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School of Information Technology and Engineering

J-Component Report, NOVEMBER 2020

B.Tech., Fall-2020-2021

COURSE CODE	ITE1014
COURSE NAME	HUMAN COMPUTER INTERACTION
SLOT	C2+TC2
FACULTY	Prof. RAMYA G.

TEAM MEMBERS:

REG. NO.	NAME
18BIT0231	KUSHAGRA AGARWAL
18BIT0272	PRIYAL BHARDWAJ

REVIEW 1

I. Identify a Computer based system of your choice and provide the description of your application in 150 words.

<u>Driver Drowsiness Detection System</u>:

Nowadays the driver safety in vehicles is one of the most wanted systems to avoid accidents. Many researches and surveys have estimated that about 1.35 million drivers have been involved in drowsiness related accidents in the past 5 years. Speaking of our country, up to 25% of road accidents are fatigue related. Drivers must keep a close eye on the road and be alert at all times so that they can react appropriately to sudden events.

Nowadays, more and more professions require long-term concentration. Drivers must keep a close eye on the road, so they can react to sudden events immediately. Driver fatigue often becomes a direct cause of many traffic accidents. Therefore, there is a need to develop the systems that will detect and notify a driver of her/him bad psychophysical condition, which could significantly reduce the number of fatigue-related car accidents.

Driver drowsiness detection systems help prevent accidents by alerting the driver whenever the system finds signs of drowsiness through the use of eye detection. Small monochrome security camera pointing towards driver's face monitors the driver's eyes in order to detect fatigue.

Drowsiness detection is a safety technology that can prevent accidents that are caused by drivers who fell asleep while driving. The objective of this project is to build a drowsiness detection system that will detect that a person's eyes are closed for a few seconds as well as the number of blinks. This system will alert the driver when drowsiness is detected. At the same time, we will also be designing a mouth detection system to detect yawning.

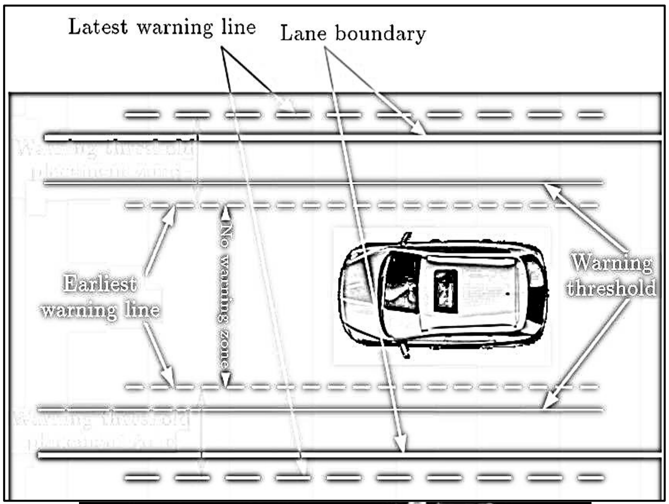
II. <u>Other components required in the document:</u>

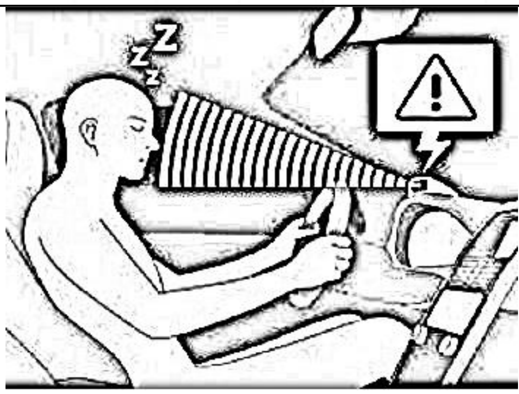
1. Identify the target user community as Senior citizen/ Children/ etc.

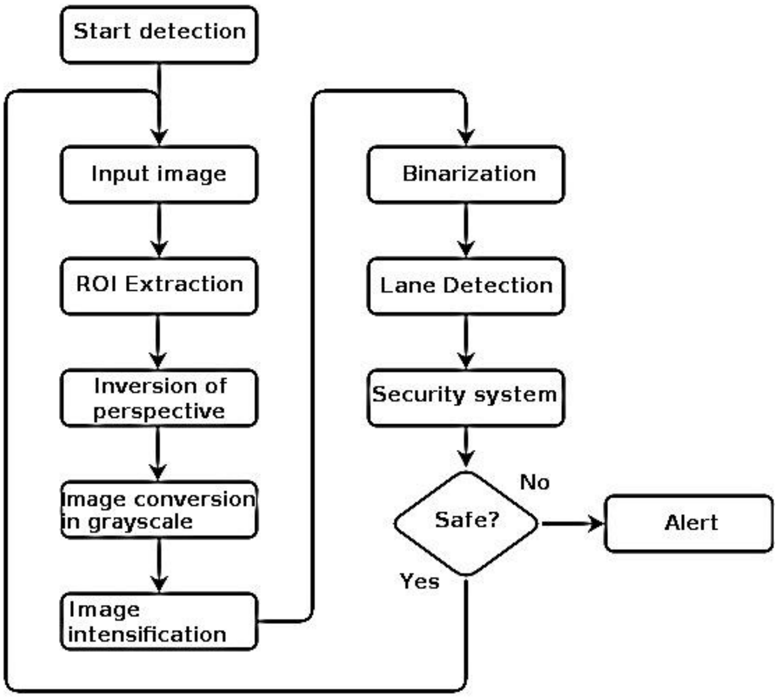
   The target user community consists of **all adults with a driving license.**

