

Future Testing of Active Safety Systems

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ABSTRACT

Active safety systems are increasingly becoming available in trucks and passenger vehicles. Developments in the field of active safety are shifting from increasing driver comfort towards increasing occupant safety. Furthermore, this shift is seen within active safety systems: safety functions are added to existing comfort systems, rather than adding new safety systems to the vehicle. Comfort systems such as cruise control are extended via ACC to pre-crash braking systems. Testing of active safety systems must follow these developments. Whereas standardized test programs are available for passive safety systems, such test programs are hardly available yet for active safety systems. Furthermore, test programs for passive safety systems consist of only a handful of scenarios. Test programs for active safety systems, however, should consist of much more scenarios, as those systems should function well in many different situations. It is not feasible to assess the intelligent vehicle safety (IVS) system's performance in all these scenarios by means of test-track testing. To speed up the introduction of active safety systems, there is a need for an efficient standardized test program, including alternatives to test track testing. This paper describes the vision of TNO Automotive on the developments that are expected in the field of development and evaluation of active safety systems and it explains the need for an efficient and complete test program for IVS systems, consisting of simulations, hardware-in-the-loop simulations and test track testing.

INTRODUCTION

Advanced Driver Assistance (ADA) systems are increasingly becoming available in trucks and passenger vehicles. In the last few years, developments in the field of ADA shifted from increasing driver comfort towards increasing occupant safety. Moreover, safety functions are added to comfort oriented

ADA systems, rather than adding new safety systems to the vehicle. Comfort systems such as cruise control are extended via ACC to pre-crash braking systems, and will be extended to collision avoidance systems in the future. Furthermore, car-to-car (C2C) and car-to-infrastructure (C2I) communication are being integrated in intelligent vehicle safety (IVS) systems.

Although strong efforts in increasing the passive safety of vehicles have resulted in a decreasing number of fatalities in Europe, the current developments in IVS systems are needed to reduce the number of fatalities even further. However, a large penetration of IVS systems and C2C or C2I communication in the vehicle fleet is not to be expected in the next 10 years.

In the mean time, developments in the IVS systems will be focused on safety by collision mitigation and even collision avoidance. The effectiveness of the IVS systems will be increased by the use of communication. Furthermore, safety of vulnerable road users (VRUs) and the non-connected road users must be considered.

The development of IVS systems should go hand-in-hand with the development of test procedures for these systems. Without a procedure to test functionality, performance and robustness, it will not be possible to implement systems at large scale in production cars. Development and subsequent acceptance of the test procedures will require strong involvement of OEM. The test procedures should be adapted to the type of IVS system that is assessed. Development of collision mitigation and avoidance systems calls for test methods that enable testing with small time-to-collision (TTC), whereas development of IVS systems to protect VRUs, calls for the development of appropriate test objects. Furthermore, to ensure efficient testing of IVS systems that comprise different functions such as comfort and safety, test

