Drowsy Driver Detection System Using Eye Blink Patterns and yawns

- Our drowsiness detection system utilizes computer vision and neural networks.
- It starts by detecting the driver's face using the Viola-Jones algorithm and then employs a neural network-based eye detector from the STASM library to locate the pupils.
- The system estimates face orientation based on the pupils' vertical positions and corrects it by rotating the frame.
- Finally, it extracts a normalized rectangular area from the eye's pupil region for further analysis, facilitating drowsiness detection.

- If the driver's eyes have not significantly changed, our model moves on to examining the lips.
- There will be a space between the driver's lips if they yawn.
- The algorithm detects this gap and forecasts whether the subject will yawn or not.
- If the user yawns, it will be obvious that they are sleepy.

It is calculated with below equations:

$$I(x,y) = \text{pow}\left(\frac{I(x,y) - \text{low}_{in}}{\text{err}_{in}}, \gamma\right) * \text{err}_{out} + \text{low}_{out}$$

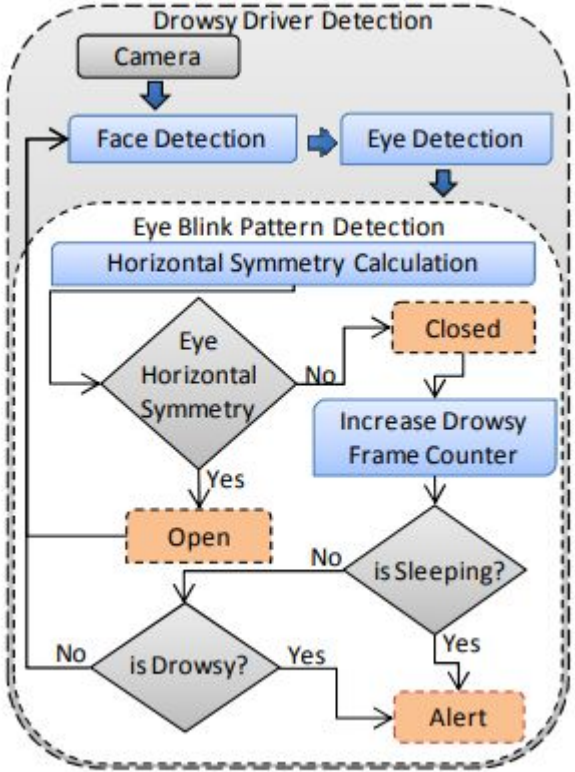
$$\text{err}_{in} = \text{high}_{in} - \text{low}_{in}$$

$$\text{err}_{out} = \text{high}_{out} - \text{low}_{out}.$$

$$I_{dif} = VF(Up(I')) - \text{Low}(I').$$

$$I_{sum} = \sum_{i=0,j=0}^{width,height} I_{dif}(i,j)$$

$$I_{state} = \begin{cases} Open & I_{sum} < T \\ Closed & I_{sum} \geq T \end{cases}$$


Drowsy Driver Detection
Camera
Face Detection
Eye Detection
Eye Blink Pattern Detection
Horizontal Symmetry Calculation
Eye Horizontal Symmetry
No
Closed
Increase Drowsy Frame Counter
Yes
Open
No
is Sleeping?
Yes
No
is Drowsy?
Yes
Alert

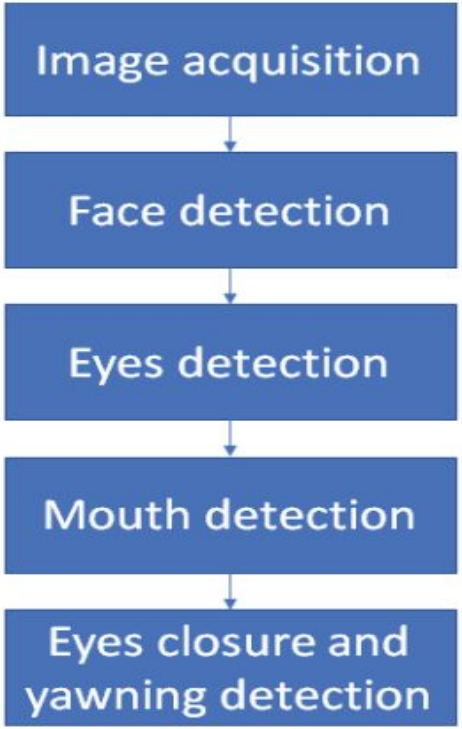


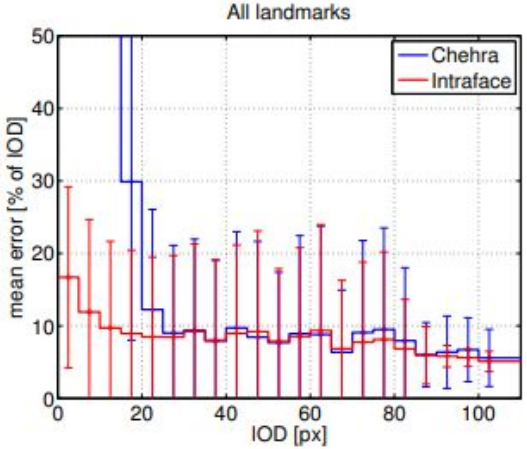
Image acquisition
Face detection
Eyes detection
Mouth detection
Eyes closure and yawning detection

