Driver Interaction with in-vehicle-telematic systems – a micro-simulation approach

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Problems:

- more information vs. limited intake capacity
- what are requirements for in-vehicle telematic systems
- challenge: interplay of different sources of information
- aim: optimal process of information
LI VES - Projekt

Research Questions

• What is the best sensory modality with respect to the given information

• How does information, given simultaneously from different systems, effect the driver

Goal

Development of guidelines for optimization of in-vehicle telematic systems in cars
Experimental Set-up I

• Empirical test in special developed test environment

• Five scenarios in which the test persons receive information from two different systems

• Every test person drives through the test track twice, whereas the modality in which the information is given differs in the two test drives.
## Test Situations

<table>
<thead>
<tr>
<th>Systems</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; run</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route Guidance</td>
<td>haptic</td>
<td>acoustic</td>
</tr>
<tr>
<td>Traffic news</td>
<td>acoustic</td>
<td>acoustic</td>
</tr>
<tr>
<td>ISA</td>
<td>haptic</td>
<td>acoustic/visual</td>
</tr>
<tr>
<td>Traffic news</td>
<td>acoustic</td>
<td>acoustic</td>
</tr>
<tr>
<td>Information about parking place</td>
<td>acoustic</td>
<td>visual</td>
</tr>
<tr>
<td>Additional information where to park</td>
<td>visual</td>
<td>acoustic</td>
</tr>
<tr>
<td>Pedestrian warning system</td>
<td>acoustic</td>
<td>haptic</td>
</tr>
<tr>
<td>Route Guidance</td>
<td>visual</td>
<td>acoustic</td>
</tr>
<tr>
<td>ACC</td>
<td>visual</td>
<td>acoustic</td>
</tr>
<tr>
<td>Traffic news</td>
<td>acoustic</td>
<td>acoustic</td>
</tr>
</tbody>
</table>
Experimental Environment I

Simulator

Experimental environment was programmed with BLENDER - software

Measured variables:
• control of pedal and steering wheel movement
• intake capacity of traffic information during the test rides by questionnaire
• behaviour observation
• subjective satisfaction
Experimental Environment II

- Two beamer projected the picture on a white wall
- Customary steering wheel for racing games
- Two pedals (acceleration and breaking pedal accordingly to an automatic car)
Experimental environment IV

- Traffic signs:
  - to guide the test drives through the course
  - speed limits
  - passing bans

- Random generated traffic volume but also based on the behaviour of the test person virtualised cars and pedestrians

- Simple engine noise based on the driven speed

- Data logged during the whole test rides
Evaluation

Sample

<table>
<thead>
<tr>
<th></th>
<th>18 till 29 years</th>
<th>20 till 49 years</th>
<th>over 50 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>female</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

\[ \sum = 19 \]

Evaluation methods

• Statistical evaluation for speed and steering wheel movement

• Behaviour observation with the help of video recording
General results

• None of the test persons could accomplish all tasks or reacted correctly on all given information

• None of the test persons could answer all question about the traffic news correctly

• Conclusion: simultaneous information leads either to an overload of the driver or is simply not perceived by the driver
# Level 1: Warnings which need an immediate reaction

<table>
<thead>
<tr>
<th>Modality</th>
<th>Type of information</th>
<th>Acoustic</th>
<th>Visual</th>
<th>Haptic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Warnings, high priority</td>
<td>+</td>
<td>-</td>
<td>(-)</td>
</tr>
<tr>
<td>Acoustic</td>
<td>suited well, it can be instinctively handled. Speech is not adequate</td>
<td>confirmed by the results of the simulator study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual</td>
<td>not adequate, modality is to slow to transfer the information in critical situation, is overlooked easily</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haptic</td>
<td>hardly any literature, short breaking impulses lead to an erroneous interpretation of the driver and therefore was stated as dangerous</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

was not tested in the project
Level 2: Retarded/latent Instruction - no immediate reaction needed

