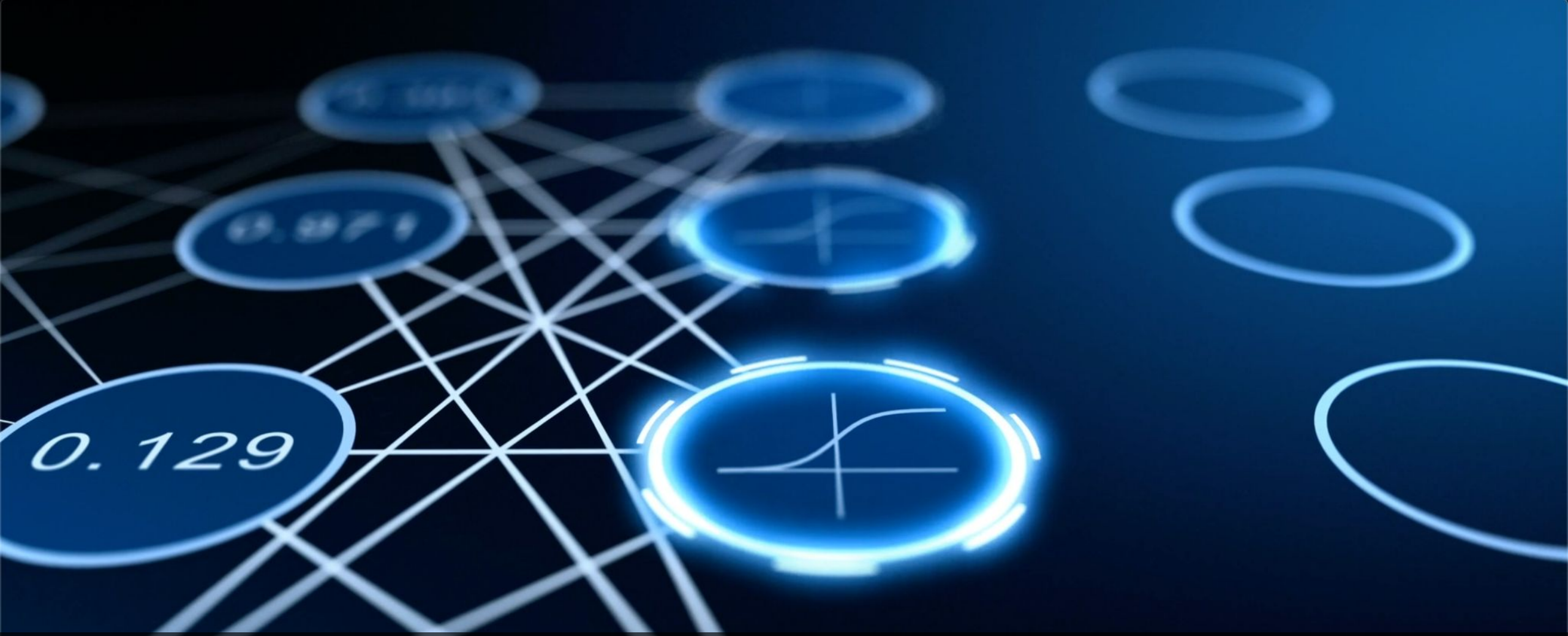


DETECTING DROWSINESS

USING NEURAL NETWORKS AND COMPUTER VISION

Jennifer Brown
Andrea Pascale
Dustin Stewart
Tenzin Wangdu

The Process

DEFINING THE PROBLEM

COLLECTING THE DATA

TRAINING A NEURAL NETWORK

APPLYING THE MODEL

DRAWING CONCLUSIONS

Background

- The National Highway Traffic Safety Administration estimates that there are 91,000 crashes involving drowsy drivers a year. These crashes lead to an estimated 50,000 injuries and nearly 800 deaths
- 1 in 24 adult drivers report having fallen asleep at the wheel in the past 30 days
- Going more than 20 hours without sleep is the equivalent of having a blood-alcohol concentration of 0.08% – the U.S. legal limit

Objective

- Our team set out to develop a neural network machine learning model that detects if eyes are closed
- This technology would be useful for drivers/owners of commercial transport vehicles, as well as anybody interested in increased safety, including everyday drivers and auto companies

02 COLLECTING THE DATA

Data Sources

“Labeled Faces in the Wild” (link)

Univ. of Massachusetts Amherst

18,983 photos of people with both eyes open

“Closed Eyes In The Wild” (link)

