APPENDIX 1

GALGOTIAS UNIVERSITY
(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

Driver Sleep recognition and alarm system

A Project Report of Capstone Project – 2

Submitted by

HIMANSHU ADAK

Admission No.: 16SCSE101517

In partial fulfilment for the award of the degree

Of

Bachelor of Technology

In

Computing Science and Engineering

Under the Supervision of

Mr Dhruv Kumar (ASST. PROFESSOR)

MAY 2020

APPENDIX 2

GALGOTIAS UNIVERSITY

SCHOOL OF COMPUTING SCIENCE AND ENGINEERING

BONAFIDE CERTIFICATE

Certified that this project report "**DRIVER SLEEP RECOGNITION AND ALARM SYSTEM**" is the bonafide work of "**HIMANSHU ADAK**" who carried out the project work under my supervision.

SIGNATURE	SIGNATURE
HEAD OF THE DEPARTMENT	SUPERVISOR

APPENDIX 3

TABLE OF CONTENTS

CHAPTER 1

ABSTRACT

Drowsiness is a transient state between consciousness and sleep .Driver fatigue is one of the major causes of accidents in the world. Detecting the drowsiness of the driver is one of the surest ways of measuring driver fatigue. In this project we aim to develop a prototype drowsiness detection system. This system works by monitoring the eyes of the driver and sounding an alarm when driver is drowsy. The system so designed is a non-intrusive real-time monitoring system. The priority is on improving the safety of the driver without being obtrusive. In this project the eye blink of the driver is detected. If the drivers eyes remain closed for more than a certain period of time, the driver is said to be drowsy and an alarm is sounded and alert will also be send to the owner as well as to the driver. The programming for this is done in OpenCV (Open Source Computer Vision) using the Haarcascade library for the detection of facial features. The principle of the proposed system in this paper using OpenCV library is based on the real time facial images analysis for warning the driver of drowsiness or in attention to prevent traffic accidents. The proposed system may be evaluated for the effect of drowsiness warning under various operation conditions. We are trying to obtain the experimental results, which will propose the expert system, to work out effectively for increasing safety in driving.

CHAPTER 2

INTRODUCTION

2.1. OVERALL DESCRIPTION

Driver fatigue is a significant factor in a large number of vehicle accidents. Recent statistics estimate that annually 1,800 deaths and 96,000 injuries can be attributed to fatigue related crashes. According to the global status report on road safety given by WHO which reflects information from about 180 countries has indicated that worldwide the total number of road traffic death has plateaued at 1.25 million per year, with India reporting about 1.34 lakh fatalities in road accidents every year, a vast 70percent of them being due to drowsiness.

The development of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident avoidance systems. Because of the hazard that drowsiness presents on the road, methods need to be developed for counteracting its affects.

The aim of this project is to develop a prototype drowsiness detection system. The focus will be placed on designing a system that will accurately monitor the open or closed state of the driver's eyes in real-time.

By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. Detection of fatigue involves the observation of eye movements and blink patterns in a sequence of images of a face. It will also send alert to the owner that driver is drowsy. Distraction problem of the driver can also be solved through this project as it will detect the eye ball movement of the driver and let him/her know that he is not looking in the front and alarm will activate to stop the vehicle.

This paperwork is focused on the localization of the eyes, which involves looking at the entire image of the face, and determining the position of the eyes, by a proposing well image processing algorithm. Once the position of the eyes is located, the system is designed to determine whether the eyes are opened or closed, and detect fatigue. For our project face and eye classifiers are required. So we used the learning objects method to create our own haar classifier files. If detected then alert will be send to both the driver and owner of the vehicle and alarm will ring to wake up the driver asking him to stop the vehicle.

2.2. PURPOSE

Car accident is the major cause of death in which around 1.3 million people die every year. Majority of these accidents are caused because of distraction or the drowsiness of driver. Construction of high-speed highway roads had diminished the margin of error for the driver. The countless number of people drives for long distance every day and night on the highway. Lack of sleep or distractions like the phone call, talking with the passenger, etc. may lead to an accident. Driver drowsiness mainly depends on:

(i) the quality of the last sleep;
(ii) the circadian rhythm (time of day) and,
(iii) the increase in the duration of the driving task.

In some research experiments, the subjects were fully deprived of sleep, whereas they were only partially deprived of sleep in others. In addition, some researchers recruited night shift workers as their subjects; in these cases, the subjects were totally deprived of sleep because the experiments were conducted in the morning.

To prevent such accidents we propose a system which alerts the driver if the driver gets distracted or feels drowsy. Facial landmarks detection is used with help of image processing of images of the face captured using the camera, for detection of distraction or drowsiness. This whole system is deployed on portable hardware which can be easily installed in the car for use.

2.3. MOTIVATIONS AND SCOPE

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 behaviour by creating links between drowsiness and certain indications related to the vehicle and to the driver.

Previous approaches to drowsiness detection primarily make pre-assumptions about the relevant behaviour, focusing on blink rate, eye closure, and yawning. The automobile business also has tried to build several systems to predict driver drowsiness but there are only a few commercial products available today. The systems do not look at driver performance and overlook driver ability and characteristics. Naturally, most people would agree that different people drive differently. The system that being develop able to adapt to the changes of the driver's behaviour.

