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Dr. Joscha Wasser

Vehicle Automation in Partially Automated Convoy Driving for Military Logistic Trucks

Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE







Fraunhofer FKIE develops models, methods and tools for **networked operational Command and Control Systems**.

Locations	Wachtberg and Bonn
Founded	1963
Fraunhofer	since 8/2009
Staff	> 500
Budget	> 40 Mio €
Director	Prof. Dr. Peter Martini
Website	www.fkie.fraunhofer.de

Research Areas

- Sensor Data and Information Fusion
- Communication Systems
- Human Systems Engineering
- Information Technology for Command and Control
- Balanced Human Systems Integration
- Product and Process Ergonomics
- Cognitive Mobile Systems
- Cyber Analysis and Defense
- Cyber Security
- Usable Security and Privacy

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System Ergonomics

balanced Human Systems Integration

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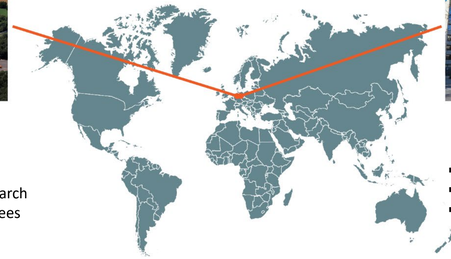
Germany

- A world wide leading organisation for applied research
- 75 Institutes, 29.000 Employees
- #WeKnowHow



RWTH AACHEN UNIVERSITY

Germany

- German Excellence University
- Top 100 world wide
- IDEA League with TU Delft, Chalmers, ETH Zürich, Polytechnico Torino
- „THINKING THE FUTURE“

Human Systems **Analysis**: Design Space, Use Space, Validation Space, Tension Fields

Human Systems **Exploration:** Participatory Design, Rapid Prototyping

Cooperative Automation/AI

StrAsRob

TAFinA

Interaction Design

GaBaCo

EnUSi I & II, MESiKa

Extended Reality

ARiE

ARJODAA

ESAR

Validation: Balanced Analysis

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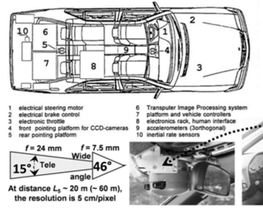
Agenda

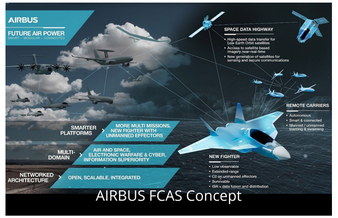
Motivation for TAFinA

High level driving automation systems are getting close to entering the civil market (L3 Mercedes) but has its origins in aviation and in ground vehicles the early work was driven by the military.

DARPA Grand-Challenge 2004/2005
Completing a 150mile Desert Course without human intervention

EUREKA-PROMETHEUS-Project, UniBw München (1987–1995)
Versuchsfahrzeug für autonome Mobilität und Rechnersehen (VaMoRs)





AIRBUS FCAS Concept


Method Development

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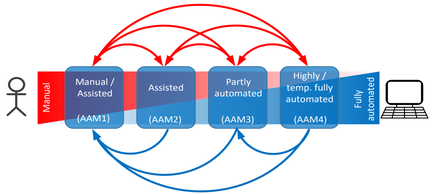
Cooperative Automation / AI: StrAsRob - Road Transport with Assistance by Robots

Flemisch et al. 2008; inspired by Sheridan & Verplank 1978 and Parasuraman et al. 2000

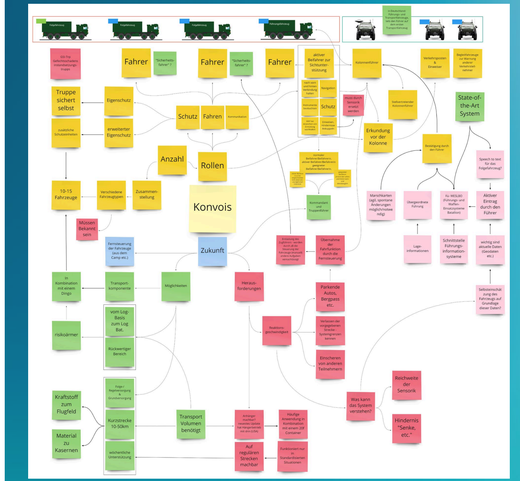
Baltzer & Flemisch 2013

Modes and Transitions in StrAsRob



Availability of different Assistance functions ordered in superior Assistance and Automation Modes (AAM):

- **AAM1:** passive, driver-informing Assistance, e.g. distance warning, lane departure warning, etc.
- **AAM2:** additionally to the driver-informing Assistance, the automation takes over longitudinal control
- **AAM3:** automation takes over longitudinal and lateral control. Driver must supervise and be ready for take-over in a 5 second time frame.
- **AAM4:** automation takes over longitudinal and lateral control. Driver needs not to supervise but needs to be ready for take-over in a 10 second time frame.



