



Adapt*://*Ve

*Automated Driving Applications and
Technologies for Intelligent Vehicles*

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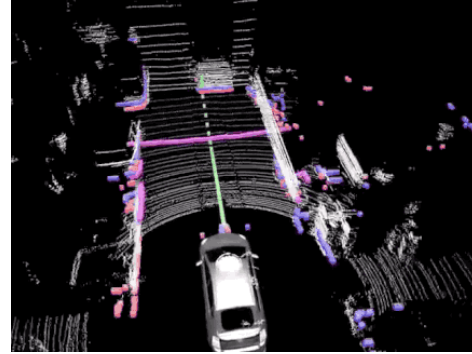
Final Event
Aachen, Germany
29 June 2017

*Mapping for GPS restricted
environments
(parking scenarios)*



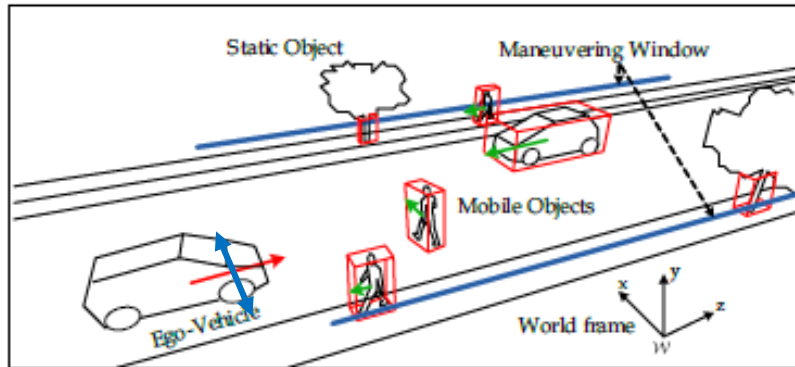
//Talk structure

- Intro: sensor-based mapping, when?



- 2D Lidar-based mapping in two AdaptIVe parking scenarios

//Intro | what does the vehicle need the map for?



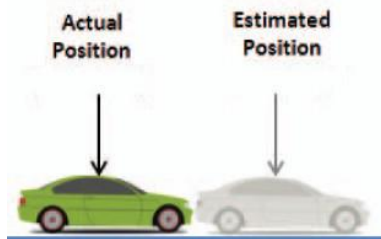
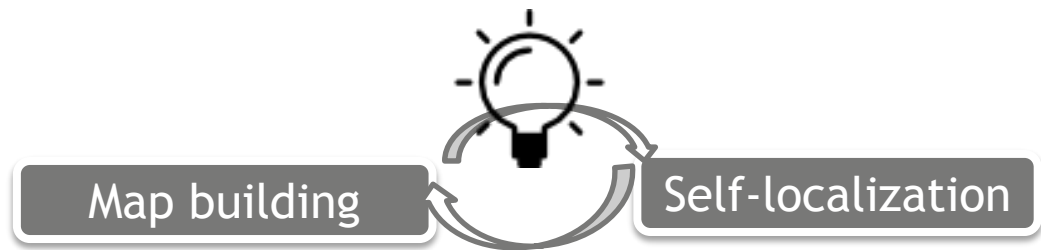
<https://hal.archives-ouvertes.fr/hal-00777442/document>

- **Robust perception**
 - filter out incorrect observation-to-track pairings
 - Accurate self-localization
- **Task driven perception**
 - focus on potential manoeuvring targets
- **Co-operative perception**

//Intro | when do we need SLAM for building it?



