Real time implementation in a multiplatform of a monitoring systems for the driver's sleepiness and distraction using artificial intelligence.

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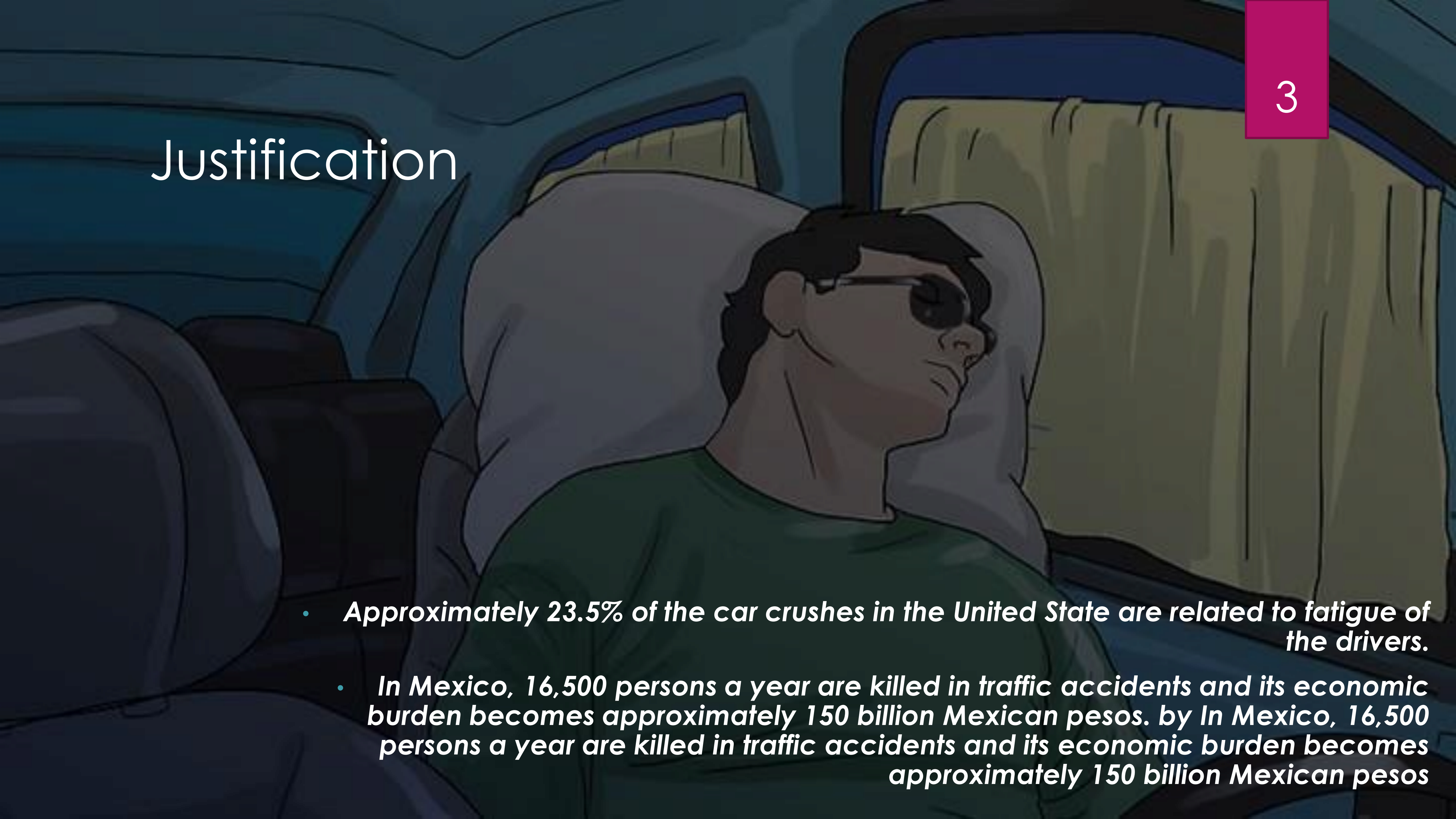
Itinerary

