Chapter 23
AdaptIVe: Automated Driving Applications and Technologies for Intelligent Vehicles

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23.1 Project Overview

With 28 partners from across Europe and a budget of 25 million euros, AdaptIVe advances the technical performance of automated systems by developing and demonstrating new integrated applications for cars and trucks. AdaptIVe’s results take automation to higher levels and support the goals of making driving safer and more comfortable and of reducing congestion and fuel consumption.

The project runs from January 2014 to June 2017 and is co-funded by the European Union with 14.3 million euros under Grant Agreement #610428. AdaptIVe tests and develops applications for typical traffic scenarios on motorways, in the urban environment and for close-distance manoeuvres, covering all levels of traffic complexity and speeds up to 130 km/h.

The functions will offer assistance and partially, conditionally and highly automated driving. A minimum risk manoeuvre will be implemented for all scenarios whereby the vehicle stops automatically in case of an emergency or if a malfunction occurs.

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AdaptIVe will combine sensor data, maps and communication to improve the perception of the traffic environment. It will integrate cooperative mobility technologies based on ITS G5. Automated systems will interact with other vehicles to anticipate their plans and avoid conflicts.

Accordingly, AdaptIVe will improve interactions between the driver and vehicle, thereby increasing user acceptance of automated systems. Guidelines for how to design and implement the driver–vehicle interaction are provided to achieve collaborative automation.

The project also focuses on the legal conditions for automated driving and in particular on product liability, road traffic and regulatory law, data privacy and security.

In addition, the project defines and validates specific evaluation methodologies, addressing both the technical functionalities and the impacts of automated driving applications. Insight will be provided into the safety and environmental benefits on European road transport as regards different levels of automation.

23.2 Technical Areas of AdaptIVe

The project covers six technical fields:

- Legal aspects
- Human–vehicle integration
- Applications for close-distance manoeuvring
- Applications for urban scenarios
- Applications for highway scenarios
- Evaluation

The main concepts and goals for each field of activity are described in the following paragraphs.

23.2.1 Legal Aspects
Today’s legal framework for automated driving is based on the prerequisite that safe driving is the driver’s sole responsibility. With a move towards automation in driving, controllability by the driver at all times may no longer be a basic design criterion. The requirement set-up by the legal framework must provide answers for the ramifications of this fundamental change.

To allow consistent terminology, the project defines a classification scheme for automated systems and typical scenarios that can occur when using an automated driving system. Legal questions are raised based on this naming scheme.

AdaptIVe comprehensively reviews the current legal frameworks in various EU member states and assesses their applicability to automated systems. The review also covers current activities in the USA. The examination of the legal framework will detail the relevant aspects found during the review.

### 23.2.2 Human–Vehicle Integration

As long as there are no fully automated systems, systems must always interact with humans at different times and to different degrees. AdaptIVe investigates the best modes of cooperation between the driver and automated systems in different scenarios. Drivers’ intentions and actions need to be taken into account in the design of automated systems.

AdaptIVe provides guidelines that specify how, when and where information, warnings and interventions should be implemented. Guidelines for the interface and signals, regardless of product type, will be provided for the development of the various functions.
23.2.3 Close-Distance Scenarios

Improving the everyday driving experience starts within the lowest speed and distance range. A particular challenge is that close-distance manoeuvring requires sensors and algorithms that haven’t been fully developed yet. Sensor sensitivity will be based on the traffic situation, allowing the vehicle to reliably detect other objects and free space over close distances and to navigate in this area by selectively giving priority to one direction over the other.

A robust perception platform is envisaged, taking into account the latest advances in embedded systems and communication and information technologies. This platform will support decision-making processes in complex situations. AdaptIVe also advances applications for automated parking at private homes and in outdoor environments, as well as in multilevel parking garages where a driver is always present. The Stop & Go function supports driving in close-distance scenarios.

Moving towards fully automated parking requires a learning car, whereby the car can train itself by becoming familiar with typical environments. The car shall then be able to drive and to manoeuvre within similar environments with a learned or provided map.

23.2.4 Urban Scenarios
Urban scenarios present special challenges due to the environment’s complexity and dynamic behaviour. Traffic is dense, several types of road users or static obstacles are present, and the driving task includes negotiating traffic at roundabouts, intersections and merging manoeuvres.

AdaptIVe is developing embedded solutions to address the most demanding driving scenarios in a city: the supervised city control and city chauffeur functions. A key point for this development is the integration of existing and new functions into one system. Examples include automated braking, feedback on the gas pedal and steering wheel, automated cruise control and full supervised automated control. The level of support given to the driver ranges from correction and stabilisation of driver manoeuvres (in assisted mode) to automatic guidance (in automated mode). Communication with the infrastructure and other vehicles is being realised to anticipate the intentions of other road users and reduce the potential for conflicts.

### 23.2.5 Highway Scenarios

Highway scenarios demand a careful consideration of the different automation levels and the added value provided by cooperative approaches. Using the most up-to-date research, the project is pushing the limits of automated driving towards higher degrees of automation and incorporating cooperative driving functionalities.

The automated AdaptIVe vehicle will enter and exit highways, perform lane changes or filter-in manoeuvres and provide support in dangerous areas such as the end of a traffic jam. Other functions include the cooperative response to emergency vehicles on duty, also based on vehicle-to-vehicle (V2V) communication, and a speed and time-gap adaptation at motorway entrance ramps based on vehicle sensors. Additionally, predictive automated driving to reduce fuel consumption and CO$_2$ emissions will be implemented as well as basic driving functions such as following lane and vehicle, performing overtaking manoeuvres and handling stop-and-go traffic.

New cooperative technologies must be developed to enable a variety of automated cooperative driving functionalities. Drafts for a new radio transmission protocol for bidirectional V2V communication are being specified, implemented and tested, procedures that will enable negotiations between vehicles.
23.2.6 Evaluation

Existing evaluation methods for advanced driver assistance systems (ADAS) do not cover the requirements for the evaluation of automated driving functions. Therefore, new comprehensive approaches and test methods are required. AdaptIVe defines specific evaluation methodologies for automated driving functions in a comprehensive framework. The test and evaluation framework considers the technical, user-related and in-traffic behaviour evaluation as well as an impact analysis focused on safety and traffic efficiency. The framework thereby includes a specification of methodologies, test procedures, key indicators and experimental design with the applicable testing tools. The impact analysis is being conceived with a pan-European perspective. Ultimately, the framework and new methodologies will be applied to a set of selected representative functions in order to verify and validate the developed evaluation approaches.

23.3 Looking Ahead

AdaptIVe builds up eight demonstrator vehicles—seven passenger cars and one truck—to test and evaluate the AdaptIVe applications and functions. The project will showcase these systems during a final demonstration in 2017. At this point of time, automated driving will be far from being comprehensively researched. AdaptIVe will have laid the foundation for further research of the topic of automated driving.