Connecting Austria
Lead project for connected, cooperative, automated driving

Connecting energy-efficient and semi-automated trucks from the motorway to the city

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A3PS Conference
November 2018
Expected Benefits from Automated Driving

- Sounding project for test field for automated driving 2016/2017
- Validation concept for automated driving functions
Expected Benefit Categories for Automated Driving

- Changing traffic modes
- Choosing the right traffic mode according to the given situation

**Benefits of Automated Driving**

- **Comfort**
  - Driving slow
  - With low density
- **Safety**
  - Driving slow
  - With low density
- **Traffic Effectiveness**
  - Changing traffic modes
  - Choosing the right traffic mode according to the given situation
- **Traffic Efficiency**
  - Driving faster
  - With high density
  - More responsive
- **Vehicle Efficiency**
  - Less responsive
  - Driving slow
  - High density for wind shadow

The only intrinsic feature!!!

- E.g., automation levels 3
Methods of Choice in Development and Validation of Automated Driving Functions

- Scenario-based Development
- Prospective Effectiveness Assessment
- Machine Learning & AI
- Integral and Holistic Top-Down Development Procedures
Scenario-Management and Development/Approval of Actions

(Monte Carlo) Variations of
- actions and vehicle characteristics
- behaviours (driver & traffic)
- streets & environment
- traffic (volume & constitution)
- traffic control
- communication (Car2X)

➢ MILLIONS OF SIMULATIONS
Detection Rates versus Misclassification for Algorithm

Sensor Concept Variants

- SC-01
- SC-02
- SC-03
- SC-04

➤ Specification for necessary sensors and information (incl. V2X)
Prospective Effectiveness Assessment

Partially dramatic differences in effectiveness
• due to details in concept realization (i.e. wrt sensors and algorithms)
• due to situations in specified „field of effectiveness“

See:
• On the Performance Evaluation of Integral Safety Systems, Andreas Kuhn et.al., SafetyAssist 2013
• Development Processes and Accompanying Performance Evaluations of Integral Automotive Safety Systems, FISITA 2014
Connecting Austria

- Lead Project for Automated Driving in Austria
- Platooning as instrument for improved energy and traffic efficiency
- Development and assessment of cooperative, connected, (semi-)automated driving strategies
- 4 Principal Scenarios
4 Principal Scenarios

S1: Highway Entry
S2: Highway Danger Zones
S3: Highway Exit
S4: Controlled Intersection
Main Entities with Effects on Automated Driving

- Traffic Situation
- Traffic Control & Management Systems
- Infrastructure
- Laws & Guidelines
- ADAS & Automated Driving
- Behavior of Drivers & Traffic Participants

Effects:
- Comfort
- Safety
- Vehicle Efficiency
- Traffic Efficiency
- Traffic Effectiveness
Main Entities with Effects on Automated Driving

Traffic Control & Management Systems

- Traffic Situation
- ADAS & Automated Driving
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- Behavior of Drivers & Traffic Participants
- Infrastructure

Quantification of Dependencies

- Comfort
- Safety
- Vehicle Efficiency
- Traffic Efficiency
- Traffic Effectiveness

Control Algorithm

Cooperation
R&D Approach / Procedures

- Comfort
- Safety
- Vehicle Efficiency
- Traffic Efficiency
- Traffic Effectiveness

Theoretical Potentials and Effectiveness

Practical Potentials and Effectiveness

Risks and Potential Counter Effects

Total Multidisciplinary Effectiveness

- Naturalistic Driving
- Traffic Observation
- Scenario Management

- Infrastructure & V2X & Traffic Control
- Vehicle Control Strategies
- Laws & Guidelines
- Dynamic Road Risk Map
Theoretical Potentials and Effects Due to Wind Shadow

- Theoretical fuel savings due to reduced distances
- Evaluation for different distances and vehicle configurations
- Practical effectiveness e.g. including reduced cooling
What are the (theoretical/practical) potentials of platooning according to traffic efficiency?

- What are the traffic advantages due to reduced distances in comparison to real traffic situations?
- Evaluation of realistic traffic situations (together with ASFINAG)

- Theoretical potentials wrt traffic densities and flow rates
Which traffic situations will result in additional congestion?

- Example
  - Elephant races: overtaking with few speed differences
  - Overtaking of long truck pelotons

Potential risks wrt traffic congestions
Different cooperative control strategies and their consequences

- Scenario based evaluation of different vehicle control strategies

- Potentials and risks of control and driving strategies for more safety and efficiency
What are necessary lengths and durations for overtaking?

- When to begin/avoid overtaking for prevention of avoid weaving

- Potential risks wrt safety
Advantages due to local and temporal compression?