<table>
<thead>
<tr>
<th>Modality</th>
<th>Type of information</th>
<th>Acoustic</th>
<th>Visual</th>
<th>Haptic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium priority</td>
<td>Acoustic signals are experienced as hindering and therefore should not be used for this level</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>confirmed by the results of the simulator study</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suitable. Drivers can partially decide themselves when they want to receive the information</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>confirmed by the results of the simulator study</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Haptic-Feedback helps the driver to adopt to the speed limit without nerving. Is functioning better than acoustic feedback</td>
<td>(+)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>confirmed by the results of the simulator study</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Level 3: General Information - no immediate relevance for the driving task

<table>
<thead>
<tr>
<th>Type of information</th>
<th>Acoustic</th>
<th>Visual</th>
<th>Haptic</th>
</tr>
</thead>
<tbody>
<tr>
<td>General information low priority</td>
<td>(+) possible, but not optimal, driver is distracted from the driving situation, confirmed by the results of the simulator study</td>
<td>+ adequate, distract driver not directly. Driver can decide himself if and when he wants to receive information, was not tested in the project</td>
<td>? Hardly any literature available, results of the simulator study gave no clear information</td>
</tr>
</tbody>
</table>
Guidelines I

1) Information and warnings have to be as simple as possible; they should include clear instructions for the driver what kind of actions have to be taken.

9) There should be the possibility that the priority level 3 information can be turned off.
Guidelines II

10) The simultaneous submission of information should, if possible, generally be avoided. The receiving of information from two different sources simultaneously is limited and distract the driver from the primary task.
Guidelines III

11) For some priority level 3 information speech could be used. Several messages from this area should not be submitted simultaneously. It has to be prioritised and the messages should be submitted consecutively.

• For detailed information there should be the possibility that the driver gets a visual message that the information is available, so that he/she could decide when the information will be submitted (this should not be done while driving)
Guidelines IV

12) The information with the lower priority should be submitted in a way that information/warnings from a higher level can be understood without any problems

- If information from a higher priority is acoustically submitted, all other information can be displayed visually with simple symbols and pictures but not in the direct visual field of the driver
- If the information from a higher priority is displayed visually, the submission of all other information should be avoided
Guidelines VI

13) The use of different modalities for the simultaneous submission of the same information is possible. Especially for acoustic and visual information
Next possibility park right and ask a pedestrian for the way!

Thank you for your attention
Priority of Information

3 priority levels:

- **level 1:** information which demand immediate reaction of the driver
  
  Examples: Pre-crash information, driver monitoring systems

- **level 2:** latent instruction - no immediate reaction needed, but ignored for a longer time, the information can change to a level 1 warning
  
  Examples: recommendation for the best route, ACC etc.

- **level 3:** general information - no immediate relevance for the driving task
  
  Examples: displays on the dashboard, traffic news, weather information etc.
Workshop

One-day Workshop with Austrian telematic experts

• Discussion of the results
• Problems of acceptance and user problems
• Recommendation for the guidelines
Test Situations I

Situation 1: Turning with Route Guidance and traffic news

Course A: Short Term Route Info *haptic*
Traffic news *acoustic*

Course B: Short Term Route Info *acoustic*
Traffic news *acoustic*
## Test Situations II

### Situation 2: Speed warning and traffic news

<table>
<thead>
<tr>
<th>Course A: ISA</th>
<th>Traffic news</th>
<th>Course B: ISA</th>
<th>Traffic news</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>acoustic</td>
<td></td>
<td>acoustic</td>
</tr>
<tr>
<td></td>
<td>haptic</td>
<td></td>
<td>acoustic / visual</td>
</tr>
</tbody>
</table>

### Situation 3: Driving on a parking space with additional information

<table>
<thead>
<tr>
<th>Course A: Route Guidance</th>
<th>additional information</th>
<th>Course B: Route Guidance</th>
<th>additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>acoustic</td>
<td>visual</td>
<td>acoustic</td>
<td></td>
</tr>
</tbody>
</table>
Situation 4: Pedestrian warning with Route Guidance

Course A: Pedestrian warning \textit{acoustic} \\
Route Guidance \textit{haptic}

Course B: Pedestrian warning \textit{visual} \\
Route Guidance \textit{acoustic}

Situation 5: ACC with traffic news

Course A: ACC \textit{visual} \\
Traffic news \textit{acoustic}

Course B: ACC \textit{acoustic} \\
Traffic news \textit{acoustic}