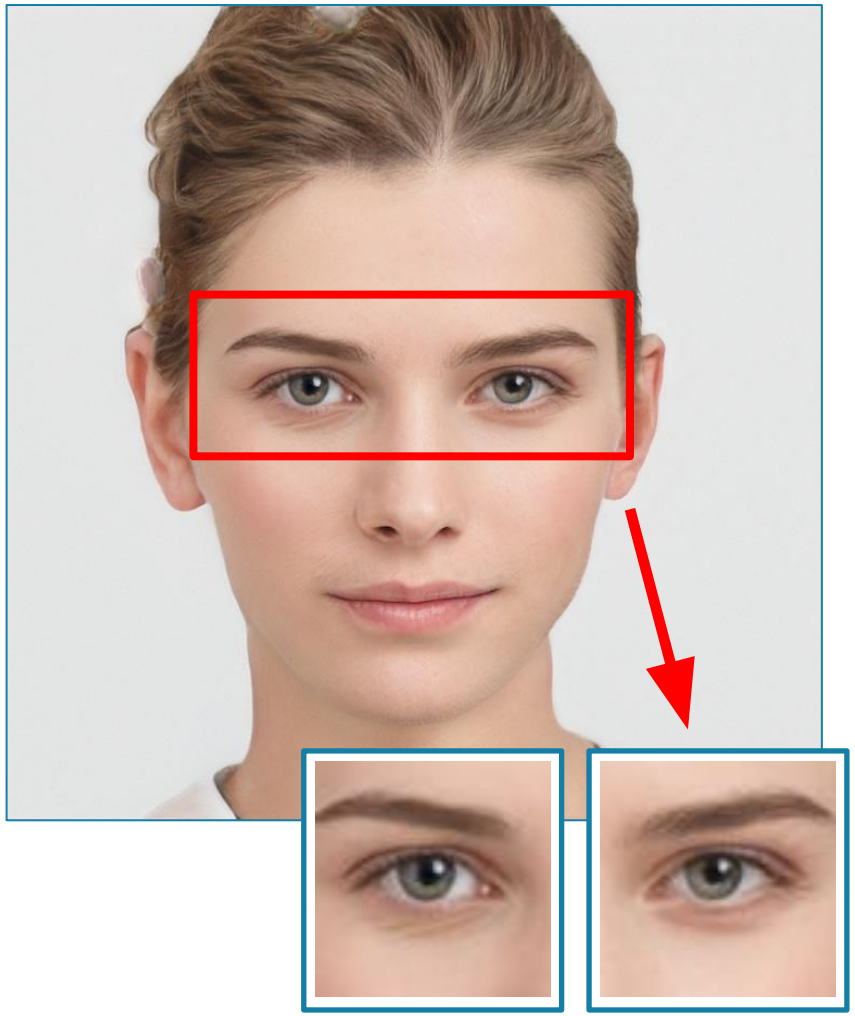
Nanjing Univ. of Aeronautics and Astronautics

1192 photos of people with both eyes closed

Kaggle Dataset (link)

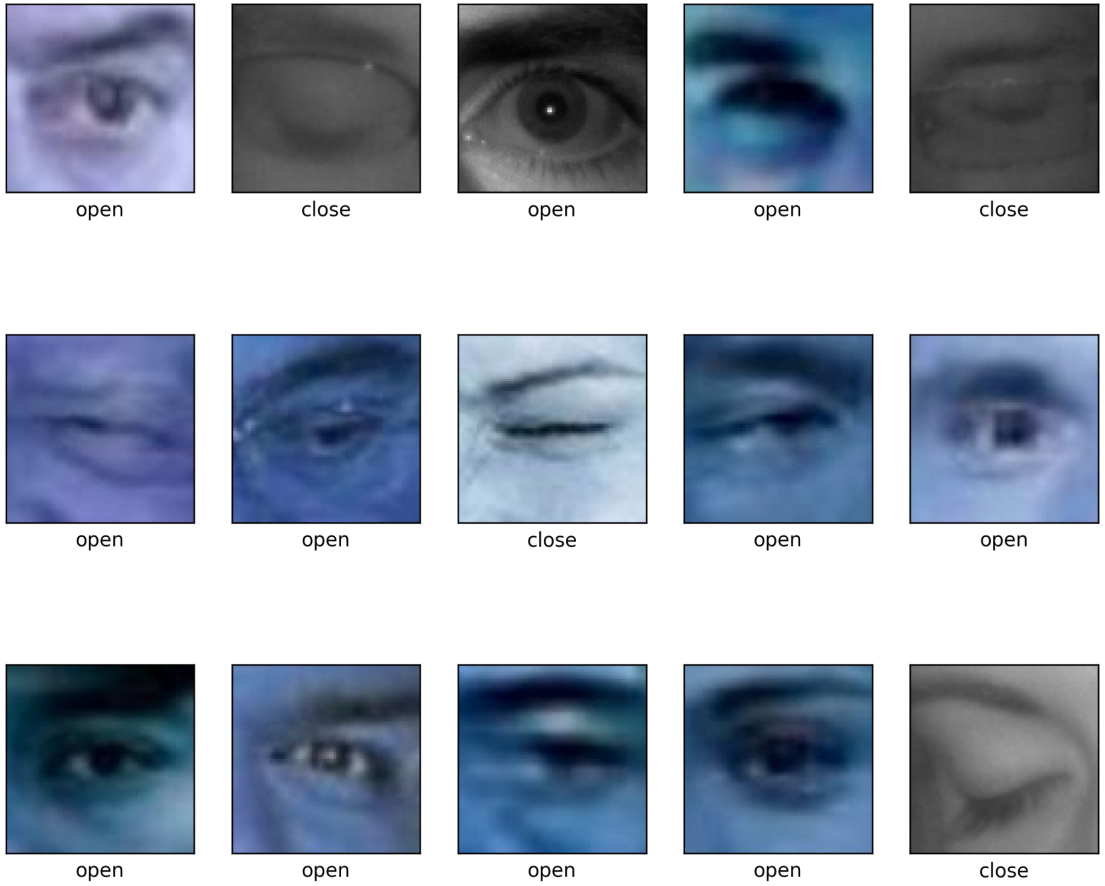
Drowsiness Detection

Professionally taken close up images of 2,000 open and 2,000 closed eyes



Pre-processing

- Photos were passed into an “Eye-Cropper” that used facial recognition to generate two 80x80-pixel eye images
- Area around the eye was included to allow for more robust predictive capability
- Images were verified and cleaned and what remained was 26,000 open-eye images and 4,000 closed-eye images



