

GUARDIAN ANGEL

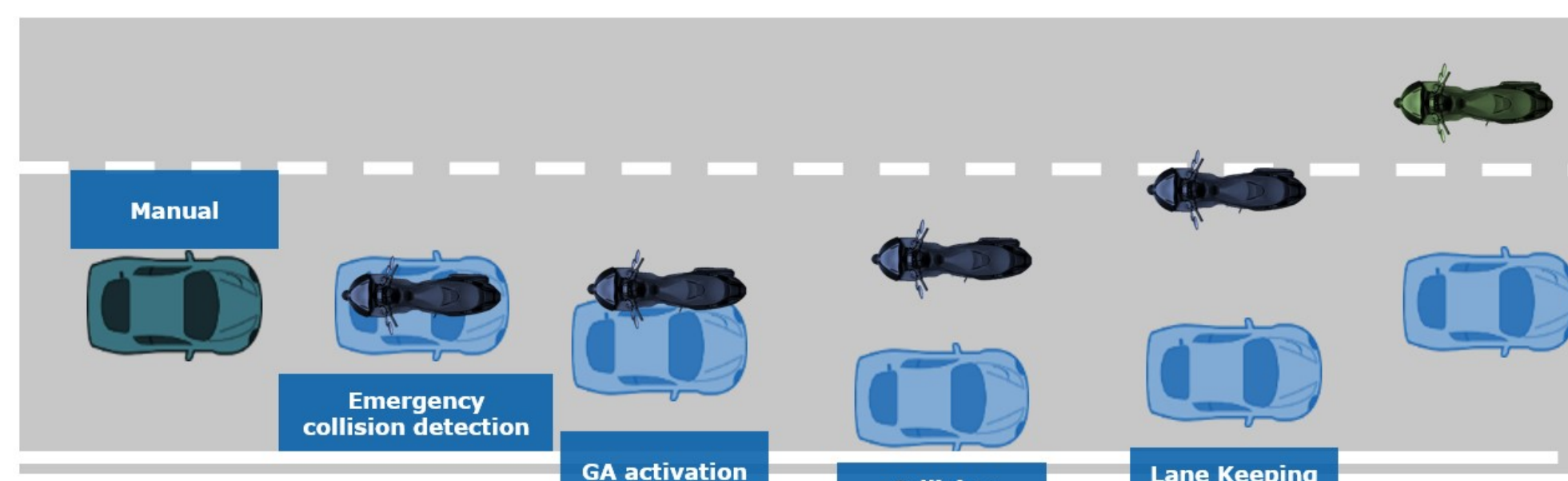
Concept

- Driving support for elderly drivers in manual mode:
- Lateral support (safety envelope)
- Visual interfaces: LEDs and HUD
- Acoustic interfaces: Sounds and tutoring system
- Haptic interface: Haptic feedback in the steering wheel

Simulator study



- Lateral evasive maneuver avoiding a motorcycle in the line
- 3 different steering wheel strength levels evaluated:
 - Gentle
 - Intermediate
 - Aggressive
- 2 driver states:
 - Attentive
 - distracted
- MPC-based lateral controller



Lateral evasive maneuver for collision avoidance with an incoming vehicle

Vehicle study

The torque thresholds determined in the simulator study used as parameters for the vehicle lateral controller



- Front camera
- Windshield lights
- Heads-Up Display
- Touch display
- Haptic feedback on the steering wheel
- Steering wheel lights
- Sounds



Scenario 1: Distracted driver



Scenario 2: Lane narrowing

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Holistic Approach for Driver Role Integration and Automation Allocation for European Mobility Needs

