BRAVE : BRidging gaps for the adoption of Automated VEhicles

SAFER Partner Day, 11 March, 2022

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723021

WHO IS BRAVE ?

vti Fraunhofer IAO UTAC CERAM Universidad de Alcalá ircas next move collaboration is the driver RACC AMZS ACFR AUSTRALIAN CENTRE FOR FIELD ROBOTICS CALIFORNIA PATH

BRAVE

SAFER Associated project!

10 PARTNERS

7 countries

France, Germany, Slovenia, Spain, Sweden, Australia, US

45 MONTHS

1 June 2017 – 28 Feb 2021

≈3 M€

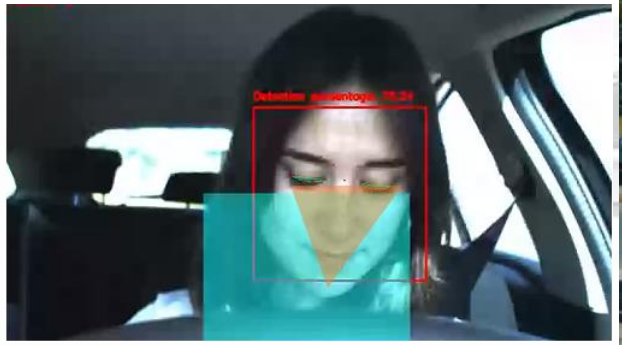
2,990,538 € funding

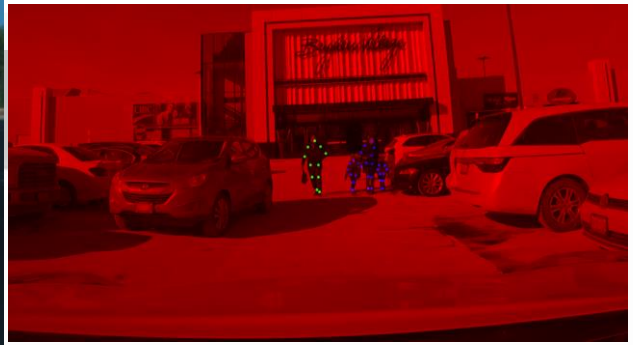
has aimed at:

Understanding and identify acceptance gaps for highly automated vehicles

Addressing the gaps – develop solutions & demonstrate functionality

Identifying mechanisms to encourage application of solutions into vehicles





What we did

Multidisciplinary study –

requirements & expectations; all road user types & organised stakeholders

Develop innovative HMI-paradigms --

bridge gap between users & automation technologies

Enhance current ADAS by new predictive algorithms --

increase accuracy of paths prediction (of vehicles, VRU) to reduce the reaction time in emergency maneuvers

Evolve validation protocols & propose enhancements --

for assessments (regulation, consumer testing)

BRAVE Population Survey

Online Dec'19 – Feb'20

≈1000 respondents in each of 7 BRAVE countries

- Focus: acceptance of and the trust in level 3 AV from the perspective of
  - vulnerable road users (VRU)
  - drivers of conventional cars

- Results:
  - Acceptance is positive, not yet widespread
  - Lack of trust, scepticism to own use
  - Road users favour communication with AVs through eHMI
  - Differences between distinct road user groups & country of residence

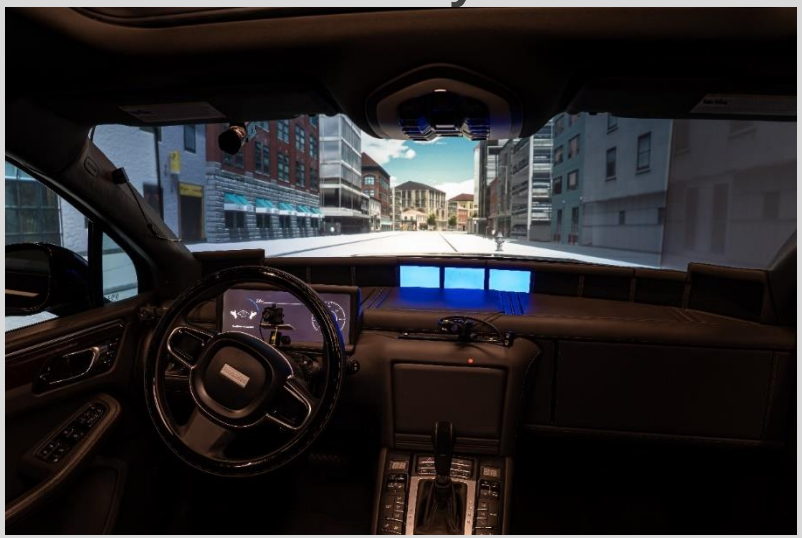
Addressing acceptance/ trust

BRAVE HMI guidelines

Simulator studies

- *General guidelines*

- If system in control, drivers do not want to be disturbed.
- **System transparency** on what the vehicle does, and why, can enhance trust.
- Amount of information provided (e.g. car's intentions) should be adjustable (e.g. depending on the **driver's trust and experience** with the system).
- To **inform** driver about the vehicle & the environment: mainly use **visual feedback.**
- **Auditory and haptic feedback** – only if **driver reaction is necessary**.