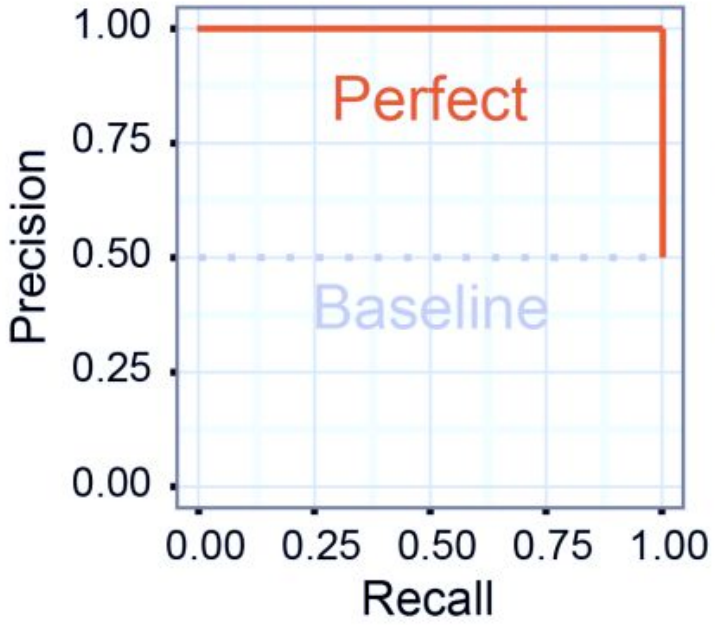
Sample of Data Used

- Gray-Scale
- RGB
- Glasses
- High quality/low quality
- Male/Female
- Diverse facial structures

03 TRAINING A NEURAL NETWORK

Identified Metrics

- Our primary metric was **the Precision-Recall Area under the Curve score (PR AUC)**. The “baseline” score for this metric is 0.5 for both precision and recall, and in a perfect classifier it is 1.
- The **PR AUC** score places the most importance on how well we predict positives (a driver is asleep), which is more important to us than predicting negatives (a driver is awake). The area under the curve represents the proportion of true positives to false positives and false negatives.



Method for Fine-Tuning

- Around 100 models were run on Google Colab using a Tensor Processing Unit, a high powered processor built specifically for machine learning

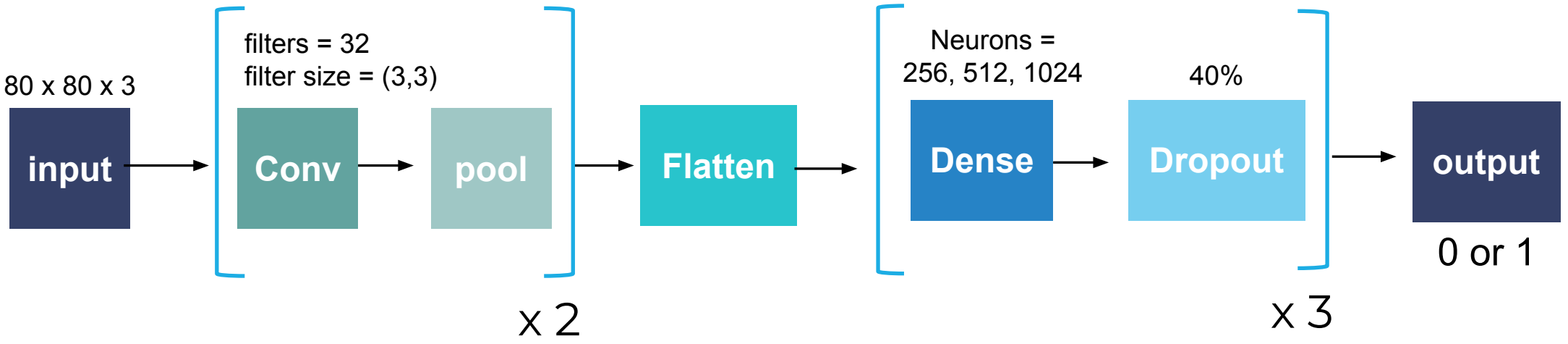
Optimizing Parameters

Convolutional Layers	Number of Layers : 1, **2**
Filters	Number of Filters : 8, 16, **32** Size of Filters: **3x3**, 5x5
Pooling	Pooling of features 2x2: **Yes**, No
Dense Layers	Number of Layers: 1, 2, **3** Neurons: 64, 128, **256, 512, 1024**
Dropout	Percent: 10%, 20%, 30%, **40%**, 50%

