TECHNISCHE
UNIVERSITÄT
DRESDEN

AirMetro
Research Training Group
2947 at TU Dresden

T5: On-board autonomous navigation

Sensor fusion for on-board autonomous navigation of AAM aircraft

Supervisor: Christoph Keßler, Frank Fitzek, Anette Eltner

Motivation

The integration of highly automated Advanced Air Mobility (AAM) aircraft in urban areas places high demands on positioning and navigation in terms of accuracy and robustness:

- The problem of navigation using global navigation satellite systems (GNSS) in an urban environment; purely GNSS-based positioning is not accurate [1]
- The obvious solution is to use additional sensors (e.g. camera, light detection and ranging, LiDAR) [2]
- Camera and LiDAR sensors as well as semantic mapping [3] of the environment (Simultaneous Localization and Mapping (SLAM)) are intended to ensure positioning for safe and reliable flight operations

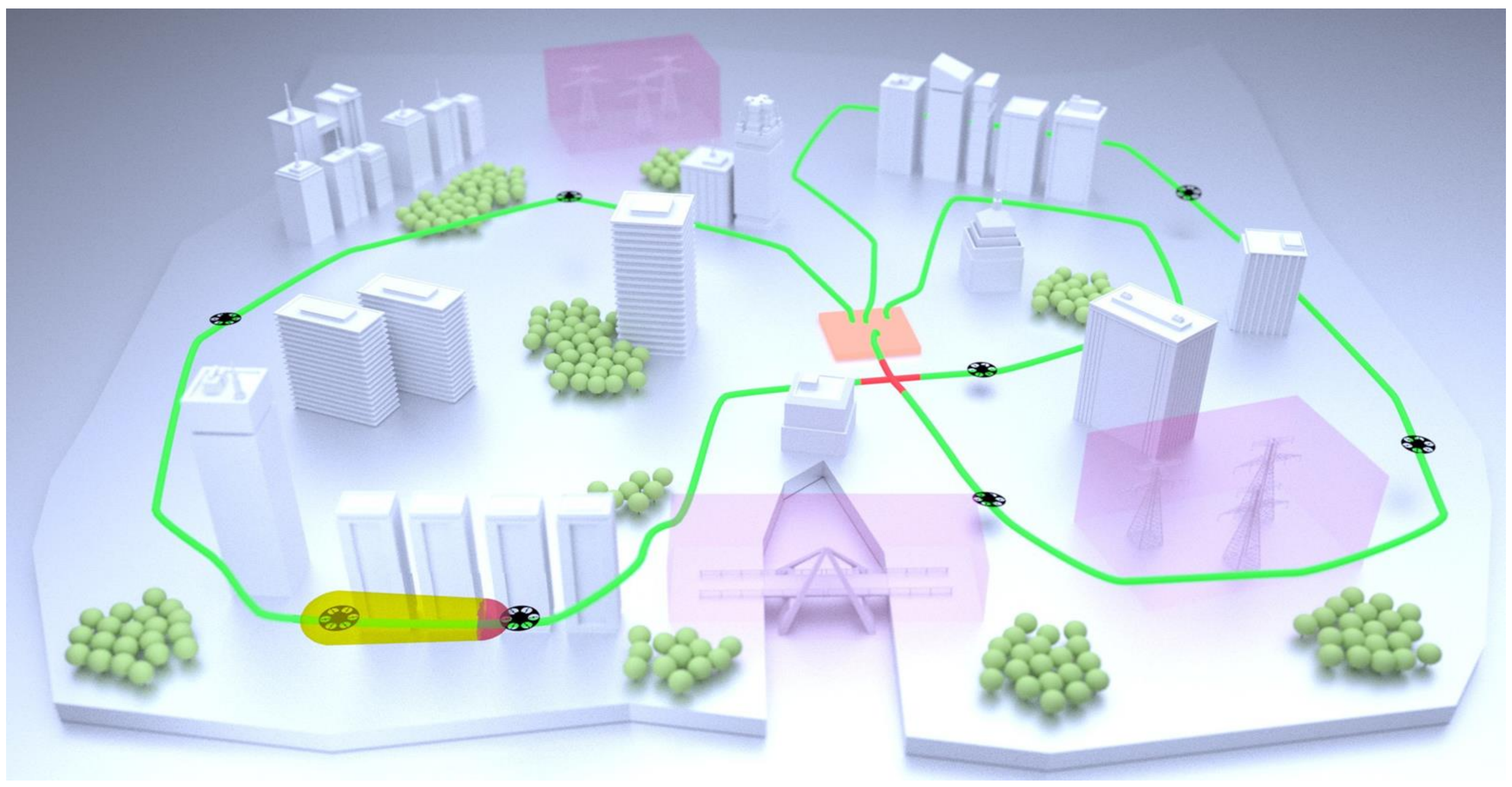
Figure 1: Scenario with geozones, buildings and potential conflicts between participating AAM aircraft

Methods

- Evaluation of optical SLAM algorithms
- Integration of semantic image features relevant for AAM aircraft by integrating neural networks
- Integration of additional sensors such as Inertial Measurement Unit (IMU) and LiDAR to increase reliability
- Integration and testing of the algorithms in the closed-loop control system of an AAM aircraft


Figure 2: Virtual representation of a village in the mountains with road, people, cars, buildings and vegetation

Results

- Determination of own position for AAM aircraft using semantic SLAM
- Fusion with other sensor data such as IMU, LiDAR
- Testing of the method in the context of AAM with a closed control loop; comparison with alternative methods
- Goal: accurate and GNSS-interference-independent self-positioning for the navigation of AAM aircraft in an urban environment

