterate over the faces and draw boundary boxes for each face.

```
for (x,y,w,h) in faces:
cv2.rectangle(frame, (x,y), (x+w, y+h), (100,100,100), 1 )
```

Step 3 – Detect the eyes from ROI and feed it to the classifier

The same procedure to detect faces is used to detect eyes. First, we set the cascade classifier for eyes in **leye** and **reye** respectively then detect the eyes using **left_eye = leye.detectMultiScale(gray)**. Now we need to extract only the eyes data from the full image. This can be achieved by extracting the boundary box of the eye and then we can pull out the eye image from the frame with this code.

l_eye = frame[y : y+h, x : x+w]

l_eye only contains the image data of the eye. This will be fed into our CNN classifier which will predict if eyes are open or closed. Similarly, we will be extracting the right eye into **r_eye**.

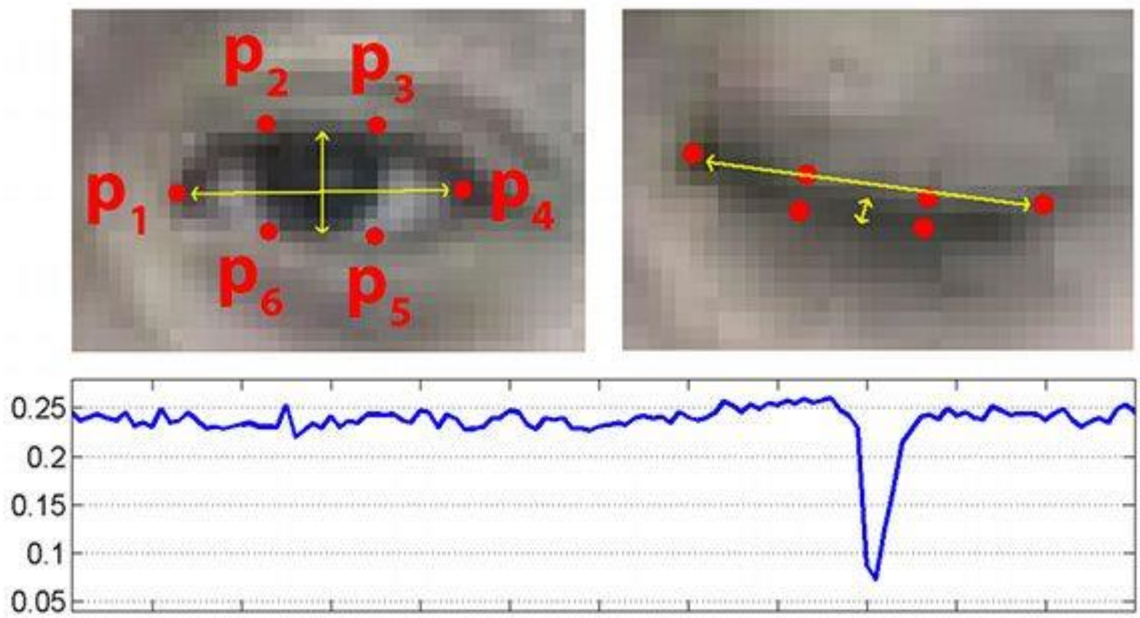
Step 4 – Classifier will Categorize whether Eyes are Open or Closed

We are using CNN classifier for predicting the eye status. To feed our image into the model, we need to perform certain operations because the model needs the correct dimensions to start with. First, we convert the color image into grayscale using **r_eye = cv2.cvtColor(r_eye, cv2.COLOR_BGR2GRAY)**. Then, we resize the image to 24*24 pixels as our model was trained on 24*24 pixel images **cv2.resize(r_eye, (24,24))**. We normalize our data for better convergence **r_eye = r_eye/255** (All values will be between 0-1). Expand the dimensions to feed into our classifier. We loaded our model using **model = load_model('models/cnnCat2.h5')** . Now we predict each eye with our model **lpred = model.predict_classes(l_eye)**. If the value of lpred[0] = 1, it states that eyes are open, if value of lpred[0] = 0 then, it states that eyes are closed.