- Ad hoc **localization** infrastructure (**map**, landmarks) **missing, changed** or **not detailed enough**



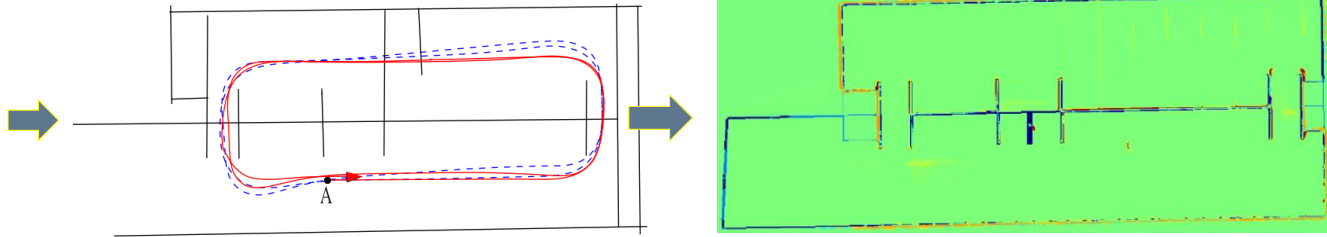
- GNSS vulnerabilities can affect automotive applications especially when high-positioning accuracy is needed

// Our approach: Mapping for parking apps

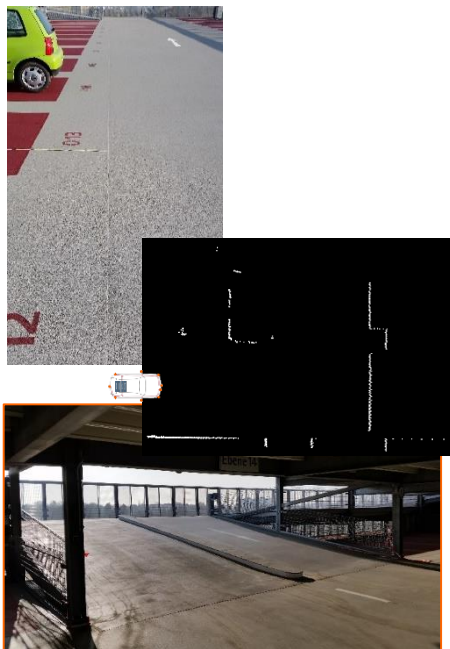
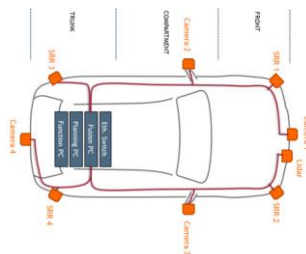


- Focus on parking garage areas (indoor and outdoor, no GPS)
- Lidar measurements are used to generate accurate 2D maps

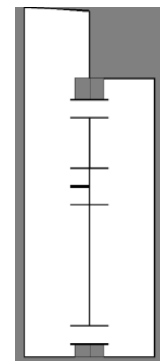
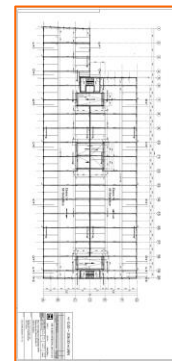
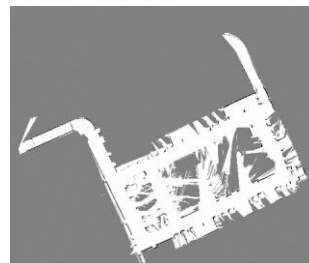
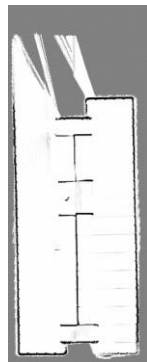
SLAM