Haptic icons

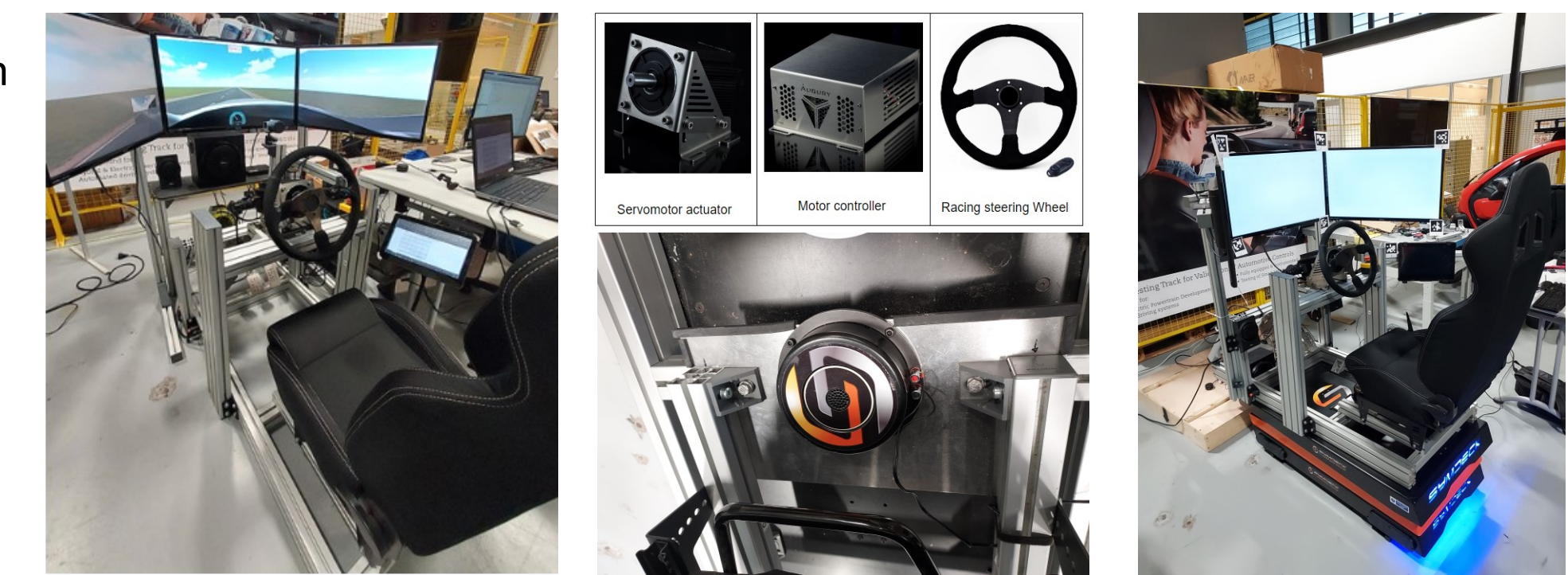
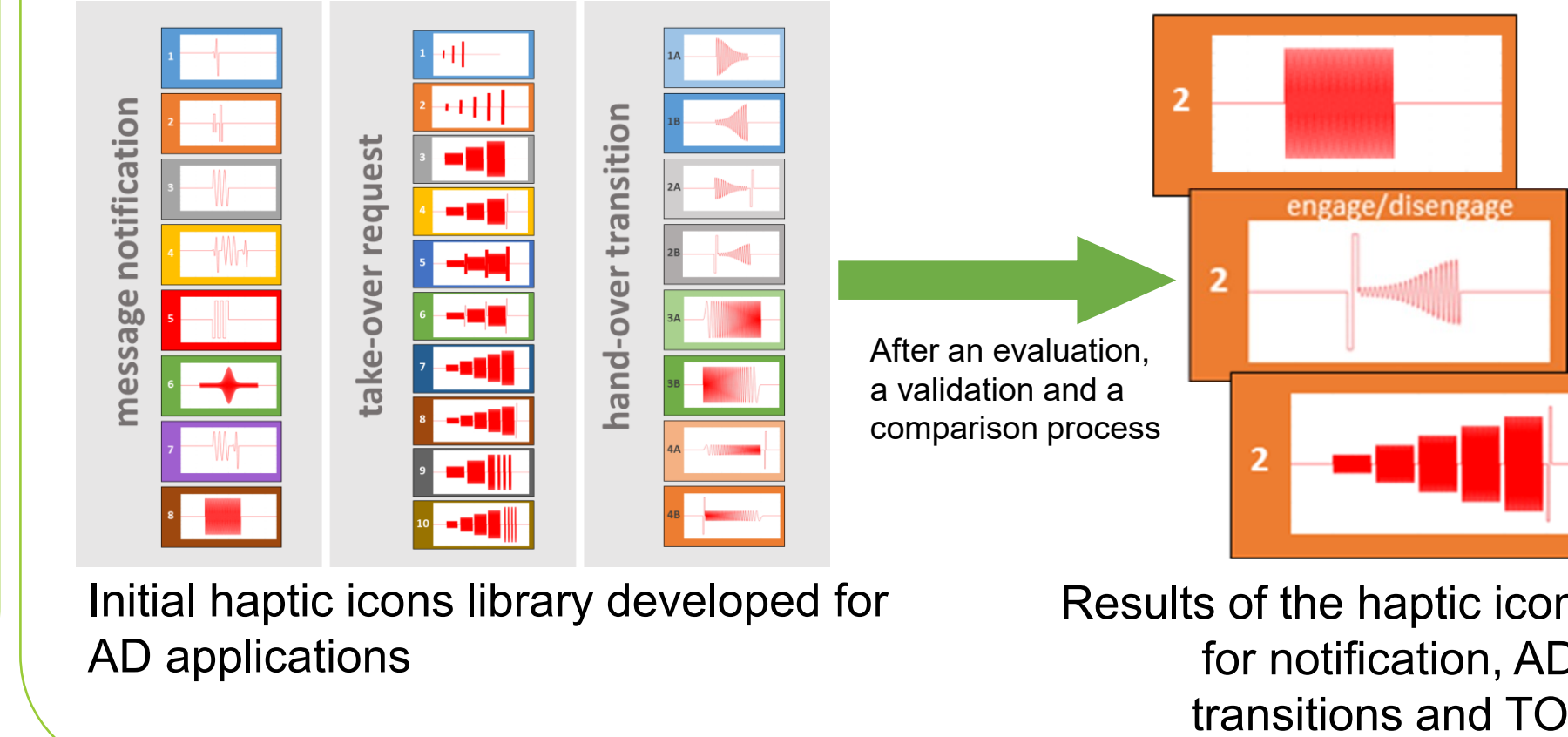
Concept: short, recognizable and differentiable vibratory patterns which are perceived in form of haptic feedback through the driver hands.