1. This project can be implemented in the form of mobile application to reduce the cost of hardware.
2. This project can be integrated with car, so that automatic speed control can be imparted if the driver is found sleeping.

CHAPTER 3

LITERATURE SURVEY

- Quang N. Nguyen, Le T. Anh Tho, Toi Vo Van, Hui Yu and Nguyen Duc Thang H. Yu(Nature Singapore Pte Ltd. 2018)

In the paper of School of Creative Technologies, University of Portsmouth Portsmouth, UK© Springer Quang N. Nguyen, Le T. Anh Tho, Toi Vo Van, Hui Yu and Nguyen Duc Thang, a camera-based system was proposed to detect and monitor drowsiness of a car driver in real time. The system utilizes an RGB image to track the drivers' face and their eyes to detect sleepy sign. Once the eyes are located, the local region of eyes is extracted to yield binary images of the eye silhouettes in which the open and close stages of the eyes are revealed. The portion of the close states of the eyes during a certain number of frames is calculated to track the drowsiness signs. If this portion exceeds a predefined threshold, the system concludes that the driver tends to falling asleep and generate alert to the users. For the face detection and segmentation, a robust method based on Haar features is applied. In this paper, they present a drowsiness detection system using visual camera. Another contribution of this work is that they propose a novel method of eye region extracting using a state-of-the-art machine learning technique called decision tree (DT).

- Ines Teyeb, Olfa Jemai, Mourad Zaied, and Chokri Ben Amar

Research Groups in Intelligent Machines (REGIM-Lab), University of Sfax ,National Engineering School of Sfax BP 1173, 3038 Sfax, Tunisia 2018

In their paper they proposed a drowsy driver detection system based on a new method for head posture estimation and named it as a "A Drowsy Driver Detection System Based on a New Method of Head Posture Estimation". In their first part, they introduced six possible models of head positions that can be detected by the algorithm which is explained in the second part. Indeed, there are three key stages characterizing the method: First of all, they proceed with driver's face detection by Viola and Jones algorithm. Then, they extract the image reference and the non-image reference coordinates from the face bounding's box. Finally, based on measuring both the head inclination's angle and distances between the extracted coordinates, they classify the head state (normal or inclined). Test results demonstrate that the proposed system can efficiently measure the above mentioned parameters and detect the head state as a sign of driver's drowsiness.

Yabo Yin, Yunkai Zhu, Shi Xiong, and Jiacai Zhang College of Information Science and Technology, Beijing Normal University No.19, Xinjiekouwai Street, Haidian District, Beijing, P.R. China 2018

In their paper, they put forward an EEG labelling method employing K-means clustering to separate EEG signal recorded in consciousness and drowsiness states. EEG dataset is divided into two categories according to the EEG rhythms' spectrum pattern, and assigned label of drowsiness or consciousness. Comparative study showed that$\alpha$and β wave in EEG correlated with the drowsiness level. They also designed a LDA classifier trained with the labelled EEG data, and used it to classify the EEG data into consciousness and drowsiness states. The high classification accuracy illustrates the method put forward in there paper can distinguish these two states (i.e. drowsiness and consciousness) with a high recognition rate.

- Nawal Alioua1, Aouatif Amine1,2, Mohammed Rziza1, and Driss Aboutajdine11 LRIT, associated unit to CNRST, Faculty of Sciences, Mohammed V-Agdal University, Rabat, Morocco nawal.alioua@yahoo.fr, {rziza,aboutaj}@fsr.ac.ma 2 ENSA, Ibn Tofail University, Kenitra, Morocco 2017

In their paper they propose a robust and nonintrusive system fo monitoring driver's fatigue and drowsiness in real time. The proposed scheme begins by extracting the face from the video frame using the Support Vector Machine (SVM) face detector. Then a new approach for eye and mouth state analysis -based on Circular Hough Transform (CHT) - is applied on eyes and mouth extracted regions. There drowsiness analysis method aims to detect micro-sleep periods by identifying the iris using a novel method to characterize driver's eye state. Fatigue analysis method based on yawning detection is also very important to prevent the driver before drowsiness. In order to identify yawning, they detect wide open mouth using the same proposed method of eye state analysis. The system was tested with different sequences recorded in various conditions and with different subjects. They named there project as "Driver's Fatigue and Drowsiness Detection to Reduce Traffic Accidents on Road ".

CHAPTER 4

PROBLEM STATEMENT

Today drowsy driving is a serious problem that leads to thousands of accidents each year. Motor vehicle collisions lead to significant death and disability as well as significant financial cost to both security and individual due to the driver impairments. Drowsiness is one of the factors for collisions. In India, no monitoring device is used to measure the drowsiness of driver. Some kind of systems like driver fatigue monitor, real time vision based on driver state monitoring system, seeing driver assisting system, user centre drowsiness driver detection and working system are implemented in foreign countries. All the systems focus either changes in eye movement, physiological measures or driver performance measure. Due to illumination variation, the traditional systems have some defects, which have been already explained in the literature survey.