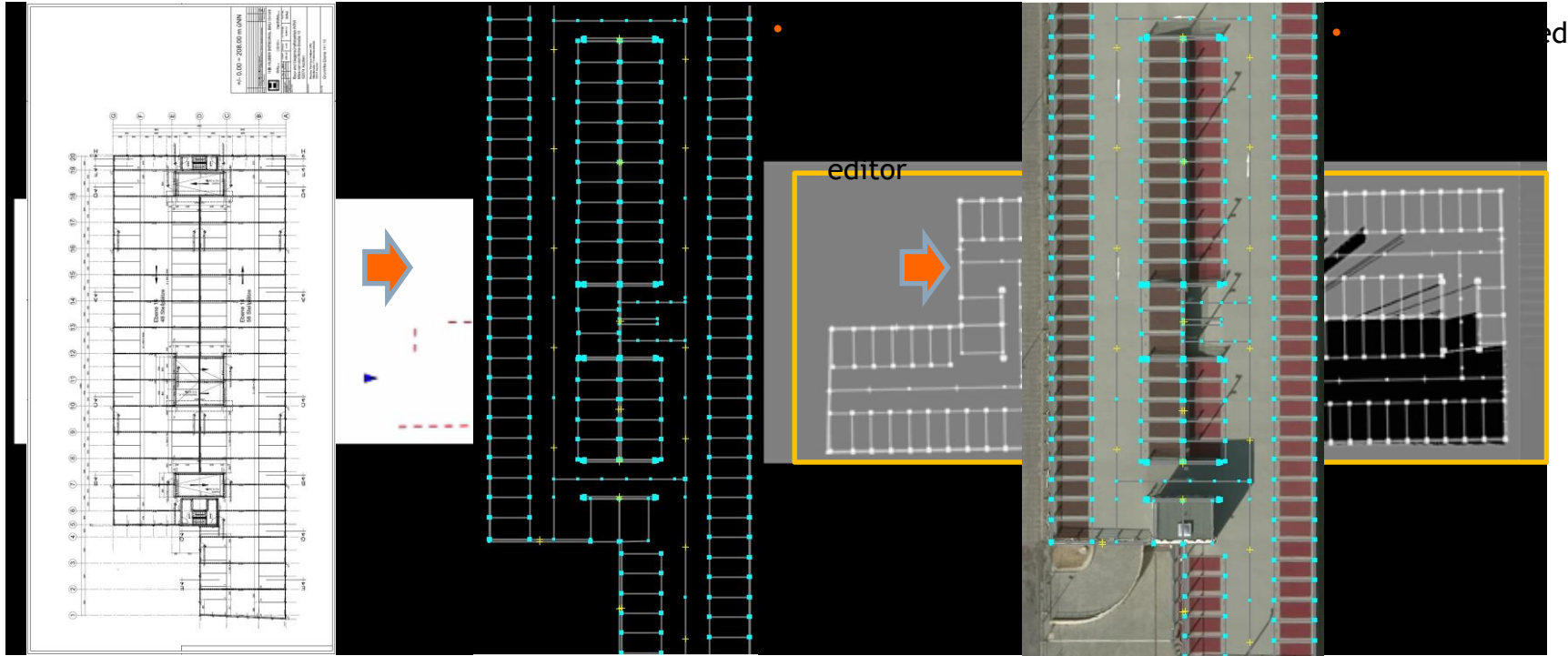
// Experimental setup



SLAM

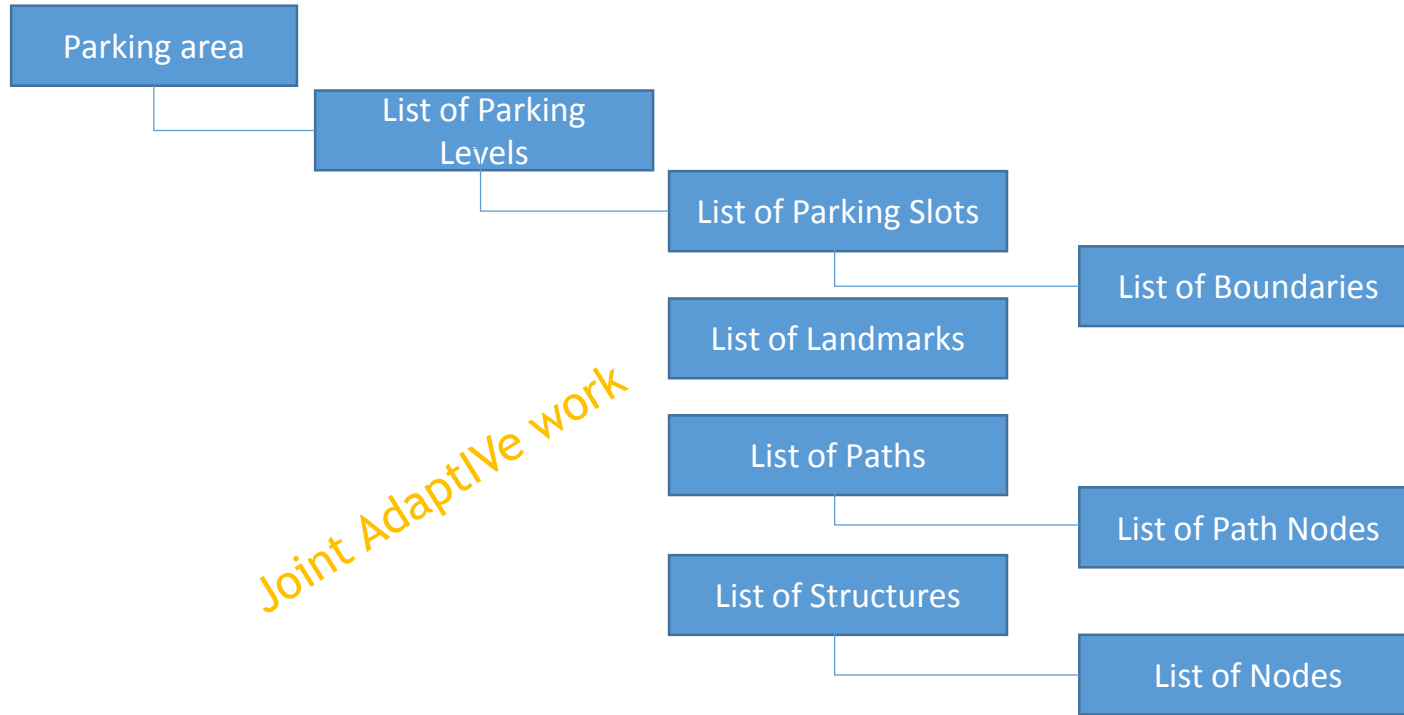