- Justification
- Background
- Proposed system
- Results
- Conclusions



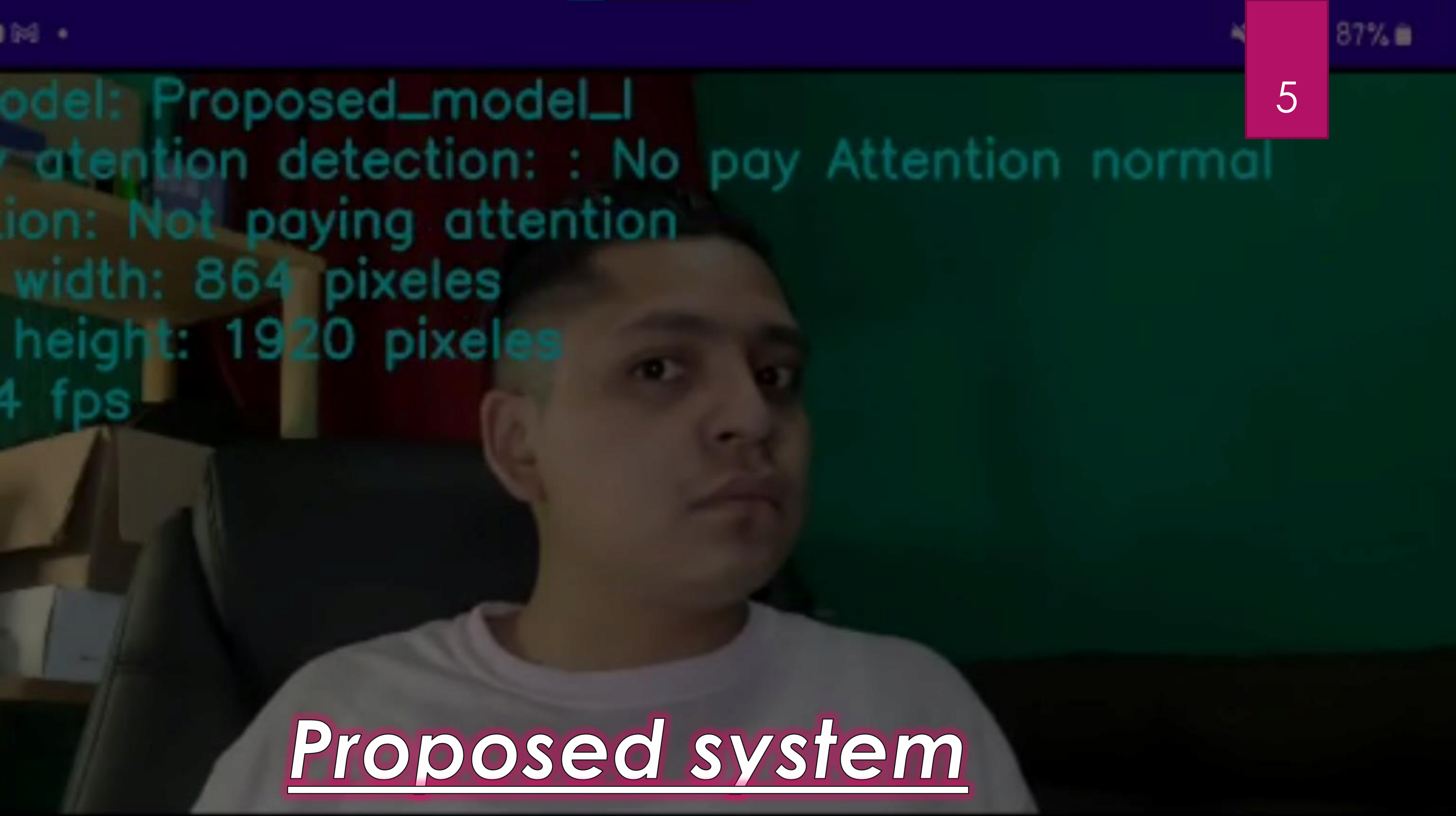
Justification

- *Approximately 23.5% of the car crushes in the United State are related to fatigue of the drivers.*
- *In Mexico, 16,500 persons a year are killed in traffic accidents and its economic burden becomes approximately 150 billion Mexican pesos. by In Mexico, 16,500 persons a year are killed in traffic accidents and its economic burden becomes approximately 150 billion Mexican pesos*

Background

Relative technologies against driver fatigue / drowsiness

- **Indirect prevention**
  - **External**
    - **The expressway construction**
  - **Internal**
    - **Dedicated systems**
    - **Improvements in the car.**
- **Direct prevention**
  - **Vehicle behavior-based system**
  - **Visual-based system**
    - ***A video camera equipped inside the vehicle takes frames of the diver's face, detecting eye blinking frequency, eyelid closure, yawning and facial expression to determine the driver's drowsiness.***
  - **Driver's physiological signals**