2. Analyse and draw the existing product's design using 2D/3D tool/snapshot/ free hand drawing.

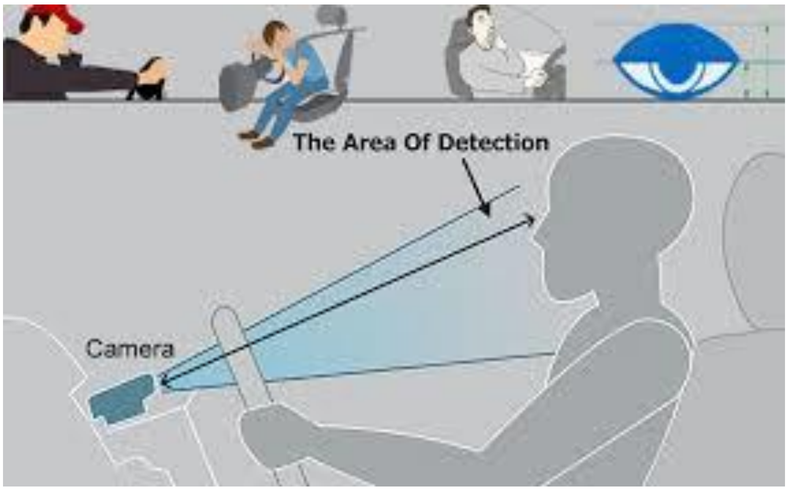
Existing product:

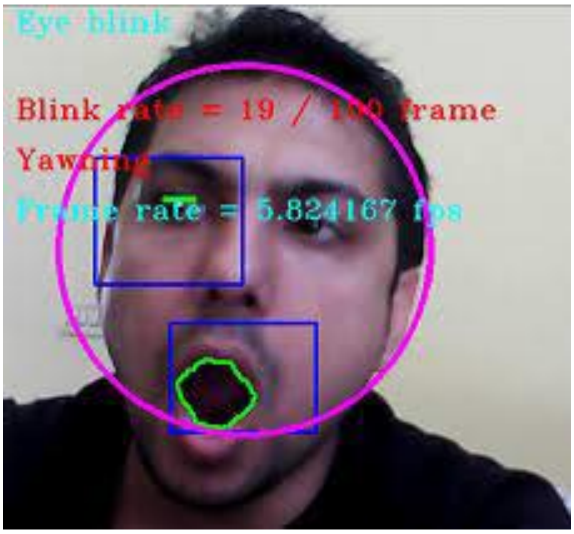


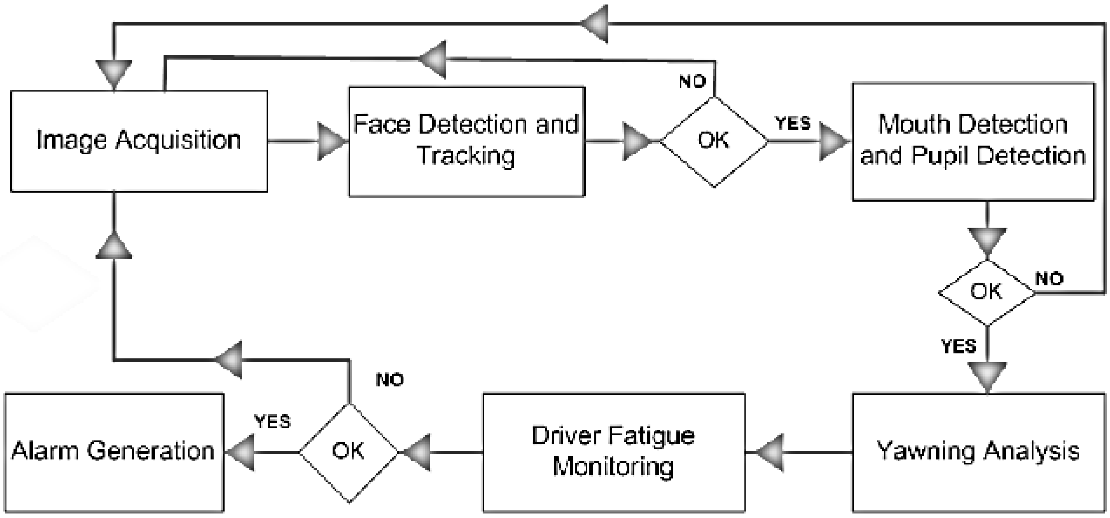




Proposed Product:







Flowchart created using online available free tools

3. Understand and list the limitations faced by the respective target user community with current design.

Some of the anticipated constraints and limitations faced by the proposed system include:

- Camera motion: Poor road conditions as well as a more aggressive style of driving can introduce significant amount of vibrations and discomfort to the driving experience. Those vibrations can be passed onto the camera and cause distortion in the images which can significantly skew the results and decrease the overall performance of the system.
- Relative positioning of device: The camera must be positioned within a certain range from the driver and within a certain viewing angle. Every computer vision algorithm has a "comfort zone" in

which it performs the best and most reliably. If that comfort zone is left, performance can be dropped significantly.

- Lighting conditions: Frequent and drastic change in darkness or brightness of a scene (or part of it), which may happen even during the shortest driving intervals, have been proven to be a significant challenge for many computer vision algorithms.
- Driver cooperation: Last, but certainly not least, all driver drowsiness detection systems assume a cooperative driver, who is willing to assist in the setup steps, keep the monitoring system on at all times, and take proper action when warned by the system of potential risks due to detected drowsiness.

4. Provide a suitable list of suggestions/ solutions for the limitations found in the product's existing HCI design.

- An adjustable camera can be used which the user can adjust as per their height as part of the setup process.
- A hybrid system is proposed which will take steering wheel pressure into account as well which will allow us to neglect the lighting issue as well as the camera motion issue.
- In vehicles if the driver has not put on his/her seatbelt, an alarm is activated until he/she does. The same can be done for keeping the monitoring system on at all times.

