FOT-Net seminar: Tools for gathering and analysing data

Session: Tools for data gathering in different FOTs
- euroFOT -

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Agenda

- Introduction
- The euroFOT project
- Methodology
- Data gathering
- Data analysis
The euroFOT project
Consortium and Budget

Duration and Budget

- Start of project in May 2008
- Duration 50 months (end of project: June 2012)
- 28 partner, 22 mio € budget, 14 mio € funding from EC
The euroFOT project

Objectives

• Assessment of impacts of ADAS in real traffic, by focusing on the analysis of:
  - safety
  - traffic efficiency
  - environment
  - driver behaviour
  - driver workload
  - user acceptance
  - usability

• Cost-benefit analysis, based on results from impact assessment
Das euroFOT project
Tested functions

Longitudinal Control Functions
- Forward Collision Warning (FCW)
- Adaptive Cruise Control (ACC)
- Speed Regulation System (SRS)

Lateral Control Functions
- Blind Spot Information System (BLIS)
- Lane Departure Warning (LDW)
- Impairment Warning (IW)

Advanced Applications
- Curve Speed Warning (CSW)
- Fuel Efficiency Advisor (FEA)
- Safe Human Machine Interaction (SafeHMI)

Around 1000 Vehicles

- CAN + Video + Extra Sensors: 35
- CAN + Video: 150
- CAN only: 275

460 Data Loggers in total

1500 questionnaires to 300 vehicles with LDW
50+ FEA trucks auto-logging
The euroFOT project

Test sites

- **Swedish-VMC**
  - VOLVO Trucks
  - VOLVO Cars

- **German1-VMC**
  - FORD
  - MAN
  - VW/AUDI

- **German2-VMC**
  - DAIMLER AG
  - BMW Group

- **French-VMC**
  - RENAULT

- **Italian-VMC**
  - FIAT
Methodology
Implementation plan

Preparation:
- Function Identification & Description
- Use Cases
- Research Questions & Hypotheses
- Performance Indicators
- Study Design
- Measures & Sensors

Analysis:
- Ethical & Legal Issues
- Socio-economic Cost Benefit Analysis
- Impact Assessment
- Research Questions & Hypotheses Analysis
- Data Analysis
- Database
- Performance Indicators

Driving:
- Data Acquisition
Methodology
Experimental design

- First three months will serve as a baseline period
- Within baseline period functions will be deactivated
- In the following treatment period functions are activated
- Drivers are free to activate functions as they usually do (no supervisor present)
- Testing of hypotheses by comparison of baseline vs. treatment period

Experimental design:

<table>
<thead>
<tr>
<th>Time 1</th>
<th>Time 2</th>
<th>Time 3</th>
<th>Time 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month 1</td>
<td>Month 2</td>
<td>Month 3</td>
<td>Month 4</td>
</tr>
<tr>
<td>Month 5</td>
<td>Month 6</td>
<td>Month 7</td>
<td>Month 8</td>
</tr>
<tr>
<td>Month 9</td>
<td>Month 10</td>
<td>Month 11</td>
<td>Month 12</td>
</tr>
</tbody>
</table>

227 vehicles (ACC + FCW)
Baseline (A) (-)

Treatment (B) (ACC + FCW)
Methodology
Definition of required signals

Research questions:
e.g. impact of ACC on safety, environment, traffic efficiency etc.

Hypotheses:
e.g. ACC decreases number of incidents

Performance indicators:
e.g. number of incidents

Signals:
e.g. vehicle speed, distance to forward vehicle, deceleration etc.
Methodology
Continuous vs. event based recording

**Advantages**
- Detailed analysis of data possible (e.g. causation and impact)
- Additional data for result interpretation available
- Data usage for other purposes after project

**Disadvantages**
- Large data sets
- Expensive data acquisition systems
- More complex data upload processes needed
- Data selection offline within data processing task

**Advantages**
- Reduced data amount
- Reduced efforts for data processing and data analysis
- Reduced costs for data acquisition systems

**Disadvantages**
- Detailed description of relevant event at beginning of data collection
- Missing information can lead to limited analysis
Data gathering
Data acquisition systems

BMW
Daimler
Ford, VW, Audi, Renault
Volvo
Data gathering
Instrumentation of vehicles