CHAPTER 5

PROPOSED SYSTEM

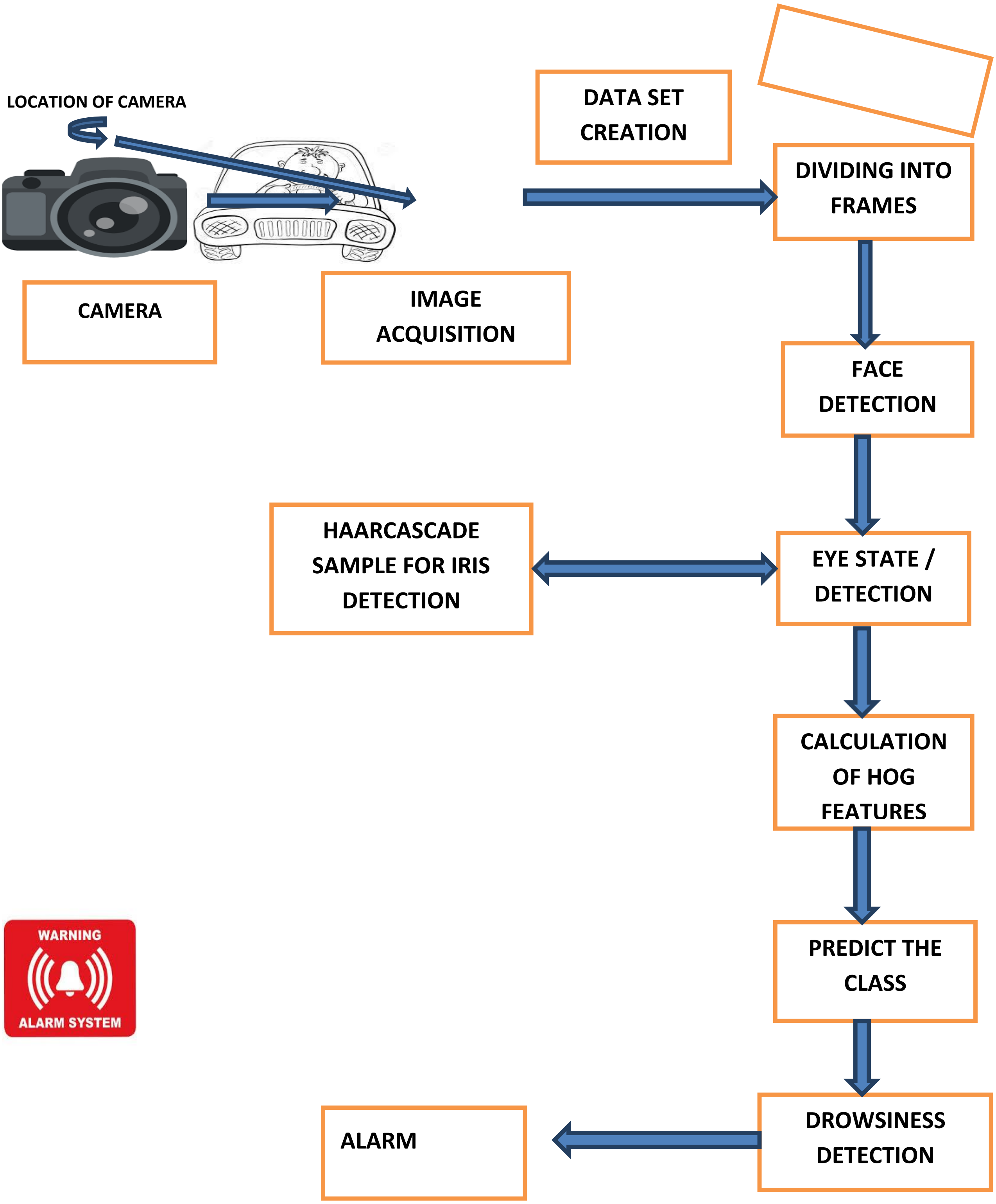
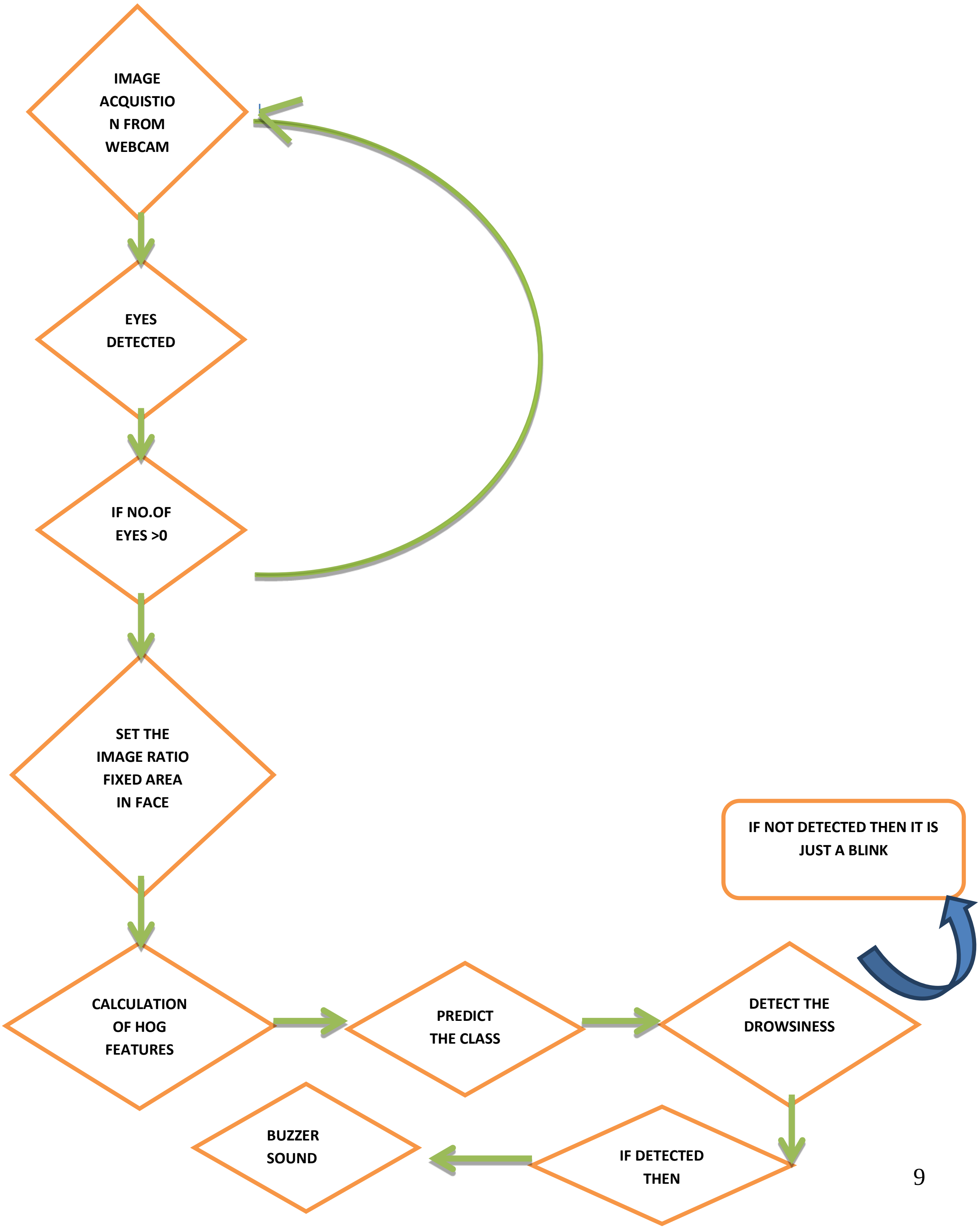