- *Driver Monitoring and warning strategy*

- Different warning alarms depending on driver's distraction level and type of distraction

Addressing acceptance/ trust

External HMI (pedestrian)

VR – pedestrian simulator studies

Population Survey | State of the Art | User Workshop

General recommendations

- **System transparency** about what the vehicle does – e.g. deceleration

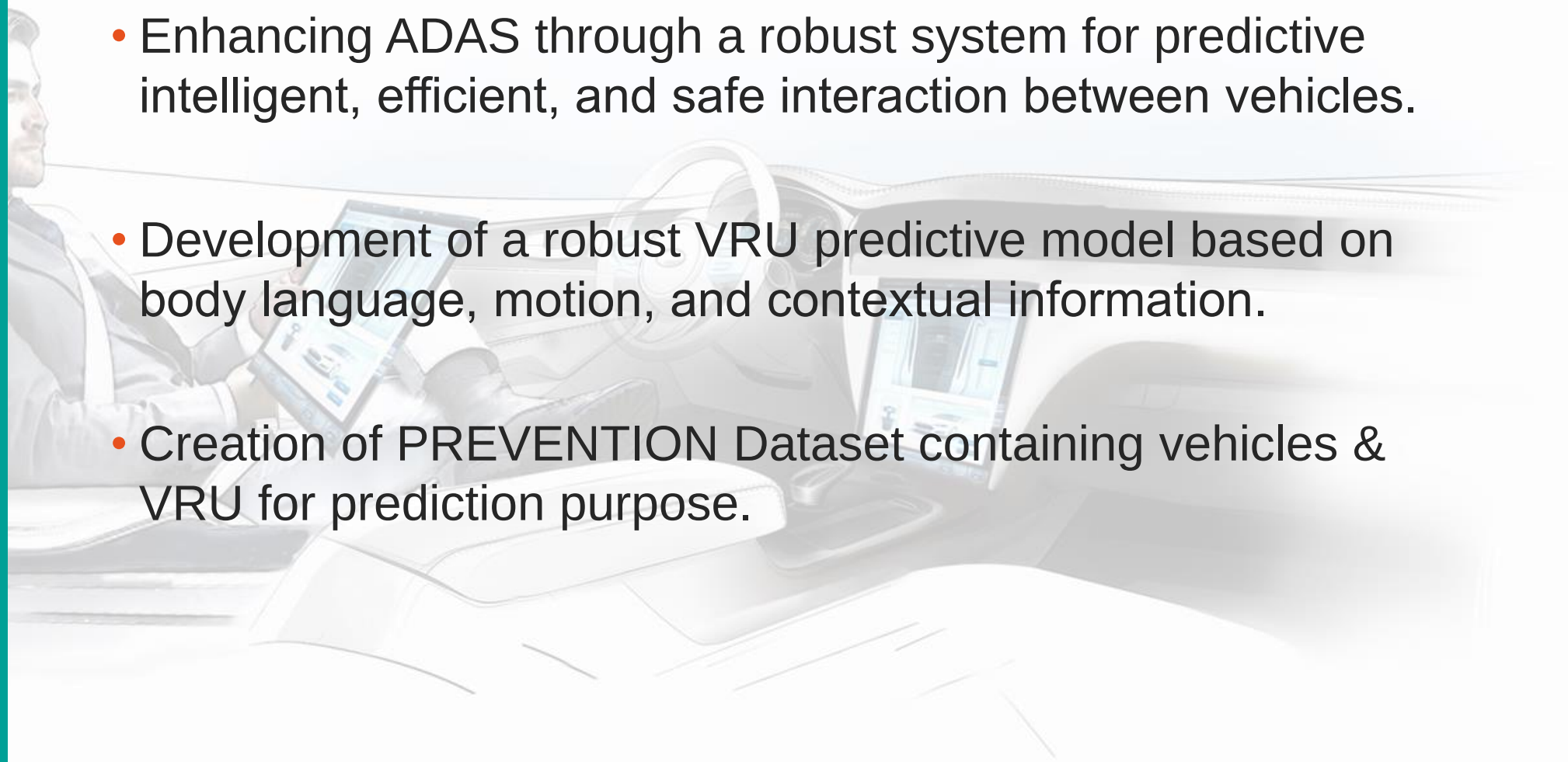
- Visual modality to inform
- Auditory modality to warn – familiar sounds! (e.g. horn)