French VMC: Renault

German VMC OC1: Ford, VW, Audi, MAN

German VMC OC2: BMW, Daimler

Swedish VMC: VCC, VTEC
## Data gathering

### Overview participants

<table>
<thead>
<tr>
<th></th>
<th>French VMC</th>
<th>German VMC Operation Centre 1</th>
<th>German VMC Operation Centre 2</th>
<th>Italian VMC</th>
<th>Swedish VMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target number of vehicles</td>
<td>35</td>
<td>100</td>
<td>100</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>No. of vehicles participated FOT</td>
<td>40</td>
<td>101</td>
<td>57</td>
<td>32</td>
<td>(20)</td>
</tr>
<tr>
<td>No. of vehicles currently running</td>
<td>40</td>
<td>10</td>
<td>57</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>No. of involved drivers</td>
<td>40</td>
<td>130</td>
<td>80</td>
<td>32</td>
<td>(20)</td>
</tr>
</tbody>
</table>

972 vehicles participated with 1068 drivers
Data gathering
Overview collected data

<table>
<thead>
<tr>
<th>Operation site</th>
<th>Total Mileage [km]</th>
<th>Mileage used for statistical data analysis [km]</th>
<th>Hours of driving [h]</th>
<th>Type of Collected data</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEESAR (French) OS</td>
<td>600.000</td>
<td>545.340</td>
<td>14.000</td>
<td>Video, CAN and CAN only</td>
</tr>
<tr>
<td>Ford (German OC1) OS</td>
<td>2.030.000</td>
<td>1.490.000</td>
<td>61.844</td>
<td>CAN only</td>
</tr>
<tr>
<td>MAN (German OC1) OS</td>
<td>7.500.000</td>
<td>180.000</td>
<td>182.467</td>
<td>CAN only</td>
</tr>
<tr>
<td>VW (German OC1) OS</td>
<td>300.000</td>
<td>130.000</td>
<td>6.315</td>
<td>CAN only</td>
</tr>
<tr>
<td>BMW (German OC2) OS</td>
<td>383.392</td>
<td>330.049</td>
<td>6.021</td>
<td>CAN and video</td>
</tr>
<tr>
<td>Daimler (German OC2) OS</td>
<td>629.870</td>
<td>610.858</td>
<td>9.108</td>
<td>CAN and video</td>
</tr>
<tr>
<td>Fiat (Italian) OS</td>
<td>&gt;8.000.000</td>
<td>8.000.000</td>
<td>194.632</td>
<td>Questionnaires only</td>
</tr>
<tr>
<td>VCC (Swedish) OS</td>
<td>1.069.460</td>
<td>1.069.460</td>
<td>26.019</td>
<td>CAN and video</td>
</tr>
<tr>
<td>Volvo (Swedish) OS</td>
<td>14.356.000</td>
<td>4.000.000</td>
<td>97.316</td>
<td>CAN and video</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34.868.722</strong></td>
<td><strong>16.355.707</strong></td>
<td><strong>597.722</strong></td>
<td></td>
</tr>
</tbody>
</table>
Data gathering
Overview trips

~ 1 000 000 Kilometers
Data gathering
Complexity of data management

![Diagram showing the relationship between fleet size, duration of monitoring, and data management methods.](image)
Data gathering
Integration of logging system

All customer vehicles were equipped with a data acquisition system (DAS), which enables recording of all relevant signals.

Driver is not involved in any of the data acquisition processes.

- Data upload procedure (upload of data from the DAS to a server system) is performed without any requirements and interactions with regard to the driver.

DAS is a small and compact unit that can easily be integrated in the vehicle.

- No modifications on the customer vehicles needed.

DAS is equipped with a GPRS module.

- Wireless upload of collected data to centralised server.
Data gathering
Overview collection of CAN data

- Collection of around 100 vehicle signals from CAN-Bus
  - Data of vehicle dynamics ($a_{lateral}$, $a_{long}$, $v_{ego}$ etc.)
  - Status of driver assistance systems (active/passive etc.)
  - Driver activities (operation of instruments)
  - Position (GPS)

- Process of data upload and processing is designed to work fully autonomously

- No driver interaction required
Data gathering
Data management - software architecture
Data management
Monitoring - Fleetmanager
Video data is stored on integrated storage devices (> 1TB)
Data upload by exchange of hard discs (e.g. monthly basis)
Exchange of hard discs by experts from operation site
Data analysis
Tools for data analysis
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