Transportforum 2011, 11-01-12
Martin Fischer
Agenda

• **Background**
  • ViP project SPASS

• **Emergency Lane Keeping Assistance - an autonomous system for the avoidance of frontal collisions**
  • Lane keeping assistance
  • Driving scenario

• **Sim IV – a realistic driving simulator for studies with advanced driver assistance systems**
  • Sim IV – the new VTI simulator in Gothenburg
  • Volvo’s Mozart system
  • Integrated ADAS test facility
Background
Institute Excellence Centre at VTI

Common platform for increased and long-term co-operation, competence building and knowledge transfer

Prospective perspective - 5, 10, ….. years

Development and application of driving simulator methodology
✓ Instrument for developing and exploring future vehicles and traffic environment from a user’s perspective
✓ Use of simulators in product development and evaluation
✓ Focus on the interaction between man and technology (HMI)

Combining 3 approaches
✓ Develop and co-ordinate a common technical framework for driving simulators
✓ Develop and use a common simulator based methodological framework
✓ Perform applied projects, guiding development right

Partners: VTI, Saab, Scania, Volvo Cars, Volvo Truck, SRA, Bombardier, Dynagraph, HiQ Ace, SmartEye, Swedish Road Marking Association

Funding: Vinnova and ViP partners

www.vipsimulation.se
Project Facts

ViP project SPASS
- Focus: Active safety function demonstrator
- Duration: 01/2010 – 04/2011
- Budget: 2,27 MSEK
- Partner: VTI, VCC, Viktoria Institute

FFI project QUADRA
- Focus: Driver models for interactions between driver and assistance systems
- Duration: 01/2011 – 12/2014
- Budget: 22,925 MSEK
- Partner: VTEC, Volvo 3P, VTI, VCC, Chalmers
ViP SPASS – Partners

VCC
* EESE AoV Systems Integration (Project mgmt and HIL Simulations)  
  Gunilla Karlsson, Martin Nilsson, Annica Normén
* Safety Center (Scenarios and Data Analyze)  
  Mats Petersson, Mikael Ljung Aust
* Active Safety Functions (Function Development)  
  Nenad Lazic
* EESE Safety Electronics (System Development)  
  Jonas Ekström
* EESE Vehicle HMI (Scenarios and HMI Properties)  
  Patrik Palo, Ingrid Pettersson
* Chassies AoV Active Safety (HIL Simulations)  
  Gaspar Gil Gomez
* Urban Kristiansson

Viktoria Institute
* HEV & EV Technology  
  Stefan Pettersson, Henrik Weiefors

VTI
* Vehicle Technology and Simulation  
  Martin Fischer, Jonas Jansson, Anders Andersson, Håkan Sehammar, Göran Palmkvist
ViP SPASS – Project Description

Titel
• SPASS - Strenghten Performance Active Safety Simulator.

Description
• SPASS will evaluate early development/rapid prototyping of new driver assist systems by utilizing an advanced driving simulator in combination with a vehicles electrical architecture (including sensors, actuators and HMI). As a case study, the project will demonstrate a novel active safety function which is rather well penetrated at Volvo Cars (i.e. Volvo Cars have reference vehicles up and running). SPASS primary focus is to visualize simulator performance during concept development. However, the results will also be useful for research as well as for verification of products. The project aim to use VTIs new simulator at Lindholmen; and by that pave the way to establish a simulator platform for evaluation of driver & system interaction.
Integrated Safety Function Test Facility
Emergency Lane Keeping Assistance - an autonomous system for the avoidance of frontal collisions
Integrated Safety Function Test Facility

Active Safety Function
Lane Keeping Assistance (LKA)

**LDW** (lane departure warning)
- **warns** with the help of sound when you accidentally run over lane markings
- is a function that is already in production

**sLKA** (safety LKA)
- **corrects steering angle** in order to straighten up the car when you are about to unintentionally leave the lane, and (if this is not enough)
- **vibrates** the steering wheel while crossing the lane markings

**eLKA** (emergency LKA)
- **takes care of the threat situations connected to unintended lane departures** (i.e. with oncoming vehicles)
- **Actively steers back** into the original lane
- Steer characteristic can be smooth (similar to the sLKA) or evasive depending on assessed danger
Driving Scenario – \( t_1 \)

At distance \( \Delta s_1 = 600 \text{m} \)
- the POV’s speed and
- the POV’s lateral position
will be related to the SV.

\[
v_1 + v_2 = v_{\text{relative}}
\]
Driving Scenario – \( t_2 \)

At distance \( \Delta s_2 = 250m \)

- both speeds will be fixed and
- the distraction task begins and
- the yaw deviation function starts.

Drivers are prompted by a pre-recorded voice to read back a sequence of 6 single digit numbers appearing on the display. Task duration approximately 2.8s.

In order to bring the SV into the opposite lane an additional heading angle is introduced to the visual system (but not to the motion system).
Driving Scenario – $t_3$

At time $t_3 = t_2 + 3s$

- heading angle ($\Psi_3$), as well as
- relative lateral ($\Delta r_3$) and longitudinal distances ($\Delta s_3$) between SV and POV

will be the same for all repetitions of the scenario.

