interactIVe

Accident avoidance by active intervention for Intelligent Vehicles

Deliverable D3.2 | IWI Strategies | Executive Summary

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SEVENTH FRAMEWORK PROGRAMME

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Executive Summary

The main goal of the interactIVe project is the design, development and evaluation of integrated advanced driver assistance systems (ADAS) with the aim of promoting safer and more efficient driving. To achieve this goal, several functions are integrated in seven demonstrator vehicles – six passenger cars and one truck. The functions belong to three concepts: (i) continuous driver support (developed in Sub Project 4, SECONDS), (ii) collision avoidance (developed in Sub Project 5 INCA), and (iii) collision mitigation or collision avoidance support (developed in Sub Project 6 EMIC). Integration of these applications allows sharing of vehicle components among the various safety functions which further allows establishing low cost solutions and might help to promote the distribution and usage of active safety functions. To support this goal a common integrated sensor and perception layer is developed in Sub Project 2.

Along with the technical development, implementation and integration of the envisioned assistance and automation functions, it is essential also to focus on the driver who remains the most essential actor also for the foreseeable future. The driver must be able to control the vehicle and understand and accept the assistance and automation offered by the various ADAS. In essence, the function is what the driver perceives, not what has been technically implemented. As the technical capabilities of ADAS increase and the automation is able to take over the driving task to a certain extent in certain situations, the design of the human-machine interaction becomes more than just a question of acceptance and drivers' personal preferences. It becomes safety-relevant!

In order to achieve an optimised interaction, it is important to consider the human-automation-vehicle interaction as a whole, see **Fehler! Verweisquelle konnte nicht gefunden werden.**. Therein, driver and automation can be viewed as two "intelligent" entities that share vehicle guidance (with varying degree of participation depending on the abilities of the automation, the situation and the driver's wish). They communicate directly or indirectly via the HMI and their respective influence on the motion of the vehicle. Note that the HMI is not limited to displays and speakers etc. and hence does not solely focus on warnings but it includes the haptic devices like the steering wheel or the pedals and regards the resulting behavior of the vehicle body (e.g. velocity, acceleration, yaw rate) just as well. Therefore, our work includes the whole chain from information and warnings to active interventions. Since active interventions are likely to be most safety critical if not designed properly, this part must represent the focal point of our work.

Analogously to the integration of the technical components, it is a main goal in interactIVe to integrate all ADAS information, warnings, and interventions into an overall function in order to maximise the efficiency with respect to the intended effects on driver behaviour. From a driver's perspective it is also highly desirable and even safety-critical to achieve consistency and compatibility not only within one vehicle but also across different vehicles and to harmonise the interaction concepts.

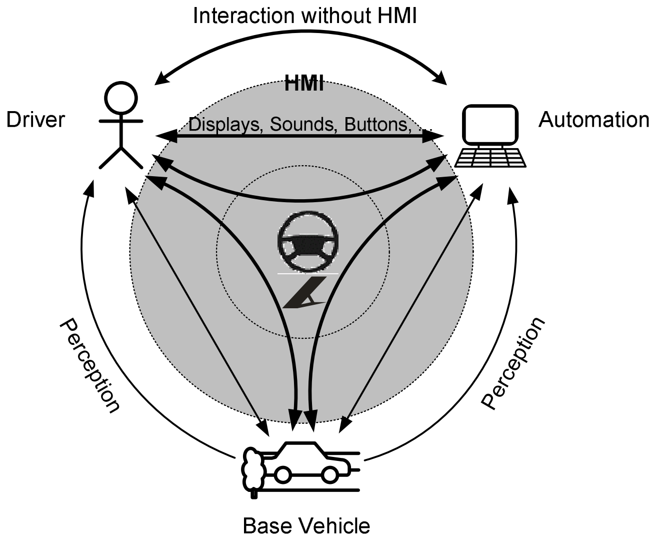

Figure 1: Generic human-machine interaction, adapted from (Flemisch, et al., 2010)

The Sub Project 3 supports these goals by analysing the space of possible human-machine interactions by developing Information, Warning and Intervention (IWI) strategies as well as generic HMI designs. IWI strategies refer to how, when and where driver information, warnings, and interventions should be activated and represent a set of guidelines, recommendations, or options for the targeted demonstrator vehicles to achieve the goals of compatibility between driver and automation and a coherent, integrated and efficient driver-vehicle interaction design.