Proposed system

General characteristics

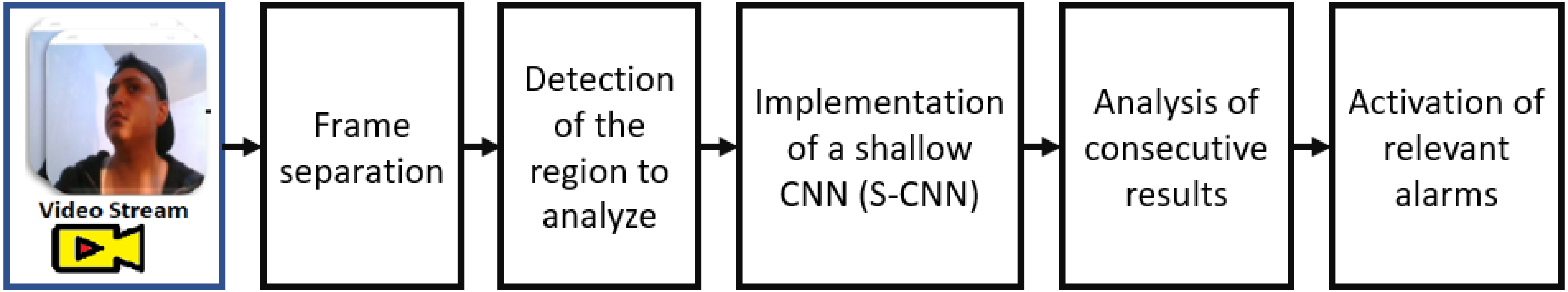
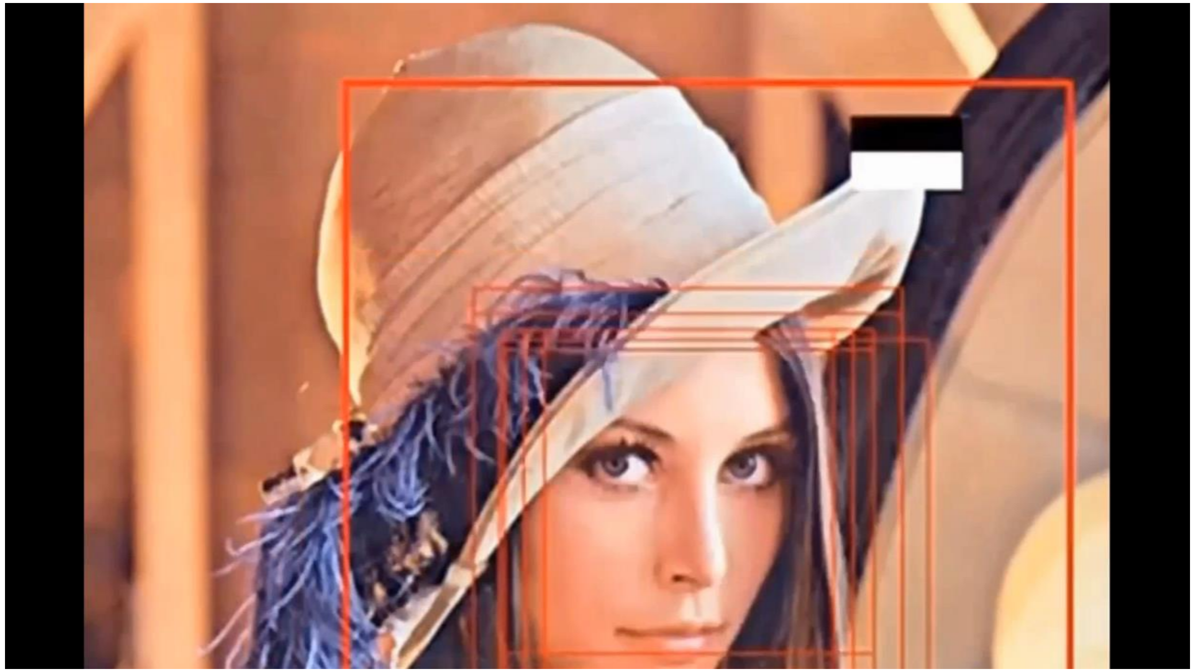


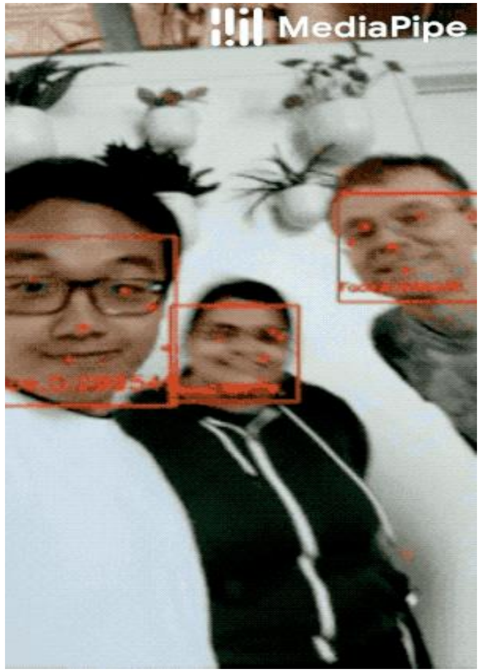
Figure 1. Proposed driver's drowsiness and distraction detection system