REVIEW 2

I. Design Task Analysis

0: Check alertness of driver

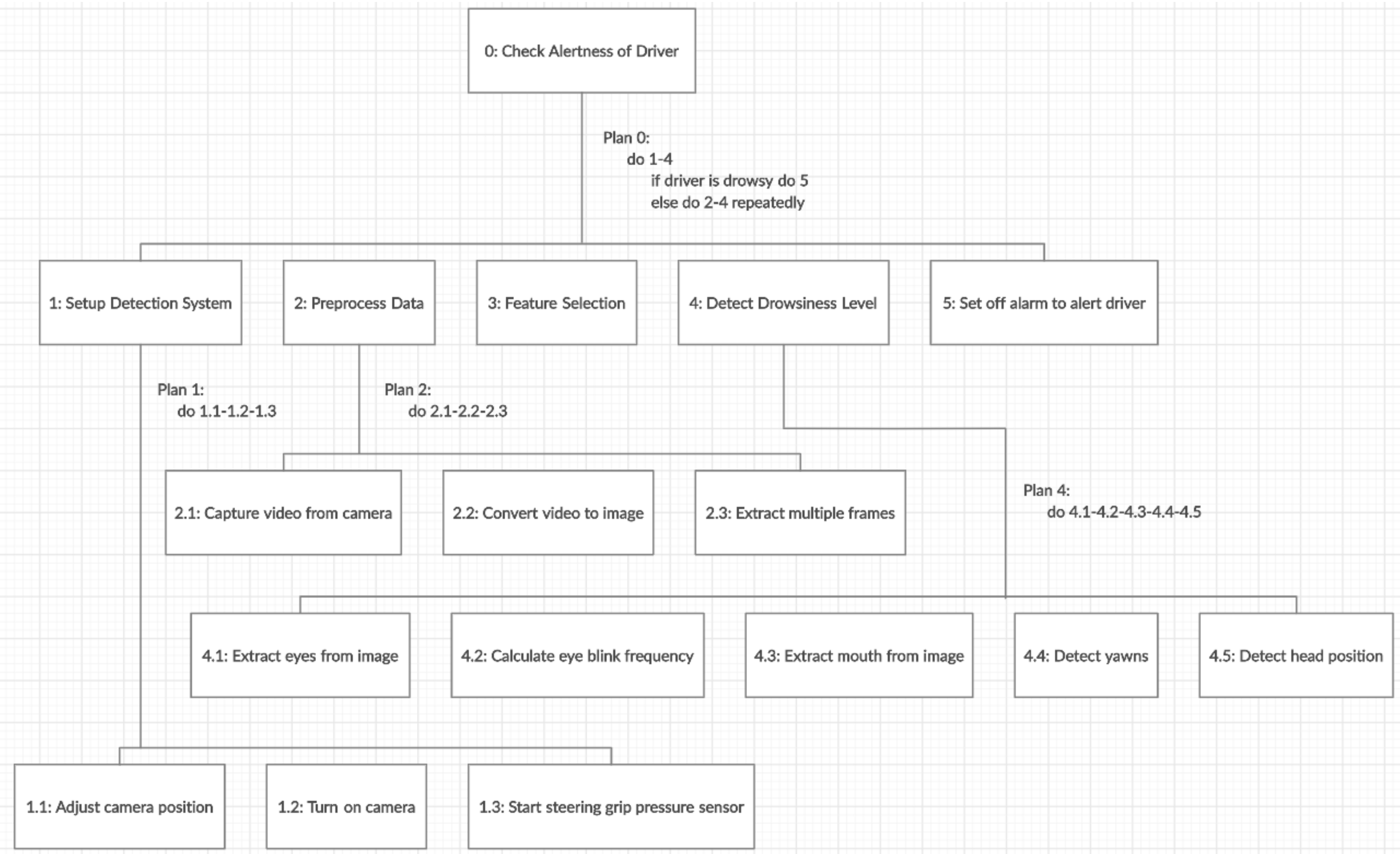
1: Setup detection system
- 1.1: Turn on camera
- 1.2: Adjust camera position
- 1.3: Start steering grip pressure sensor

2: Pre-process data
- 2.1: Capture video from camera
- 2.2: Convert video to image
- 2.3: Extract multiple image frames

3: Feature selection

4: Detect drowsiness level
- 4.1: Extract eyes from image
- 4.2: Calculate eye blink frequency
- 4.3: Extract mouth from image
- 4.4: Detect yawning
- 4.5: Detect head position