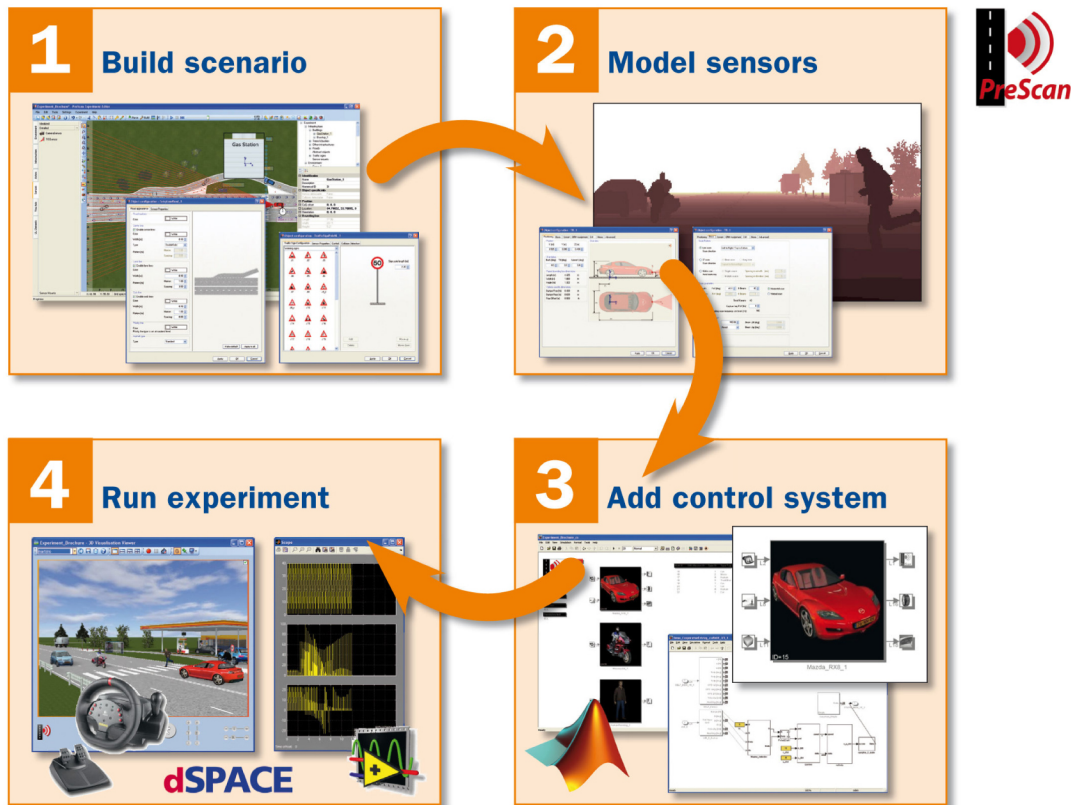


Figure 1. The four stages in PreScan

programs are needed that allow for testing of various different functions.

TESTING OF IVS SYSTEMS

Whereas passive safety systems are assessed by standardized test programs which are accepted by OEMs, customers and governments for several decades all over the world, no widely accepted standard test program is available for active safety systems.

Standardized test programs for passive safety systems typically consist of only a handful of scenarios. In contrast, standardized test programs for IVS systems should consist of a number of scenarios in the range of 100 to 1000. This is because IVS systems should function well in many different situations and under many different conditions. However, as this is a very large number of tests, the standardized test programs should be an incentive for OEMs to consider all these situations and conditions during the IVS system's development process, in an efficient way.

It will be infeasible to assess the IVS system's performance in all these scenarios by means of test-track testing. Not only because test-track testing is expensive and time-consuming, but also because it is potentially unsafe. This is especially true when testing pre-crash systems. Furthermore, the

reproducibility of the test scenarios in test-track testing is somewhat limited, which makes it difficult to compare different IVS systems in an objective way. Therefore, some alternatives to reduce the amount and complexity of tests to be performed are needed. In the next sections a complete test method for IVS systems, consisting of simulations, hardware-in-the-loop simulations and test track testing is presented.

TNO has developed a simulation and a testing environment that can be used for standardized test programs for IVS systems: PreScan [1,2] and VeHIL [3]. PreScan is a Software-in-the-Loop (SIL) environment whereas VeHIL is its Hardware-in-the-Loop (HIL) counterpart.

PRESCAN

By means of high-fidelity simulation that is based on real physics, PreScan allows for development and testing IVS systems on a desktop PC. PreScan consists of four stages ([figure 1](#)). In the first stage, the traffic scenario is built, using a database of road sections, infrastructure components and road users. This can be based on "ideal" scenario parameters, but also on logged (dGPS) data from test track driving. Also weather conditions and light circumstances can be incorporated. In the second stage, the environmental sensors of the system are modeled (or a standard sensor from the PreScan library can be used). In the third stage, a Matlab/