Detection of the region to analyze

V&J algorithm



MediaPipe face algorithm

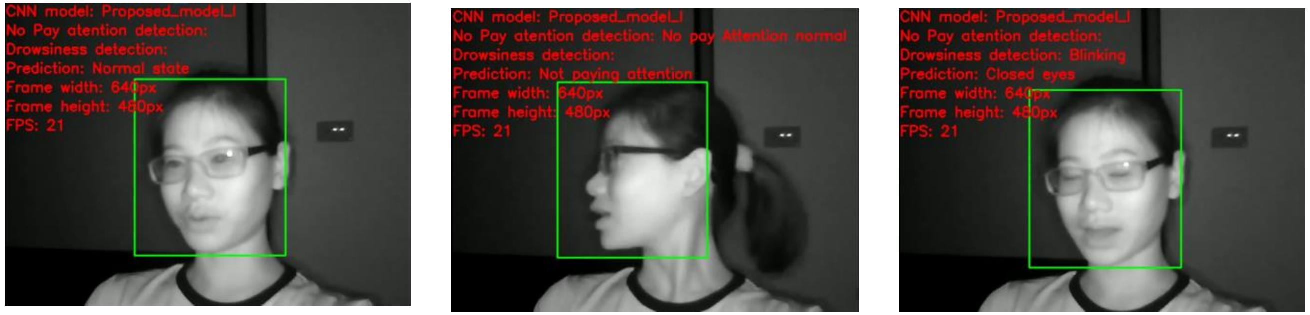


Implementation of a shallow CNN

Table 1: Characteristics of the proposed convolutional neural network

PROPOSED STRUCTURE OF S-CNN (CNN used)		
Layer name	***Size of feature msp***	***Number of parameters***
Conv2D	62 × 62 × 32	896
BatchNormalization	62 × 62 × 32	128
MaxPooling2D	31 × 31 × 32	0
Conv2D	29 × 29 × 32	9248
BatchNormalization	29 × 29 × 32	128
MaxPooling2D	14 × 14 × 32	0
Conv2D	12 × 12 × 64	18496
BatchNormalization	12 × 12 × 64	256
MaxPooling2D	6 × 6 × 16	0
Flatten	2304	0
Dropout	2304	0
FC	128	295040
Dropout	128	0
FC	128	16512
FC	3	387

Total parameters: 341,091
Trainable Parameters: 340,835
Non-trainable parameters: 256
Accuracy= 95.77

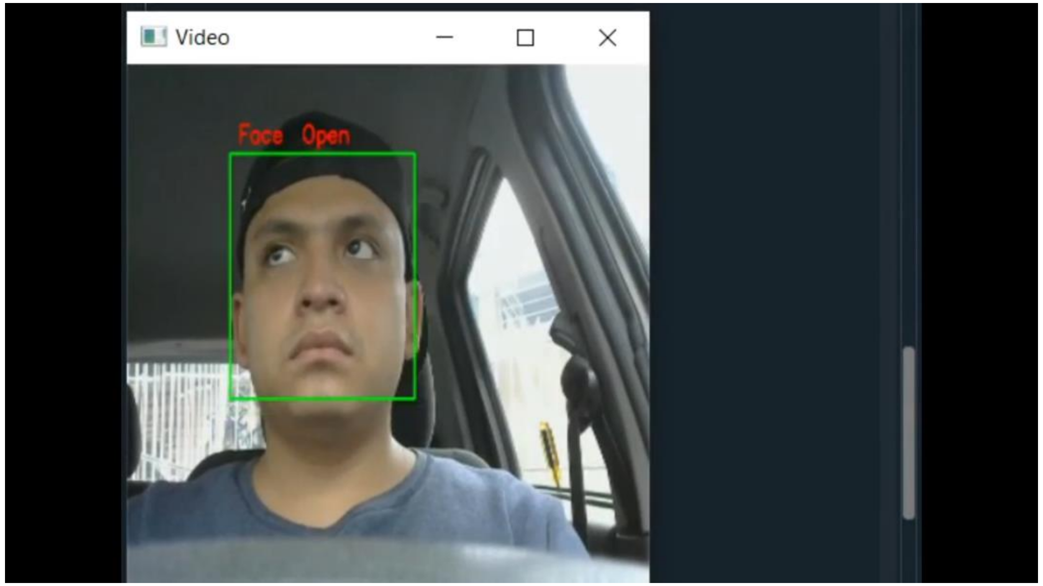


Classification of 3 states of the driver.

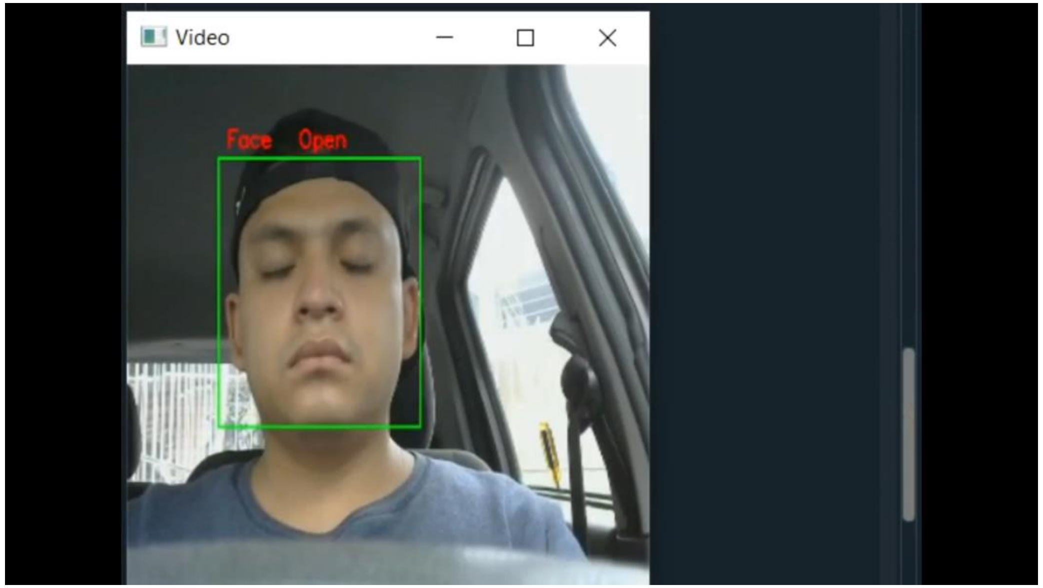
Analysis of consecutive results

Activation of relevant alarm

Alarm triggered by "distraction"



