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Artificial Intelligence for Adaptive, Responsive, and Level-Compliant Interaction in the Vehicle of the Future

Motivation

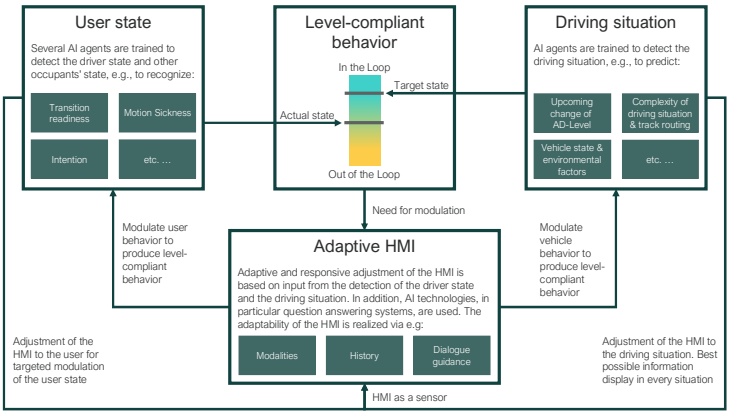
- Automated driving systems need
  - **level-specific human-machine interactions** and
  - **driver state models**
- **Artificial intelligence (AI)** offers the potential to exceed the performance and functions of current State-of-the-Art systems

- The KARLI project develops three AI applications
- All applications contribute to a common use case: LCB is supported by the AII and also integrates MS as a non-appropriate state.

Applications

i. The **level-compliant behavior application (LCB)** determines the driver state and compares it with dedicated KARLI User Role requirements in all levels of automation
ii. The **AI-interaction application (AII)** focuses on user and situational adaptive multimodal human-machine interaction and system reaction with the aim of creating a positive user experience
iii. The **motion sickness prediction and mitigation application (MS)** combines environmental and personal factors to predict motion sickness and uses the AI interaction application to provide personalized and proactive support to motion sickness prone users

Method



- KARLI achieves **level-compliant behavior** by a **congruence** of the **current user state** and its **target state**
- The approach establishes **mode and situation awareness** and **readiness for transition** and **adapts** the **trajectory planning** and the **automation level** accordingly
- Detailed **labeled data sets** are collected in **real vehicles** to investigate the potential of AI for driver and occupant monitoring in a **scalable "small-to-big data" approach**
- **Rural roads** serve as the main application context
- KARLI features **four vehicles**:

Results

- The project results will be **demonstrated in four real vehicles** (proof of concept)
- The results will be evaluated at the end of the project, the KARLI applications will be assessed regarding **AI performance measures** and **user experience benefits**
- As one of the first project results, **five KARLI User Roles** have been defined
- The roles extend the SAE levels of driving automation, with a focus on driver's role.

KARLI User role		Description	Related SAE-Level
	Active Driver (K-R1)	Responsible, active driver who may be supported by assistance systems.	L0 and L1
	Monitoring Driver (K-R2)	Responsible driver who is supported by assistance or automation systems that take over the driving task under permanent supervision of the user.	L2
	Standby Driver (K-R3)	Responsible driver who is supported by automation systems that take over the driving task completely but can request the user to take over at any time (fallback).	L3
	Temporary Passenger (K-R4)	Passive passenger on defined sections of the route. User must possess and maintain driving ability during the trip for transitions into lower AD levels.	L4 (Sub-Trip)
	Permanent Passenger (K-R5)	Passive passenger during the entire journey. User does not need to possess nor maintain driving ability.	L4 (Full-Trip) and L5

Discussion

- The KARLI project is approaching two main challenges that are ambitious and have a high potential:
  i. **Raising and investigating the potential of AI** for driver monitoring and driver-vehicle interaction in the context of (partly) automated driving
  ii. **Accelerating the transfer from research to series production applications**

Conclusion

- The KARLI methodological approach and the target applications raise awareness on the work in progress and discussion in the scientific community
- The created knowledge and the generated data are highly valuable for further research projects and further work of the KARLI partners

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