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

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Universidad del País Vasco
Euskal Herriko Unibertsitatea

A fluid-HMI approach for Haptic Steering Shared Control for the HADRIAN Project

Myriam E. Vaca-Recalde[1,2], Mauricio Marcano[1,2], Joseba Sarabia[1,2], Leonardo González[1,2], Joshué Pérez[1], Sergio Díaz[1]

Eng. Myriam E. Vaca Recalde

Tecnalia Automotive[1]
Industry and Transport Division

University of the Basque Country[2]

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Introduction

TECNALIA
AUTOMATED DRIVING

OUR VISION OF THE SOCIETY´S FUTURE IS BUILT THROUGH EFFICIENT, SAFE, SUSTAINABLE AND CLOSE TO MARKET INTELLIGENT TRANSPORTATION SYSTEMS

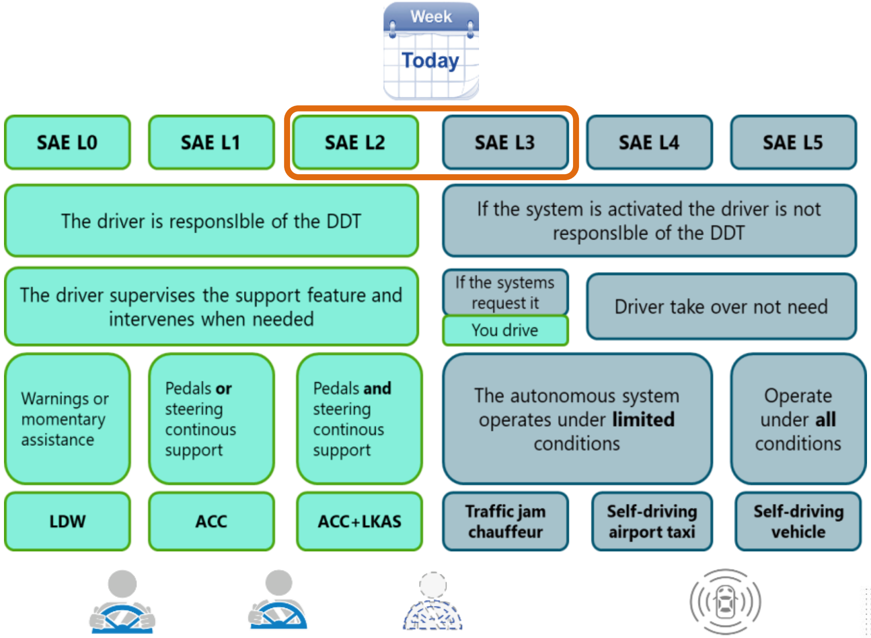
Our group is working in the newest tendencies of Automated Driving and developing market solutions:

- Real–time and optimal trajectory planning.
- Cooperative automated driving.
- Environment recognition and obstacle detection.
- Real–time evaluation and risk assessment.
- **Shared control and driver-automation cooperation**

AUTOMATED DRIVING NOWADAYS

STATUS OF THE CURRENT COMMERCIAL VEHICLES WITH AUTOMATED FUNCTIONALITIES

- **SAE L0-L1:** Vehicles with Advanced Driver Assistance Systems (ADAS)
- **SAE L2:** Automated vehicles with autopilots at high speed in highways.
- **SAE L3:** Automated vehicles with autopilots at slow speed in traffic jam.
- **Momentary support** or continuous support but **low cooperation** with the driver



WHY SHARED CONTROL?
BENEFITS AND DRAWBACKS

HOW TO ALLOW HUMANS AND MACHINES INFLUENCE ACTUATORS SIMULTANEOUSLY WITH A FLUID TRANSITION BETWEEN THEM?