Step 5 – Calculate Score to Check whether Person is Drowsy

The score is basically a value we will use to determine how long the person has closed his eyes. So if both eyes are closed, we will keep on increasing score and when eyes are open, we decrease the score. We are drawing the result on the screen using cv2.putText() function which will display real time status of the person.

cv2.putText(frame, "Open", (10, height-20), font, 1, (255,255,255), 1, cv2.LINE_AA)



Chapter 5

RESULT

Files on PC for the model:

Name	Date modified	Type	Size
DLLs	30-09-2021 22:17	File folder	
Doc	30-09-2021 22:17	File folder	
include	30-09-2021 22:17	File folder	
Lib	30-09-2021 22:17	File folder	
libs	30-09-2021 22:17	File folder	
Scripts	30-11-2021 19:51	File folder	
tcl	30-09-2021 22:17	File folder	
Tools	30-09-2021 22:17	File folder	
DriverDrowsyness Model	30-11-2021 19:38	Python File	2 KB
LICENSE	30-08-2021 20:37	Text Document	32 KB
NEWS	30-08-2021 20:37	Text Document	1,061 KB
python	30-08-2021 20:36	Application	100 KB
python3.dll	30-08-2021 20:36	Application extens...	59 KB
python39.dll	30-08-2021 20:36	Application extens...	4,384 KB
pythonw	30-08-2021 20:36	Application	98 KB
shape_predictor_68_face_landmarks.dat	30-11-2021 20:14	DAT File	97,358 KB
vcruntime140.dll	30-08-2021 20:37	Application extens...	95 KB
vcruntime140_1.dll	30-08-2021 20:37	Application extens...	37 KB