The development of the IWI strategies follows an iterative design-prototyping-testing cycle, displayed in **Fehler! Verweisquelle konnte nicht gefunden werden.**, to cope efficiently with the high degree of freedom and uncertainty, (Boehm, 1988). This iterative design process mainly involves possible future users but also technical and human factors experts from the interactIVe project.

Starting with the definition of use cases based on target scenarios (Deliverable D1.5), a set of initial requirements has been derived by the vertical Sub Projects (Deliverable D1.6). The developed IWI strategies and IWI requirements have then been iteratively tested and updated based on test results documented in Deliverable D3.1 and in close cooperation with the function developing Sub Projects. As additional initial input to this development, two user needs and expectations studies were carried out and an initial search of literature and available systems on the market was performed. In addition, for each strategy aspect further literature was searched and expert knowledge aggregated. The final set of IWI strategies documented in this Deliverable D3.2 is complemented by a set of final IWI requirements and specifications in Deliverable D3.3.

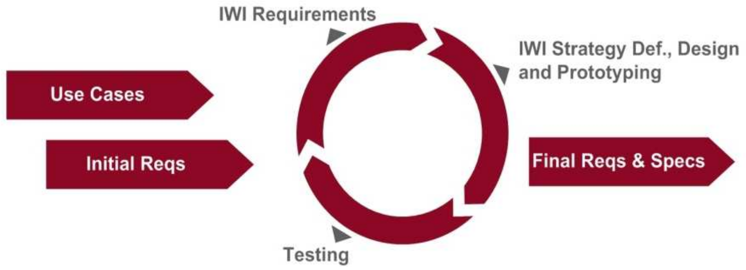

Figure 2: Development process as iterative design-prototyping-testing cycle

Based on the concepts of problem space (Simon, 1969), and design space (Stankiewicz, 2000), the concept of *strategy space* was established. In an SP3 workshop the space of human-machine interaction was structured into a number of *aspects* which represent different dimensions, perspectives, or categories, (see **Fehler! Verweisquelle konnte nicht gefunden werden.**). These aspects organise the discussions about possible IWI strategies and thereby facilitate the comparison or harmonisation of human-machine interactions in the different interactIVe demonstrators, the identification of the important open research questions, and evaluations of prototypes. The aspects do not have to be mutually exclusive or all on the same level of detail or hierarchically structured. This maintains a great flexibility while still providing the desired structural backbone.

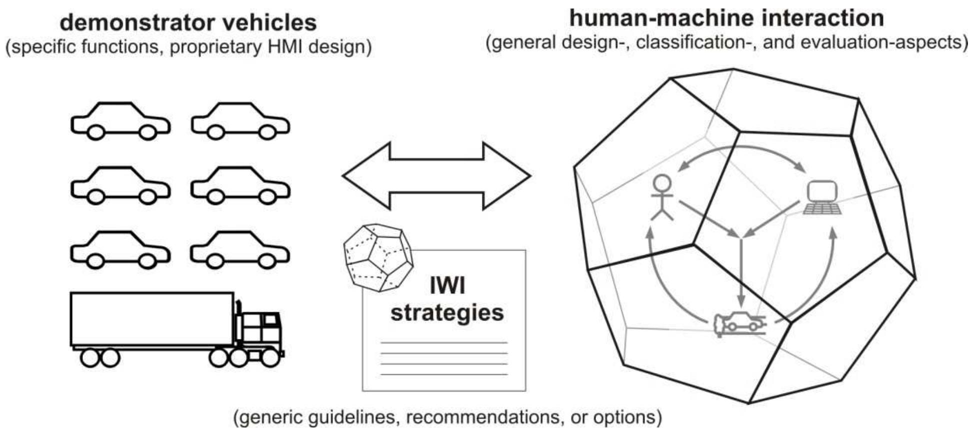

Figure 3: IWI Strategies for different aspects of the human-machine interaction (Hesse, et al., 2011)

The development of IWI strategies has been performed by investigating the interplay between the specific demonstrators and their assistance functions on the one hand and general considerations of human-machine interaction on the other hand, as depicted also in **Fehler! Verweisquelle konnte nicht gefunden werden.**. Specific application of IWI strategies are presented in Deliverable 3.3.