Manual Driving
- High reasoning
- Deducting and judging
- Socially accepted
- 94% of accidents
- Requires full attention
- Social exclusion

Shared Driving
- Automation support driver
- Driver supports automation
- Increase safety
- Reduce driver workload
- Driver-automation conflicts
- Legal issues

Autonomous Driving
- Faster response
- Multitasking
- Better perception
- Autopilot crashes
- Legal issues
- Humans like to drive

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HADRIAN

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

The HADRIAN project

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

THE PROJECT
HADRIAN

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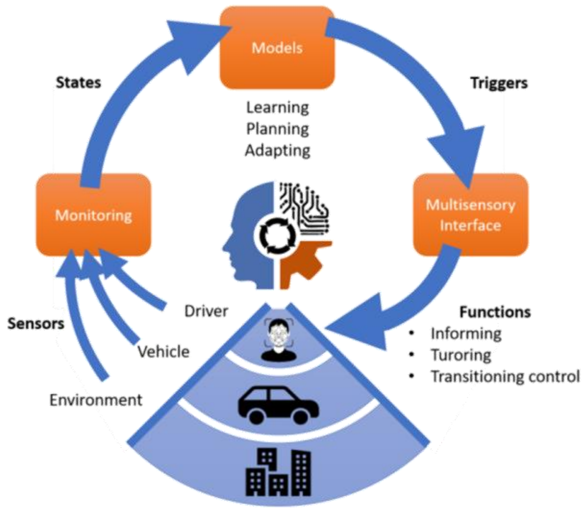
Holistic Approach for Driver Role Integration and Automation Allocation for European Mobility Needs

Research Innovation Actions

- **Human-centered design** for the new driver role in highly automated vehicles
- **16 European partners**
- 3 Demonstrator on ***fluid-HMI*** concepts for different LoA
  - Automated passenger vehicle for elderly drivers
  - Automated driving functionalities SAE L3-4 for trucks
  - Automated passenger vehicle for business travel
- **Intelligent co-driver** that provides an adaptive level of assistance and switches between automation levels



HADRIAN General Driver-Automation Framework

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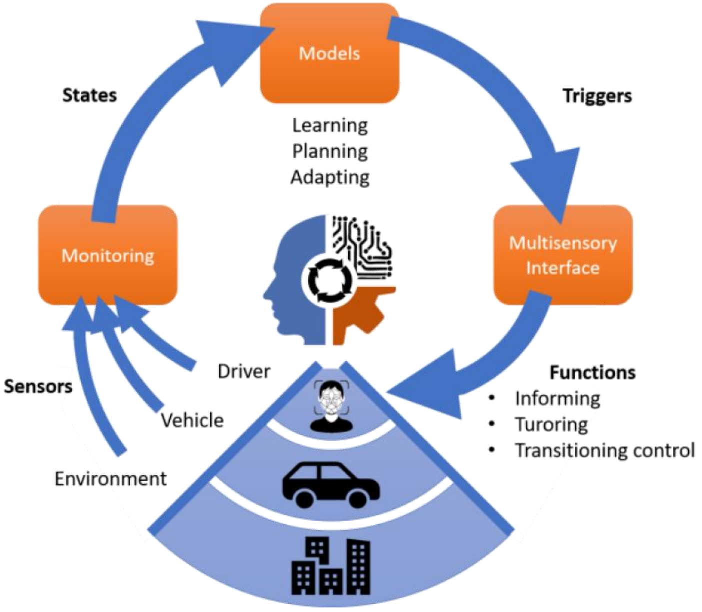
Holistic Approach for Driver Role Integration and Automation Allocation for European Mobility Needs

Demonstrator tasks

- **Development of a Driver Monitoring System**
  - Driver state
  - Calculate the need for assistance
- **Implementation of shared control system**
- **Integration of different HMIs in a complete driver-automation collaborative framework**



