HADRIAN'S EYE:
A video analysis tool to coding drivers' mannerisms and behaviours in simulated settings

HADRIAN

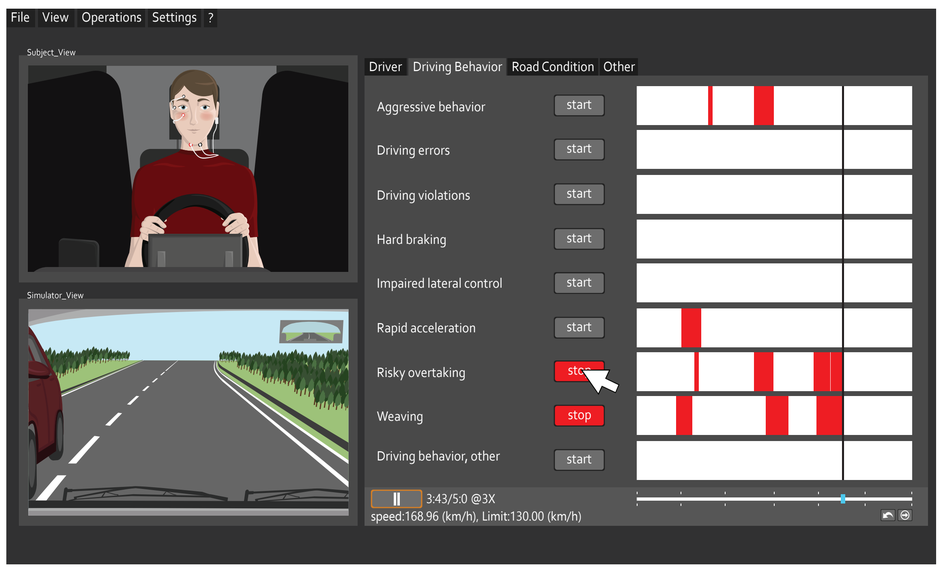
Holistic Approach for Driver Role Integration and Automation Allocation for European Mobility Needs

Abstract

Driver monitoring systems (DMS) should issue warnings when drivers show signs of unsafe behaviours or unfitness-to-drive. Advanced (A)DMS try to increase their robustness by fusing multiple sources of neurobehavioural and environmental indices (often) in an unsupervised fashion. However, when testing ADMS in real-world settings, their overall performance remains sub-optimal. The intrinsic complexity of the psychophysical states being monitored (e.g., overload), and the variability of the indices and data quality, might in part explain the weakness of the unsupervised approaches. An alternative approach is to provide informative inputs, based on the knowledge of human experts, to the ADMS models. Here, we present a customized software –developed within the EU-project HADRIAN– that allows trained observers to code idiosyncratic behaviours/events known to be related to drivers' states (of interest for ADMS) during complex simulated human-vehicle interactions. One of its strengths is that the interrater agreement between observers can be periodically checked. To help develop the HADRIAN-ADMS, three couples of observers used the HADRIAN's EYE software to code more than 150 driving sessions [1- to 3-hour-long each]. They monitored each session throughout multiple videos, which integrated information from more than eight neurobehavioral indices, while coding predetermined selected indicators. The key idea behind developing this video analysis tool is to include the ability of humans to detect mannerisms and other elements, not easily observable in the data streaming, into the ADMS models development.

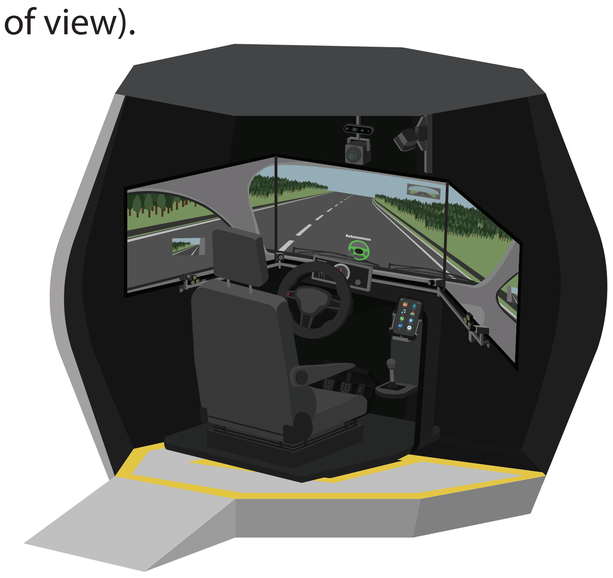
HADRIAN'S EYE SOFTWARE

HADRIAN's Eye is a video analysis tool that allows labelling driving data based on the identification of behavioural and mannerism indicators driver state-related constructs. The labelling interface integrates in a single window an in-car video, the reproduction of the virtual scenario, and the annotation view, allowing simultaneous inspection of participants' behaviours, movements, and the on-road situation through time.