- **Vehicle movement as part of the eHMI**

- **Careful integration –**
  - timing of vehicle dynamics & messaging
  - early & visible decelerations

New prediction algorithms

General approach



- Enhancing ADAS through a robust system for predictive intelligent, efficient, and safe interaction between vehicles.
- Development of a robust VRU predictive model based on body language, motion, and contextual information.
- Creation of PREVENTION Dataset containing vehicles & VRU for prediction purpose.

New prediction algorithms

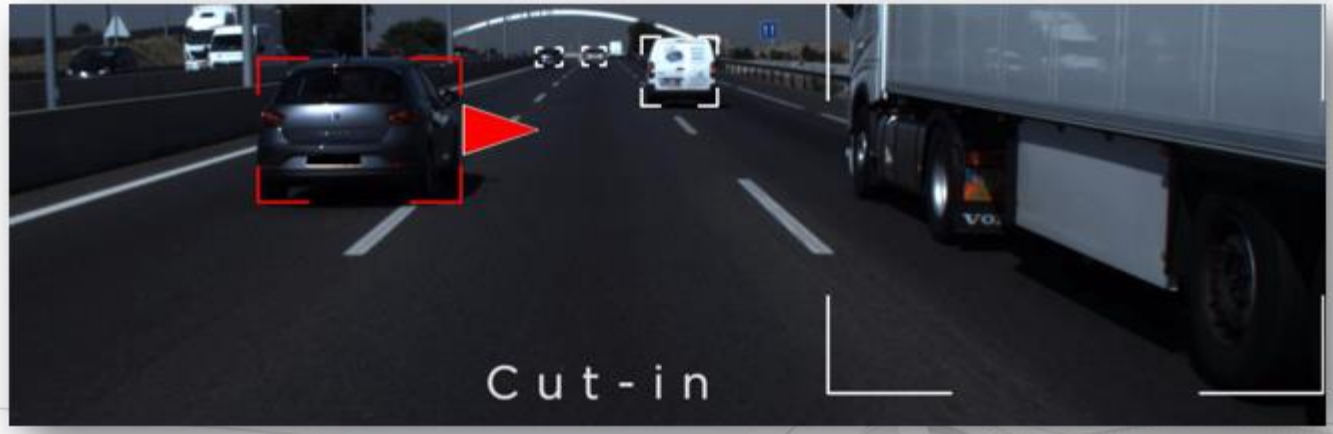
Predictive system

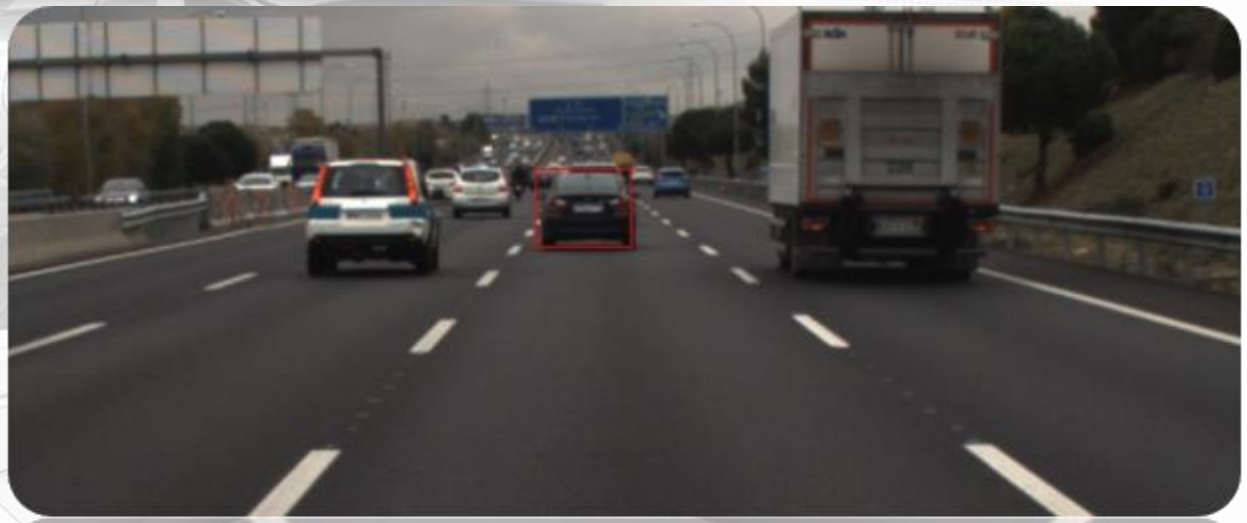
- Anticipating pedestrians’ intention to cross.