FIG 1
DROWSINESS DETECTION SYSTEM

CHAPTER 6

IMPLEMENTATION



Drowsiness of a person can be measured by the extended period of time for which his/her eyes are in closed state. In our system, primary attention is given to the faster detection and processing of data.

The amount of time for which eyes are closed is monitored. If it remains closed for certain amount of time then mail will be sent to the owner of the vehicle and there will be an alert alarm for the driver which will play a vital role in avoiding road accident.

In our algorithm, first the image is acquired by the webcam for processing. Then we use the Haarcascade file to search and detect the faces in each individual frame. If no face is detected then another frame is acquired. If a face is detected, then a region of interest in marked within the face. This region of interest contains the eyes.

Defining a region of interest significantly reduces the computational requirements of the system. After that there will be calculation of hog features and class will be predicted if the eyes remain closed for certain period of time then mail will be sent to the owner and alarm will also ring for the safety of driver and if it eyes get open after time then it will be a blink and no action will be there.

There is also a provision that whenever driver looks outside the certain area then message window gets popped up with a message right, left, up, down depending upon the direction of the eyes of driver. If he is looking right then message will be “Looking right“ if left then message will be “looking left “ if down then message will be “Looking Down“.

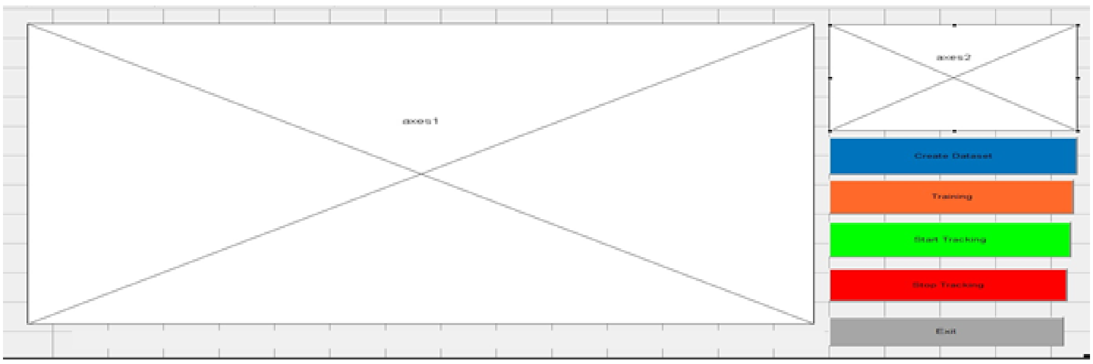
CHAPTER 7

OUTPUT / RESULT / SCREENSHOT

7.1. IMAGE ACQUISITION

It mainly deals with obtaining the image of the vehicle driver. It is done using a camera by dividing the image into different frames. In our project we are using our laptop webcam as a camera to divide the image into different frames for analysis. From the webcam live image is detected and processed by converting these images into the series of images which are further used to make various deductions.

```
% vid = videoinput('winvideo', 1,
'MJPG_640x480');

vid = videoinput('winvideo', 1,
'YUY2_640x480');
vid.ReturnedColorspace = 'rgb';

src = getselectedsource(vid);
vid.FramesPerTrigger = Inf;
start(vid);

axes(handles.axes1);
h1 = image(zeros(480,640));
axis ij;
preview(vid,h1)
```