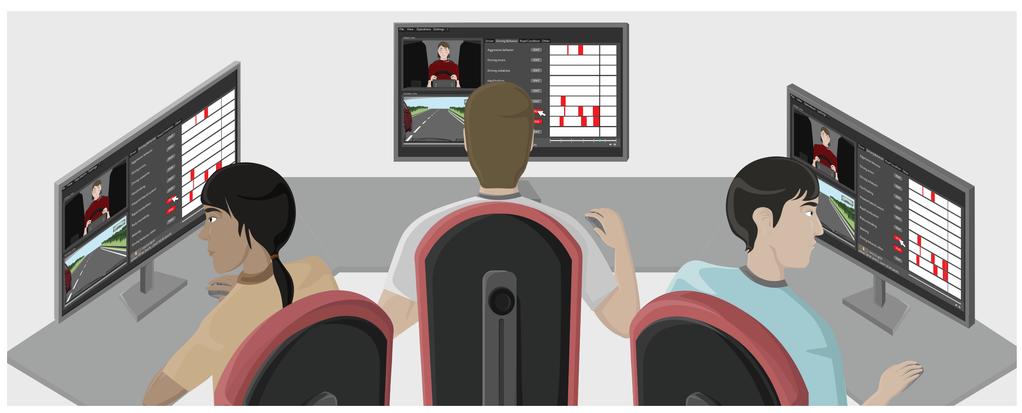
HADRIAN DRIVING SIMULATOR

The simulation system is located inside a dedicated octagonal dome. It is based on a four-degree-of-freedom motion platform. To control the car, participants used a sensorized steering wheel, and gas and brake pedals. Speedometer is displayed on a dedicated screen placed behind the steering wheel. A Logitech 5.1 audio surround system reproduces the engine sound, traffic noise, vocal instructions. The virtual driving scenario is displayed on three 49" screens to simulate the horizon of the virtual world (130° field of view).



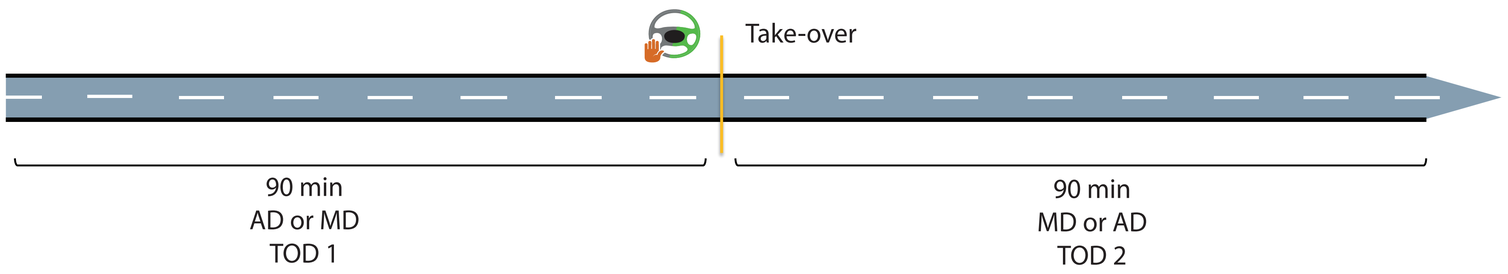
Annotation Procedure

Two independent coders employ the HADRIAN's Eye tool to identify and annotate participants' fatigue- and sleepiness-related mannerisms and behaviours (e.g., snorting/sighing, rubbing and holding the face, yawning, see table below). Previous to the coding, they are trained to label the video material of a series of pilot sessions. To detect discrepancies in the outputs of the two coders, we developed a customized Matlab-based code. Two types of discrepancies might be detected: (i) typology, and (ii) timing of the detected indicators. In case of discrepancies, a third independent coder is involved to solve the issue.

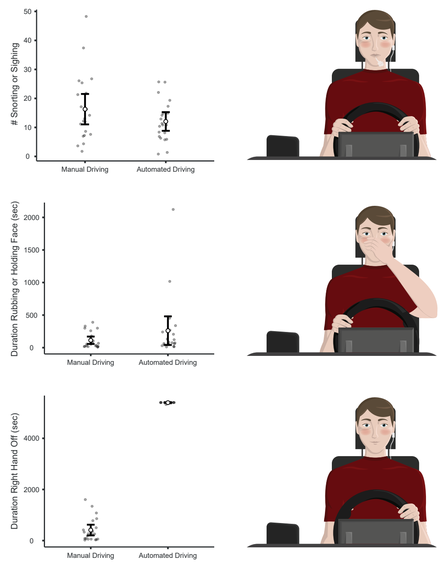


Results

As an example, we present the results obtained from a within-subjects design with the Time-On-Driving (TOD) and Automated Driving Level (ADL, manual vs. automated ADL 3+) as the independent variables. Participants performed one driving session consisting of two 90-min TOD blocks. Drivers did not rest between the TOD blocks. A fixed-time (15 seconds of lead time) take-over signal to perform the transition between automated [AD] and manual driving [MD] or vice versa was presented after 90-min of driving.



Punctual Events	Bi ng licking lips
	Facial contor ons
	Grimacing
	Snor ng sighing
	Hair scratching
	Hair straightening
	Rapid head movement
	Startling awake
	Crash
	Near miss
Indefinite Events	Rubbing holding face
	Rubbing scratching eyes
	Yawning
	Leaning
	Rubbing holding head
	Nodding drooping
	Tilted head
	Body posi on change
	Leaning slumping
	Le hand off steering wheel
	Right hand off steering wheel
	Sleeping
	Stretching



Acknowledgments

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Demonstrator video of HADRIAN experimental studies

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