// Resonih (RWTH) expert debugging empty

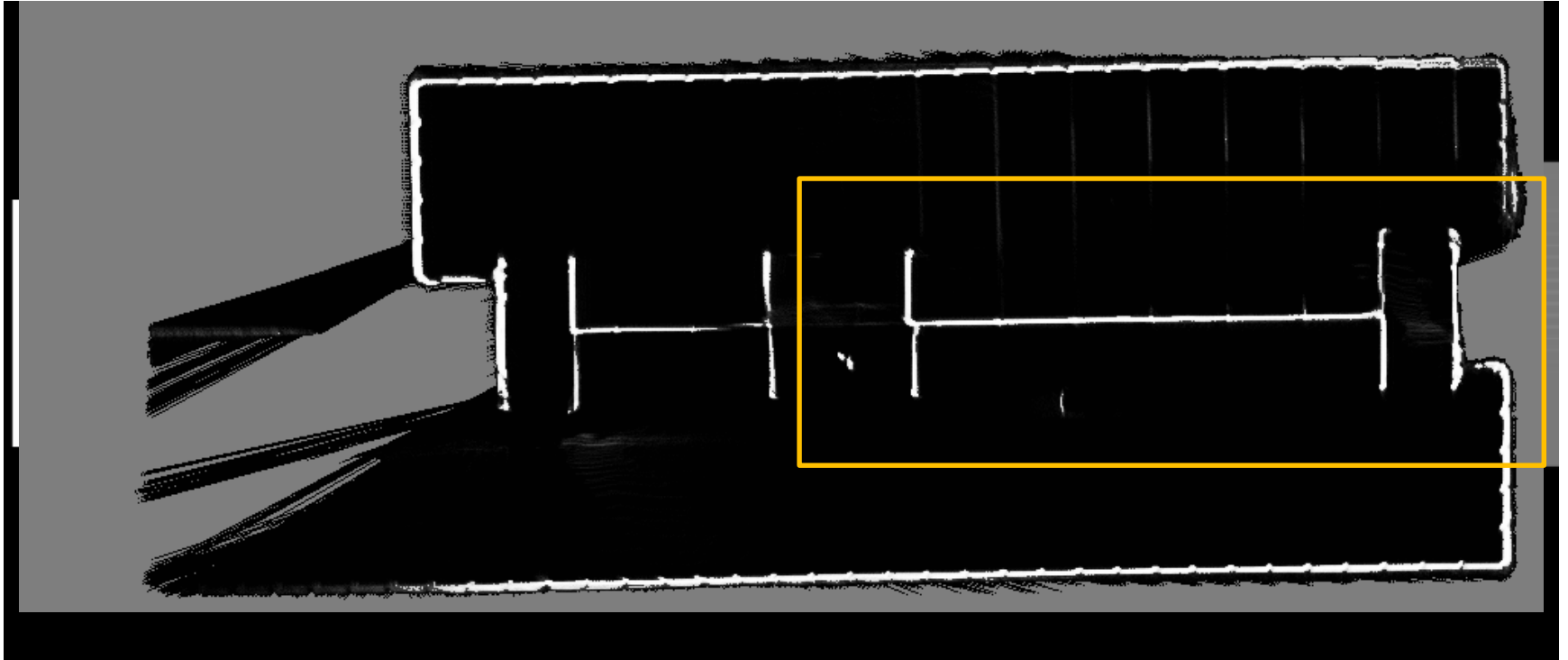


// Zoom-in 1: Blueprint digitalization