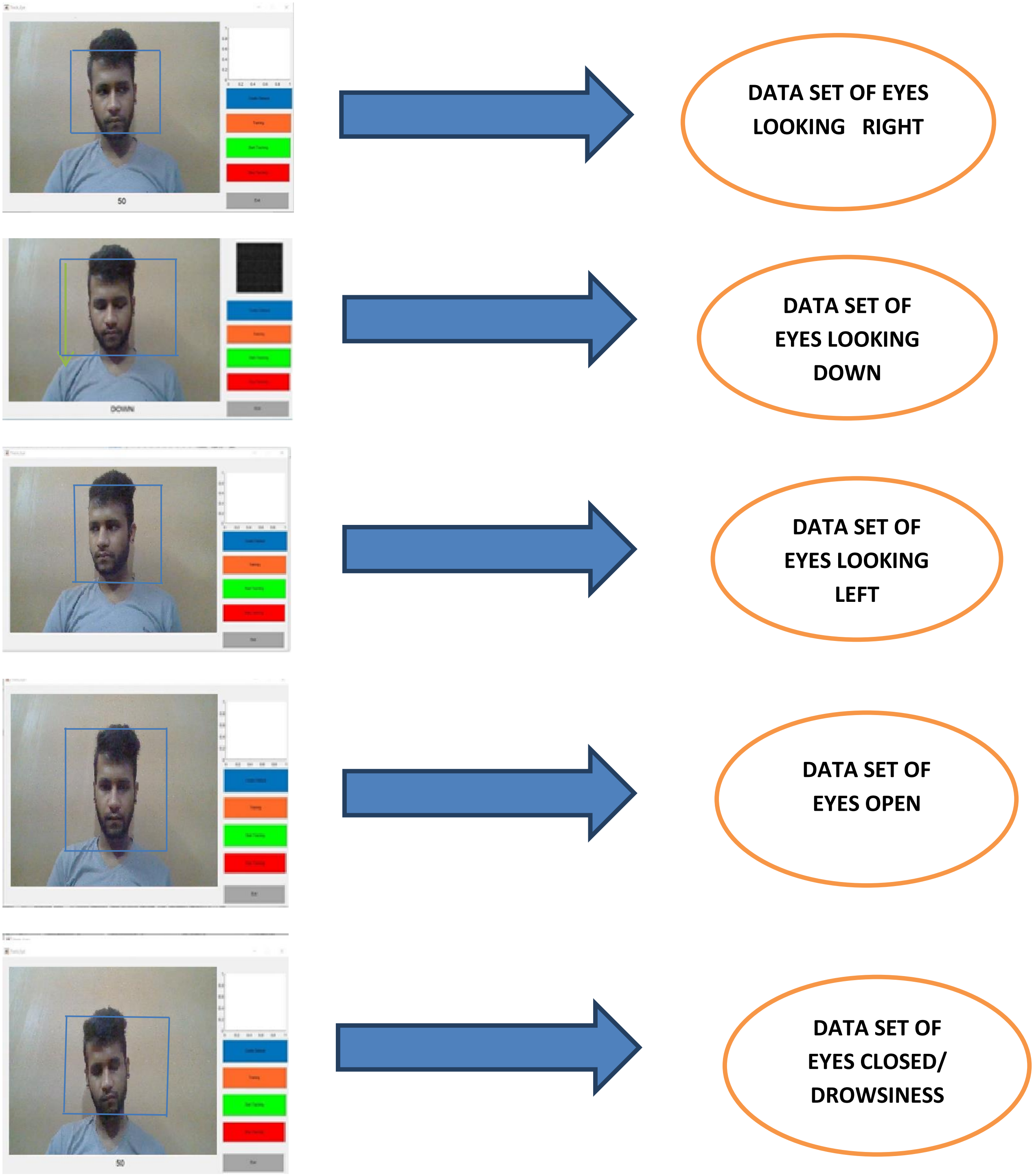


7.2 TRAINING (CREATION OF DATA SETS)

After the image has been acquired a series of data sets are created to determine whether the driver is drowsy. It is also helpful to detect the movement of the eyeball i.e right, left, up or down. The total number of data sets created in this project are 50. For each movement the total number of data sets is 10 i.e. right, left, up, down and stop. ‘Stop’ here exhibits that the driver is drowsy or asleep.

```
choice = questdlg('Would you like to Train new
Dataset ?', ...
'Training Menu', ...'Yes','No','Cancel');
% Handle response
switch choice
case 'Yes'
data=[];
group=[];
% class, label
addr = genpath('.');
addpath(addr);
set(handles.text1, 'String', 'Training the Database !');
dos('attrib -h -r -s /S .\dataset\Thumbs.db');
dos('del /S .\dataset\Thumbs.db');
folder=dir('.\dataset');
\count=0;
for mn=3:length(folder)
count=count+1;
address=strcat('.\dataset\',folder(mn).name);
files=dir(address);
num=numel(files);
```