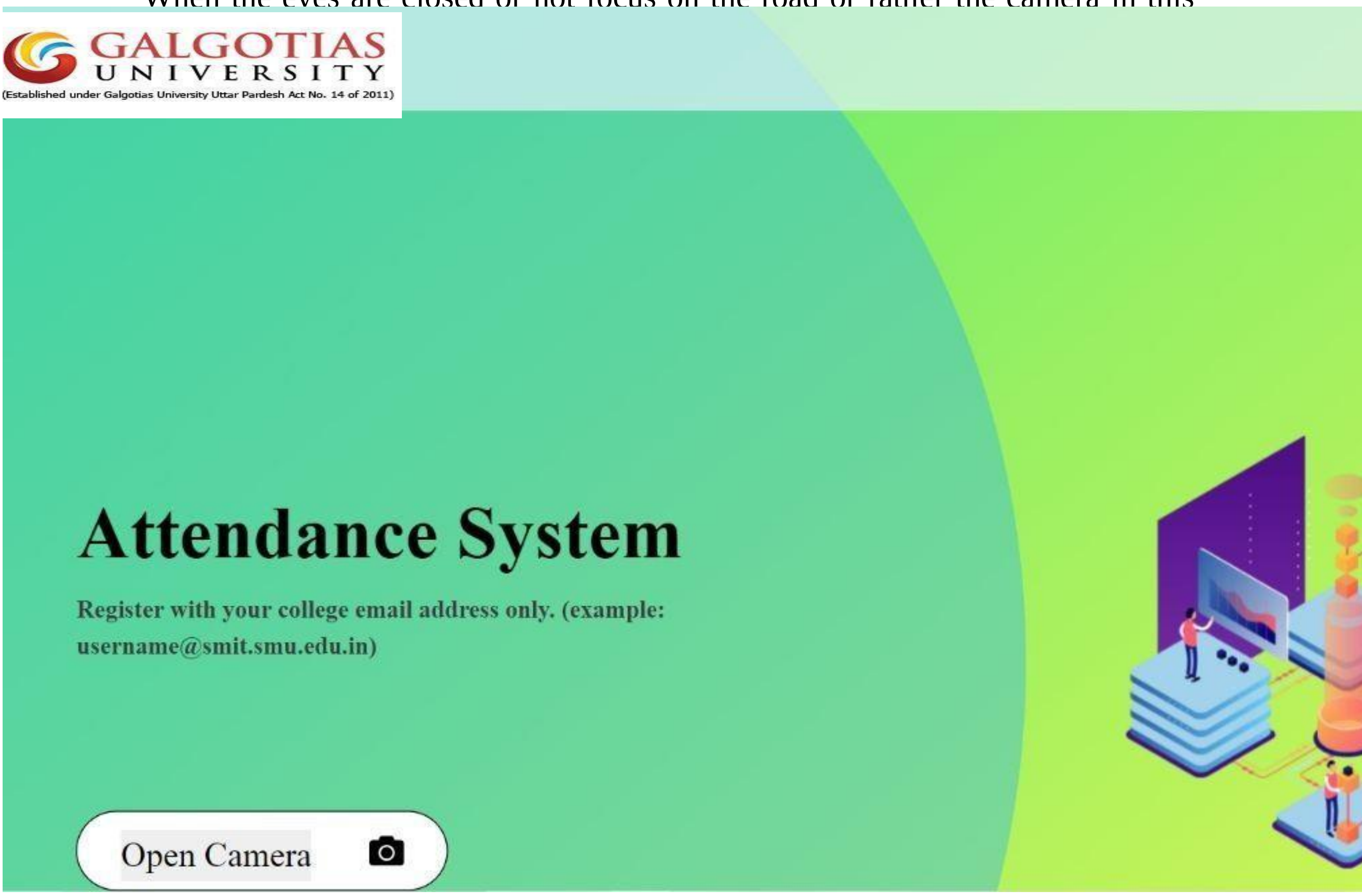
Working model

5.1 Detection of the eye without glasses

The first thing to do is to find eyes before we can move on to image processing and to find the eyes, we need to find a face. The facial key point detector takes a *rectangular object of the dlib module* as input which is simply the coordinates of a face. To find faces we can use the inbuilt frontal face detector of dlib. You can use any classifier for this task. If you want high accuracy and speed is not an issue for you then I would suggest you use a CNN as it will give much better accuracy especially for non-frontal facing faces and partially occluded faces as shown.