HADRIAN General Driver-Automation Framework

A fluid-HMI approach for Haptic Steering Shared Control for the HADRIAN Project

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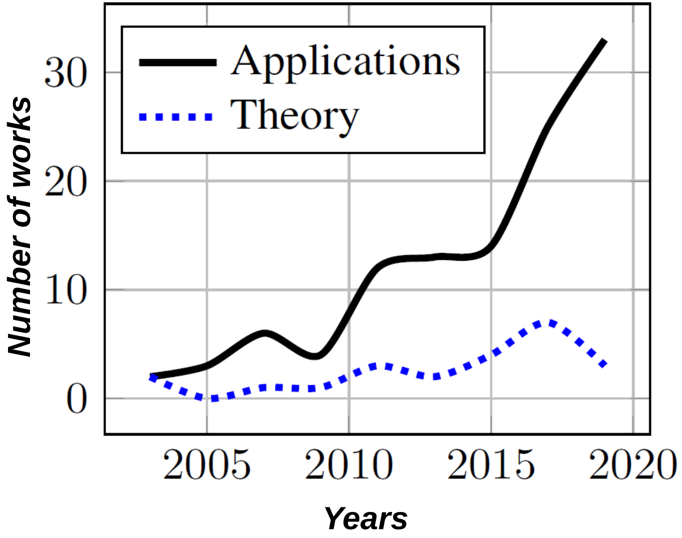
Related works

GENERAL FRAMEWORK
Driver-vehicle interaction

SHARED CONTROL IN AUTOMATED VEHICLES

- **Increasing** number of works
- Applications developed at **research level**
- Most applications in **DiL Simulators**
- Technology **under development**
- **LKAS** is a shared control based ADAS
- **Model-based control** methods are tendecy



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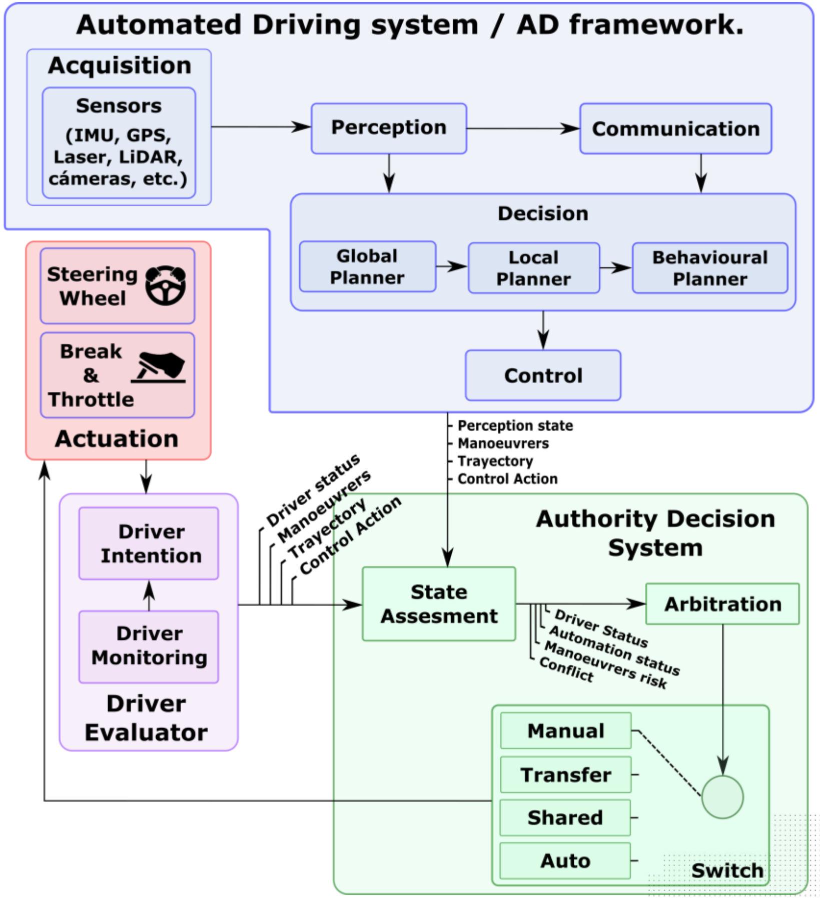
General Framework

GENERAL FRAMEWORK
Driver-vehicle interaction

Additional modules had to be included to manages the driver-automation collaboration.