Alarm triggered by “sleeping"



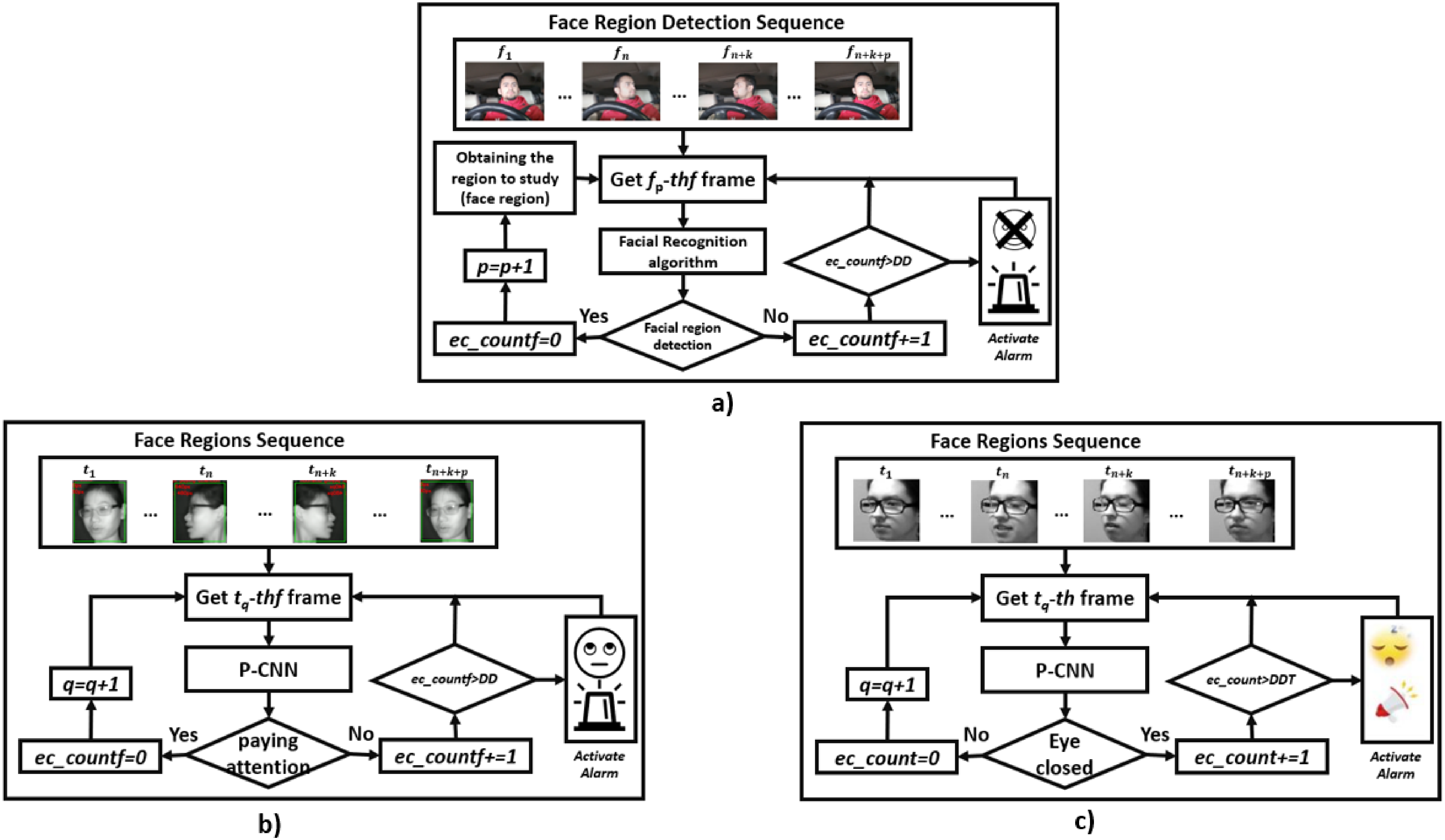


Figure 2. Proposed algorithm for the detection of drowsiness and distraction
a) Facial recognition process and its various actions when the region to be studied is detected or not
b) Distraction recognition process through the proposed convolutional neural network (P-CNN)
c) Sleepiness recognition process by means of a proposed convolutional neural network (P-CNN)

Results

Comparative tables

Model name	*Total parameters*	*Trainable Parameters*	*Non trainable ponrameters*	*Best accuracy*	*Size od the model*	*Input image size*
Proposed model	*341,091*	*340,835*	*256*	*0.9577*	*3.98 MB*	*64x64*
Mobilenet V2 Fine-Tuning 18	*2,590,083*	*2,549,011*	*41,072*	*0.9675*	*10.30 MB*	*64x64*
VGG16 Fine-Tuning 7	*14,850,179*	*14,590,019*	*260,160*	*0.9777*	*56.8 MB*	*64x64*
Resnet 50 Fine-Tuning 7	*24,116,419*	*24,053,699*	*62,720*	*0. 9760*	*92.5 MB*	*64x64*
Inceptionv3 Fine-Tuning 229	*21,938,275*	*12,947,395*	*8,990,880*	*0.96*	*84.5 MB*	*75x75*
Xception Fine-Tuning 26	*21,390,187*	*21,144,843*	*245,344*	*0.97125*	*81.9 MB*	*64x64*

Table 2: Comparative table of the best retrained models according to their best accuracy.