New prediction algorithms

Predictive system

- Lane change prediction





New prediction algorithms

Predictive system

•Assessment of Predictive Performance

- **Comparison with BRAVE Predictive system:**

Accuracy:	85%
Average Human delay:	1.08 s
Average BRAVE delay:	0.66 s

BRAVE predictive system overcomes humans' anticipation in lane changes by 0.42s.

Addressing acceptance/ trust

Simulator studies

System predicting possible VRU conflict

Predicting / Anticipating system → →

- Driver trust in AV ↗
- Driver ability to react to sudden pedestrians ↗
- Supports driver to determine when to engage in other task

Additionally:

- Predicting systems that increase the time for motion planning

→ → smoother deceleration

→ → Safety & Comfort ↗

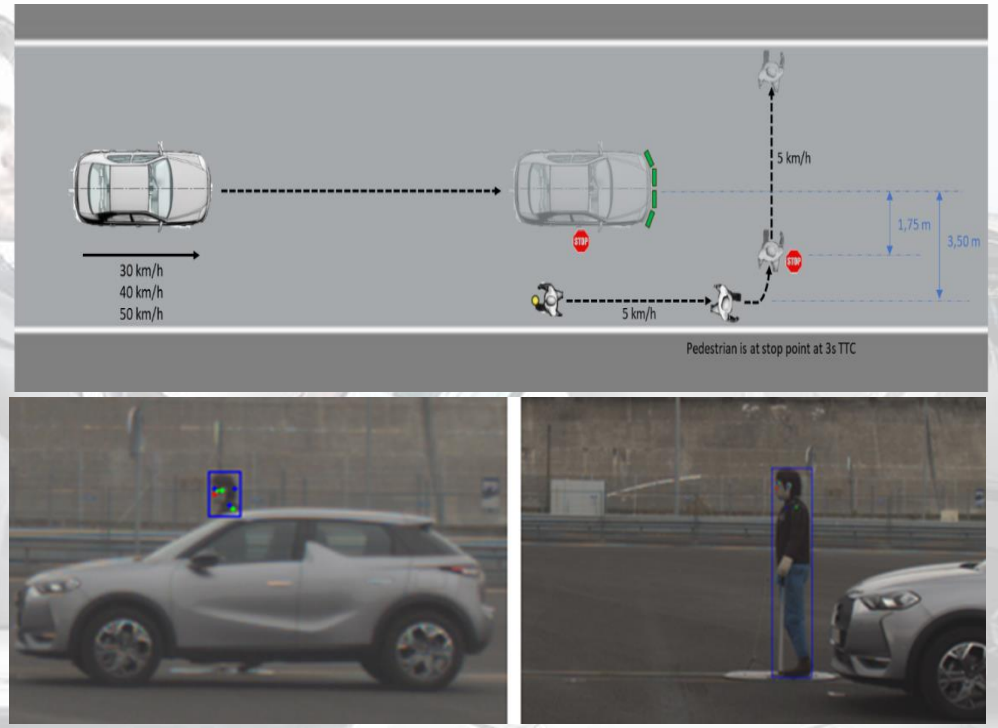
→ → Acceptance ↗

Methods for evaluating trust enhancing systems

4 proposals

Starting point: EuroNCAP test protocols

1. Articulated pedestrian dummy (H2020 project PROSPECT) - more realistic human representation & enable anticipation-oriented scenarios.



Scenarios to identify pedestrian & anticipation maneuver

2. Car-to-Pedestrian Longitudinal to Nearside crossing Adult New scenario

3. Partially obscured pedestrian scenario

4. Smooth driving assessment (currently not assessed) proposal for criteria to complement current EuroNCAP AD protocol

CONCLUDING REMARKS

What are the gaps for acceptability of highly automated vehicles?

Examples of solutions that aim at bridging the gaps?

- Transparency of automation status is important to occupants, other road users

- Interior HMI guidelines and concept
- Driving monitoring and warning strategy
- Vehicle´s deceleration etc as part of eHMI for VRU

- Predicting / Anticipating system - for better and faster reaction
- PREVENTION Dataset containing vehicles & VRU for prediction purpose
- Development of VRU detection (CNN-based) and prediction (RNN-based) system.

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And how can they reach wider application?

- Test protocols to recognise predictive systems – recommendations to EuroNCAP and regulatory WG's

THANK YOU

for your attention!

http://www.brave-project.eu/

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Questions?

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