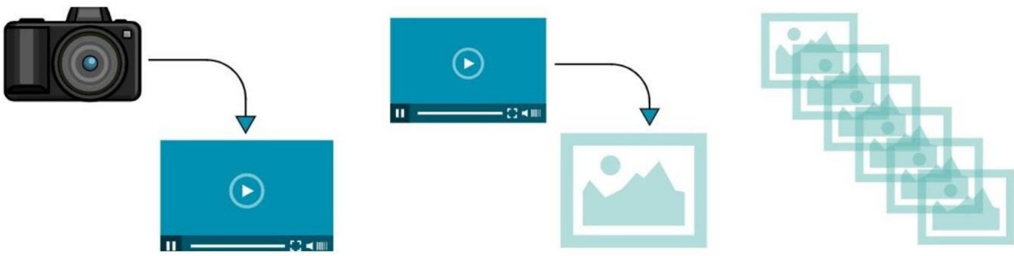
5: Set off alarm to alert driver



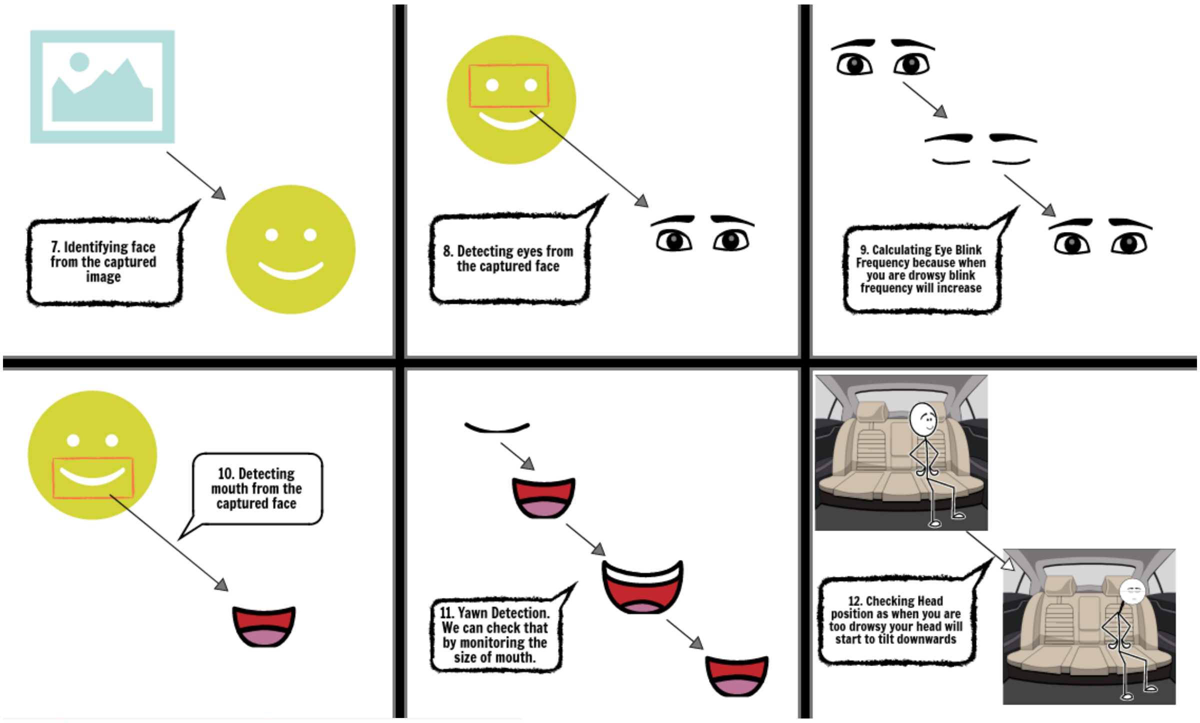
II. Design Story Boarding

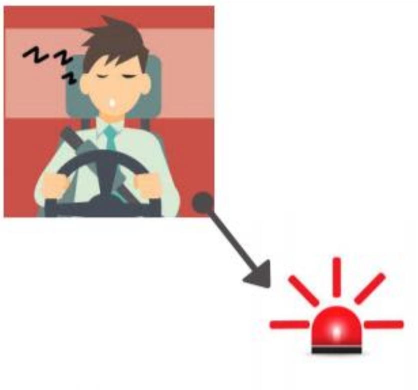
PROJECT: DRIVER DROWSINESS DETECTION SYSTEM

1. Setup Detection System 2. Adjust camera position and turn it on 3. Start Steering grip pressure sensor



4. Capture video from camera 5. Convert video to image 6. Extract multiple frames





13. Alert the Driver

III. What input and output devices would you use for the system? For each, compare and contrast alternatives

Hardware Input:

1. Camera: For face and eye detection.
2. Pressure Sensor: For steering wheel grip force.

Software Input:

1. Training dataset: To train the model to accurately detect drowsiness level.

Alternative: More diverse dataset to improve accuracy of detection for people across various ethnicities.

2. Image: Taken as input from the camera by the software
3. Algorithm: Machine Learning algorithm using OpenCV is used.

Alternative: Deep Neural Networks for Image Recognition can be used in future for better results.

Output:
Sound Alarm: It will be activated if the driver is found to be drowsy. For different levels of drowsiness, alarm can be activated at different volumes.
Alternative: A screen can be used at which a warning message in red colour can be flashed as red colour will catch attention.

IV. Literature Review

No	Name	Journal	Author	Methodology	Research Gap
1	Drowsiness Detection of a Driver using Conventional Computer Vision Application Link	2020 International Conference on Power Electronics & IoT Applications in Renewable Energy and its Control (PARC)	Garg, Hitendra	In this paper, in order to detect a driver's yawning, her nose tip is first identified in the depth image of the face and then the lower area of the face is separated. In the resulting image, the approximate area of the mouth is found and using depth information and the active contour model, an open mouth is identified.	The algorithm's performance is decreased as the driver's head is rotated widely such that the nose tip is not the lowest depth point anymore.
2	Real Time Driver Fatigue Detection System Based on Multi-Task ConNN Link	IEEE Access Volume 8	Burcu Kir Savaş, Yasar Becerikli	Multi-task ConNN models used to detect driver fatigue in real time. Dlib algorithm used to accurately identify the driver's eye and mouth information. Finally, depending on fatigue parameters, fatigue is evaluated as ‘‘very tired, less tired and not tired’’.	Does not take head position and condition into account which is as important as eyes and mouth.
3	Real-Time Driver-Drowsiness Detection System Using Facial Features Link	IEEE Access Volume 7	Wanghua Deng, Ruoxue Wu	Used MC-KCF algorithm to track the driver's face using CNN and MTCNN to improve the original KCF algorithm. Defined the facial regions of detection based on facial key points. Introduced a new evaluation method for drowsiness based on the states of the eyes and mouth.	Fails to properly detect alertness level if driver is wearing glasses especially dark sunglasses
4	A Fatigue Driving Detection Algorithm Based on	IEEE Access Volume 8	Kening Li, Yunbo Gong, Ziliang Ren	Used YOLOv3-tiny convolutional neural network, and trained the network with the open-source dataset WIDER	Falters if the driver is wearing glasses. Difficult to detect mouth shape since