The respective values are chosen such that the eLKA function is triggered at $t_3$. 
Driving Scenario – $t_4$

Between $t_3$ and $t_4$
- the eLKA function is going to steer the SV back to the own lane and
- the drivers reactions to the intervention can be studied.
Demo Set-up

3 groups of test driver

- VCC management
  - "Normal" driver with the following distribution
    - 50:50 male/female
    - 20% younger than 30
    - 20% older than 50

- VCC test driver/function developer

{ Demonstration }

{ Validation }
Next Step

<table>
<thead>
<tr>
<th>Driver state</th>
<th>FCW Warning</th>
<th>ELA Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alert</td>
<td>True Positive</td>
<td>True Positive</td>
</tr>
<tr>
<td></td>
<td>False Positive (2)</td>
<td>False Positive (2)</td>
</tr>
<tr>
<td>Drowsy/Distracted</td>
<td>True Positive (1)</td>
<td>True Positive (1)</td>
</tr>
<tr>
<td></td>
<td>False Positive</td>
<td>False Positive</td>
</tr>
</tbody>
</table>

- **ELA & FCW - False positives for alert drivers** – force over median using bicyclist
- **ELA & FCW - True positives for distracted drivers** – pour over median with yaw deviation

*vti*
Sim IV – a realistic driving simulator for studies with advanced driver assistance systems
Integrated safety function test facility

Driving Simulator
Sim IV motion system

- Bosch Rexroth
  - Hexapod
    - Excursions
      | Excursions   | Velocity | Acceleration |
      |--------------|----------|--------------|
      | surge        | +/- 0.80 m/s | +/- 6.5 m/s² |
      | sway         | +/- 0.80 m/s | +/- 6.0 m/s² |
      | heave        | +/- 0.60 m/s | +/- 6.0 m/s² |
      | roll         | +/- 40 deg/s | +/- 300 deg/s² |
      | pitch        | +/- 40 deg/s | +/- 300 deg/s² |
      | yaw          | +/- 50 deg/s | +/- 350 deg/s² |
  - XY-Sled
    - Excursions
      | Excursions  | Velocity | Acceleration |
      |-------------|----------|--------------|
      | Surge (X)   | 2 m/s    | +/- 5 m/s²   |
      | Sway (Y)    | 3 m/s    | +/- 5 m/s²   |
Sim IV sound system

Hardware layout:

![Diagram of Sim IV sound system hardware layout]
Sim IV projection system

- 9x Epson EB-410W projectors
- Mersive SOL software
  - Auto calibration
  - Edge blending
  - Color correction
- >180 degree field-of-view
Simulation software

- VTI kernel
  - Scenario and event control
    - Traffic
    - Weather
  - Data logging
  - Communication

- VTI vehicle dynamics model

- VTI graphics engine VISIR

- VTI motion cueing
Integrated safety function test facility

Vehicle Cabin
XC 60 cabin

- Rear- and Side-Mirror Displays
- Sound System
- Buttkicker
- Force Feedback Steering Wheel
- Virtual Cockpit Display

Specifications:
- Cycle time: 1 msec
- Rated torque: 7.5 Nm
- Maximum torque: 16.5 Nm
- Torque resolution: 0.03 Nm
- Angle resolution: 0.009°
Integrated safety function test facility

MOZART
Mozart – Project facts

Titel: Mozart, Model- and Hardware In the Loop simulator for vehicles
Duration: January 2006 – August 2008
Budget: 16MSEK
Partners: None
Implemented in conjunction with leading consulting firms

Background: Preparation of Salieri and Mozart were organized by Lindholmen Science Park along with Saab, Scania, AB Volvo and Volvo Car Corporation. Other scheduled participants were LSP, SP, VTI and 2-4 leading consulting firms. Salieri was cancelled and only VCC’s internal project Mozart was conducted.

Source: Martin Nilsson, VCC
Mozart – Project goal

Virtual environment
engine, crankshaft, roads, obstacles, tyres, weather etc.

Virtual cockpit
Interactive/automated driver interaction

Substitute node
Model running on rapid prototype hw

System under test
A mix from models to real components

Source: Martin Nilsson, VCC
Mozart – General simulator strategy

Traffic System

Vehicle

EESE System

Sub-system

Verification Environment for Vehicle-in-the-Loop "Right HW & SW – ASTA?"

Second Road (Function – Attribute – Shared Scenarios)

Hexapod & X-Y-table (Function – HMI & Technology)
  e.g. VTI Sim IV

MOZART II (Function – HMI & Technology)

HEV-HILs

Active Safety HILs

V2I resp V2V

Usability Simulator

Model Repository

Source: Urban Kristiansson, VCC
Integrated safety function test facility
Next steps

Sim IV
- Installation of moving base and dome
- Test phase, Initial motion tuning

→ follow progress via weblink: http://62.119.60.80/

SPASS
- Final tests with XC60 cabin
- Functional test eLKA
- Preparation of demonstrations
- Demonstration activity March/April 2011

Q1 2011