Goals

- Provide non-intrusive and time-dependant warnings to the driver
- Increase trust in ADAS
- Increase situational awareness
- Avoid driver drowsiness

Limitations of the system

- At least on hand in the steering wheel required
- Difficult to differentiate in a vibrating environment
- Small range of acceptable amplitudes and frequencies



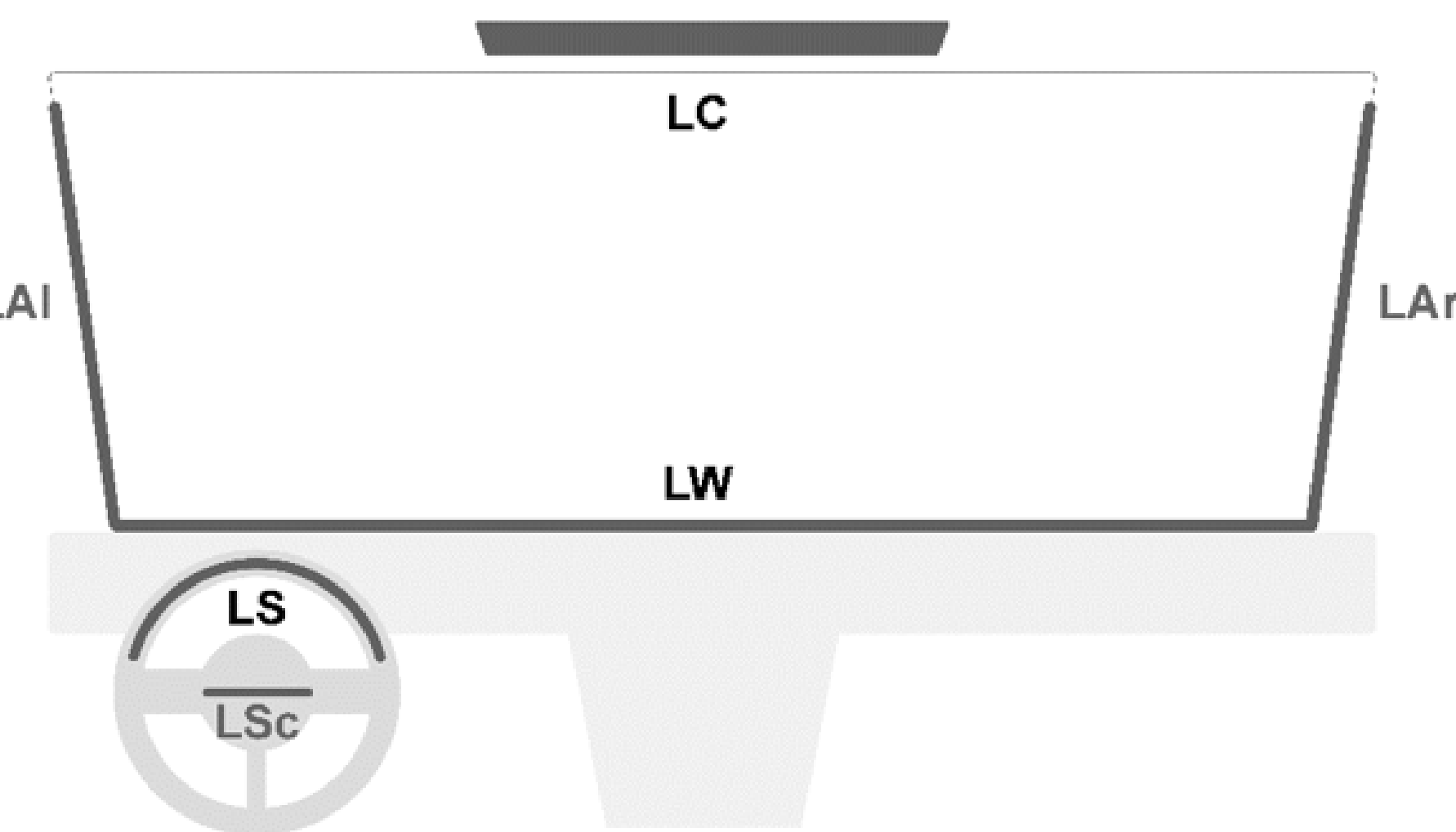
Simulator setup



Renault Twizy setup

Improvement processes of the simulator and the vehicle setups

AMBIENT LIGHTNING FLUID HMI



Manual (LW)

ADL2, ADL3 (LW, LC)

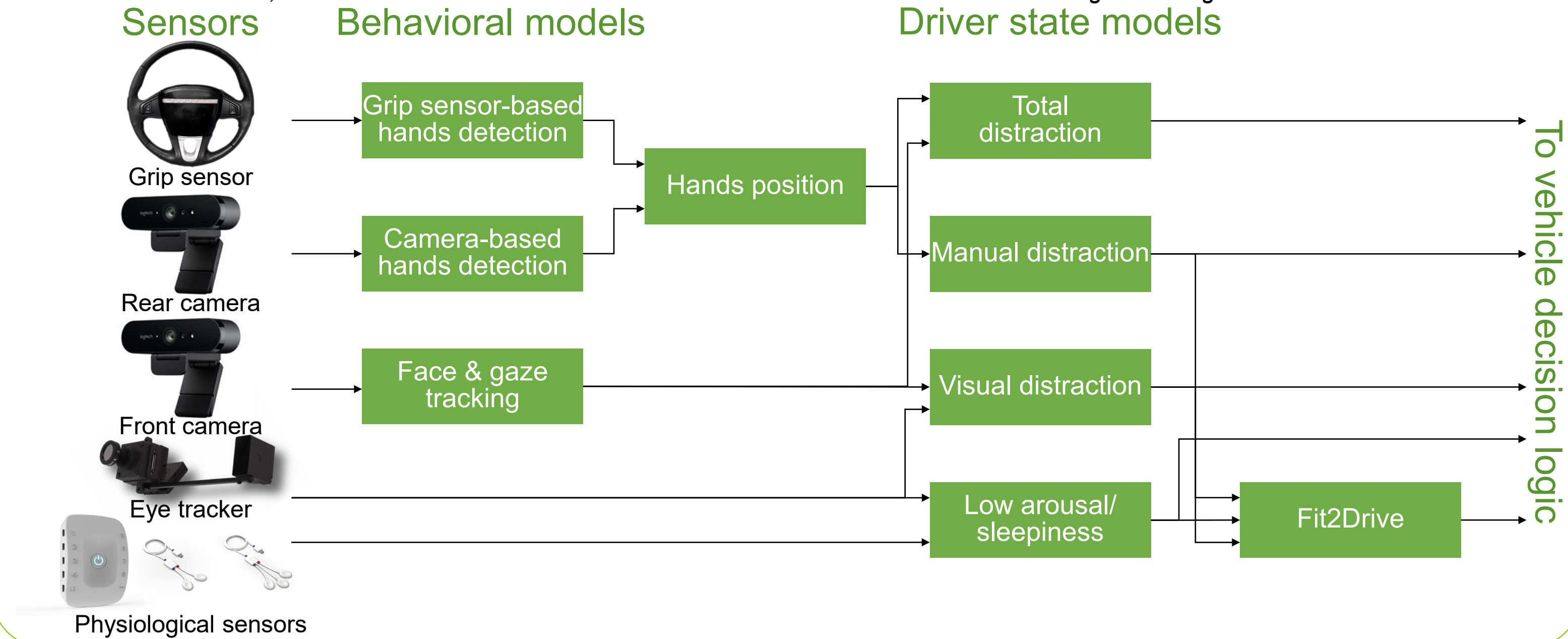
ADL3+ (LW, LC)