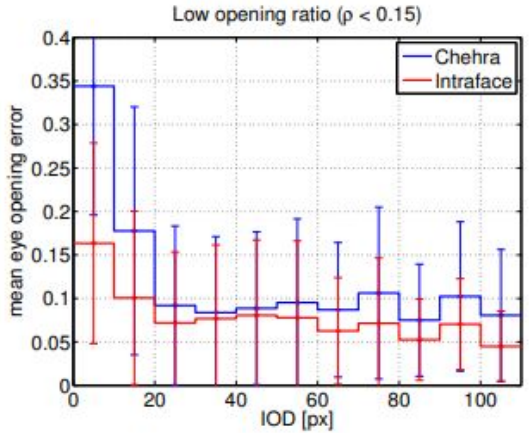
Data Preprocessing techniques used

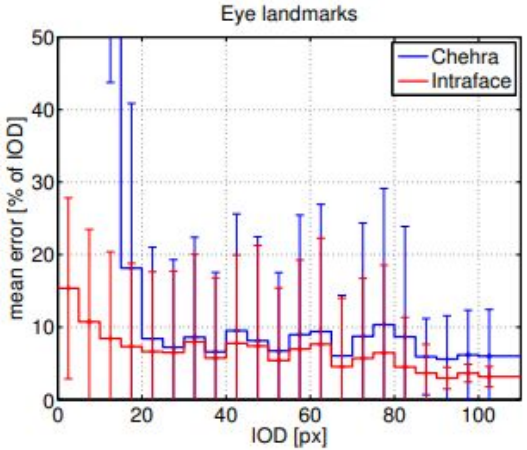
- Prewitt operator (edge detection)
- yeo - johnson transformation (normalization)
- Desaturation method (conversion of image to grayscale)
- Anisotropic diffusion (noise reduction)

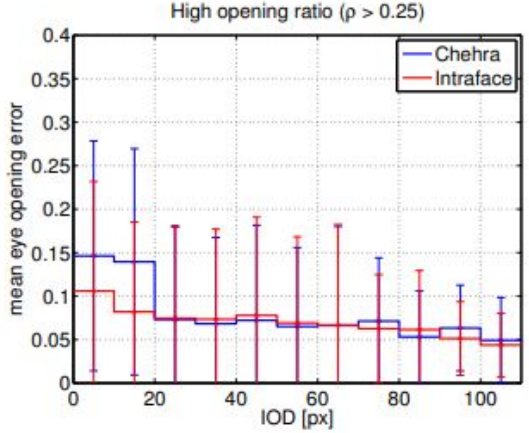
Data post processing techniques used

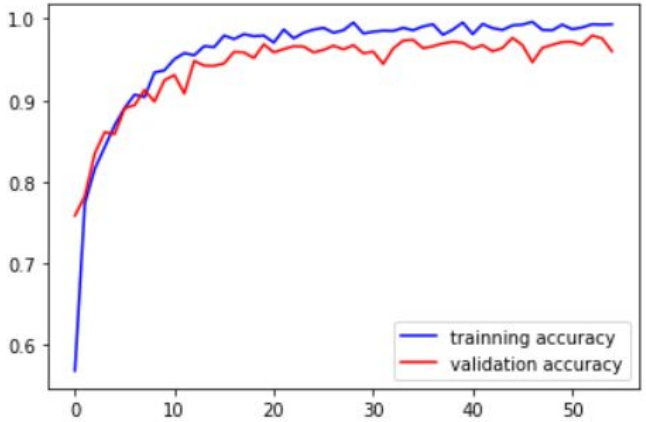
- Histogram Equalization transformation
- T - distributed stochastic neighbour embedding
- Semantic enrichment (metadata integration)

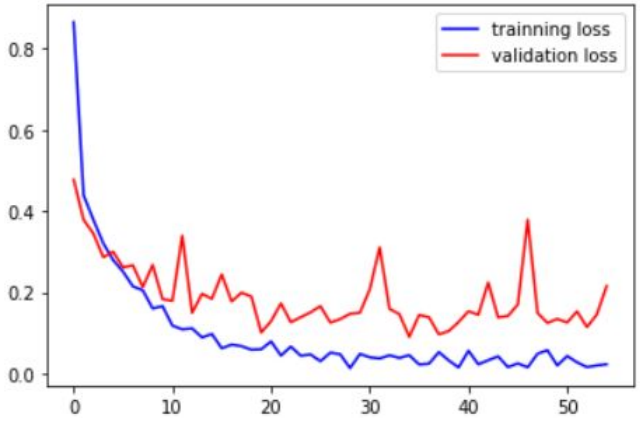

All landmarks
Chehra
Intraface
mean error [% of IOD]
IOD [px]
0
10
20
30
40
50
0
20
40
60
80
100


Low opening ratio (ρ < 0.15)
Chehra
Intraface
mean eye opening error
IOD [px]
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0
20
40
60
80
100


Eye landmarks
Chehra
Intraface
mean error [% of IOD]
IOD [px]
0
10
20
30
40
50
0
20
40
60
80
100


High opening ratio (ρ > 0.25)
Chehra
Intraface
mean eye opening error
IOD [px]
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0
20
40
60
80
100





	precision	recall	f1-score	support
yawn	0.90	0.83	0.86	63
no_yawn	0.81	0.86	0.84	74
Closed	0.99	0.68	0.81	215
Open	0.76	0.98	0.85	226
accuracy			0.84	578
macro avg	0.86	0.84	0.84	578
weighted avg	0.86	0.84	0.83	578