Automated Driving - Driving Experience & Road Map

Prof. Bernhard Schick, Seda Aydogdu, University of Applied Sciences Kempten
Introduction and Challenges

Fireworks of ADAS /AD technologies

- Environment Sensors
- Environment Model
- Artificial Intelligence
- New Functions
- Sensor Simulation
- Virtual Validation
Introduction and Challenges

Fireworks of ADAS /AD technologies

- Environment Sensors
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- Artificial Intelligence
- New Functions
- Sensor Simulation
- Virtual Validation
It is about the human being ...  
and how the human being accepts new technologies!
Introduction and Challenges

Vehicle fleet show a relative low technology penetration of Advanced Driver Assistance Systems

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<th>Year of Registration</th>
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* Overall Vehicle Fleet 59,1 % < 10 years, 40,1 % > 10 years  
Source: Mobile.de
Positive driving experience remain important!
Introduction and Challenges

Customer **acceptance and trust** will be the key to a successful introduction of (highly) automated driving.
Motivation and Method Approach

How to transfer today’s “fun-to-drive” into future “fun-to-be-driven” within an attribute-driven development?
Reality?
Where are we standing?
Sample: “State of the Art” Level 2 Function

Function of a Lane Keeping Assistance System

Edge Guidance
Sample: “State of the Art” Level 2 Function

Function of a Lane Keeping Assistance System
Drift Weaving

Sudden System Drop-Out
1. Drift Weaving
2. Object Lost
3. Sudden System Drop-Out
Drift Weaving
Object Lost
Sudden System Drop-Out
Object Hopping
Object Lost
Sudden System Drop-Out
How does customer feel?

What does he accept and what are no-go‘s?

How can we improve the human experience?
Subject Studies with Customer Test Rides

With real cars, real systems on public roads!

- > 300 test persons: survey*
- > 30 specialist evaluations
- > 70 physiological measurements
- > 2000 online survey*

*with Kano Method
Subject Studies with Customer Test Rides

„I love big cars...“

„This is a great vehicle brand! The lane keeping assistant can't be bad...“

„awesome car!“

„My dream is fulfilled! I’m allowed to drive this car!“

„Thank you for allowing me to experience that!“

„Absolutely great!“

„Immediately when I’m sitting in it I feel more relaxed...“

„My husband is jealous of me...“

„The car is sexier than a woman!“

„I’m glad it worked out this time.!”

„The brand is just amazing“
Subject Studies with Customer Test Rides

Survey

Stress- and Vehicle Measurement

**Measurement**
- **Hearth Rate Variability**
  - ECG – Electrocardiography
- **Skin Conductibility / Wetness**
  - EDA – Electrodermal Activity
- **Pulse Rate**
  - PPG – photoplethysmogram
- **Relative Depths of Breathing**
  - RSP – Respiratory Rates

**Indication**
- Physiological Stress
- Emotional Attention
- Physiological Stress
- Physiological Stress

Length of the entire test track: 70.5 km
Travel Time: 50 minutes
Subject Studies with Customer Test Rides - Results

Subjects feel more stressed with LKAS instead of without LKAS

Subjectively perceived stress "with" versus "without" lane-keeping assistant

Statistical Analysis >50 Measurements
Subject Studies with Customer Test Rides - Results

Unexpected, sudden or difficult situations leads to strongly increasing of skin wetness = MENTAL STRESS
Subject Studies with Customer Test Rides - Results

Fulfillment Degree of the systems

Importance of Criterion

Fulfillment Degree Vehicle 1

Fulfillment Degree Vehicle 2

Fulfillment Degree Vehicle 3

Availability

Driver-Vehicle Interaction

Edge Guidance

Lane Tracking Quality

HMI

Vehicle Reaction

De-Stress

Safety Feeling
Subject Studies with Customer Test Rides - Results

“I can not believe they sell it.”

„They did not do their homework...“

“This is absolutely annoying.”

„Am I the assistant or is it the system?“

„What’s wrong with that?“

„If this is a lane keeping assistant, then it’s a joke!“

„I can not count on it.“

„I do not trust it!“

„The developers can not be satisfied with that ... “

“You can turn that thing off!”

„I feel better when I drive myself ...“

„It drives snake lines - that's bad! "

„It was worth a try...“

„So close to the other cars - that's a bit scary for me ...“

„This is a total disaster! “

„It was worth a try...“

„I pretend it was a planned lane change."
"The most important thing about ADAS/AD is that it is common used. And it's only used when it's experienced as usefulness and ease of use."
Conclusion and Outlook

Maslow’s Hierarchy of Needs

- **Physiological Needs**: Trust; 100% (subjective) Availability
- **Safety and Security**: Predictability; Safety Feeling; Central guidance with early support
- **Social Needs**: Clear Instructions & Communication; Minimal Monitoring
- **Individual Needs**: Clear Feedback
- **Self Actualization**: Fun

For lane keeping assistant system
Conclusion and Outlook

LKAS significantly reduces the steering torque effort while driving

Steering torque histogram of 50 subjects with and w/o LKAS

Unexpected steering interventions or overrule by the driver.
Conclusion and Outlook

Consideration of mental stress is of immense importance for a holistic comfort assessment beside physical stress.
We want people to love cars in the future too!