interactIVe

Accident avoidance by active intervention for Intelligent Vehicles

Deliverable D1.6 | Initial System Specifications Executive Summary

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SEVENTH FRAMEWORK PROGRAMME

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Executive Summary

The vision of interactIVe integrated project is accident-free traffic realized by means of affordable integrated safety systems penetrating all vehicle classes, and thus accelerating the safety of road transport. To fulfil this vision the general objective of this project is to develop new high performance and integrated ADAS applications, enhancing the intelligence of vehicles and promoting safer and more efficient driving. These applications will be introduced on specific demonstrator vehicles, namely six passenger cars and one truck.

The general structure of interactIVe is composed of seven sub-projects. Three sub-projects [SP4-Safety Enhancement through Continuous Driver Support (SECONDS), SP5-Integrated Collision Avoidance and Vehicle Path Control (INCA), and SP6-Cost-Efficient Emergency Intervention for Collision Mitigation (EMIC)] constitute application oriented developments, also called vertical sub-projects. These aim at developing and evaluating the integrated functionalities considered within interactIVe. These activities are supported by cross-functional activities, the so-called horizontal sub-projects, which deal with technical or methodological aspects common to all applications. The three horizontal sub-projects are: SP2-Perception, SP3-IWI Strategies, and SP7- Evaluation. An additional sub-project, SP1-IP Management, is included for handling project coordination, links to external activities, dissemination, and general administration.

The main scope of this deliverable is to highlight the specifications of the interactIVe system and to be the driver for the definition of the system architecture and the organization of the development phase. That entails the co-operation among SP2, SP3 and the vertical sub-projects in order to derive system's specifications based on the specific application requirements and the overall project objectives.

A systematic work has been conducted on the specification of interactIVe applications, starting from a set of use cases and requirements, which constitutes the background of this work. The requirements were specified with the aim to obtain the greatest possible and realisable benefit in accident reduction, and taking into account both heavy vehicles and passenger cars. Three major functionalities have been considered, according to the project concept:

(i) Continuous driver support

(ii) Collision avoidance and

(iii) Collision mitigation.

These three sets of general functionality are treated by a combination of functions in each of the three vertical sub-projects, namely the SP4, SP5 and SP6. Note that these functionalities constitute a time-wise continuum. The first one aims at assisting drivers also during normal driving, so that the ADAS 'closer to an accident' (avoidance, mitigation) does not need not to be put on trial. In more critical situations, then the two other systems can intervene: these systems can take direct control of the vehicle for a short period of time. Compared to previous developments like in Prevent, the emphasis is now on active intervention of vehicle safety systems considering that drivers very often are late in their responses to critical situations, or carry out erroneous manoeuvres. An additional novel aspect is the principle of a common usage for sensors, making the systems eventually more affordable to customers.

This deliverable first presents the general functional architecture of interactIVe system and continues by detailing instantiations of the general functional architecture for each application function. With respect to the project's structure, the specifications are organized per vertical sub-project and per function. Inside every function there is a short overview of it and specifications about the perception and application components relevant to this function. Moreover, the specifications concerning the selected sensors and actuators that serve this function for the different demonstrator vehicles are outlined. Note, that every vertical sub-

project has its own functions with specific target scenarios. One demonstrator can host more than one functions and one function can be implemented in more than one demonstrators.

The system's architecture is based on the concept that by integrating applications together, vehicle components may be shared among the various safety systems. This is accomplished by discrete architectural layers that are common to all applications. In particular, a modular framework has been defined, based on the following four layers: (i) the **sensors layer**, (ii) the **perception layer**, (iii) the **application layer** and (iv) what the driver perceives as the system, the **Information**, **Warning**, and **Intervention** (**IWI**) **layer** (Actuators/HMI). Each of the SP4, 5, 6 sub-projects has its own target scenarios fulfilled by specific application functionality and each function can get the part of the perception "awareness" it needs from the perception layer.

