ISI-PADAS

Integrated Human Modelling and Simulation to Support Human Error Risk Analysis of Partially Autonomous Driver Assistance Systems

Funding: European (7th RTD Framework Programme)
Duration: Sep 2008 - Aug 2011
Status: Complete with results
Total project cost: €4,462,737
EU contribution: €3,276,151

Call for proposal: FP7-SST-2007-RTD-1
CORDIS RCN: 89119

Background & policy context:

The project encompasses 7 WPs. In WP1 experiments with human drivers were performed in order to generate an empirical basis for the driver model development and validation in WP2. In WP3 PADAS target systems were designed and prototypically implemented. These systems were used in second phase driver experiments in WP1 to investigate the influence of PADAS on driver behaviour. In WP4 a simulation platform was developed that integrates the driver models (from WP2) with models of the vehicle (including a target system) and the road environment (Joint Driver-Vehicle-Environment Simulation Platform) in order to enable closed-loop simulation of driver behaviour. This platform will provide an execution environment for the driver models and will allow the prediction of emergent behaviour including the prediction of driver errors in realistic traffic scenarios.

The simulation platform was used for two purposes in the project:

1. In WP2 the platform was used to execute the driver models in order to predict driver behaviour that can be compared with the data traces of human drivers recorded in the empirical investigations in WP1. This comparison will allow thorough validation of the driver models.
2. In WP5 the platform formed the basis for the development of a support tool for Human Error Risk Analysis as part of a risk based design process. The industrial requirements for such a tool will be analysed in WP5 and subsequently the tool was implemented and embedded in an improved methodology for risk based design of PADAS. The aim is to use the driver models (from WP2) within the simulation platform (from WP4) to simulate and analyse a vast number of scenarios in accelerated time to predict human error probabilities and risk to support classical safety analysis and human error risk analysis techniques.

Objectives:

The main objective of the ISI-PADAS project was to provide an innovative methodology to support risk based design and approval of Partially Autonomous Driver Assistance Systems (PADAS) focusing on elimination and mitigation of driver errors by an integrated Driver-Vehicle-Environment modelling approach. The methodology contributed to:

- Halving the number of road fatalities by 2010 (respect to 2001 levels) and reducing number and severity of injuries caused by road accidents;
- And decreasing the level of human error.

Methodology:

The targets described above were achieved through research and technology development in:

- Improved risk based design: implementation of a human error risk based approach for designing
advanced control systems, such as PADAS;
• Advanced driver modelling: development of models for predicting correct and erroneous driver
  behaviour, based on modern approaches and algorithms, capable of capturing the key aspects of
  human behaviour, and retaining the fundamental characteristics of cognition and decision making;
• Joined Driver-Vehicle-Environment Simulation Platform: integration of the driver models into a
  Driver-Vehicle-Environment computerised, fast running, and simple simulation tool for predicting
  driver behaviour and driver errors to be integrated in a risk based approach;
• New knowledge about driver behaviour including errors: extensive empirical studies and
  experiments with human drivers in real cars and car simulators will lead to new insights in sources
  of accidents and potential counter measures as a basis for the driver model development. A target
  system was developed to demonstrate the advantage of the new risk based design methodology
  with regard to an improved system design, a highly effective human error risk assessment and,
  consequently, an increased traffic safety.

The project encompassed Seven Work Packages (WP's), being:

• WP1: Empirical Investigation of Driver Behaviour;
• Wp2: Driver Modelling;
• WP3: Development of the PADAS Target System;
• WP4: Joint Driver-Vehicle-Environment Simulation Platform;
• Wp5: Improved Methodology for Risk Based Design;
• WP6: Dissemination and Exploitation;
• WP7: Project Management.

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Parent Programmes:
FP7-TRANSPORT - Transport (Including Aeronautics) - Horizontal activities for implementation of the
transport programme (TPT)

Institute type: Public institution
Institute name: The European Commission
Funding type: Public (EU)

Lead Organisation:

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EU Contribution: €726,640

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EU Contribution: €148,084
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<td>Centro Ricerche Fiat - Societa Consortile Per Azioni</td>
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**EU Contribution:** €307,451

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**Technologies:**

- Advanced driver assistance systems
- ADAS learning and harm prevention platforms

**Development phase:** Research/Invention

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**Key Results:**

Improvement of the current design process of driver assistance systems, such as Partially Autonomous Driver Assistance Systems (PADAS'), was the objective of this project. To achieve that a tool-supported risk based design methodology has been introduced, to enable evaluation of hazards associated with human error and/or inadequate driver behaviour.

With Risk Based Design ('RBD') it is possible to create predictions of critical or error-prone situations for drivers, using modelling and simulation. A huge amount of fully automatic simulations have been performed. These were based on models of the vehicle, the environment, the PADAS and the driver. For this purpose, ISI-PADAS developed a Joint Driver Vehicle Environment ('JDVE') Simulation Platform. Throughout the project the JDVE was used in different configurations: using human subjects or driver models, using PADAS or no assistance, and collecting data from real or simulated cars.

Several studies in different scenarios have been carried out, like: focussing on analysing driver behaviour without a PADAS, or investigating driver behaviour in interaction with different PADAS. Critical situations are most relevant for the risk assessment process but do not occur very often, even in
the case of many simulation runs. To provide a better estimation of probabilities of critical but rare situations, an approach based on Extreme Value theory has been used.

Finally, the applicability of the Risk Based Design methodology has been successfully demonstrated on traffic light approaches as use-case scenario.

**Innovation aspects**

Development of the Joint Driver Vehicle Environment (‘JDVE’) Simulation Platform. The major advantage is a substantial gain in speed of evaluation.

**Technical Implications**

This JDVE (Joint Driver Vehicle Environment) Simulation Platform serves as the core technical infrastructure of the simulation process and as a flexible framework for integrating different models and tools.

**Strategy targets**

Innovating for the future (technology and behaviour): A European Transport Research and Innovation Policy

Documents:
- ISI-PADAS Newsletter#1 (Other relevant documents)

**STRIA Roadmaps:**
Cooperative, connected and automated transport, Vehicle design and manufacturing

**Transport mode:** Road transport

**Transport sectors:** Passenger transport
Societal/Economic issues, Safety/Security, Digitalisation,

**Transport policies:** Decarbonisation

**Geo-spatial type:** Other