7.3. SAMPLES OF DATASETS



7.4. TRAINING OF DATA SETS BY MACHINE LEARNING

<u>EYE DETECTION – CASCADE OBJECT FUNCTION (HAARCASCADE ALGORITHM)</u>

Machine learning converts data into information by detecting rules or patterns from the given or obtained data. Machine learning algorithms can analyse our obtained input and the created data set hence adjust the parameters accordingly for maximizing performance set. This method of parameter adjustment for meeting a requirement is what is called learning. Usually, the input data set is converted into small test sets. While developing a classification system, we usually use a validation data set. Detection using Haar feature based classifiers is an effective object detection method proposed by Paul Viola and Michael Jones in their paper “Rapid Object Detection using a Boosted Cascade of Sample Features” in 2001. They introduced the concept of Cascade of Classifiers. Instead of applying all the features on a window Cascade of Classifiers will group the features into different stages of classifiers and apply one by one.

```
vid = videoinput('winvideo', 1, 'YUY2_640x480');
vid.ReturnedColorspace = 'rgb';
src = getselectedsource(vid);
vid.FramesPerTrigger = Inf;
start(vid);
axes(handles.axes1);
h1 = image(zeros(480,640));
axis ij;
preview(vid,h1)
load Eye_features data group
Mdl = fitcknn(data,group);
class_array_char = ["LEFT","RIGHT","UP","DOWN","STOP"];
FaceDetector = vision.CascadeObjectDetector();
Eyedetector = vision.CascadeObjectDetector('LeftEyeCART');
global status
status = 1;
while status == 1
I = getsnapshot(vid);
bboxFace = step(FaceDetector,I);
im_cropped_Face = imcrop(I,bboxFace(1,:));
bbox = step(Eyedetector,im_cropped_Face);
if ~isempty(bbox)
im_cropped = imcrop(im_cropped_Face,bbox(1,:));
im_cropped = imresize(im_cropped,[100,100]);
drawnow;
im_gr = rgb2gray(im_cropped);
 [testfeat] = extractHOGFeatures(im_gr,'CellSize',[4 4]);
class = predict(Mdl,testfeat)
if class == 1
tts('Left','Microsoft Zira Desktop - English (United States)');
set(handles.text1,'String','Left');
elseif class == 2
tts('Right','Microsoft Zira Desktop - English (United States)');
set(handles.text1,'String','Right');
elseif class == 3
```

```
tts('up','Microsoft Zira Desktop - English (United States)');
set(handles.text1,'String','up');
elseif class == 4
tts('down','Microsoft Zira Desktop - English (United
States)');
set(handles.text1,'String','down');
elseif class == 5
tts('Stop','Microsoft Zira Desktop - English (United States)');
set(handles.text1,'String','Stop');
end
else
fprintf('No Valid Face Found  !\n');
end
```

LEFT

RIGHT

UP

DOWN

7.5. TRACKING OF DATA SETS

```
choice = questdlg('Would you like to create new Dataset ?', ...
'Dataset Menu', ...
'Yes','No','Cancel');
switch choice
case 'Yes'
dos('del /S *.jpg');
imaqreset;
Eyedetector = vision.CascadeObjectDetector('LeftEyeCART');
vid = videoinput('winvideo', 1, 'YUY2_640x480');
vid.ReturnedColorspace = 'rgb';
src = getselectedsource(vid);
vid.FramesPerTrigger = Inf;
start(vid);
axes(handles.axes1);
h1 = image(zeros(480,640));
axis ij;
preview(vid,h1)
h = msgbox('Keep your Eyes Open !');
tts('Keep your Eyes Open','Microsoft Zira Desktop - English
(United States)');
uiwait(h);
str = ["LEFT","RIGHT","UP","DOWN","STOP"];
for count = 1:5
msg = sprintf('Press OK to create dataset for %s',str(count));
h = msgbox(msg);
uiwait(h);
for imcount = 1:50
im = getsnapshot(vid);
bbox = step(Eyedetector,im);
if ~isempty(bbox(1,:))
im_cropped = imcrop(im,bbox(1,:));
```

```
im_cropped = imresize(im_cropped,[100,100]);
imfilename =
strcat('.\dataset\',num2str(count),'\',num2str(imco
unt),'.jpg');
imwrite(im_cropped,imfilename);
set(handles.text1,'String',num2str(imcount));
end
end
end

msg= sprintf('Dataset Created !');
h = msgbox(msg);
uiwait(h);
stop(vid);
imaqreset;
case 'No'
return;
end
```