Transitions (LW, LS)

DRIVER MONITORING SYSTEM (DMS)

System architecture

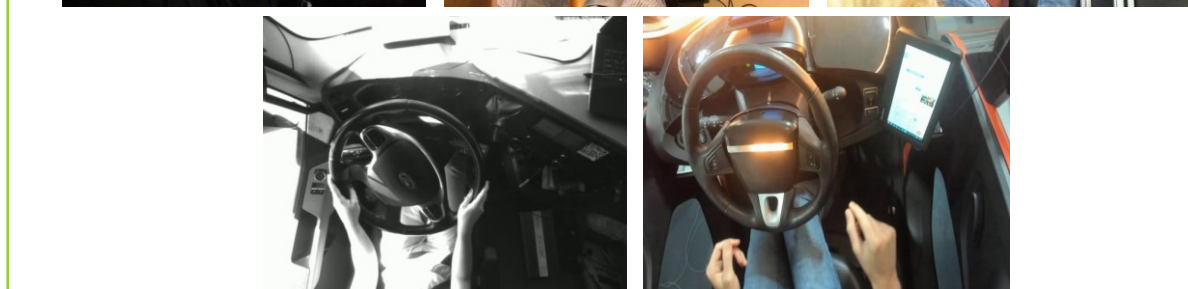
Thanks to the sensors, we estimate the driver behavior and deduce the driver states which are merged into a global indicator named Fit2Drive.



Project outcomes & innovations

2 Databases to train the DMS

- Open Access Driver State Database
- Driver Hands Database:
 - 108 sessions
 - 5 different set-ups
 - 45600 annotated images with bounding boxes



Multiple driver monitoring models

- Grip sensor-based hand detection
- Camera-based hand detection
- Face & gaze tracking
- Low arousal/sleepiness
- Visual distraction
- Manual distraction
- Fit2Drive

Publications

S. Aloui *et al.*, « Driver Monitoring Systems in automated interactions: A real-time, thermographic-based algorithm », in *HCI SI 2022*

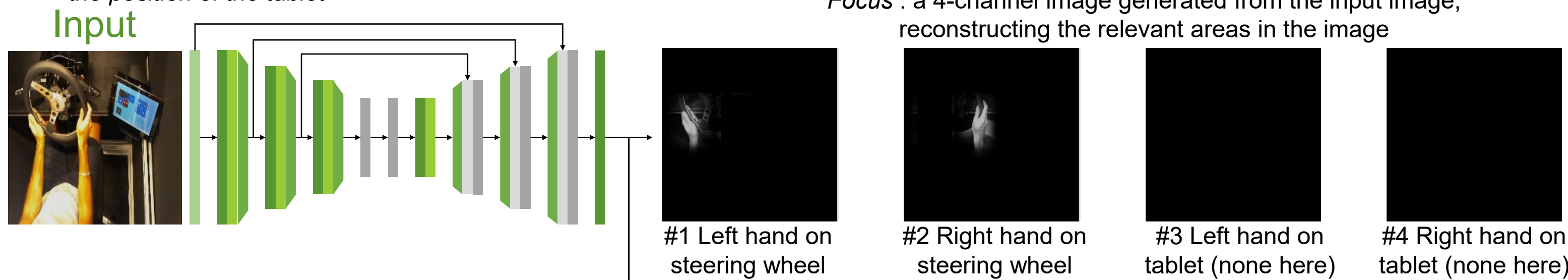
R. Morvillier, C. Prat, et S. Aloui, « A Camera-Based System to Detect Driver Hands on the Steering Wheel in Semi-autonomous Vehicles », in *ECML PKDD 2022*

More to come !

