Proceedings of the
2007 IEEE Intelligent Vehicles Symposium
Istanbul, Turkey, June 13-15, 2007



# Evaluation Methods and Results of the INTERSAFE Intersection Assistants

Jian Chen, Stefan Deutschle and Kay Fuerstenberg

*Abstract*— **In the EU-project INTERSAFE, driver assistance systems were developed to improve safety at intersections. These systems were implemented in two demonstrator vehicles: a VW Phaeton and a BMW 5 series. According to its applicable scenarios, the systems include two assistance functions: Traffic Light Assistant (TLA) and Intersection Assistant (IA).**

**In order to inspect the systems' functionality and the user acceptance, the onboard environmental sensors and the full systems have been tested. The testing approach and the results are described in this paper. The tests were carried out in three phases: sensor test, system test and user test.**

**Sensor test and system test have proved the functionality of the INTERSAFE system. The systems are able to fulfill the tasks of assisting the driver to avoid potential traffic accidents at an intersection. The user test focused mainly on the user acceptance of the systems and the HMI design. After driving both demonstrator vehicles and experiencing the INTERSAFE systems, the test persons rated the systems helpful and relieving. They stated that these systems could have helped them in their daily driving and would improve the traffic safety.**

## I. Introduction

Mobility is very important in our modern society. Industry, trade and commerce rely on the feed of goods as the gross national product is related to the transport capacity. Beyond the desired positive effects of traffic, with benefits such as the achieved value added or employment creation, one has to deal with negative aspects like killed or injured traffic participants, an increasing traffic density, traffic jams and emissions (e.g. harmful substances and noise).

Especially the increasing market penetration of active and passive safety systems play a particular role in the reduction of injured and killed traffic participants in recent years. For the future advanced driver assistant systems (ADAS) are expected to contribute to a further reduction of accidents, injuries and fatalities, as still up to 95 % of all accidents are caused by human [1]. In this context, intersections are an accident hotspot and according to [2] about 60%-72% of all accidents in intersections are related to:

- Collisions with oncoming traffic while turning left
- Collisions with crossing traffic while turning into an intersection or straight crossing an intersection
- Red light/stop sign violation

Measures to improve the intersection safety have a long history in traffic engineering. So far conducted improvements of intersection layouts and traffic light control are important factors as they effect the traffic environment and the traffic flow. But for an integrated view, the driver as the main source of error must be included in the consideration as driver distraction is expected to be the main reason for intersections accidents.

Within the field of ADAS (direct measures), intersection safety is a relatively new topic, mainly addressed by the current research projects like [3], [4,], [5], the German national initiative INVENT (Intelligent Traffic and User-Friendly Technology) and the subproject INTERSAFE of the integrated European project PReVENT.

The objective of the INTERSAFE subproject is to improve safety and to reduce (in the long term avoid) fatal collisions at intersections. Drivers shall be prevented from crossing red lights at intersections. Furthermore, a driver will be informed in case of a potentially dangerous turning off maneuver to avoid collisions with other vehicles. This is achieved by using path prediction of road users based on Laserscanner data and infrastructure to vehicle communication (I2V). These warning functions are implemented in demonstrator vehicles (BMW and VW) and in the BMW driving simulator.

In order to analyze the impact on traffic safety and assess the system's user acceptance a testing procedure for the evaluation of intersection safety systems is essential. In this paper the testing methods and results of the BMW and VW demonstrator vehicles are presented. The results of the driving simulator approach are presented in [6].

## II. System Architecture and the Demonstrators

### A. System Architecture

Fig. 1 shows the system architecture of the INTERSAFE system. In general, the system is composed of three different levels. At the basic level – the onboard sensors level – general data acquisition is performed. In addition to the onboard sensors, the so-called high level map (HLM) and the communication device are located on the sensor level. The HLM for INTERSAFE contains geometric information and attributes of the intersection.

Manuscript received January 15, 2007.

J. Chen is with Institut für Kraftfahrwesen Aachen, Steinbachstr. 7, 52074 Aachen, Germany (phone: +49/241/8025615; fax: +49/241/8022147; e-mail: chen@ika.rwth-aachen.de).

S. Deutschle is with Institut für Kraftfahrwesen Aachen, Steinbachstr. 7, 52074 Aachen, Germany (phone: +49/241/8025630; fax: +49/241/8022147; e-mail: deutschle@ika.rwth-aachen.de).

K. Fuerstenberg is with IBEO Automobile Sensor GmbH, Fahrenkroen 125, 22179, Hamburg, Germany (phone: +49/40/64587140; e-mail: Kay.Fuerstenberg@ibeo-as.com).

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