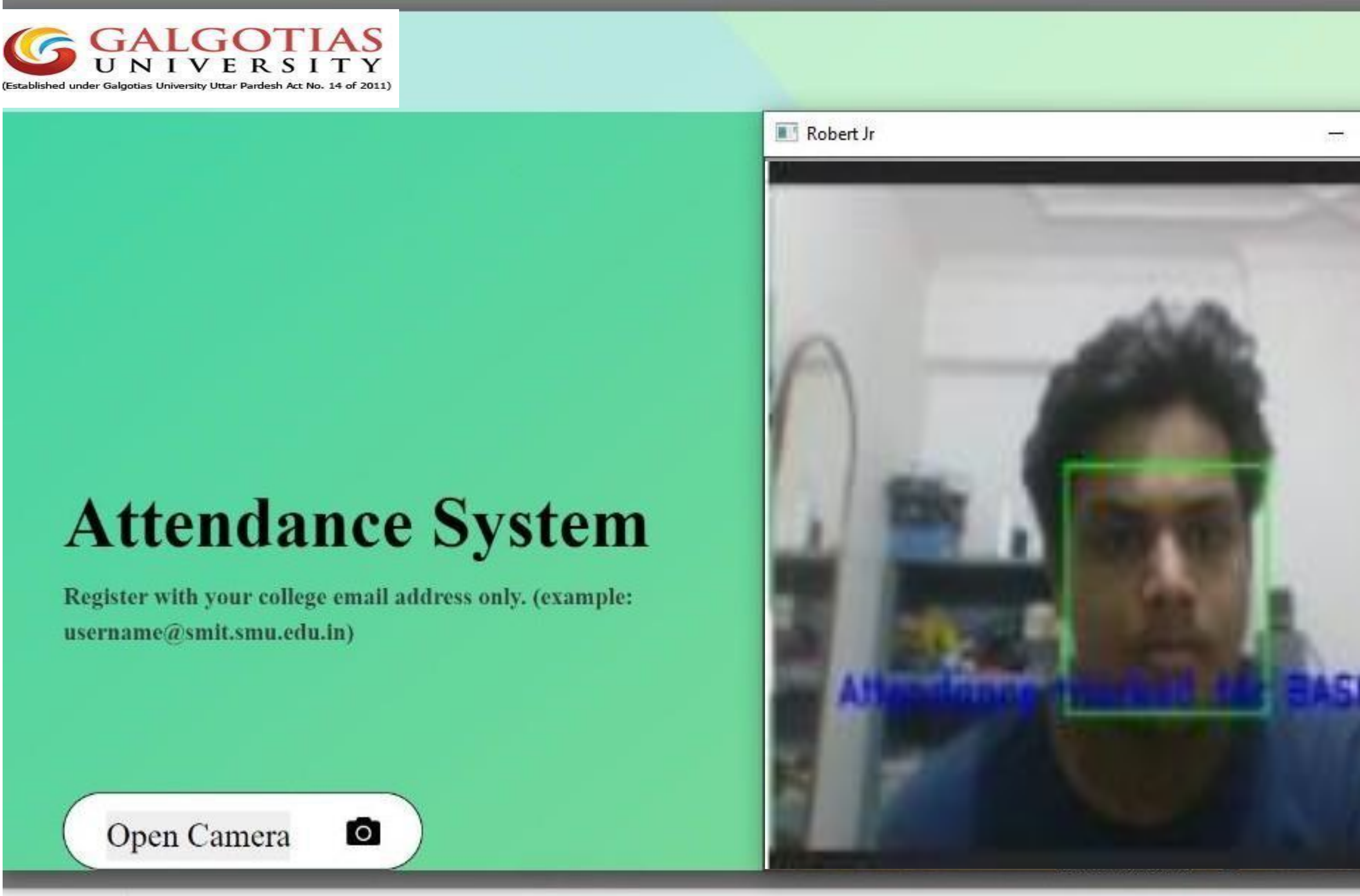
Warning for the driver without glasses

When the eyes are closed or not focus on the road or rather the camera in this



Detection of the eye with glasses

Here we will see how the eyes are tracked in the model when we are wearing



Warning for the driver with glasses

When the eyes are closed or not focus on the road or rather the camera in this case an warning message is displayed to the driver.

Here we are creating a region of interest based on the facial landmark on the face that is total 68 landmark using the dlib library and check if the ROI satisfy the area id it does then ok if not then we display the drowsiness message. In the below case the message is displayed as the roi is not fulfilled.

Chapter 6

CONCLUSION

The drowsiness detection proposed here is a minimum intrusive approach for monitoring driver drowsiness, based on computer vision techniques, installed on a real car, capable of dealing with real operation conditions. Results obtained with the system are similar or even better than other commercial ones being more flexible and open source. The commercial systems often require a non-trivial calibration procedure, to adjust the detection. This method is accurate up to 98% .This method of drowsiness detection takes less computational very less time. Hence, it is very advantages to use this technique in the real time applications. Coming to future scope this system can be further extended to have security like only certain people can access the vehicle. In case of theft, the vehicle does not start and an mms of the burglar could be sent to the owner of the vehicle.

LIMITATIONS

6.1 The limitations of the system are as follows

1. Dependence on ambient light: - With poor lighting conditions even though face is easily detected, sometimes the system is unable to detect the eyes. So it gives an erroneous result which must be taken care of. In real time scenario infrared backlights should be used to avoid poor lighting conditions.

2. Optimum range required: - when the distance between face and webcam is not at optimum range then certain problems are arising. When face is too close to webcam(less than 30 cm), the system is unable to detect the face from the image. When face is away from the web cam (more than 70cm) then the backlight is insufficient to illuminate the face properly. So eyes are not detected with high accuracy which shows error in detection of drowsiness. This issue is not seriously taken into account as in real time scenario the distance between drivers face and webcam doesn't exceed 50cm. so the problem never arises. Considering the above difficulties, the optimum distance range for drowsiness detection is set to 40-70 cm

3. Hardware requirements: - The system was run in a PC with a configuration of 1.6GHz and 1GB RAM Pentium dual core processor. Though the system runs fine on higher configurations, when a system has an inferior configuration, the system may not be smooth and drowsiness detection will be slow. The problem

was resolved by using dedicated hardware in real time applications, so there are no issues of frame buffering or slower detection.

4. Orientation of face: - when the face is tilted to a certain extent it can be detected, but beyond this system fails to detect the face. So when the face is not detected, eyes are also not detected. This problem is resolved by using tracking functions which track any movement and rotation of the objects in an image.

5. Poor detection with spectacles: - When the driver wears glasses the system fails to detect eyes which are the most significant drawback of our system. This issue has not yet been resolved and is a challenge for almost all eye detection systems designed so far.

6. Problem with multiple faces: - If more than one face is detected by the webcam, then our system gives an erroneous result. This problem is not important as we want to detect the drowsiness of a single driver.

Chapter 7

Future Scope

The drowsiness detection proposed here is a minimum intrusive approach for monitoring driver drowsiness, based on computer vision techniques, installed on a real car, capable of dealing with real operation conditions. Results obtained with the system are similar or even better than other commercial ones being more flexible and open source. The commercial systems often require a non-trivial calibration procedure, to adjust the detection. This method is accurate up to 98% .This method of drowsiness detection takes less computational very less time. Hence, it is very advantages to use this technique in the real time applications. Coming to future scope this system can be further extended to have security like only certain people can access the vehicle. In case of theft, the vehicle does not start and an mms of the burglar could be sent to the owner of the vehicle.

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