	Facial Multi-Feature Fusion Link			FACE. Designed the eye and mouth SVM classifier that takes driver characteristics into account.	people wear masks due to COVID.
5	Detecting Human Driver Inattentive and Aggressive Driving Behavior Using Deep Learning: Recent Advances, Requirements and Open Challenges Link	IEEE Access Volume 8	Monagi H. Alkinani, Wazir Zada Khan, Quratulain Arshad	The detection of human driver aggressive driving behavior (HADB) was classified according to the aggressive driving styles adopted by aggressive drivers. Solutions for human driver Inattentive and Aggressive Driving Behavior (HIADB) detection were reviewed, highlighting their detection accuracies.	Expensive & high performance can be achieved by utilizing deep learning models and strategies like deep reinforcement learning and Q-learning.
6	Vision-Based Instant Measurement System for Driver Fatigue Monitoring Link	IEEE Access Volume 8	Yin-Cheng Tsai, Peng-Wen Lai, Po-Wei Huang, Tzu-Min Lin, Bing-Fei Wu	Remote photoplethysmography (rPPG) signal measured by camera to evaluate fatigue. System measures both the motional and physiological information by using one image sensor.	This system alone is not enough. Should be combined with other methods to create a hybrid system.
7	An Investigation of Early Detection of Driver Drowsiness Using Ensemble Machine Learning Based on Hybrid Sensing Link	2018 IEEE International Conference on Intelligent Transportation Systems	Jongseong Gwak, Akinari Hirao, Motoki Shino	Measured drowsiness level, driving performance, physiological signals (from EEG), and behavioral indices of a driver using a driving simulator and driver monitoring system. Driver alert and drowsy states were identified by ML algorithms. Hybrid system made for early drowsiness detection.	Effects of age and gender on driving performance during drowsy driving not included. Vibration and changes in gravity, sound, in a driving simulator are different from real vehicles. Further investigation is needed.
8	Applying deep neural networks for multi-level classification of driver drowsiness using Vehicle-	Expert Systems With Applications, Elsevier	Sadegh Arefnezhad, Sajjad Samiee, Arno Eichberger, Matthias Frühwirth, Clemens	This study presented a new method for multi-level detection of drivers' drowsiness using deep neural networks based on vehicle-based measures. Three levels for drowsiness were considered: awake, moderately drowsy, and	It is difficult in cases where the drivers scarcely show movements or mimics at all. Also, the input measures of the presented neural networks rely on active steering and will not work when

	based measures Link		Kaufmann, Emma Klotz	extremely drowsy. Three different neural networks using convolution layers and their combinations with two different recurrent layers consisting of LSTM and GRU were employed.	driving without, like an active lane-keeping assist
9	Tensor-Based EEG Network Formation and Feature Extraction for Cross-Session Driving Drowsiness Detection Link	2020 International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)	Mu Shen, Bing Zou, Xinhang Li, Yubo Zheng, and Lin Zhang	Tensor network formation and feature extraction is applied in driving drowsiness detection and overcomes variability across different sessions and subjects. These features reflect more intrinsic and underlying patterns of drowsiness.	Accuracy of the model is still less when compared to other models. More careful network structure design and feature extraction algorithms will be needed to further improve the accuracy and robustness
10	Real-time classification for autonomous drowsiness detection using eye aspect ratio Link	Expert Systems With Applications, Elsevier	Caio Bezerra Souto Maior, Márcio José das Chagas Moura, João Mateus Marques Santana, Isis Didier Lins	The proposed method uses face landmarks to estimate Eyes Aspect Ratio(EAR), and then applies the ML model to classify the user state with low-cost processing and in real-time. This was an efficient and reliable method only using an ordinary web camera.	People often try to compensate for the effects of fatigue so that the performance appears to be normal (e.g., keeping the eyes wide open). This is a limitation of the model because it uses only images as evidence for drowsiness.
11	Evaluation of driver drowsiness using respiration analysis by thermal imaging on a driving simulator Link	Multimedia Tools & Applications; Jul2020, Vol. 79 Issue 25/26, Springer	Kishari, Serajeddin Ebrahimian Hadi Nahvi, Ali Bakhoda, Hamidreza Homayounfard, Amirhossein Tashakori, Masoumeh	In this paper, a new drowsiness detection system was introduced based on analyzing driver respiration features using thermal imaging. Based on the data obtained from 30 participants, the SVM classifier resulted in the best performance in detecting drowsiness using the fusion of all respiration features with the accuracy of 90%	Due to driver’s head and body movements, the respiration region may be blocked or go out of the thermal camera viewing window. Since it relies on respiration features, the model may not give accurate results for people having some respiratory problem.
12	Real-time monitoring of driver	Neural Computing &	Jasper S. Wijnands, Jason	This research proposed real-time video monitoring with a 3D	Since this method uses a deep learning model for prediction,

	drowsiness on mobile platforms using 3D neural networks [Link](#)	Applications; Jul2020, Vol. 32 Issue 13, Springer	Thompson, Kerry A. Nice, Gideon D. P. A. Aschwanden, Mark Stevenson	convolutional neural network, providing early warning signals to a drowsy driver. This method implicitly decides which features are important for drowsiness detection, applies separation of blinking versus micro-sleep, talking versus yawning and the identification of important face movements.	it needs a huge amount of dataset for high accuracy. Also, it may be slower than other models as deep learning models require more time for computation.
13	EDDD: Event-Based Drowsiness Driving Detection Through Facial Motion Analysis With Neuromorphic Vision Sensor [Link](#)	IEEE Sensors Journal, VOL. 20, No. 11, June 1, 2020	Guang Chen, Lin Hong, Jinhu Dong, Peigen Liu, Jörg Conradt, Alois Knoll	By using a novel neuromorphic vision sensor, the proposed work simplifies the traditional vision-based detection process as the new sensor is a natural motion detector for the drowsiness driving related motions. The proposed method can get robust and high-accuracy performance in corner-case scenarios such as driving with sunglasses or driving at night, which is very challenging for traditional frame-based vision sensors.	This model is still in the processing stage and isn't completely developed for real-time detection of the driver's head from other sensing modalities such as RGB images.
14	Driver Alertness System using Deep Learning, MQ3 and Computer Vision [Link](#)	International Conference on Intelligent Computing and Control Systems, IEEE	Aashreen Raorane, Hitanshu Rami, Pratik Kanani	Real-time analysis is performed on both the driver as well as the road to detect any important aspect that cannot be missed. This model is useful whenever it is the driver's fault, like, when the driver is distracted, angry, misses a sign or is drunk, as well as it proves to be helpful to guide the driver when it is not his fault, the cases wherein a car or a person is close or lane crossing.	The model is trained to detect lanes and alert the driver if the vehicle does not obey lane for a longer period or if it crosses the lanes many times in a few seconds. However, it fails to detect if the road ahead has a curvature which may result in false prediction.