- **Full automation architecture:**
  - Acquisition
  - Decision
  - Perception
  - Control
  - Communication
  - Actuation
- **New Modules:**
  - Authority Decision System
  - Driver Evaluator



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Needs and Challenges of the Implementation

Needs and Challenges of the Implementation

Shared Control

- **Needs:**
  - Actuators with haptic feedback
  - Optimal control algorithms
  - Driver models

- **Challenge:**
  - Driver and system interaction:
  - **Low forces** → does not affect driver understanding of automation
  - **High forces** → instabilities and discomfort while driving
  - Transitions of control

Authority Decision System

- **Need:**
  - Development of a robust decision system that understand who is more suitable for the driving task

- **Challenge:**
  - It is a complex task to evaluate each driving situation to assign the authority correctly based on environment, vehicle, and driver state.
  - Develop the if-then logic

Needs and Challenges of the Implementation

Driver Monitoring module

- **Needs:**
  - Reliable systems that measure the driver state
  - Sensors that measure different driver variables
- **Challenge:**
  - Unifies the different variables of the driver state in a single value
  - Achieve reliable systems without false detections.
  - User acceptance upon intrusive sensors

Driver Evaluation module

- **Needs:**
  - Detect driver behavior, and predict the intention while driving
- **Challenge:**
  - Each person has a particular driver style and a general model is hard to achieve

Needs and Challenges of the Implementation

Complementary human-machine interfaces

- **Needs:**
  - Visual screen
  - Haptic interfaces
  - Audio warnings

- **Challenge:**
  - The interfaces design
  - Increase driver understanding
  - Avoid excessive information

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Conclusions and Future works

CONCLUSIONS and FUTURE WORKS

THE SHARED CONTROL FRAMEWORK IS USEFUL TO COVER THE COMPLETE SPECTRUM OF AUTHORITY FROM MANUAL TO AUTOMATION

- **Contribution 1:** A detailed definition of the **general framework for cooperative control**.
- **Contribution 2:** A presentation of the basic needs for achieving a safe and effective human-machine interaction in Automated Driving**.**
- **Future work:** needs and challenges defined **will be implemented** in the framework of the EU-H2020 Hadrian project with other HMIs.