Scoring the Model

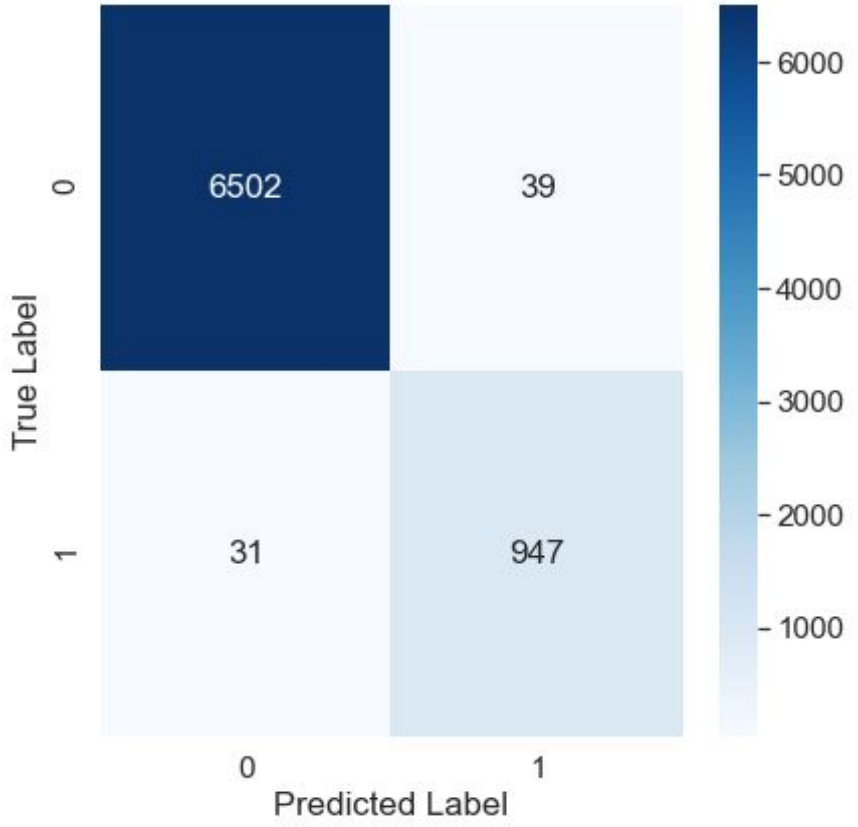
Dense Layer 1 Neurons	Dense Layer 2 Neurons	Dense Layer 3 Neurons	Dropout Rate	Number of Iterations	Input Filters	Shape of Filters	Pooling Layer	Average Test Score
256	512	1028	0.4	30	32	2*3x3	1	0.9814
256	512	1028	0.3	30	64	2*3x3	1	0.9810
128	128	128	0.1	10	32	5x5		0.9523
128	128	128	0.1	10	16	3x3		0.9428
64	64	64	0.5	10	32	3x3		0.9125
64	64	64	0.1	10	32	3x3	1	0.9089
64	64	64	0.1	10	8	3x3	1	0.9084
128	128	128	0.5	10	32	3x3	1	0.9075
64	64	64	0.1	10	16	5x5	1	0.9072
64	64	64	0.1	10	16	3x3		0.8563
64	64	64	0.5	10	16	5x5		0.8456