Device	Facial recognition speed using V&J algorithm (fps)	Facial recognition speed using MediaPipe face algorithm (fps)	Resolution of the input image (pixels x pixels x channels)
D1	20	21	640 x 480 x 3
D2	15	17	640 x 480 x 3
D3	6	8	640 x 480 x 3
D4	21	-	600 x 800 x 3
D5	14	-	864 x 1920 x 3

Table 7: Table of performance tests on the various devices using the proposed P-CNN

Dataset used and Confusion matrices

Figure 3: Dataset used NTHU-DDD

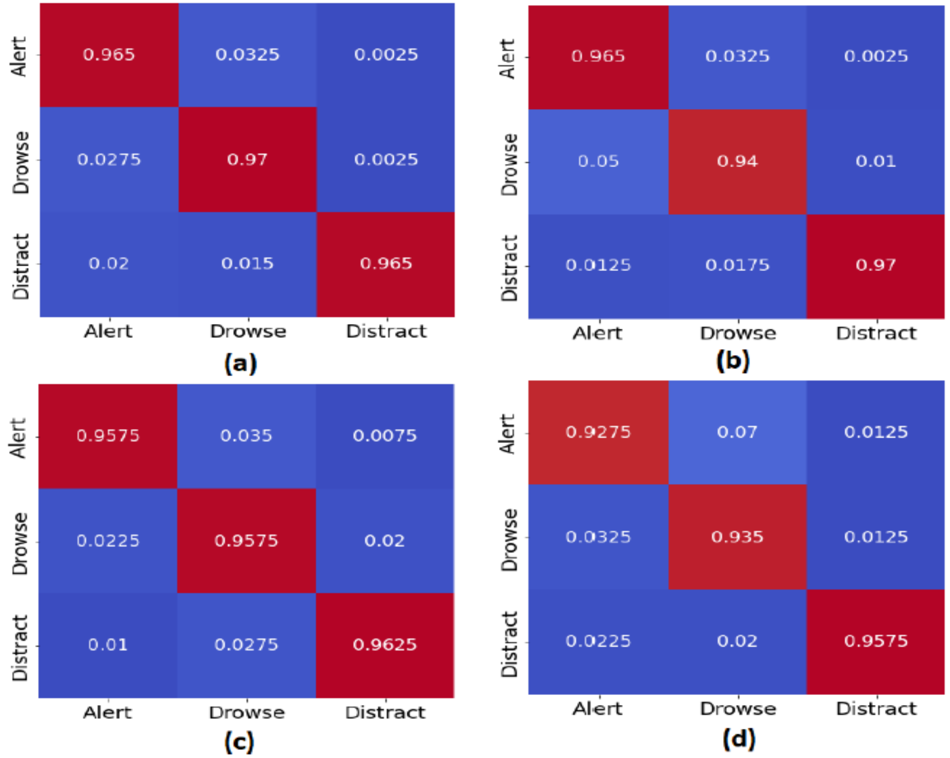
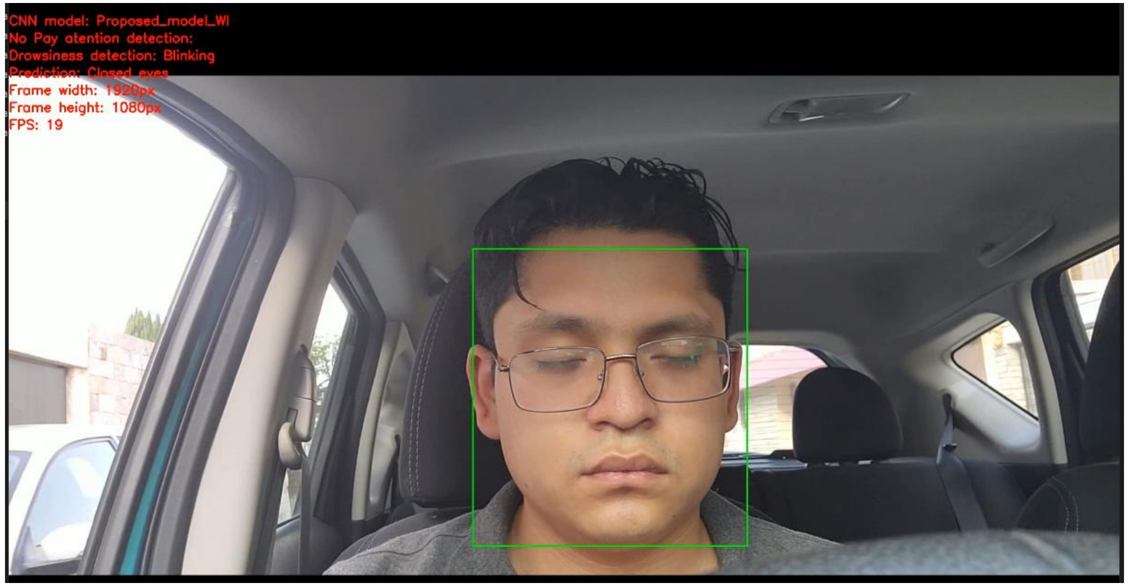