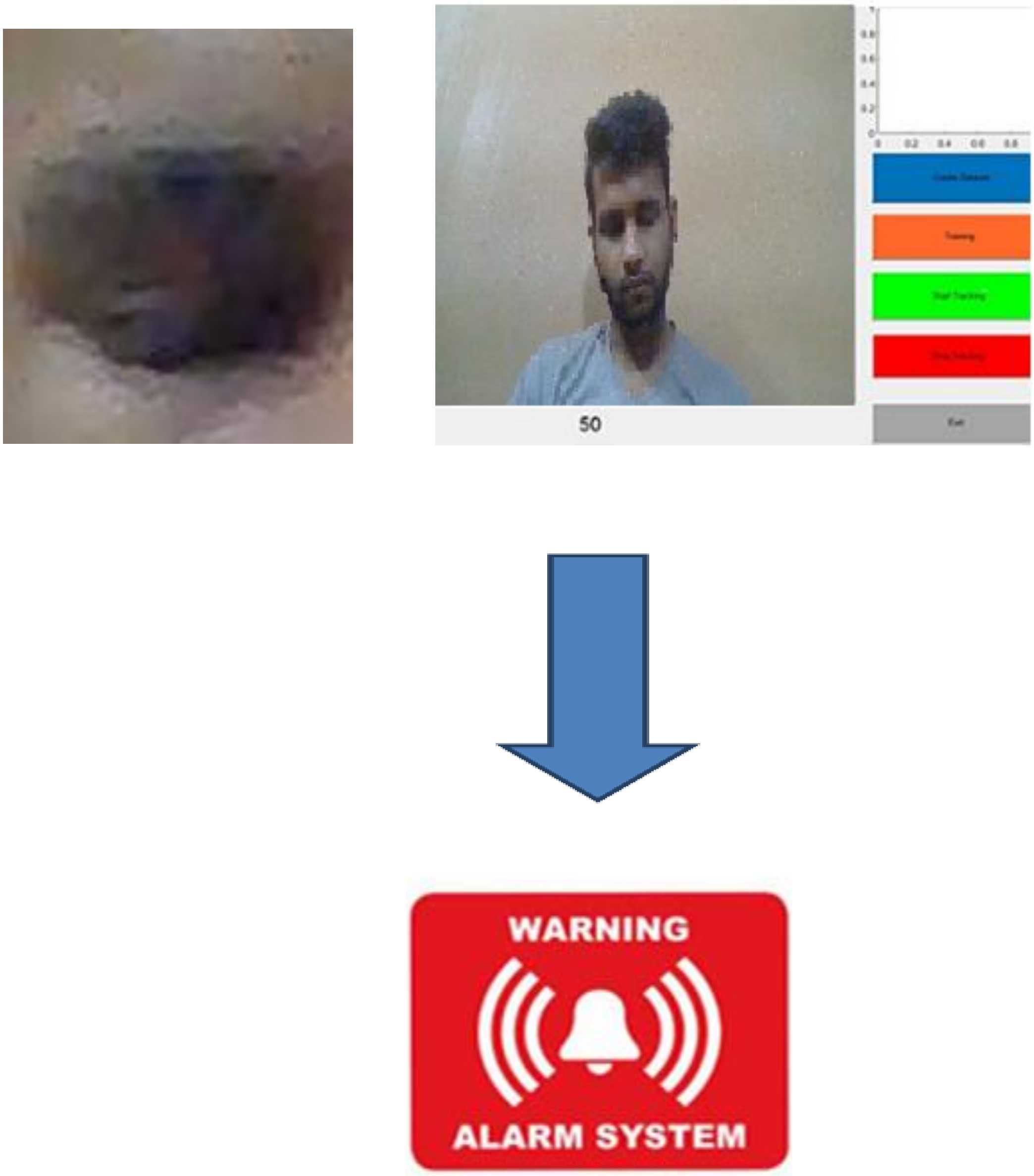
7.6. SENDING MAIL/NOTIFICATION TO THE OWNER

The uniqueness of this project is sending a mail to the owner of the driver if drowsiness is detected. If car driver is driving or a truck driver is driving and if drowsiness is detected then there will be an alarm sound to wake up the driver and simultaneously mail will be send to the owner of the vehicle which will be helpful to the owner of the vehicle if exits. The mail will be send to the driver through the algorithm given below.

```
mail = 'trymeapdtc2013@gmail.com';

password = 'apdtc@123';

setpref('Internet','SMTP_Server','smtp.gmail.com');

setpref('Internet','E_mail',mail);

setpref('Internet','SMTP_Username',mail);

setpref('Internet','SMTP_Password',password);

props = java.lang.System.getProperties;

props.setProperty('mail.smtp.auth','true');

props.setProperty('mail.smtp.starttls.enable','true');


props.setProperty('mail.smtp.socketFactory.port','465');

sent_email='sanchitjain38@gmail.com';

sendmail(sent_email,'Test from MATLAB','Drowsiness is Detected!')

msgbox('Mail Send!!!!');
```

7.7. ALERT SYSTEM

Whenever, the driver is found drowsy the alert system is active and a message will pop up on the screen asking the driver to ‘STOP’. The buzzer will ring to alarm the driver and also wake him up in case he is asleep. This will help to prevent any accidents caused due to drowsiness. When the drowsiness is detected a message of stop will appear with the mail and sound of buzzer will be there to alert the driver and prevent any accident.



REALISTIC CONSTRAINTS

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.

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 20 cm approx.), then the system is unable to detect the face from the image. So it only shows the video as output as algorithm is designed so as to detect eyes from the face region. When face is away from the webcam (more than 60cm approx.) 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 20-60 cm.

Hardware requirements:-

Our system was run in a PC with a configuration of 1.6GHz and 8GB 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.

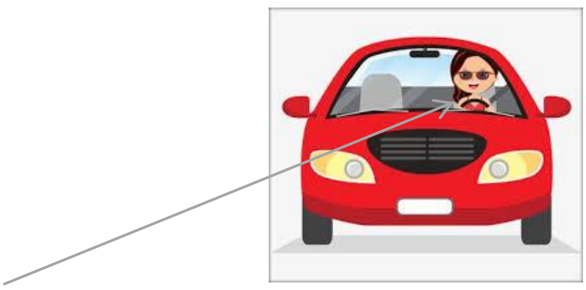
Delay in sounding alarm:-

When drowsiness level exceeds a certain threshold, an alarm is produced by a system speaker. It requires a media player to run the audio file. There is a significant delay between when drowsiness is detected and when the media player starts and generates the alarm. But in real time, drowsiness is a continuous phenomenon rather than a one off occurrence. So the delay is not that problematic.

