AIM in-vehicle platform for ITS services

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Abstract: The application platform for intelligent mobility (AIM) is a large scale research infrastructure operated by the Institute of Transportation System of the German Aerospace Center (DLR) in the city and region of Braunschweig. The in-vehicle platform for ITS services (ITS, Intelligent Transportation Systems) is an integral part of this large-scale research facility. The in-vehicle platform for ITS services can be seen as a modular kit which enables up to 50 vehicles to take part in a Vehicle-to-Vehicle and Vehicle-to-Infrastructure (V2X) communications in test sites like the V2X reference track in the city of Braunschweig. The in-vehicle platform for ITS services along with its integration into the AIM test field provides answers to a broad set of research questions in the Field of V2X communications on public roads. For example effects can be analyzed, which take place when vehicles with mixed equipped communication technologies are sharing one road.

1   Introduction

V2X is one of the key technologies on the way to automated vehicles in urban, suburban and even highway environments. Thus the research of this technology is important for further progresses in the field of partial and fully automated driving. The large-scale research facility AIM in-vehicle platform for ITS services allows flexible and easy equipment (retrofitment) of vehicles to communicate with one another (V2X). In addition to this equipped vehicles can interact with existing traffic management infrastructure (e.g. traffic light controllers) using the same communication protocol. Together the AIM in-vehicle platform for ITS services and the AIM reference track form a unique research basis for scientific issues around V2X (Schnieder & Lemmer, 2012, 2014).

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2 Technical Description

The large-scale research facility AIM in-vehicle platform for ITS services consists of a mobile vehicle platform for V2x-communication (see Section 2.1), a navigation platform (see Section 2.2), a modular platform for driver observation in naturalistic driving studies (see Section 2.3) as well as a reference vehicle around the field of V2X (see Section 2.4). Each of these platforms can be independently equipped in common vehicles cars, busses or even trains. After the usage in a project they can be cleanly removed.

2.1 Mobile vehicle platform for V2X-communication

The mobile vehicle platform supports the V2X communication and is able to position itself via the global positioning system (GPS). The vehicle platform consists of an application unit and a V2X communication unit:

- The V2X communication unit has interfaces for a V2X Antenna, an Ethernet port for servicing and data transmission as well as a GPS Antenna. The GPS subsystem provides an accurate time stamp for the V2X messages as well as positioning with an accuracy of around 5m. The open linux system which is installed on the V2x communication unit, offers the ability to run small applications directly on the systems.
- The application unit provides more computing power than the V2x communication unit. A special automotive Car-Pc, allows to run applications which exceed the available computing resources of the V2X communication unit.

Figure 1: V2X communication unit.

2.2 Navigation platform

For highly accurate positioning applications the navigation platform can be used in research projects. The navigation platform is an inertial measurement system (IMU) consisting of a 3 axis gyroscope and accelerometer aided by GPS signals. The ability to process correction data of a GPS reference station (like SAPOS, the Satellite Positioning Service of the Official German Surveying and Mapping) offers an accuracy of fewer than 20cm. Positioning information can be read out via a wireless local area network (WLAN), Controller Area Network Bus (CAN) or a serial interface.

2.3 Naturalistic Driving Study (NDS) Platform

The NDS Platform is a driver and environment observation system. It is also a module based system, which is able to record video, radar, accelerometer, lane recognition, position and velocity information. This platform is also able to record data from other CAN-Bus systems. At the maximum equipment level:
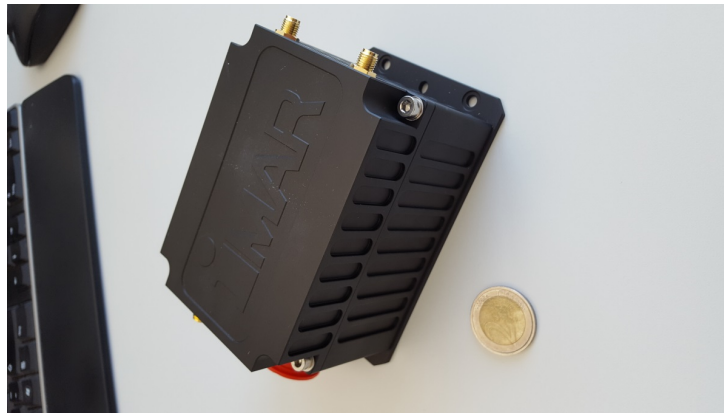
Figure 2: Navigation platform.

- four cameras, usually two cameras for front and rear view and two cameras for driver observation (see number 1 in Figure 3)
- a radar system, to observe the area in front of the vehicle (see number 2 in Figure 3),
- a lane recognition sensor, used for lane information such as lane distance, distance to the middle between the lanes and curvature of the lanes (see number 3 in Figure 3)
- a 3-axes accelerometer, to detect acceleration maneuvers (see number 4 in Figure 3)
- a GPS receiver, to achieve position and velocity information and (see number 5 in Figure 3)
- a memory card to record data for several hours (see number 6 in Figure 3) are installed.

Figure 3: Naturalistic Driving Platform.

2.4   Reference Vehicle

As a reference vehicle for the named platforms and as a moving lab in AIM, a Volkswagen T5 is used. It is equipped with all three platforms and a high-precision IMU with a 3-axes micro-electro-mechanical system (MEMS) based accelerometer and a 3-axes fiber-optical gyro (FOG) as a position, velocity and rotational rate reference. Thus the vehicle can be used to compare the platforms to other products on

public roads. As a moving lab in AIM it is also be used for project specific application in the field of V2X.

Figure 4: Reference Vehicle T5.

3   Project Application Examples

The large-scale research facility AIM in-vehicle platform for ITS services was and is used in several projects. This only a short overview of some of the projects the research facility was involved in:

- An approach for measuring V2X infrastructure communication coverage and signal quality (Frankiewicz et al., 2013)
- Application platform for Intelligent Mobility - Test site architecture and Vehicle2X communication setup (Frankiewicz et al., 2012)
- A naturalistic driving study with bus drivers – ecological Validation and acceptance analysis of a psychometric vigilance test in the test site AIM (Preuk et al., 2016).

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