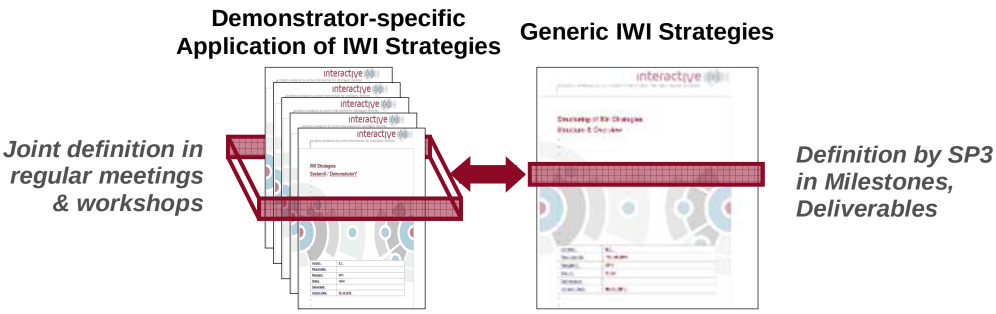

Figure 4: Generic IWI strategies and applied versions for each demonstrator

A set of categories, so called aspects, which structure the IWI Strategies are depicted in **Fehler! Verweisquelle konnte nicht gefunden werden.**. Below, examples of research questions and issues for each aspect are presented.

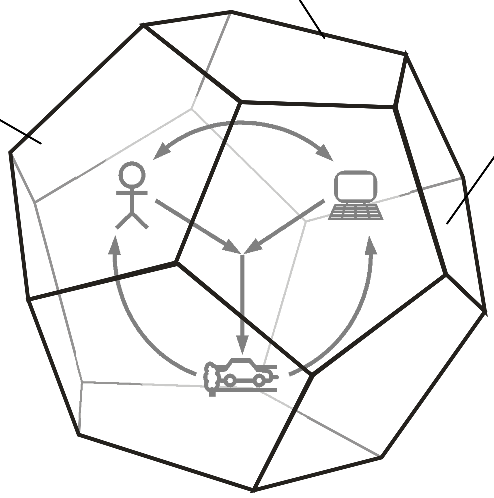

Figure 5: Strategy aspects as different facets or perspective on the human-machine interaction, compare (Hesse, et al., 2011)

Some of these aspects address rather basic structuring concepts for which no specific strategies have been compiled. They are discussed in Chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**.

- *Layer of Driving Task*

  On which layer of driving task is the driver supported? E.g. navigation, guidance, stabilisation

- *Level of Assistance and Automation*

  How much assistance and automation is offered to the driver? E.g. driver assisted, semi-automated, highly automated

- *Situation Awareness, Mental Model, Mental Workload, Trust*

  How can the information, warnings and interventions be easily understood and accepted by the driver? E.g. the selection between braking or steering intervention is done in order to be understandable for the driver
  These concepts can also be used to express general design goals, such as achieving an appropriate level of trust, high situation awareness, a correct mental model, etc.

For the other aspects, a set of IWI strategies has been developed. These aspects are discussed in detail in the Chapters **Fehler! Verweisquelle konnte nicht gefunden werden.** to 1**Fehler! Verweisquelle konnte nicht gefunden werden.**.

- *Range of Operation and Availability*

  What are meaningful ranges of operation for the assistance and automation functions? E.g. what are the sensor capabilities and how do they affect the detection of certain objects in different speed ranges, weather conditions etc?

- *Communication Channel*

What communication channel (visual, auditory, haptic) should be used by the system in order to interact properly with the driver? E.g. should an acoustic warning be accompanied by a steering wheel vibration for lateral threats?

- *Sequence of Interaction*

  How does the assistance evolve in specific situations? E.g. should a driver be given visual or auditory warnings before a steering or braking intervention?

- *States, Modes and Mode Transitions*

  What states and modes exist for the overall system? Which is the default mode after the ignition cycle? What transitions exist and how are they initiated? E.g. should all assistance functions be grouped into a low number of modes, where an emergency function can be on by default when ignition is turned on, while other functions have to be activated by the driver?

- *Communicate System Status*

  What information about current status is communicated to the driver? What elements could an integrated display design have? E.g. could current mode and detected objects be presented to the driver in the cluster display?

- *Arbitration*

  How should disagreement between driver and function be resolved? E.g. should automated acceleration always be overrideable by the driver by braking?

- *Prioritisation and Scheduling*

  How can information, warning and interventions of several concurrently or subsequently active functions be integrated? E.g. should longitudinal threats and active support by braking be prioritised over lateral support by steering when concurrent situations happen simultaneously?

- *Adaptivity and Adaptability*

  When and how do functions adapt themselves to the driver or the environment? When and how can a function be adapted by the driver? Which settings can the driver change? E.g. should the system be able to shift headway distance and timing of emergency warnings automatically depending on observed driver behaviour? Should the driver be able to alter these settings in a menu?

Literature

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