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TransSec

IIGS

TransSec - Autonomous emergency maneuvering and movement monitoring for road transport security

Motivation and Goal

Development of a system to prevent terror attacks using trucks:

- Permanent monitoring of the vehicle
- Automatic start of emergency routines for reducing the danger in case of critical driving maneuvers
- **Project Partners**: Institute of Engineering Geodesy (IIGS), University of Stuttgart, Germany; Daimler AG, Germany; TeleConsult Austria GmbH, Austria; Vicomtech, Spain; Waterford Institute of Technology, Ireland

Overview of Work Packages
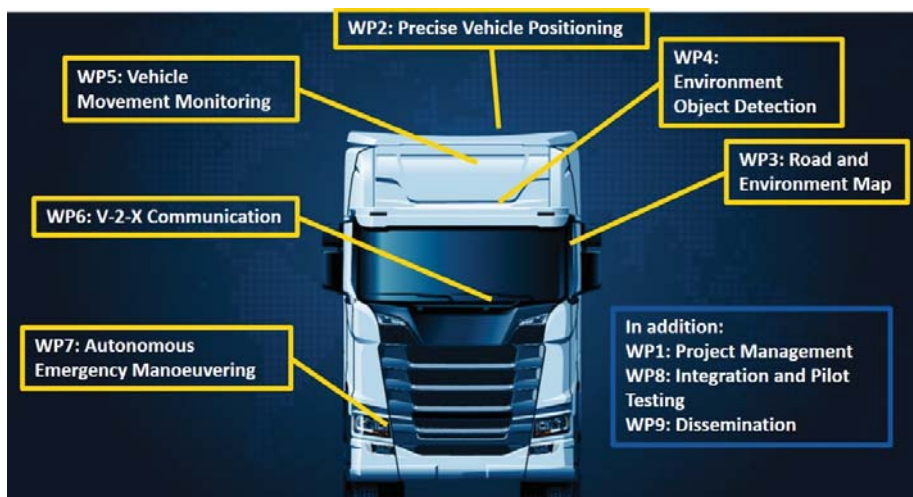
- Development of a robust and reliable positioning system by using the Galileo navigation satellite system and multi-sensor systems
- Detection of forbidden driving maneuvers by localization of the truck positions on the digital road map via map-aiding approach
- Detection of dynamic objects around the truck by cameras and Lidar sensors and development of a local dynamic map
- Risk analysis-based monitoring of vehicle movement and reduction of danger during critical driving maneuvers
- Warning to the surrounding area through a vehicle-to- everything communication (V2X-technology)

Main Tasks of IIGS:

- Multi-sensor integration for reliable and precise vehicle positioning
- Analysis of the quality of maps in NDS format (Navigation Data Standard)
- Map-aiding algorithm

Results

- Multi-sensor integration by development of a strapdown algorithm and an error-state Kalman Filter using low cost GNSS receiver systems (u-blox C099-F9P application board) and Xsens IMU (MTi-100)
- Accuracy analysis of the NDS maps used

Accuracy	Test Area 1	Test Area 2	Test Area 3	Test Area 4	Test Area 5
$\mathbf{rms}_{ds}$ (abs.)	1.45 m	1.47 m	1.54 m	1.57 m	1.53 m
$rms_{\Delta\Delta\alpha}$ (rel.)	$2.7°$	$2.6°$	$2.6°$	$2.2°$	$2.6°$
$rms_{\Delta\Delta\alpha}{}^*$ (rel.)	0.62 m	0.59 m	0.59 m	0.49 m	0.58 m
$rms_{\Delta\kappa}$ (rel.)	$7.9\frac{1}{km}$	$5.2\frac{1}{km}$	$5.7\frac{1}{km}$	$7.4\frac{1}{km}$	$6.7\frac{1}{km}$
No. of GNSS points	1048	225	559	1963	545
Total length	19.6 km	2.6 km	10.7 km	34.5 km	12.1 km

- Development of a lane-level map-aiding approach based on non-lane-level digital road map data: Results of real trajectories (55 km): false positive rate are 1.25 % for off-road and 0.35 % for wrong-way driver detection

Selected Publications

Zhang, L., Wang, J., Wachsmuth, M., Gasparac, M., Trauter, R., & Schwieger, V. (2019). Role of Digital Maps in Road Transport Security. FIG Working Week 2019, Hanoi. FIG Working Week, Hanoi, Vietnam.

Zhang, L., Wang, J., Wachsmuth, M., Gasparac, M., & Schwieger, V. (2019). Die Rolle digitaler Karten für Sicherheitsfunktionen im Straßenverkehr. zfv – Zeitschrift für Geodäsie, Geoinformation und Landmanagement, 4/2019, Article 4/2019.

Wachsmuth, M., Koppert, A., Zhang, L., & Schwieger, V. (2020). Development of an error-state Kalman Filter for Emergency Maneuvering of Trucks. European Navigation Conference (ENC); Dresden, Germany, 22.-25.11. https://doi.org/10.23919/ENC48637.2020.9317306

Luz, P., Zhang, L., Wang, J., & Schwieger, V. (2021). Lane-Level Map-Aiding Approach Based on Non-Lane-Level Digital Map Data in Road Transport Security. Sustainability, 13(17), 9724. https://doi.org/10.3390/su13179724

Funding

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