HADRIAN HMIs

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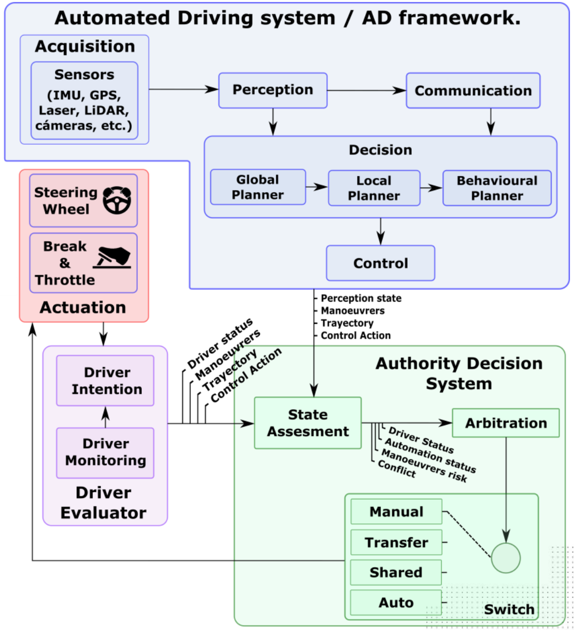
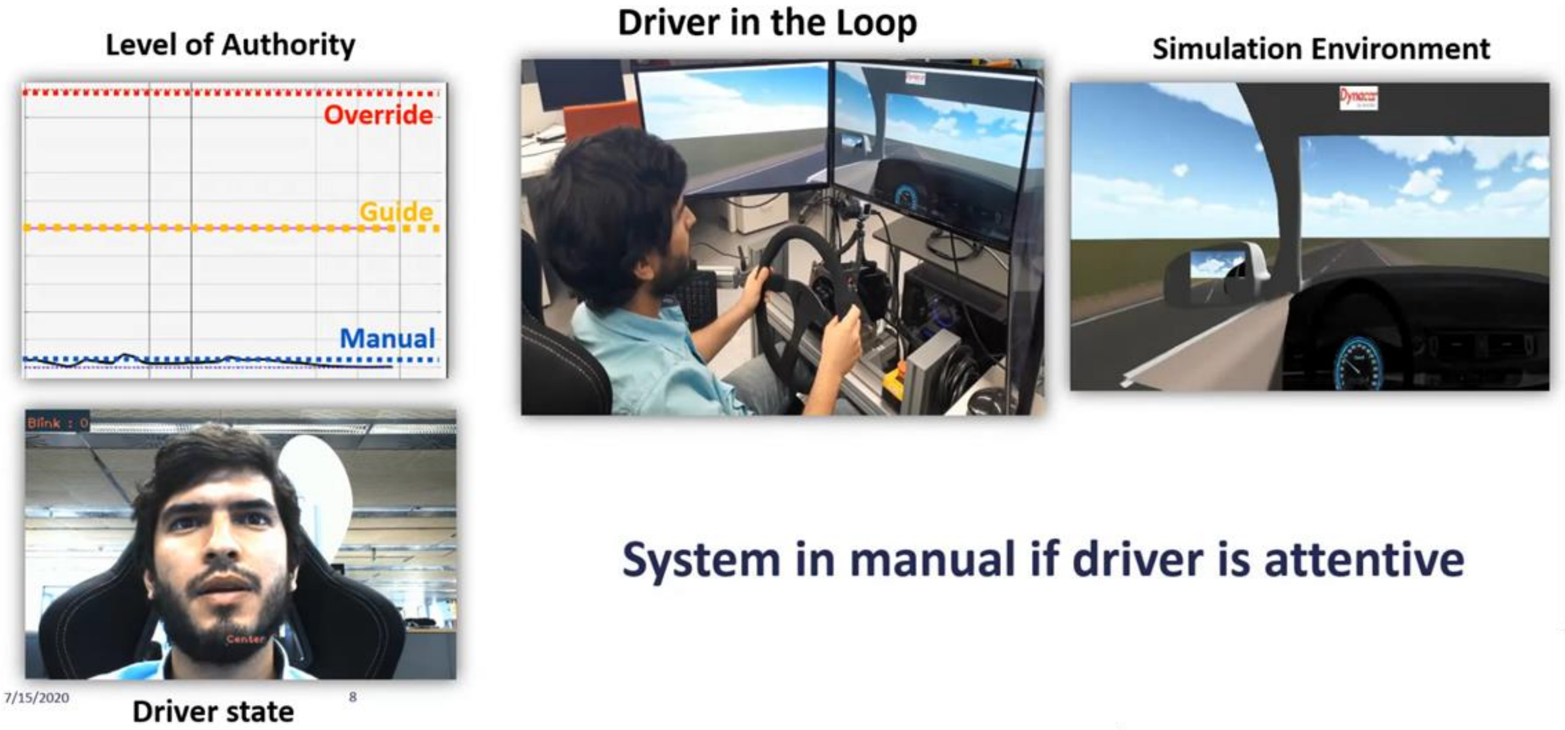


First prototype of the shared control module

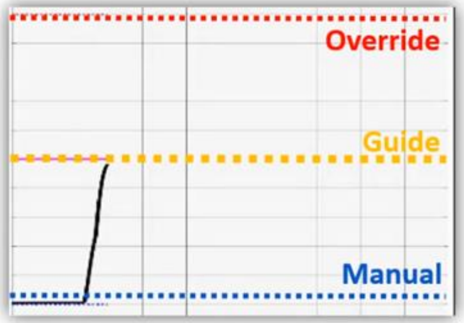
Support to distracted driver



First prototype of Shared Control module

Support to distracted driver

Level of Authority



Driver in the Loop

Simulation Environment

7/15/2020 **Driver state** 8

Driver gets distracted and automation is activated

First prototype of Shared Control module
Support to distracted driver

Level of Authority

Driver in the Loop

Simulation Environment

7/15/2020

Driver state

8

Distracted driver deviates from the lane and automation overrides

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GRACIAS
THANK YOU

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