Final Network Architecture

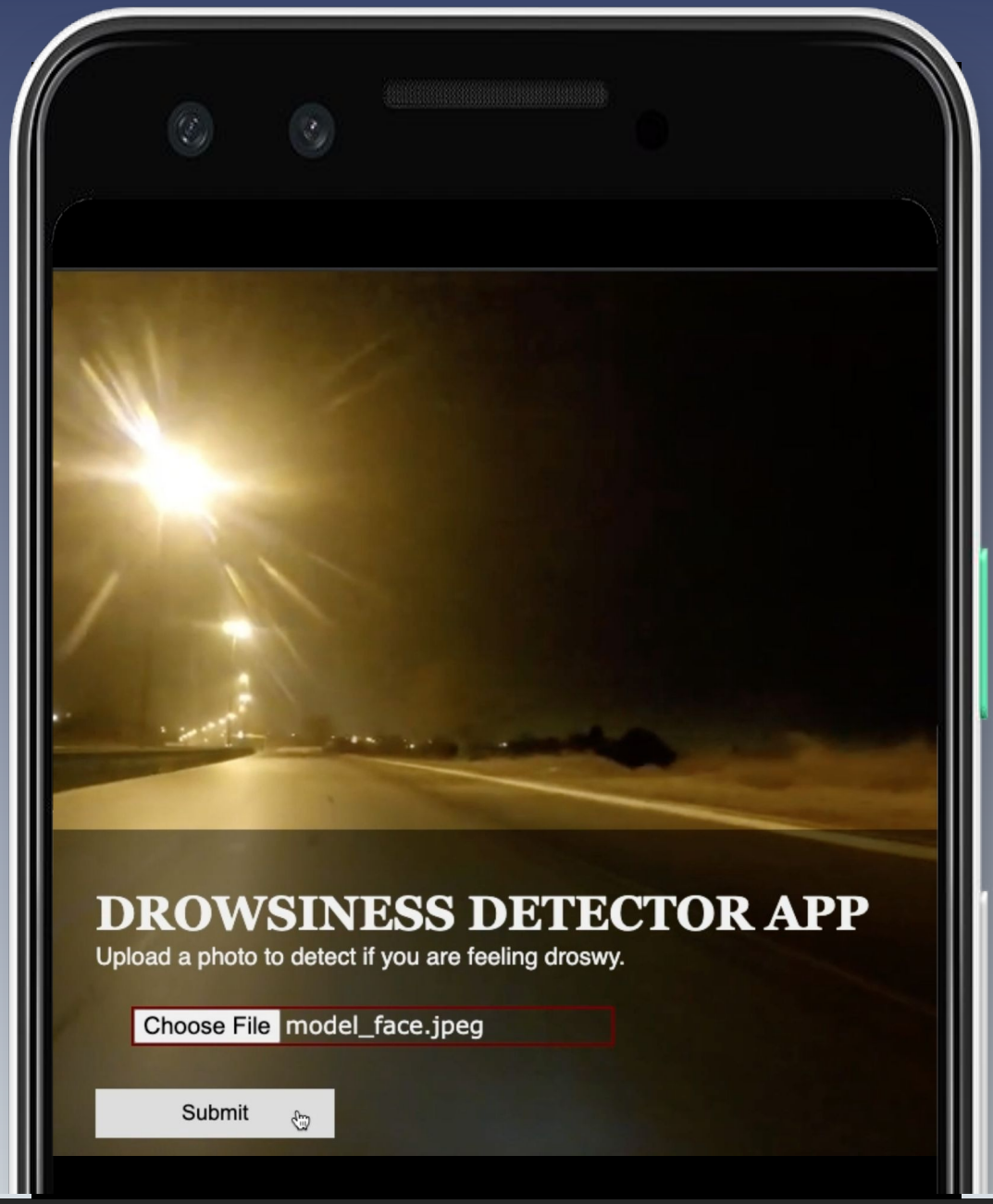


Classification Model Performance

- 947 correctly predicted as closed eyes
- 6502 correctly predicted as open eyes
- 39 incorrectly predicted as closed eyes
- 31 incorrectly predicted as open eyes

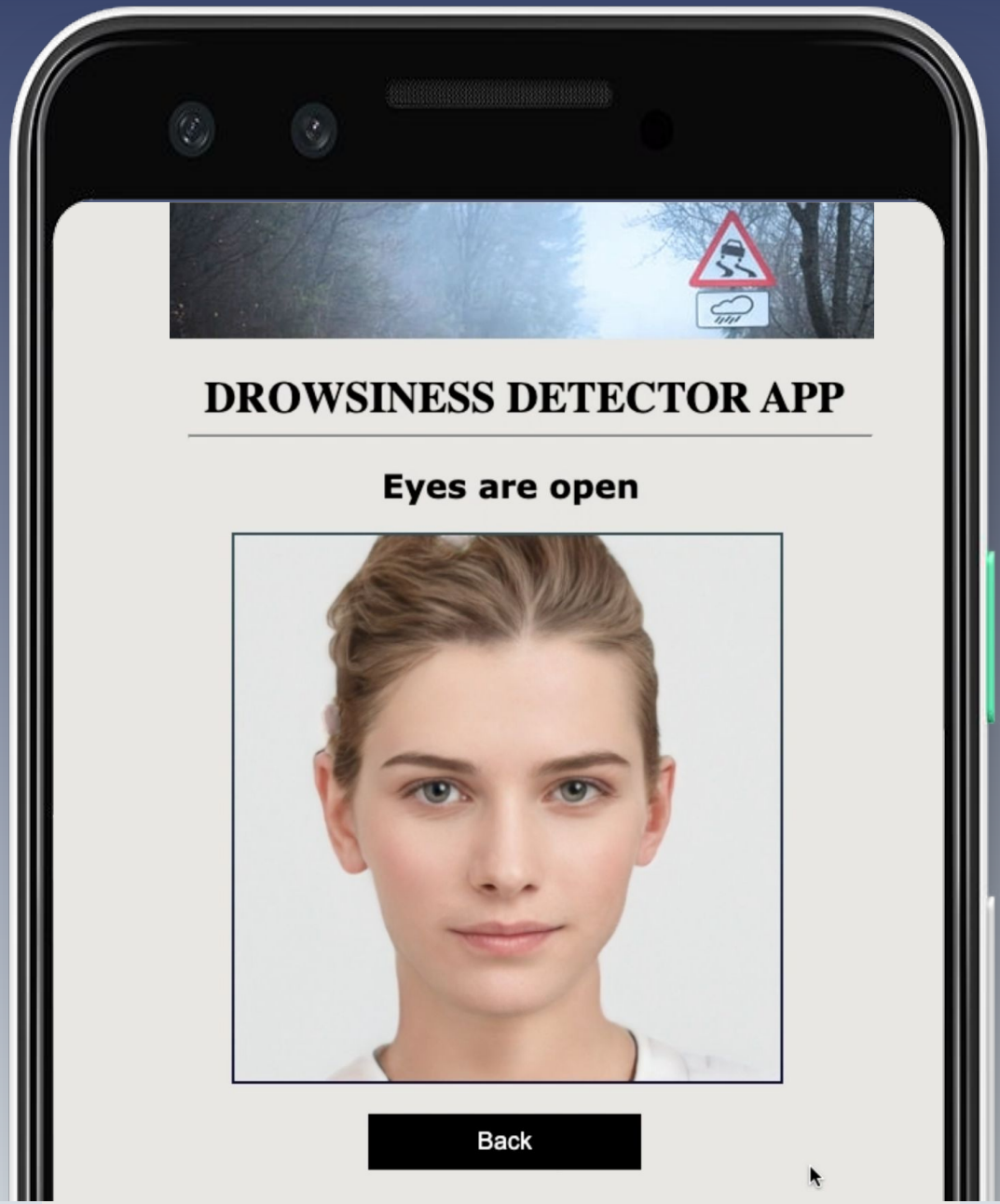


05 APPLYING THE MODEL



Web App Demo

- An earlier model application was a web app that generated a prediction of closed/open eyes from an uploaded photo