Workshops

- Military driver trainers, strategists, military drivers
- Extended understanding of how convoys are structured and used
- A realistic use scenario for the InterRoc system
- Information on how crews act within a convoy
- Typical procedures during a convoy: Communication, Setup, Incidents

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Test Case Catalogue

1. Hand over driver initiated – A-Kit to Manuel
2. Hand over A-Kit initiated – A-Kit to Manuel
3. Hand over driver initiated – Manuel to A-Kit
4. Assemble convoy
5. Start drive
6. Come to stop
7. Drive straight
8. Drive turns
9. Overtake of a vehicle
10. Foreign vehicle in the convoy
11. Intentional separation of the convoy
12. Unintentional separation of the convoy
13. Emergency Stop
14. Push Back
15. Change in road condition (Tunnel, Slalom, Obstacle)
16. Control following distances using the UI
17. Avoid a stationary obstacle
18. Teleoperation

Additional Factors

General factors, relevant to all cases

Road surface (Forest track, Gravel, Asphalt, Concrete, ...)

Road conditions (Slippery, Muddy, Grippy, ...)

Weather conditions (dry, windy, sunny, dusty, rainy, ...)

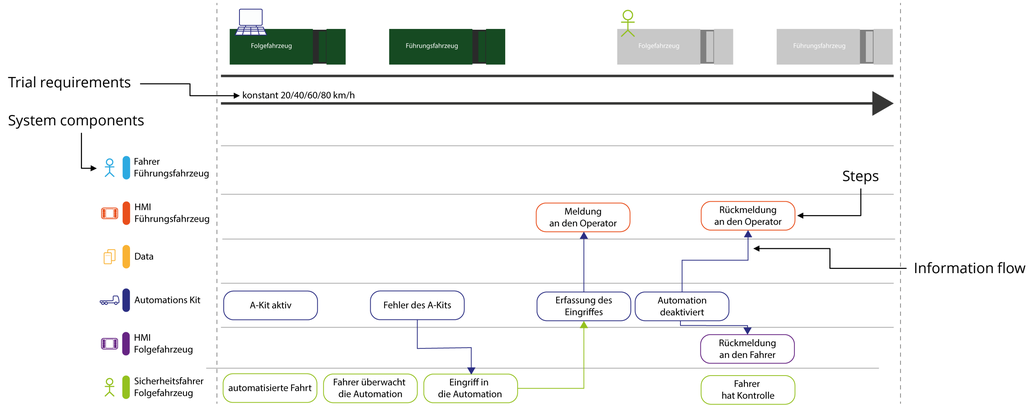
Light conditions (Bright sun light, Shadow, Cloudy, Sunset, Night, ...)

Load & Trailer (Weight, Axels, ...)

Robustness of the system (Connectivity, Sensors, ...)

Schematic

7. Fahrerinitiierte Übergabe A-Kit -> Manuell



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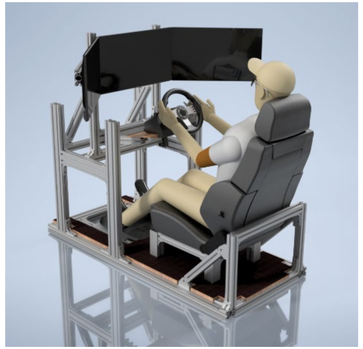
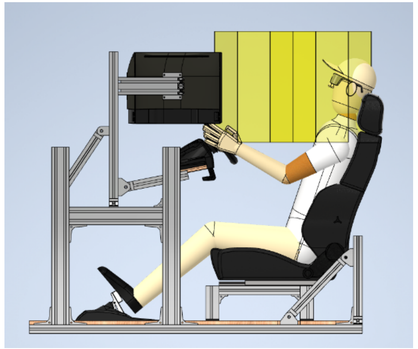
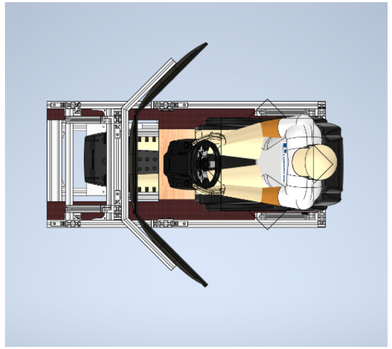
Reconstruction of the main driver space

Adjustable Pedalbox, Steering wheel and seating position & 3x 27“ Screens, flexible mounts







Creation of a MotionLab

- Specifically for the evaluation of driving automation
- Bosch Rexroth Micro Motion 600
- Driving dynamics
- Influence on the simulator immersion
- Evaluation of the interfaces in rough terrain
- Up to three vehicles in a single joint simulation

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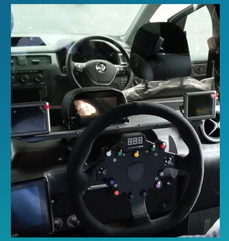
Theatre method
based on the „Wizard of Oz“ method

