INSTITUTE OF NAVIGATION
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CrashPos

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Introduction

CrashPos dedicates on the development of a test system for Advanced Driver Assistance Systems (ADAS). These systems are integrated into modern cars to detect and prevent accidents. Along with ADAS gaining more and more importance in the car industry, also the development of control modules to facilitate the test process of these systems becomes necessary. One big part of such control modules is the positioning of the vehicles involved, which is necessary to perform realistic and reliable tests. Existing commercial systems are based on expensive GPS and INS components. Instead of that, the target of this project is to develop a demonstrator for ADAS testing based on reasonably priced positioning components (single-frequency RTK and INS) installed on the vehicles.

Single-frequency RTK for an Advanced Driver Assistance System test-bed

Details of the Project

Positioning Concept and Requirements

Existing systems for ADAS testing are usually based on a high-cost geodetic dual-frequency Multi-GNSS RTK (Real-Time Kinematic) solution integrated with an INS to get reliable results and high update rates. Some approaches do not use INS, but they use GNSS receivers with update rates of up to 100 Hz. Although GNSS only approaches are cheaper, they are not that reliable because of possible shadowing and Multipath effects.

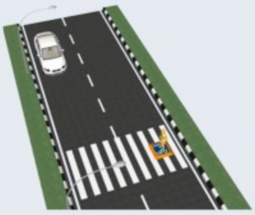

Fig. 1: ADAS test scenario

In our project, low-cost positioning sensors are in the main focus, since they were getting better in the last years while the costs decreased. Especially the developement of inertial MEMS (Micro Electronic Mechanical Sensors) is preceeding fast and every year new accuracy levels are achieved. Our goal is to reduce the hardware costs for the positioning equipment by a factor of 5 in comparison to the existing high-cost test systems (> 30,000 €).

Besides cost requirements the positioning accuracy was the main factor for sensor evaluation. Leading car manufacturers expressed their need of a system accuracy of 1 dm.

For these requirements a single-frequency GNSS solution will be sufficient, since the test areas for ADAS testing are usually not larger than 1x1 km and a local base station will be used. The use of only one frequency will not worsen the position quality because of the short baseline but will have an effect on the ambiguity resolution process. The advantage of Multi-GNSS instead of GPS-only will be investigated since it further increases costs.

In addition to the GNSS equipment the dummy platform(s) called UFO (Ultraflat Overrunnable Obstacle, see Fig. 2) will be further equipped with a low-cost INS to improve the positioning accuracy. This is not possible for the test vehicle because the so-called lever-arm (offset between INS and GNSS reference point) needs to be determined very precisely. This calibration procedure is very time consuming and cannot be done by the car manufacturers itself.

Fig. 2: UFO with dummy

System Components

The test system consists of one test vehicle with ADAS components onboard and one or more UFOs, all driving synchronized along a predescribed trajectory. At some point the trajectories meet, which simulates a potential accident scenario. A control center will monitor the tests and may abort it in case of a system malfunction. The UFO was designed to be flat enough that the test vehicle can overrun it in case of a crash with the dummy without getting damaged.

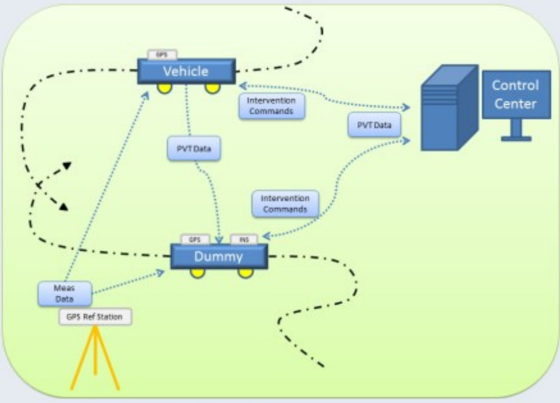

Fig. 3: System components

Responsibilities

The Institute of Navigation (INAS) is responsible for the GNSS positioning and the GNSS/INS integration. The Institute of Smart System Technologies is responsible for the INS processing, the GNSS/INS integration together with INAS and the steering of the vehicles. DSD is responsible for the hardware, the control center and the communication.

Evaluated Equipment

To achieve the overall monetary restrictions, we have to use low-cost equipment for this application. Today, a variety of low-cost GNSS receivers and antennas exist. The task is, to evaluate low-cost GNSS receivers, antennas as well as inertial sensors. A selected range of sensors, which were evaluated, are shown in Fig. 4.

Fig. 4: Evaluated low cost GNSS equipment
FLTR: AT575-142 (300 €) , Antcom G3 (420 €), ublox LEA6T (300 €)

In Fig. 5, the selected GNSS receiver ppm20xx is shown. The ppm20xx is equipped with the Ashtech Mb100 GNSS board and an Antcom G3 antenna. It is purchased with the option to use GPS and GLONASS as well as a float ambiguity solution with an integrated dynamic filter for the position solution. The accuracy, according to the manufacturer, is 5 cm RMS.

Fig. 5: ppm20xx with Ashtech MB100 board (~2700 €)

As an inertial measurement unit (IMU), we selected the Gladiator Technologies Landmark 10, shown in Fig. 6. This is a compromise of price and accuracy parameters. It is a small, lightweight and vibration resistant MEMS IMU. Especially the bias stability is an accuracy measure we put focus on, so turn-on biases can be calibrated for a measurement phase as best as possible. The Landmark 10 has a maximum gyroscope bias of 360 °/h and a bias stability of 25 °/h. It offers an accelerometer bias of 3 mg and a bias stability of 0.1 mg. In addition, the time synchronization with GPS is possible.

Fig. 6: Gladiator Technologies LM 10 (2500 €)

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