Web App Demo

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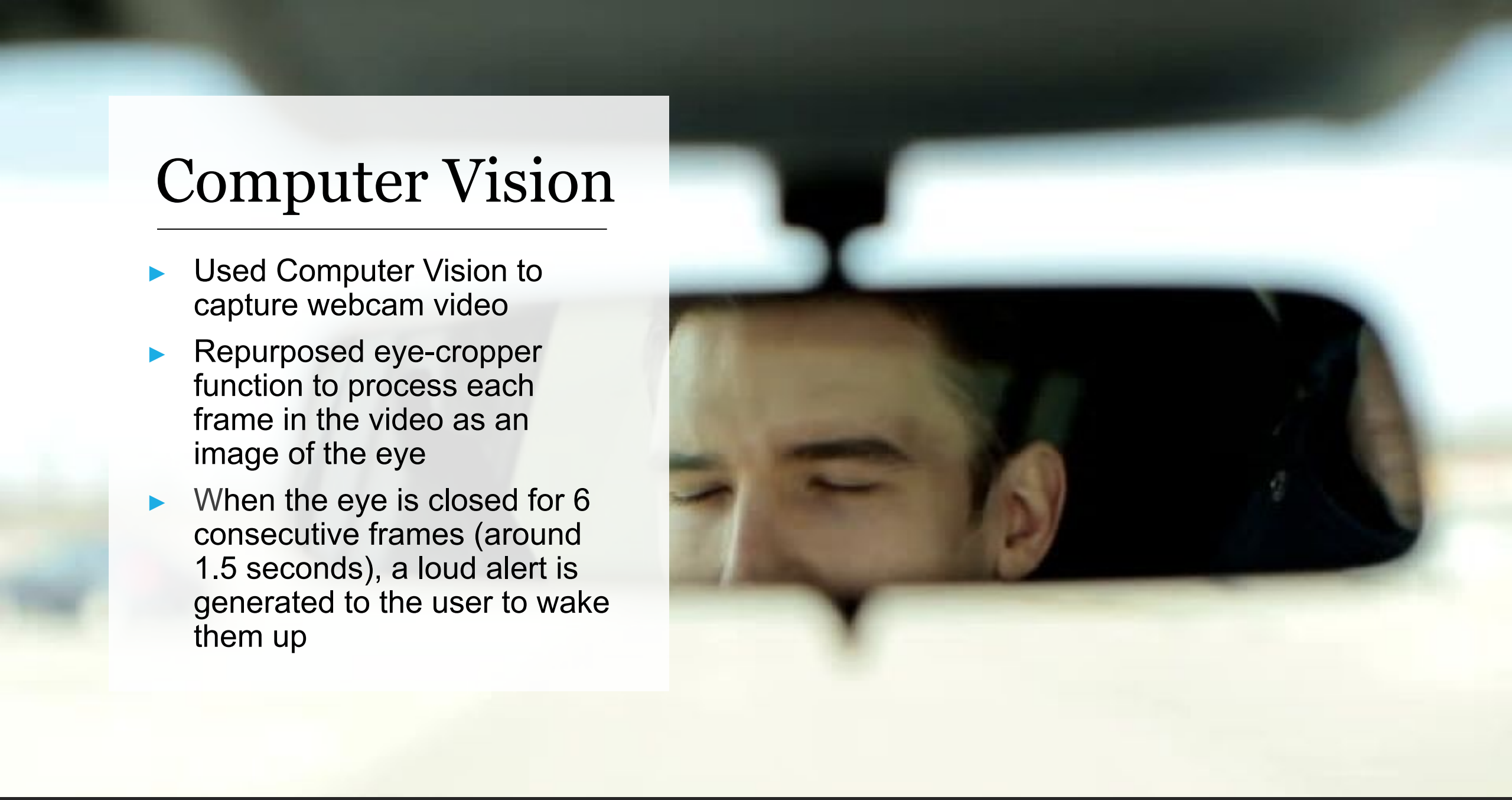
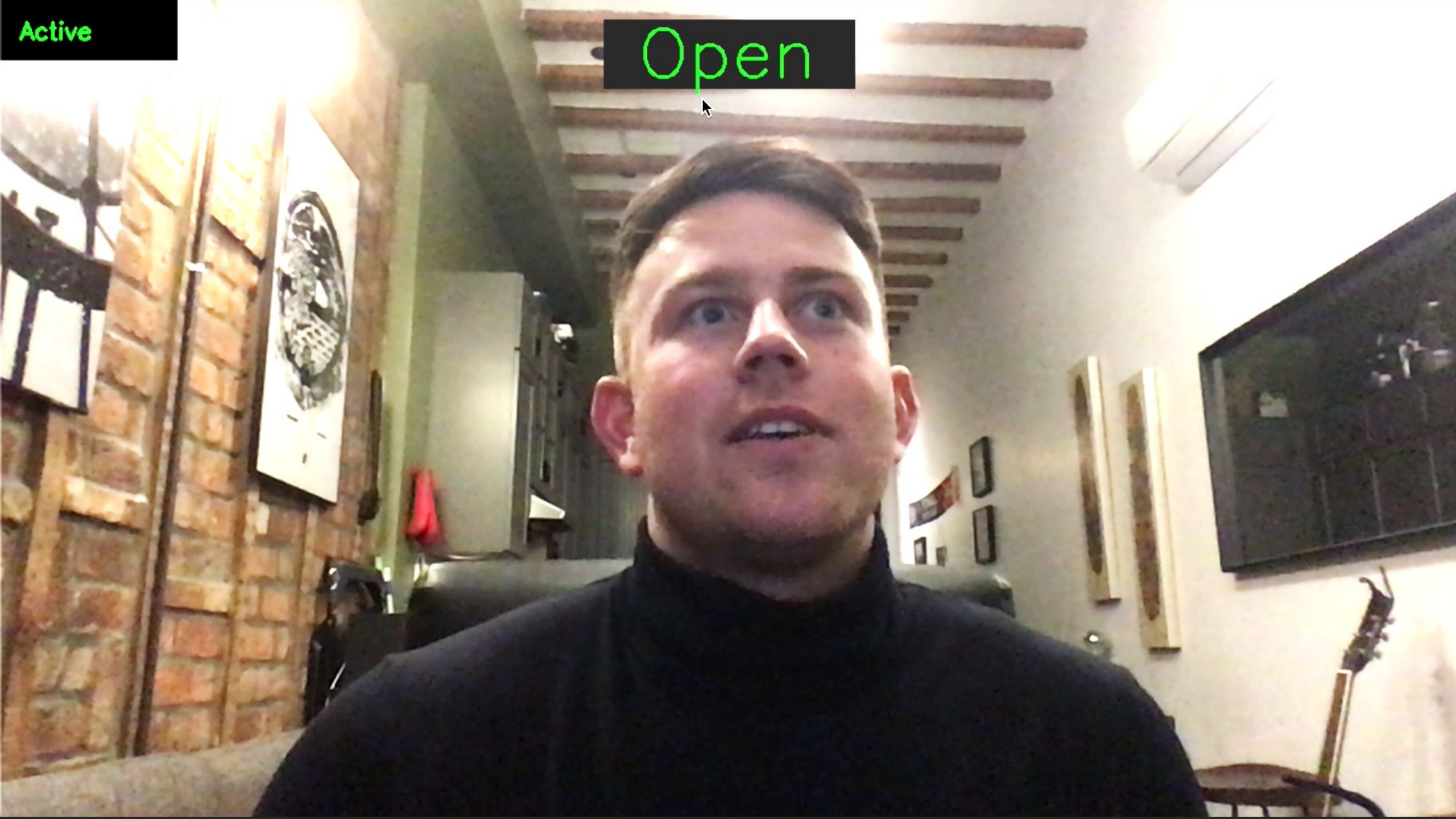
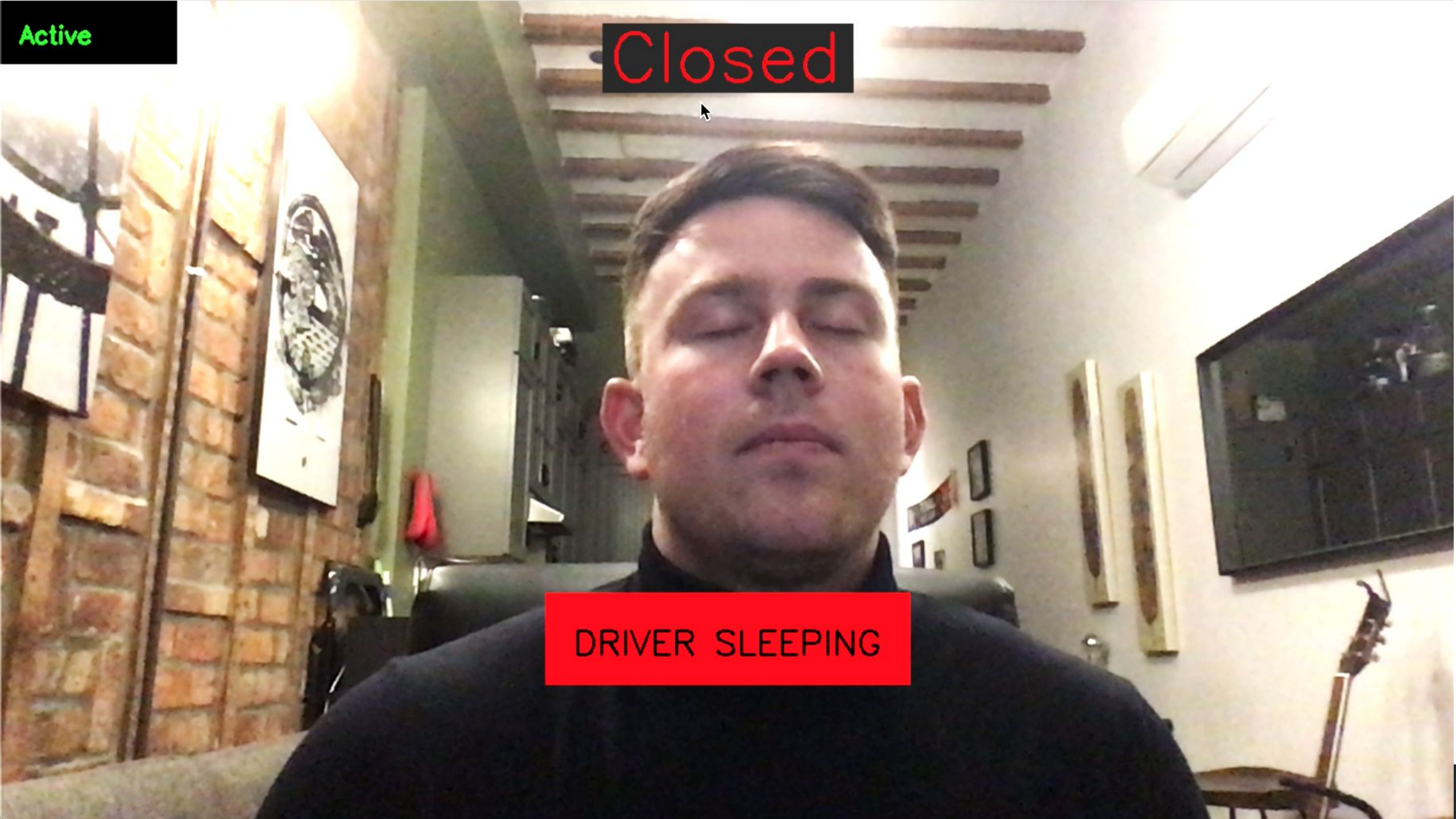
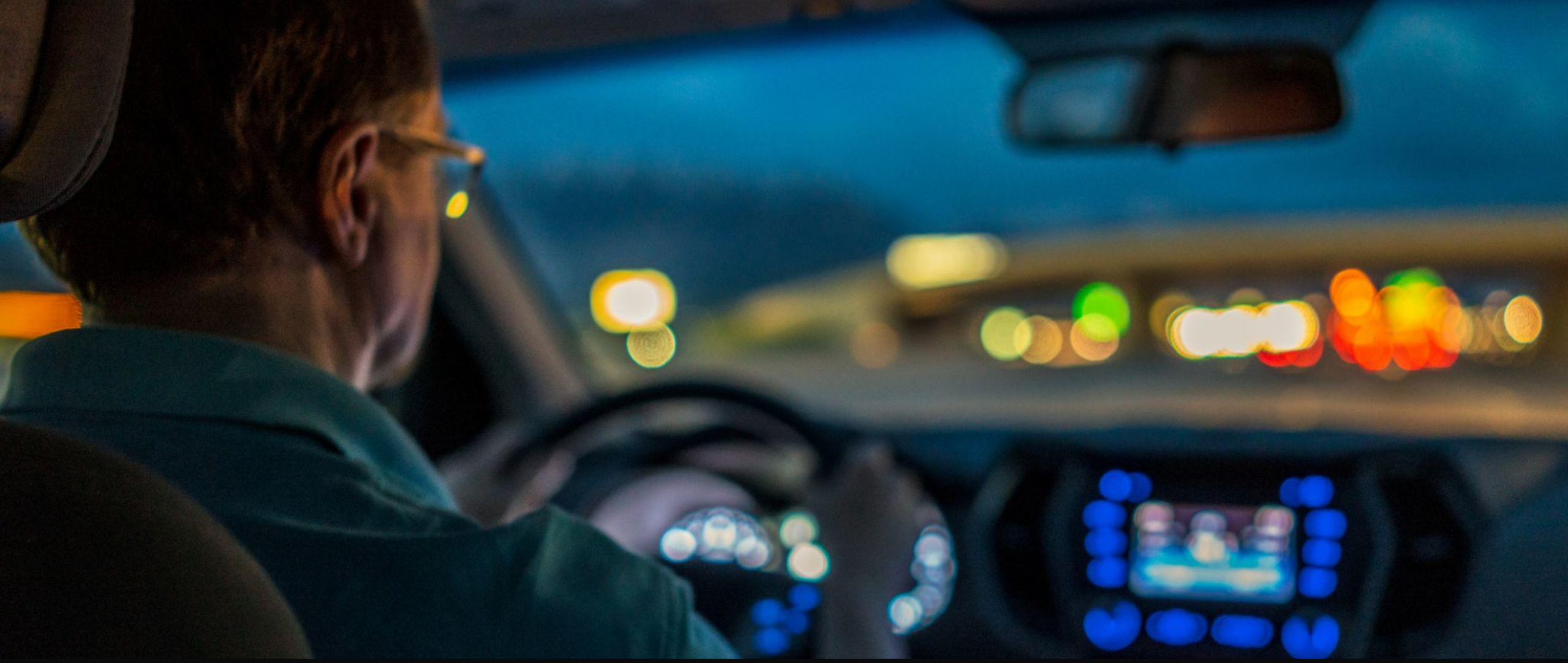
Computer Vision

- Used Computer Vision to capture webcam video
- Repurposed eye-cropper function to process each frame in the video as an image of the eye
- When the eye is closed for 6 consecutive frames (around 1.5 seconds), a loud alert is generated to the user to wake them up




Active
Open


Active
Closed
DRIVER SLEEPING



06

CONCLUSIONS

Conclusions

- Neural Networks are a promising area of machine learning for drowsiness detection
- The model built was reliable and by optimizing the video input, this could very well be used in real life applications

Ethical Considerations

- Factories or commercial vehicle companies could use it as a way to overwork employees, rather than give them proper rest
- Drivers may rely on being awoken by the alert and feel more comfortable driving while drowsy, but even an alert 1 second after falling asleep could be too late to prevent a crash

Going Forward

Make program compatible with different operating systems

Low Light conditions, other passengers

Additional test data for closed eyes

Image augmentation such as rotated or flipped images

Deployment of app to remote server