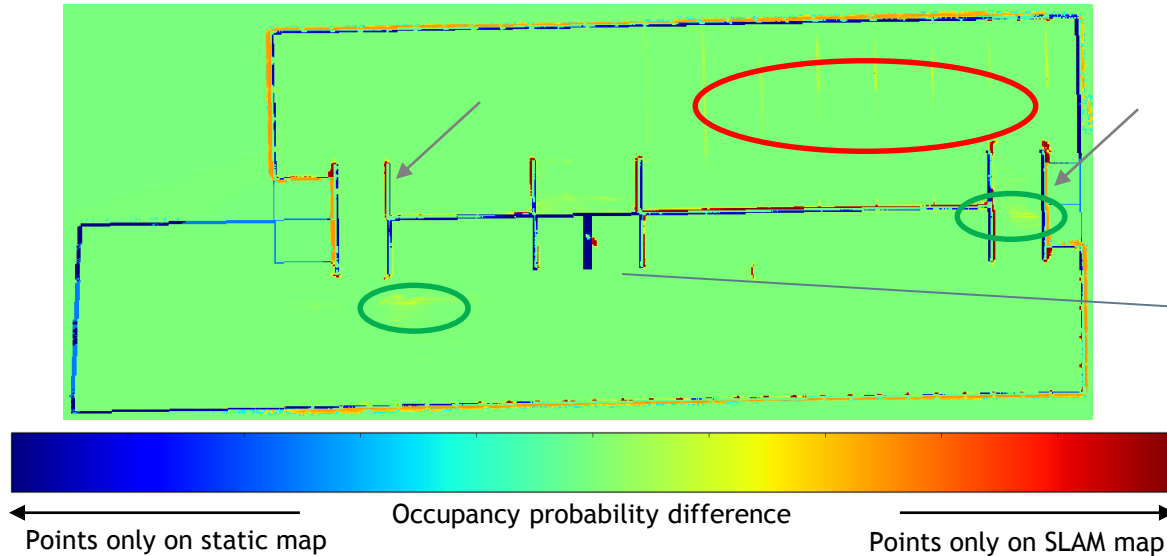
Adaptive OSM Static Elements schema



// Result I (RWTH outdoor garage - empty)