Camera-based hands detection

Architecture of the proposed neural network detecting:

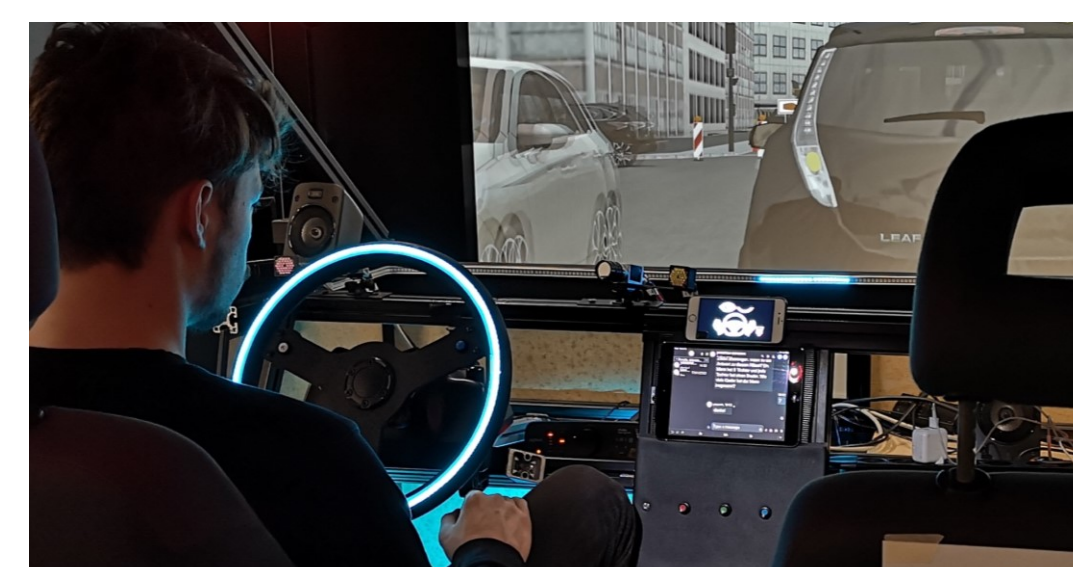
- the number of hands on the steering wheel
- the number of hands on the tablet
- the position of the tablet



- Innovations
- able to distinguish a hand over the steering wheel from a hand grasping it.
 - introduces the focus for increased performances

Number of hands on steering wheel	Achieved accuracy
1	93%
2	98%
3	100%

Simulator Study 1



- Switching between Manual, ADL2 and ADL3 driving
- LED positions: LS, LW and Footwell
- LED colors: white, blue, turquoise for driving modes; yellow and red for transitions down

Simulator Study 2



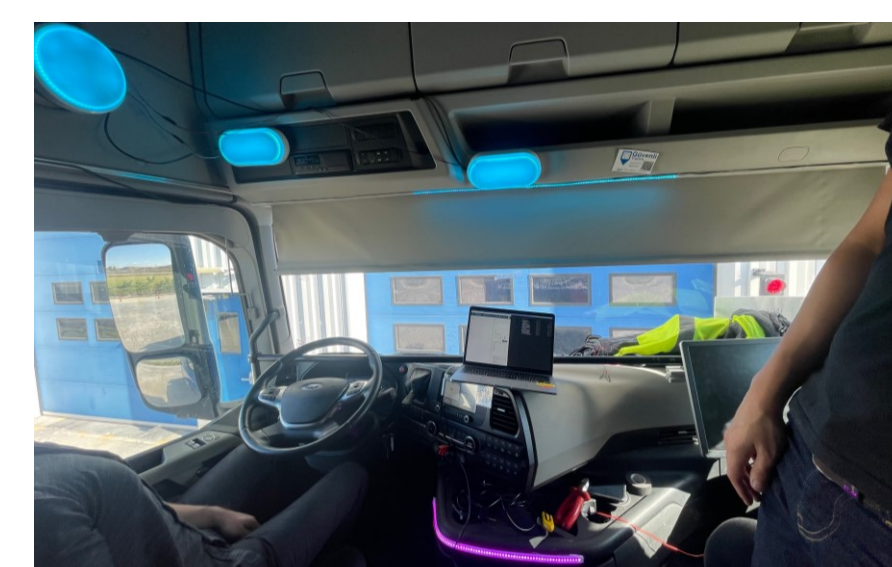
- Switching between Manual and ADL3+ driving
- LED positions: LW and LC
- LED colors: white, turquoise for driving mode and dis- and re-engagement; 2200K white for relaxation

Twizy Integration



- Renault Twizy from Technalia Research Center in Spain
- Integrated Lights: LW, LSc and LAI+Lar
- Light colors: orange, green, red

Ford Truck Integration



- Truck from FORD Turkey
- Integrated Lights: LW, LC spots, NDRA
- Light colors: white, 2200K white, turquoise, purple, orange



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