- **Scenario**
  - Lane reduction
  - Tunnels, construction sites, accidents

- **Target**
  - Efficient lane merge
  - Minimal lost time
  - Maximum safety
  - Avoidance of congestion

- **Example:**
  - Zip-Assistant System
Traffic Micro Model of Hallein

- Scenario based evaluation of different traffic control strategies
- Extensively validated micro model of Hallein for evaluation of different control strategies and traffic situations
Simulation of different control strategies
- Variation of vehicle control actions
- Variation of traffic control actions
- at different traffic situations

- Green time extension
- Green time start assist
- Local compression

Traffic Analysis for Test Region Hallein
Evaluation of Traffic Situations with xFCD

- Automated detection of relevant traffic scenarios

- FCD evaluations and anomalies detection already running
Automated Object Detection

- Video-Tracking of all traffic participants
Automated Detection of Traffic Situations

- Video tracking with continuous trajectories across intersections

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Comfort  Safety  Vehicle Efficiency  Traffic Efficiency  Traffic Effectiveness

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Automated Detection of Anomalies and Dangers

Driving at wrong lane  Diagonal crossing of intersection
Data Acquisitions from Fleet and In-Vehicle Data (Naturalistic Driving)
Solution Concept for Development/Validation
Automated Driving and Traffic Automation

Scenario Management
Scenario Catalog

- Simulations
- Naturalistic Driving
- Connected Mobility
- Test Fields

The Data Cube(s) for Vehicle and Traffic Automation

- Artificial Intelligence
- Big Data Analytics
- Robustness Mgt
- Complexity Mgt
- Effectiveness Rating
- Reference Systems
- System-of-Systems
- Conflict Analysis
- Cond. Probabilistics
- Var. Labellings

Variation of Systems/Components
Variation of Situations / Conditions
Variation of Actions
Variation of Behaviours

- Quick Identification and Resolution of Requirement Conflicts
- System Understanding
- Conform Specification of Components
- Realistic Performance Ratings
- Best Control Algorithms

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Dynamic Risk-rated-map

Adaptive wrt
- local conditions
- traffic situation
- weather
- temporal incidents
- ...

[Map with various colors and labels indicating different categories such as Free For Platoon, Non free For Platoon, Entries, Exits, Bridges, Tunnels]
Summary and Conclusions

- Connecting Austria: lead project for connected, cooperative, automated driving
- Scenario-based development of platooning strategies and control policies
- Focus on infrastructure aspects and safe traffic/vehicle efficiency
- Carry on validation concept from WienZWA
- Preparing next steps for Car2X
- Open for 3rd party Platooning Tests
Thank you

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13 Project Partners
Projektdaten

- Projektdauer: 36 Monate
- Projektstart: 01/01/2018
- Projektbudget: 4,3 MEuro
- Projektförderung (bmvi): 2,5 MEuro
- www.connecting-austria.at
- Projektleiter: Dr. Wolfgang Schildorfer, mailto: connecting-austria@hitec.at
Technisch inhaltlicher Hintergrund

- Ausgangssituation
- Ergebnisse aus WienZWA
Example of „Misinformation(?)“ about Traffic Situation

What’s going wrong?
- TMC-Message?
- C-ITS-Message?
- Internet?
- Data fusion algorithm of car?
- Policy of message provider?
- Typing error of operator in traffic management center?
- Error of algorithm for traffic prediction?
- Misinterpretation of C-ITS codes?
- ...

Consequences for automated car?
- Stop?
- Reroute?
- Gain confidence? Ask for confirmation?
- Eyes (/ears) shut and go for it?
- ...

Traffic Control & Management Systems

ADAS & Automated Driving

Traffic Situation

Infrastructure

Laws & Guidelines

Behavior of Drivers & Traffic Participants
Main Entities with Effects on Automated Driving

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- Traffic Control & Management Systems
- ADAS & Automated Driving

Diagram showing relationships between entities.
Laws of Robotics aka Asimov's Laws

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

- Automated cars must be very conservative and defensive!
- Will other traffic participants compensate to take individual, singular advantage?

- Singapur's solution: FINES for non-cooperative bahaviour
Who takes over responsibility and coordination?

**Thought experiment:** crowded situation at intersection with automated, self driving vehicles

Nothing different than today!

- Somebody has to take the lead and control
- Traffic control cannot be avoided and skipped

But:

- Self driving cars can be trained to be cooperative
- Traffic control must be refactored/redesigned to take advantage

**Automation of traffic control**
Who takes over responsibility and coordination?

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  - **Automation of traffic control**
Data Driven and Evidence Based Development Procedure

- Overwhelming complexity requires new development and testing paradigms

- Open test fields as common playground for all disciplines
Dependent Methods for Automated Driving Development

- Complexity & Robustness Management
- Effectiveness Rating
- Parametrized Field of Effectiveness
- ML based Reference Algorithms
- Process Automation
- Conflict Analysis
- Big Data Analytics
- Artificial Intelligence & Machine Learning
- Anomalie & Incident Detection
- GIS
- Behavioral Models
- Usability Testing
- Naturalistic Driving
- Open Test Fields

Scenario Based Approach
- different actions/systems
- different situations
- different behaviours
- different components
- different detailization levels

System-of-Systems Architecture

Connected Mobility
Evaluation and Rating of the Systems and Components

- Evaluation of effectiveness accompanying the product development process

Market driven > Requirements/Spec

Field of Effects

Electronics

Sensors

Algo

Action

Neural Networks, Machine Learning

Functional requirement for algorithm:
- Which action to take when
- in which situations
- based on which sensors/information

Effect! > Visible to customer
Scenario Management and Automated Design/Development of According Actions