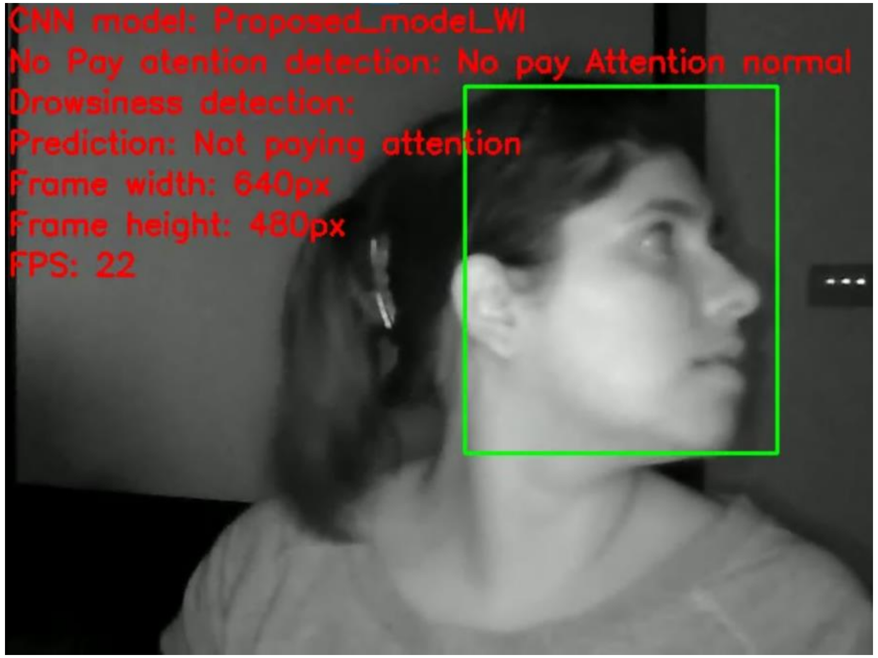
Fig. 4. Confusion matrices in four different conditions. (a) without glasses under normal illu-mination, (b) with glasses under normal illumination, (c) without glasses under IR illumination and (d) with glasses under IR illumination.

Performance tests on PC - Workstation

PC AMD Ryzen 7 3700X 8-Core Processor 3.60 GHz, 32GB RAM, 64-bit, 3070TI GPU, 8GB Memory, 6144 cores, 1.770MHz.

Huawei D16 LAPTOP, AMD Ryzen 5 4600H, GPU Radeon Graphics 3.00GHz, 16.0GB RAM, 64bits.