The perception layer feeds the application layer with a real-time interpretation of the driving environment and thus enables intelligent decision functionality. As input to the perception layer different type of sensors are used ranging from radars, cameras and lidars to GPS receivers for the extraction of the electronic horizon (based on ADASISv2) and even C2X communication. The perception layer receives the data from all involved sensors, performs low-level and high-level data fusion and sends a set of parameters representing the state of the vehicle, the detected objects and in general the perceived environment to the interactIVe applications. In turn, the applications perform the assessment of dangerous situations such as the need for a collision avoidance including emergency braking and/or active steering. Then they decide what needs to be done and pass the control to the actuator modules. At this stage warnings might be issued by an appropriate HMI device or vehicle dynamics actuators such as steering, brakes might be activated according to the threat level of a potential accident situation.

Considering the above mentioned system architecture, the focus of the present report is on specifications at the sensor level, the perception level, the application level and the IWI level for the three major types of functionalities described above. The innovative aspect within interactIVe is the integration of longitudinal and lateral support, aiming at safety, comfort, and economy features. These will provide a continuous and easily understandable interface between the driver and the vehicle. Additionally, active interventions by autonomous braking and steering, offer new possibilities not only for mitigating collision effects, but also for actively avoiding accidents in a wider range of situations. Note that, the more detailed IWI specifications are the subject of on-going work and will be detailed later on in the project.

The perception layer will incorporate, for the first time, general sensor interfaces. There will be a general interface defined for each input sensor type, which allows transmitting all necessary information. It has to be noted that sensors, in the context of the perception framework, includes any type of source that gives information to the perception platform. Required set of input sensors and their initial specifications per application are reported in the dedicated "Sensors" subchapters 4.(2,3,4).(2-7).3 of this deliverable.

The perception layer has been modularly specified by 14 discrete modules, namely the Vehicle Filter/state module, the ADASIS Horizon module, the Frontal Object Perception module, the Side/Rear Object Perception module, the Moving Object Classification module, the Enhanced Vehicle Positioning Module, the Lane Recognition module, the Road Data Fusion module, the Vehicle Trajectory Calculation module, the Assignment Of Objects To Lanes module, the Detection Of Free Space module, the Vulnerable Road Users module and the Relative Positioning To the Road Of the Ego Vehicle module. Each VSP records in this deliverable the anticipated perception modules output signals in order to deliver the desired vehicle functionality per prototype. Following this line, "Perception components" subchapters 4.(2,3,4).(2-7).4 are dedicated to the requested perception modules input for the specific applications.

The output of the perception layer is delivered in form of an interface called Perception Horizon interface which actually is the joint output of all modules/use-cases in the perception

layer. For the first time, this comprises all clusters of information including sensors, digital maps, and information from communication nodes. Through this general interface ego-vehicle dynamics, road attributes, obstacles, moving objects, and other environment features will be transferred in a defined way to the applications. VSPs Perception Platforms are then instantiations of the Perception Platform output for every specific demo vehicle. At this stage of the project work the PH interface specifications are still under discussion. Precise content of the PH interface will be included in the forthcoming D1.7 deliverable which will include system updated specifications and architecture. Preliminary interface specifications regarding sensors-to-Perception Platform, the Perception Platform-to-Applications and the Application Platform-to-IWI devices are reported in “Interfaces” subchapters 4.(2,3,4).(2-7).7 of this deliverable.

Based on a standard methodology outlined in chapter 2, this work is based on the outcome of the requirements phase, namely the deliverable D1.5, the internal report I-2 and the deliverable D2.1. The above mentioned preceding work mainly included the interactIVe use cases and general requirements as well as the hardware, software, functional and non-functional requirements of the central system’s layer which is the perception layer. An intermediate version of D2.1 was taken into consideration because the two deliverables (D2.1 and D1.6) were expected to be finalized about the same period.

The specifications included in this deliverable are considered initial, as (a) the work on this deliverable performed in parallel with the work on the D2.1 deliverable on the interactIVe perception platform requirements (b) the equipment of the demonstrator vehicles inside interactIVe system is not fully defined and (c) interactions and co-ordination among the various development teams of the perception platform can result in several functional architecture adaptations. Future updates including the system architecture will be treated in the upcoming Deliverable D1.7.

In conclusion, this deliverable presents the initial phase of interactIVe system specifications’ derivation, where the actual parts and components are specified in order to fulfil the overall system requirements. That includes the initial specifications of interactive system input sensors and functional blocks that will be used by Interactive applications. This document is the middle point between requirements of D2.1 and final specifications of D1.7 and thus it will form the basis for the definition of the system’s architecture and the organization of the development phase of the project.