Persona:

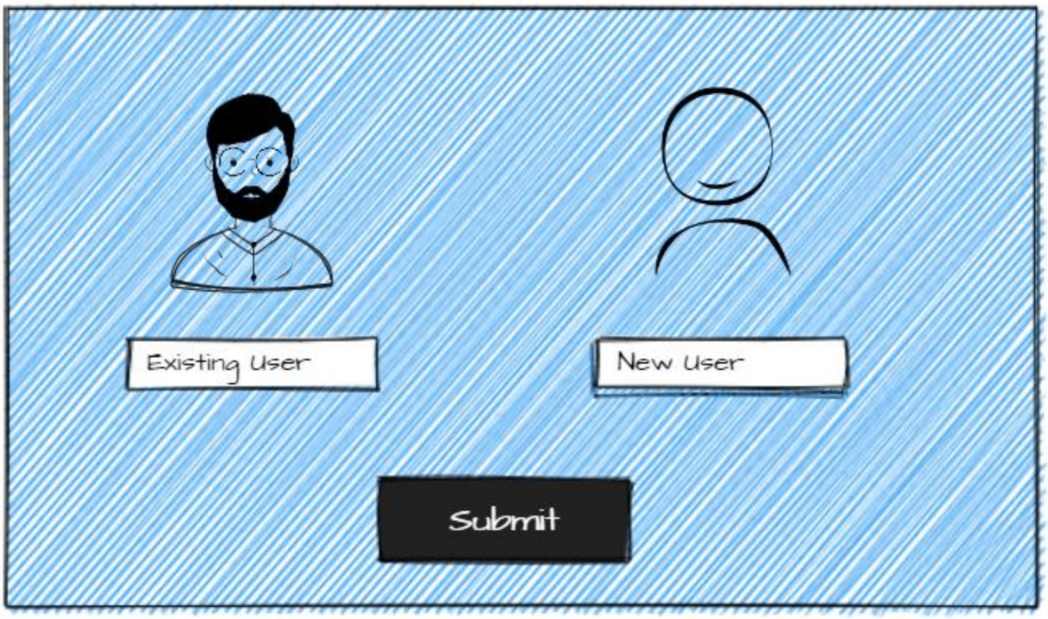
	Bio	Goals	Frustrations
 **Jai Joshi** **Software Developer** **B.Tech. IT** **VIT University**	Jai is a 27-year old software developer at HPE, Bangalore. He works long hours and is mentally exhausted due to the workload.	He wants to take safety precautions to avoid road accidents due to his own fatigue.	He tries to get rest but the workload keeps increasing and he finds himself getting drowsy while driving home from work.

	Bio	Goals	Frustrations
 **Rohan Jain** **Truck driver** **HSC CBSE** **DPS Risali**	Rohan is a 31-year old truck driver working for a delivery company and has to travel overnight for most of his deliveries.	He wants to take safety precautions to avoid road accidents at night caused by his drowsiness.	Since he has to travel overnight, sometimes he can't help but feel sleepy and has swerved off the road sometimes by accidently falling asleep.

REVIEW 3

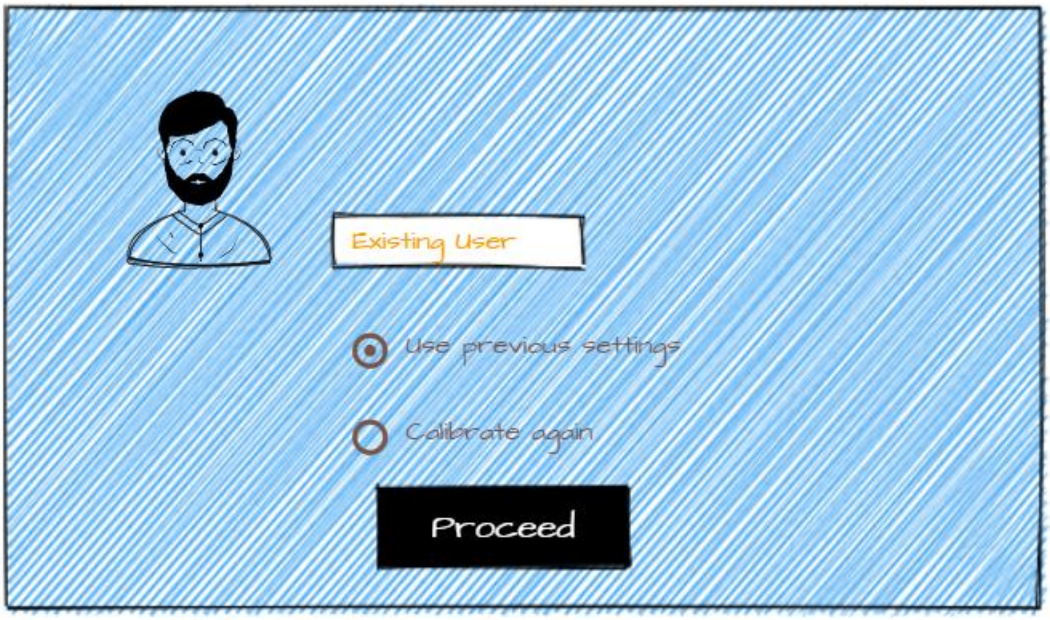
Prototype:

Initial Screen

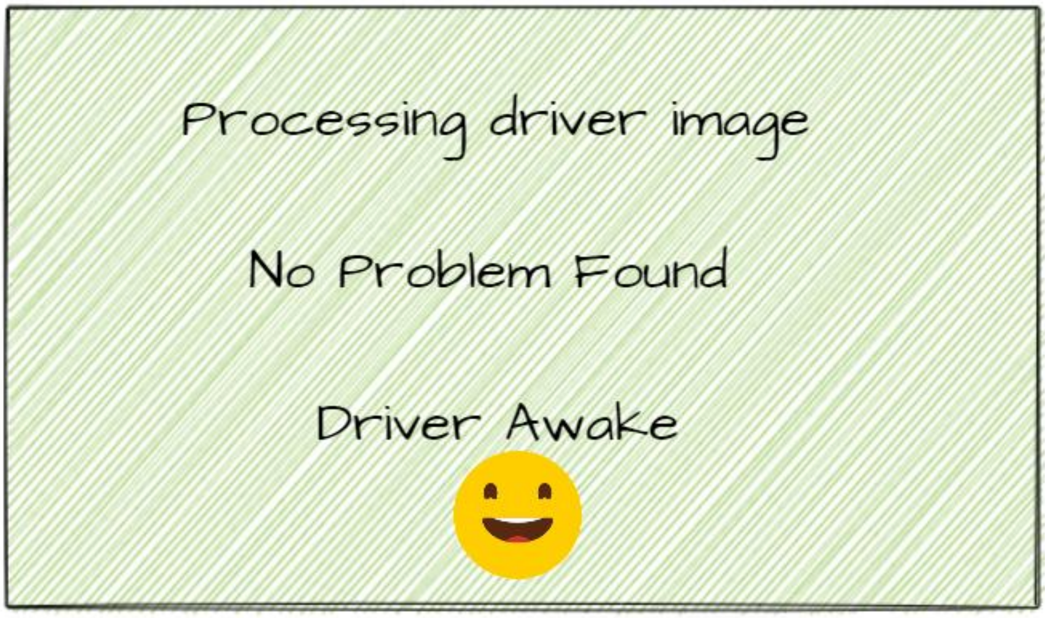


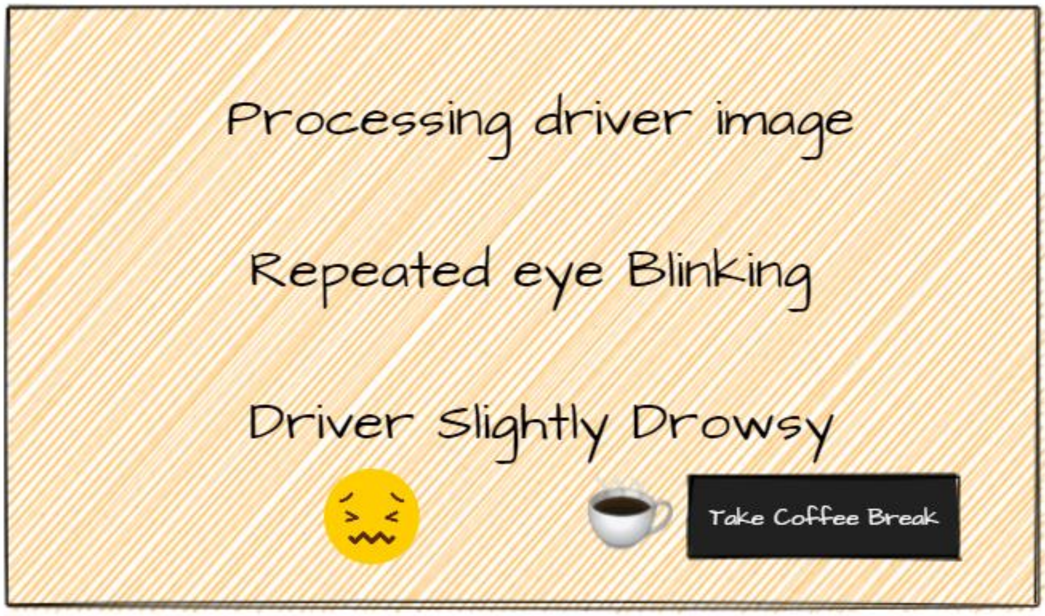
New User

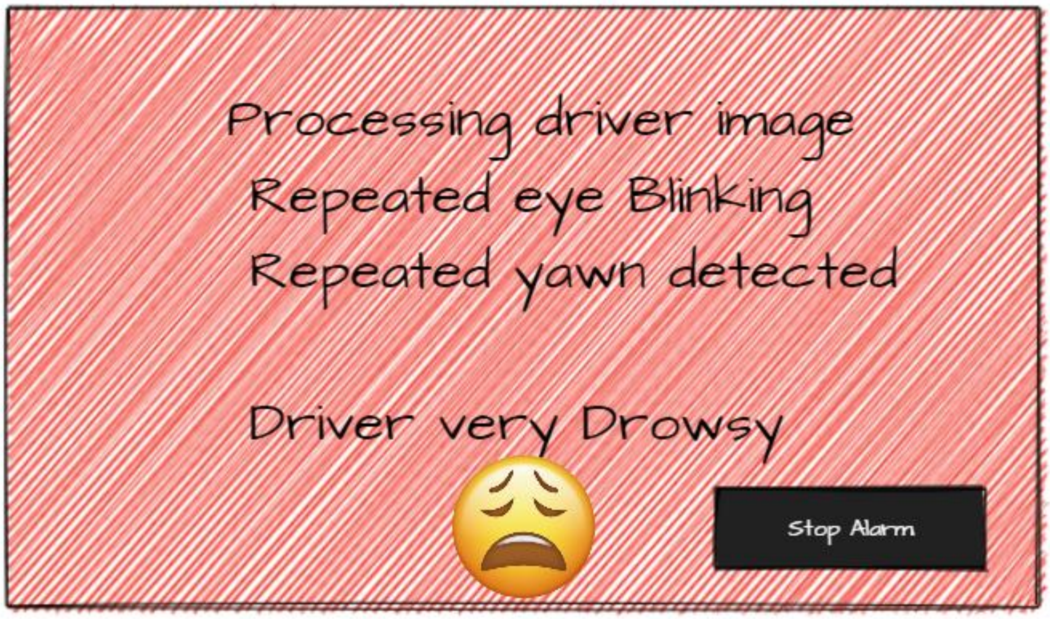
Skip Calibration for existing user



No drowsiness detected







Cognitive Walkthrough:

Cognitive walkthroughs are used to examine the usability of a product. They are designed to see whether or not a new user can easily carry out tasks within a given system. It is a task-specific approach to usability (in contrast to heuristic evaluation which is a more holistic usability inspection).