- A „wizard“ (a researcher) simulates a complex system function such as a driving automation for a participant without their knowledge, creating the impression of a real function.
- In the theater method, the metaphorical curtain can be opened, and the participant can interact directly with the researcher to jointly adjust the function, as if the two (or more) would be on a theatre stage.
- The method was first used at NASA in Langely by Flemisch et al. (2003) and later refined at DLR by Schieben et al. (2009)



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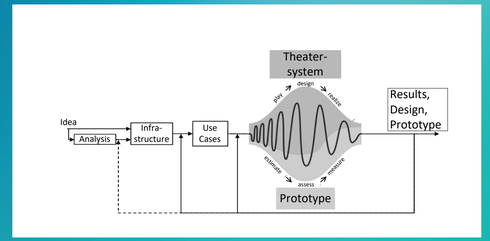
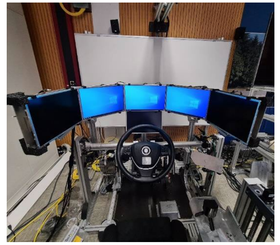
Paravan WoZ Fahrzeug



Based on: Schieben et al. (2009)

Main Driver & Wizard

- 3 Monitors (extended view)
- Mock-Up/ Vehicle dynamic of the MAN HX
- Connected steering und pedals



Lead vehicle

- Simplified setup
- Shown as MAN HX
- Lead vehicle (safety driver setup)
- Follower vehicle (lead driver setup)

Civilian vehicle

- Simplified setup
- Shown as passenger vehicle (Citroen)
- Merging into the convoy
- Creating a road block

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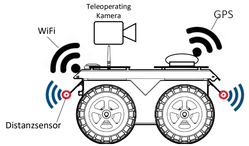
Field Test

- Demonstrating the test cases in reality
- Two Jackals (in combination with a Husky) from Clearpath Robotics
- Manually controlled lead vehicle
- GPS localisation



“driving off“

“slow driving in a straight“

“coming to a stop“

“driving turns“

Vehicle Tests

Conducted by the German Army and Rhein Metall

Test Case 15. Change in road condition (Tunnel, Slalom, Obstacle)

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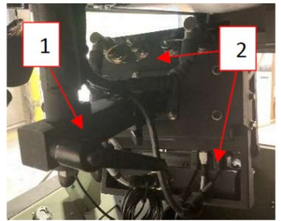
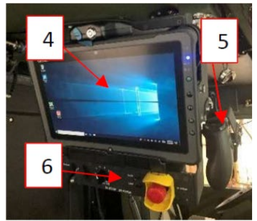
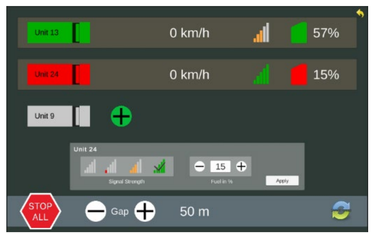
User Interface

Warfighter Maschine Interface (WMI)

- Single touch screen interface for the control of the convoy
- Integrated in all vehicles
- Assembly and Overview of joint vehicles
- Basic vehicle information
  - Description
  - Automation Status
  - Connectivity
  - Fuel
- Game Controller for remote driving







Research Challenges

- User in Loop
  - Monitor the system
    - Controllability
  - Take over ability
    - Mode awareness / confusion
- Different Users
  - Driver of the lead vehicle
  - Convoy operator
  - Safety driver
- Generic copy for the simulation
- Take-over animation to change between manual and automated mode

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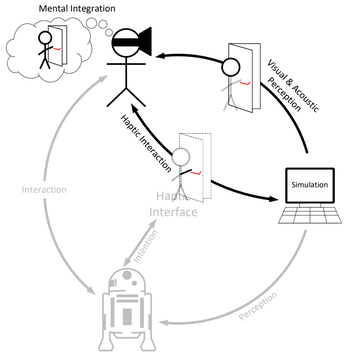
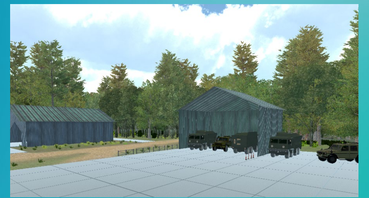
Development of a method for the evaluation of vision support systems in battle spaces



- *Tangible XR Simulator*
  - *A development tool – not a high fidelity training simulator*
  - *Very agile and cost effective*
  - *Strong immersion due to haptic feedback*
  - *The methodology can be used to develop and evaluate a number of aspects of crew work stations*

Future Outlook

- *Comparison study with a real vehicle evaluation*
- *Integration of real hardware using NGVA*
- *Connectivity and Networking to enable the evaluation in more complex, multi-national and larger scenarios with multiple units*



Digital recreation of the NATO Training Ground „Munster“

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Thank you!

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