Chapter 2

The Research Domain of this Thesis and its State of the Art

2.1 Advanced Driver Assistance Systems

*Driver Assistance Systems* (DAS) are additional electronic systems in vehicles to support the driver in specific driving situations. They may aim at increasing safety, higher comfort, less fuel (or resource) consumption or informing the driver about the current traffic condition, the traffic situation or the route. These systems may be informative, semi-autonomous or autonomous. They may intervene in vehicle propulsion, actuation or vehicle control or may simply provide useful additional information.

Components and architecture of an intelligent automobile and hence, the combination of a variety of DAS are described in [Stiller et al., 2007, Robert Bosch GmbH, 2011b, Robert Bosch GmbH, 2011a]. DAS are based on the control loop of mechatronic systems as defined in [DIN IEC 60050-351:2006, 2006] (formerly DIN 19226). Basically, DAS consist of multiple sensors for perception, one or several ECUs for information processing and up to several actuators for DAS function execution. This will be briefly introduced in the next subsections 2.1.1 to 2.1.3.

2.1.1 Advanced Driver Assistance Functions

DAS with various specific functions are already commonly used within vehicles. Such functions are, for example, speed control, parking assist, rain-light-sensor, anti blocking system (ABS) and electronic stability control (ESP). These systems operate with a very specific focus of control, in very specific situations or under specific conditions.

ADAS research has recently focused on providing extended functionality in a wider range of situations and with less supervision by the driver. Such functions include adaptive cruise control (ACC), (semi-) autonomous parking, pre-crash, collision warning, mitigation and prevention, road sign recognition, lane keeping assist, curve speed control, intersection assistance up to even autonomous driving functions.

A common clustering of ADAS has two functional dimensions, one dimension distinguishing active and passive/informative functions, the other comfort and safety [Robert Bosch GmbH, 2011b, Robert Bosch GmbH, 2011a] (see Fig. 2).
2.1.2 Sensors for Driver Assistance

Sensors may perceive information about the current state of the ego vehicle (vehicle sensors) as well as its global position (global positioning sensor) or may perceive information about the vehicle’s environment (environmental sensors). A variety of sensor types for these kinds of information exists. Processing perceived sensor data is a research field on its own. Recent research especially focuses on how to combine information from different sensors.

2.1.2.1 Sensor Types

Sensor types for the ego vehicle state include wheel speed sensors, inertial sensors, steering wheel angle sensors, pedal sensors, gear sensors, pressure and temperature sensors and more. Positioning is mainly provided by GPS sensors, but new technologies such as fine positioning by wireless networks in range and positioning by landmarks are gaining interest and application.

The range of environmental sensors covers imaging sensors such as mono and stereo vision camera systems, infrared camera systems, radar sensors, laser scanners, PMD cameras and ultrasonic sensors [Robert Bosch GmbH, 2011b, Robert Bosch GmbH, 2011a]. From a wider point of view, navigation databases and communication units may be regarded as environmental sensors as well, including Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) information in the vehicles perception.