<u>GOAL 1: Calibrate detection system</u>

<u>User Action 1</u>: Turn on camera
<u>System Display 1</u>: Red light to confirm if camera is on

Question 1: Is the effect of the action the same as the user's goal at that point?
Yes, a red light will start blinking to indicate that the camera is switched on.

Question 2: Will users see that the action is available?
Yes, the dashboard display will alert the user to turn on camera as soon as the vehicle starts.

Question 3: Once users have found the correct action, will they know it is the one they need?
Yes, the dashboard alert will stop once the camera is turned on.

Question 4: After the action is taken, will users understand the feedback they get?
Yes, as feedback a red light will be constantly on making the user understand that the camera is successfully turned on.

User Action 2: Adjust camera position
System Display 2: Green light to confirm if face is in focus

Question 1: Is the effect of the action the same as the user's goal at that point?
Yes, a green light will start blinking to indicate that the driver's face is captured in the camera.

Question 2: Will users see that the action is available?
Yes, the dashboard display will alert the user to adjust the camera after it's switched on.

Question 3: Once users have found the correct action, will they know it is the one they need?
Yes, the dashboard alert will stop once the driver's face is detected in proper position.

Question 4: After the action is taken, will users understand the feedback they get?
Yes, as feedback a green light will be constantly on making the user understand that the camera is properly adjusted.

<u>User Action 3</u>: Start steering grip pressure sensor
<u>System Display 3</u>: Displays button for user to click to start sensor

Steering wheel with grip sensor

Question 1: Is the effect of the action the same as the user's goal at that point?
Yes, the steering wheel pressure sensor will start once the button is pressed.

Question 2: Will users see that the action is available?
Yes, the dashboard will display the option to turn on the sensor.

Question 3: Once users have found the correct action, will they know it is the one they need?
Yes, the dashboard will simply display that the sensor is on.

Question 4: After the action is taken, will users understand the feedback they get?
No, the user cannot see any physical response unlike the blinking lights on the camera.

<u>GOAL 2: Alert the driver in case drowsiness detected</u>

<u>User Action 1</u>: Turn off alarm once more alert
<u>System Display 1</u>: Display will return to previous state

Question 1: Is the effect of the action the same as the user's goal at that point?
Yes, the alarm sound will stop.

Question 2: Will users see that the action is available?
Yes, the dashboard display will have a "Turn off alarm" button.

Question 3: Once users have found the correct action, will they know it is the one they need?
Yes, the dashboard alert will stop once the button is pressed.

Question 4: After the action is taken, will users understand the feedback they get?
Yes, since the alarm will stop, the user will understand that the system is no more in alert state.

Usability Evaluation using Nielson's Heuristics

A heuristic evaluation is a usability inspection method for computer software that helps to identify usability problems in the user interface (UI) design. It specifically involves evaluators examining the interface and judging its compliance with recognized usability principles (the "heuristics").

1. **Visibility of system status:**
   The software will display alerts and options to turn on camera, adjust position, turn on steering wheel sensor and alert the driver in case of fatigue. The display keeps the user informed about the steps to take to calibrate the system and makes sure to alert the driver if drowsiness is detected to avoid accidents.

2. **Match between system and the real world:**
   The software supports multiple languages and default language can changed quite easily so that people from all over the world can use the software without facing any issues related to language barrier.

3. **User control and freedom:**
   While using this software, different users can adjust camera position manually according to their height and convenience. Since this is a safety device the user does not have the freedom to turn it off since it is for their own and fellow passengers' safety. However, they will have the option to skip the system calibration and use previous settings applied for a quicker startup.

4. **Consistency and standards:**
   The dashboard display maintains uniformity in all of the different alerts and options. This makes sure that the user will not have to wonder whether different screens/icons mean the same thing or not.

5. **Error Prevention:**
   The device does store the video captured by the camera but it does not store any confidential information once deleted. The security rating of this flaw is 0 as this is not at all a usability problem. If the system is facing any drastic error then the user needs to contact customer service which is available on the display of system.

6. **Recognition rather than recall:**
   There is a consistency in the all the design on the screen. Also, the options available are quite less. The navigation is quite simple and the same options are available in all the screens. Therefore, the user does not have to remember any information and can easily recognize from the display icon.

7. **Flexibility and efficiency of use:**
   The options available to the user are quite less. The navigation is simple as well with all the options available in all the screens. This does not require to go back multiple times to jump from one option to the other. Therefore, there are no Accelerators – shortcuts to do any particular task. The security rating of this flaw is 0 – that means that this is not a usability problem.

8. **Aesthetic and minimalistic design:**
   All the screens in the display of our device follow a uniform and a minimalistic design. The icons used in the UI are quite relevant. The screens contain minimum texts and everything is explained using proper icons. Therefore, there is no information that is irrelevant or rarely needed.

9. **Help users recognize, diagnose and recover from errors:**
   Since our device does not store any confidential information or any detail that is of very high importance, so there isn't much scope for errors while using the device. All necessary changes to be made in the device are physical – the adjustment of the camera. Any error in doing so will make the device show the error on the dashboard display. The user can recover from the error by physically adjusting the camera.
   However, error may generate in the backend of the system, i.e. during analysis of image using Machine Learning. If the system falsely identifies the user as drowsy then it may sound the alarm thus causing unnecessary distraction to driver. To recover from such error, driver may contact the customer service whose information will be available in the system display.

10. **Help and documentation:**
    Our device is quite user-friendly and can be operated without any user manual or help-book. However, a user manual will be provided with the device as well. Apart from the user manual, a digital manual will also be available under the help section of display. Also, when the system will be booted up for the first time, a quick guide will be displayed to the driver to know about the function of the icons. The severity rating of this is 0 – that means this is not at all a usability problem.

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