EU-Projects on Automation of Road Transport and the iMobility Forum: Joint Systems Perspective

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Overview

- Motivation for Joint Driver-Automation System Design

- Joint System components addressed in EU-Projects and iMobility Forum

- Application examples for highly automated road transport systems
Motivation for Joint System Design

- Raising number of different ADAS used in parallel
- Raising complexity of particular ADAS used in parallel
Toward Joint Human-Machine Systems Design

Technology centered system design
- Systems Engineering

Human and user centered system design
- Human Factors
- Assistance Systems

Joint System design
- Concepts?

Diagram concept: Denis Javaux
Joint Driver-Automation System: Elements

- Simplified **human** perception-action model
- **Machine** as a **cognitive agent**
- Human and machine **interacts** with each other

- Human and machine **compete** for vehicle control (shared control)
- **Arbitration** using
  - self-organization
  - role, task, control allocation

(*) Hollnagel & Woods, 1983
Joint Driver-Automation System: Elements

HMI

Co-driver

Mobile Devices

VRUs

Traffic Management

picture sources: http://office.microsoft.com
- Supported by EU commission & ERTICO (Brussels)
- DLR, TRL, ITS LEEDS, ICCS, IFSTTAR, UNIROMA, VEDECOM, TU EINDHOVEN, UNI CHALMERS, TU DELFT, EUCAR, VALEO, HIT

- Human Factors in Highly Automated Road Transport
- Automation effects on driver & other traffic participants (e.g. VRUs)
- HF related Joint System design issues
  - System distribution vs. system integration (e.g. connectivity effects)
  - Controllability (e.g. automation level transitions)
  - Observability (e.g. joint HMI concepts)
  - Usability
- HF related roadmaps & recommendations for the EU commission
Joint Driver-Automation System: Taxonomy

- **Human Factors** is about human related system **problems**
- **Human Factors** is about human related system **solutions** as well
- **Interaction Design**
  - uses Human Factors knowledge
  - technical requirements meet Human Factors

<table>
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<tr>
<th>Generic problem</th>
<th>generic solution</th>
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Joint Driver-Automation System: Design Patterns

- **Automation Levels*** and transitions
  - Problem of correct human-machine control distribution
  - Quantitative solution
  - How much automation is there?

- **Cooperation Modes**
  - Problem of correct human-machine task allocation
  - Qualitative solution
  - Who does what and how?

- Both perspectives are **compatible** to each other***

(*) Parasuraman et al. 2000,  (**) Hoc 2001,  (***) EU-Project D3CoS D3-03
Joint Driver-Automation System in EU-Projects

- Joint System
- Automation Levels
- Transitions…

- Design patterns for cooperation
- Cooperation modes
- Methods & Tools…

- Inform/Warn/Intervene strategies
- Joint HMI Concepts
- Arbitration…

Deliverable D3.2 | IWI Strategies | Executive Summary
Joint Driver-Automation System Design Aspects
Join System Controllability: Decoupling Concept

- Joint System performance in conditions
  - no automation
  - steering intervention (coupled)
  - steering intervention (decoupled)
  - true vs. false decoupling

- FASCar II from the German Aerospace center (DLR)
- equipped with steer-by-wire system
- Possibility to decouple the driver from vehicle control

- Obstacle covering half the lane
- Unfolds in 0.8 sec.
Controllability: Steering intervention (decoupled)

Light barrier

50 km/h

Obstacle

Driver can recouple

0.5 sec.

Driver decoupled

0.3 sec.

Manual driving

Manually driving

Manual driving
Controllability: Driver Decoupling Concept

- ‘true’ decoupling
  - Lateral deviation (50 km/h) in ‘true’ decoupling was significantly higher than in other conditions → GOOD
  - ‘True’ decoupling seemed to be well controllable for the driver

- ‘false’ decoupling
  - Lateral deviation (30 km/h) in ‘false’ decoupling was significantly higher than in other conditions → BAD
  - ‘False’ decoupling seemed to be badly controllable for the driver
Joint System Observability: HMI Concepts
Joint System Observability: Cooperative Lane Change

120 km/h

80 Km/h

Conflict

70 km/h
Joint System Usability: Cooperative Lane Change Assist

- Well accepted system design
- Easy to understand
Our research focus in...

- Designing a Joint System
- Ambient display
  - visual, haptic & acoustic stimuli
- **Idea:**
  - Transporting information by using peripheral vision
  - Supporting / inhibiting drivers’ actions by using affective design
- **Aim:** Improving performance in
  - primary driving tasks
  - automation mode transitions
  - in normal & emergency situations
Conclusion

- Developing ADAS and vehicle automation, systems become complex

- Closely integrated Joint System Design is needed

- EU-Projects are addressing Joint System components, methods & tools

- Exemplary solutions show the possible developments in the future

- DLR develops Joint Systems enriched with affective HMI
References

Thank You

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