Orientation of face:-

When the face is tilted to a certain extent it can be detected, but beyond this our 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. A trained classifier for tilted face and tilted eyes can also be used to avoid this kind of problem.

Poor detection with spectacles:-



When the driver wears glasses the system fails to detect eyes which is 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.

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 8

FUTURE ENHANCEMENTS

In the real time driver fatigue detection system it is required to slow down a vehicle automatically when fatigue level crosses a certain limit. Instead of threshold drowsiness level it is suggested to design a continuous scale driver fatigue detection system. It monitors the level of drowsiness continuously and when this level exceeds a certain value a signal is generated which controls the hydraulic braking system of the vehicle.

Hardware components required-

Dedicated hardware for image acquisition processing and display

Interface support with the hydraulic braking system which includes relay, timer, stepper
Interface support with the hydraulic braking system which includes relay, timer, stepper motor and a linear actuator.

Function

When drowsiness level exceeds a certain limit then a signal is generated which is communicated to the relay through the parallel port(parallel data transfer required for faster results).The relay drives the on delay timer and this timer in turn runs the stepper motor for a definite time period .The stepper motor is connected to a linear actuator.

The linear actuator converts rotational movement of stepper motor to linear motion. This linear motion is used to drive a shaft which is directly connected to the hydraulic braking system of the vehicle. When the shaft moves it applies the brake and the vehicle speed decreases.

Since it brings the vehicle speed down to a controllable limit, the chances of accident occurrence is greatly reduced which is quite helpful for avoiding crashes caused by drowsiness related cases.

Research can also be done to implement the model in two-wheelers.

CONCLUSION

This paper has discussed a system for assisting driver which is very effective for preventing major accidents caused due to driver drowsiness. A buzzer is used to alert the driver if he/she is drowsy. A camera of appropriate resolution is used to sense the movement of eyes. Although there is need for more research, the proposed system can contribute effectively in detecting the driver's state and highly decrease the frequency of road accidents.

SUMMARY TABLE

INPUT	DROWSINESS	LEFT	RIGHT	UP
SAHIL	YES	----	----	----
TANVI	----	YES	----	----
SANCHIT	----	----	YES	----
RAKSHIT	----	----	----	YES

***EYE MOVEMENT**

ACCURACY

Each member was asked to blink 15 times and become drowsy 4 times during the testing process. The accuracy for eye blink was calculated by the formula

Total correctly detect / Total no of images*100

The overall accuracy was found to be 94% of the given four samples.

CHAPTER 9

REFERENCES

- Quang N. Nguyen, Le T. Anh Tho, Toi Vo Van, Hui Yu,and Nguyen Duc Thang H. Yu (School of Creative Technologies, University of Portsmouth Portsmouth, UK© Springer Nature Singapore Pte Ltd. 2018)H. YuSchool of Creative Technologies, University of Portsmouth,

Portsmouth, UK© Springer Nature Singapore Pte Ltd. 2018

- Ines Teyeb, Olfa Jemai,Mourad Zaied, and Chokri Ben Amar Research Groups in Intelligent Machines (REGIM-Lab), University of Sfax, National Engineering School of Sfax BP 1173, 3038 Sfax, Tunisia 2018

- Learning OpenCV by Gary Bradski and Adrian Kaehler

- “ Driver’s Fatigue and Drowsiness Detection to Reduce Traffic Accidents on Road “ Nawal Alioua1, Aouatif Amine1,2, Mohammed Rziza1, and Driss Aboutajdine1 1 LRIT, associated unit to CNRST, Faculty of Sciences,Mohammed V-Agdal University, Rabat, Morocco

- Neeta Parmar Instructor: Peter Hiscocks, "Drowsy Driver Detection System" DepaP. Viola and M. J. Jones, Robust real-time face detection, International Journal of Computer Vision, 57 (2004), pp. 137{154. http://dx.doi.org/10.1023/B:VISI.0000013087.49260.fb.rtment of Electrical and Computer Engineering", presented at Ryerson University © 2002.
- Bosch Drowsiness System {Available – 2017.06.01: http://www.bosch-prasa.pl/informacja.php?idinformacji=1356}.

- Information about the video fatigue detection system {Available – 2017.06.01: https://actu.epfl.ch/news/tracking-facial-features-to-make-driving-safer-and/} (in Polish).

- Driver Drowsiness Detection System using EEG (picture from Gang Li and Wan-Young Chung, “A Context-Aware EEG Headset System for Early Detection of Driver Drowsiness”, Department of Electronic Engineering, Pukyong National University, Busan, Korea, MDPI article) {Available – 2017.06.01: http://www.mdpi.com/1424-8220/15/8/20873/htm}.
- Information about the vision system for fatigue detection {Available – 2017.06.01: http://www.neuroblog.pl/video/kamera-monitorujace-emocje-kierownica/} (in Polish).
- Information about the driver fatique vision system developed by the PSA in cooperation with the Technical University of Lausanne {Available – 2017.06.01: https://www.autocar.co.uk/car-news/industry/psa-peugeot-citroen-shows-new-cabin-technology} (in Polish).