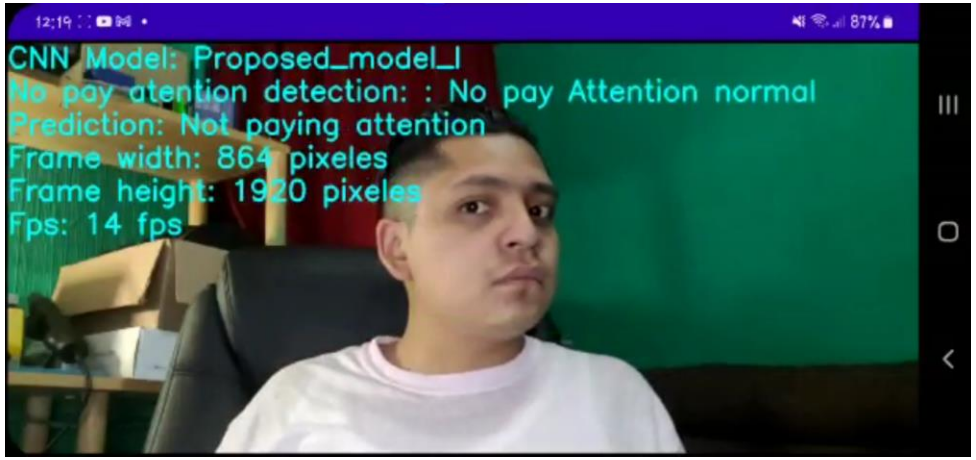


Performance tests on mobile devices

Samsung S20 fe

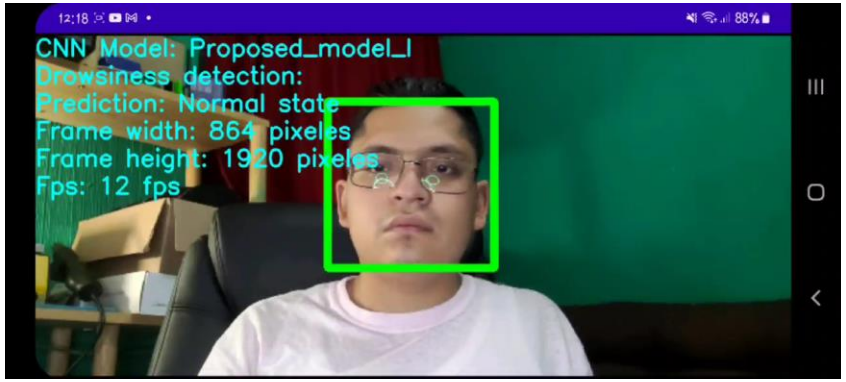
PROTOTYPE IMPLEMENTATION

Graphic sample of the implementation of the proposed system in real conditions.



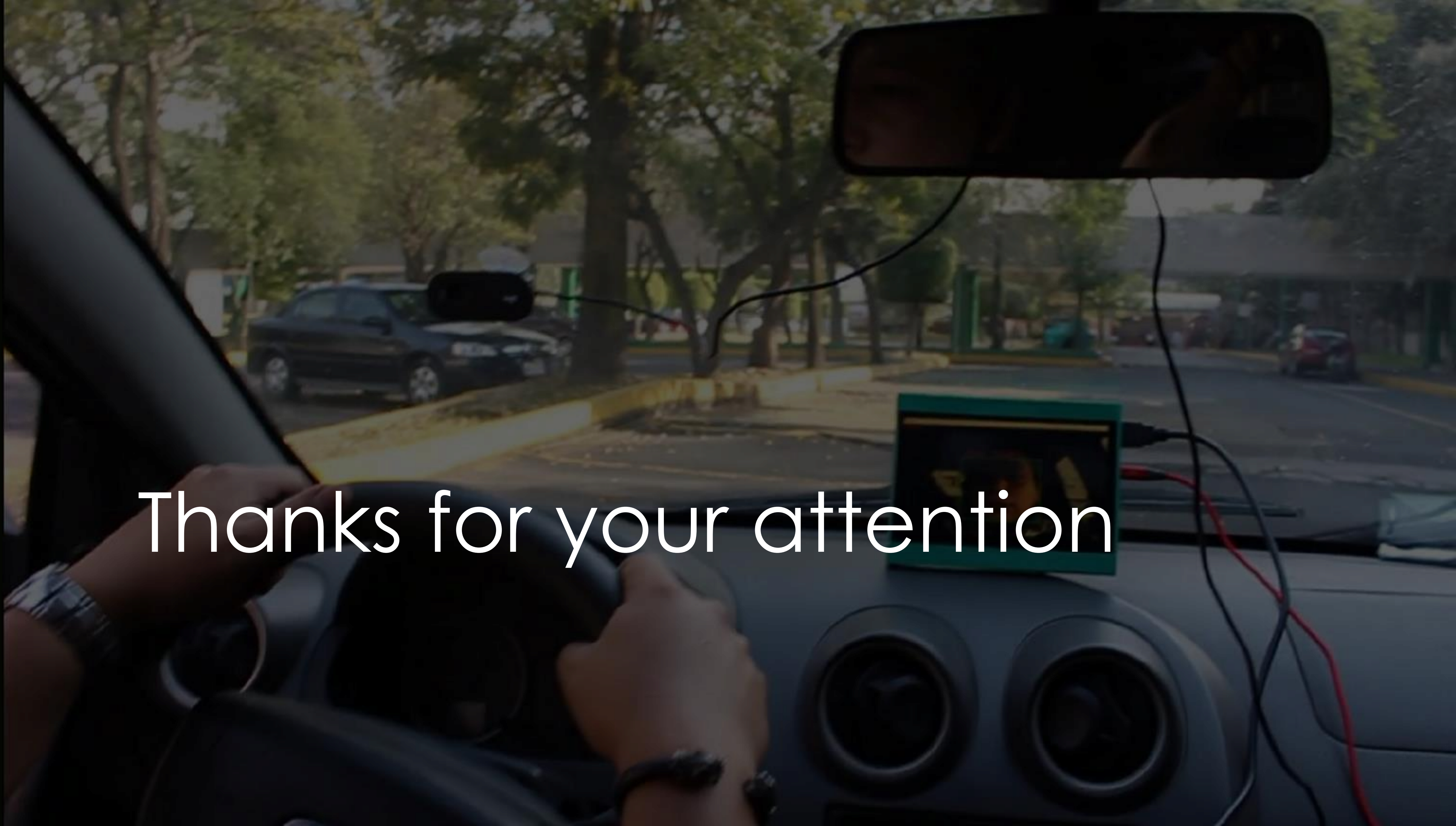
Conclusions

SOFTWARE IMPLEMENTATION ON DEDICATED DEVICES



SOFTWARE IMPLEMENTATION ON MOBILE DEVICE

SOFTWARE IMPLEMENTATION ON WORKSTATION


Thanks for your attention