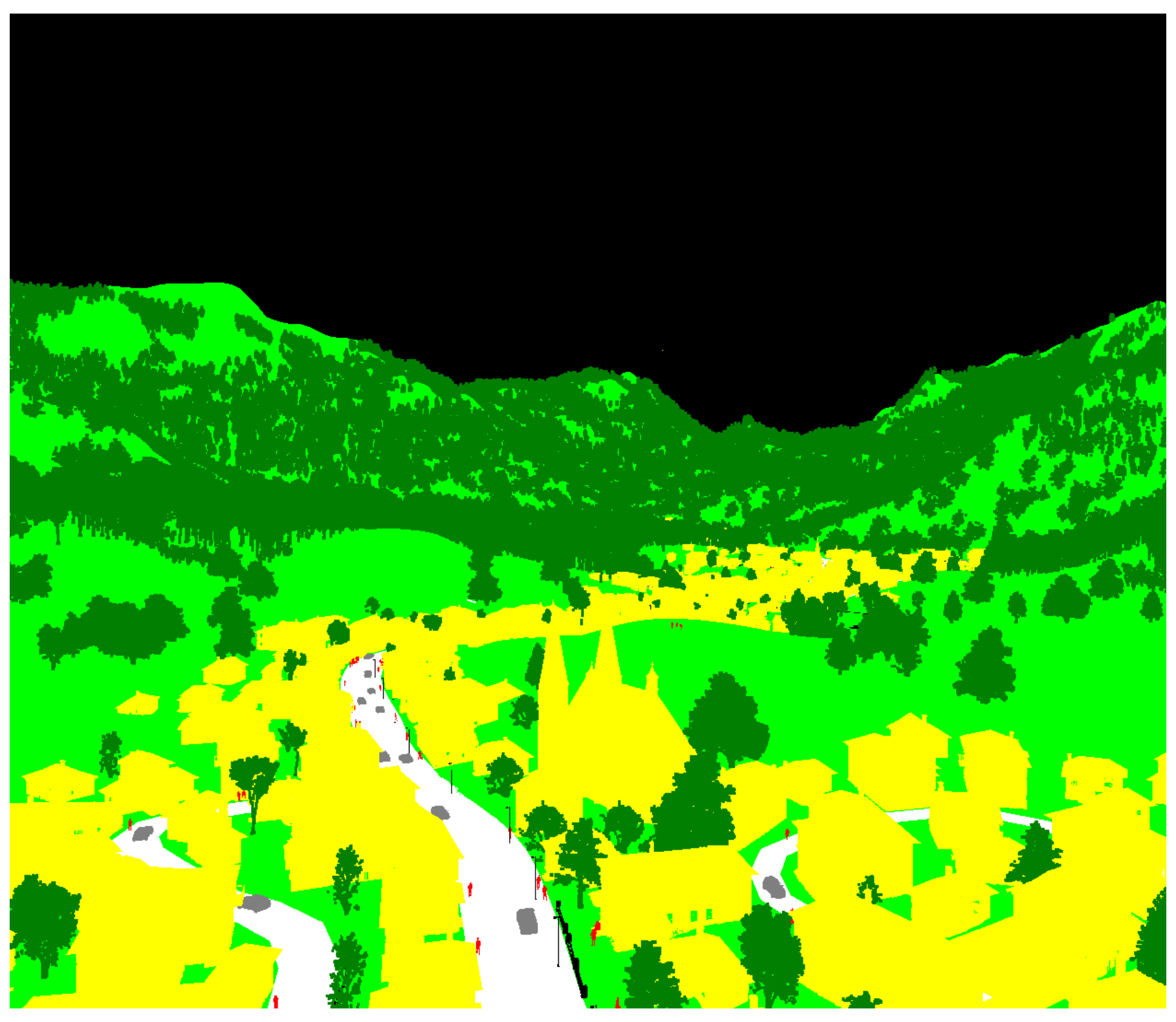
Figure 3: Semantic representation of the scene from Figure 2, different object classes are shown in different colors

Networking in the RTG

- T1 to T3 and T7 (boundary conditions)
- Reliable, robust self-position for T6 and postdoc project
- Description of landmarks (semantics) and initial maps for T8
- DLR: Regular scientific exchange with the department of Unmanned Aircraft of the Institute of Flight Systems, use of test equipment/facilities and joint flight tests, use of VAST


Figure 4: DLR test aircraft CDO DJI M600 (max. take-off weight: approx. 15 kg, diagonal propeller axes distance: 1,133 mm, propeller diameter 21")

Literatur:

[1] *F. Andert, N. Ammann, J. Puschel und J. Dittrich, "On the safe navigation problem for unmanned aircraft: Visual odometry and alignment optimizations for UAV positioning", in 2014 International Conference on Unmanned Aircraft Systems (ICUAS), 2014, doi: 10.1109/icuas.2014.6842318.*

[2] *F. Andert und S. Krause, "Optical aircraft navigation with multi-sensor SLAM and infinite depth features", in 2017 International Conference on Unmanned Aircraft Systems (ICUAS), 2017, doi: 10.1109/icuas.2017.7991319.*

[3] *C. Hinniger, J. Rüter: "Synthetic Training Data for Semantic Segmentation of the Environment from UAV Perspective", Aerospace. 2023; 10 (7): 604. https://doi.org/10.3390/aerospace10070604*

Network member in:

DRESDEN
concept
SCIENCE AND
INNOVATION CAMPUS

Institut für
Luftfahrt und
Logistik

DLR