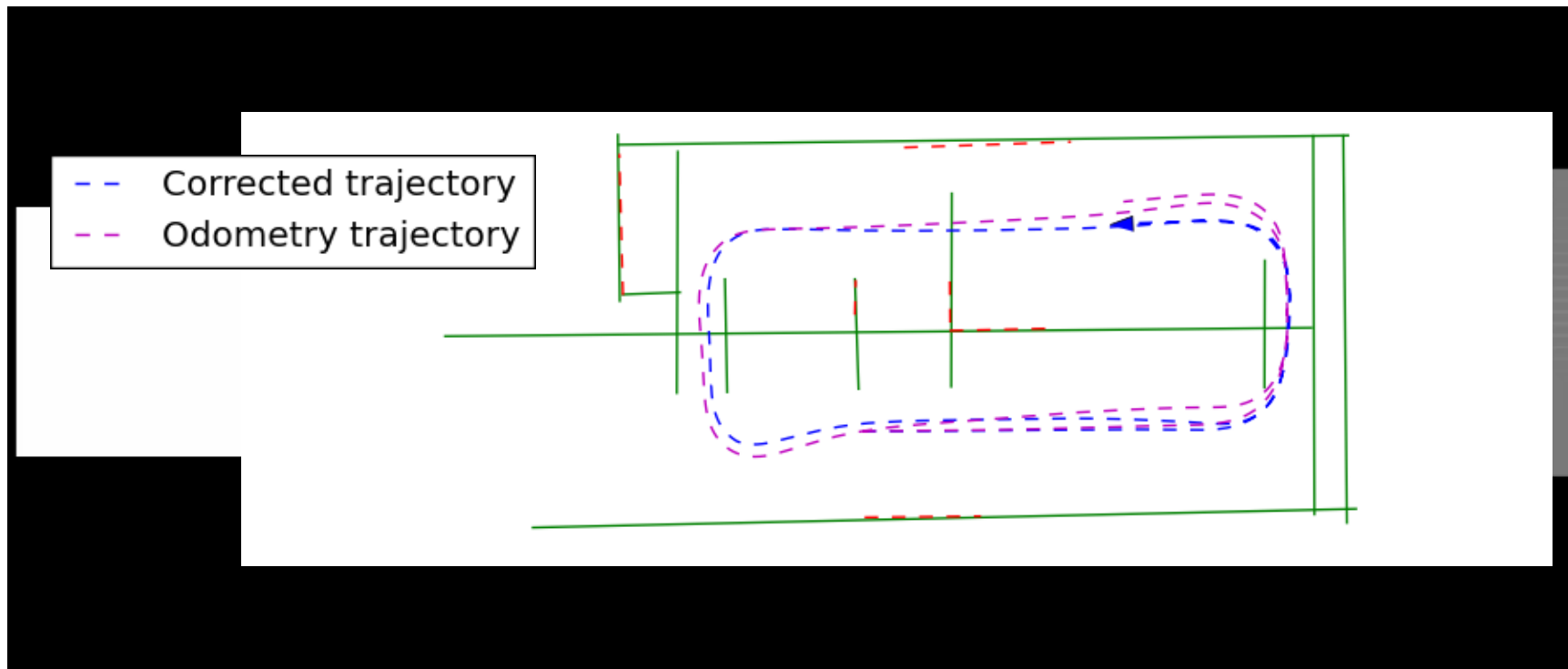
// Zoom-in 2: Challenges



- Uncertainty when exiting from corridors (occlusions)
- Multi-level parking | Metallic surfaces (3d map would solve this)
- Ground false positives in inclined ramps (IMU missing)

// Result I (RWTH outdoor garage - empty)

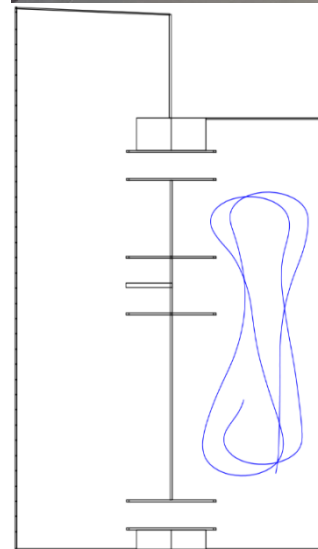
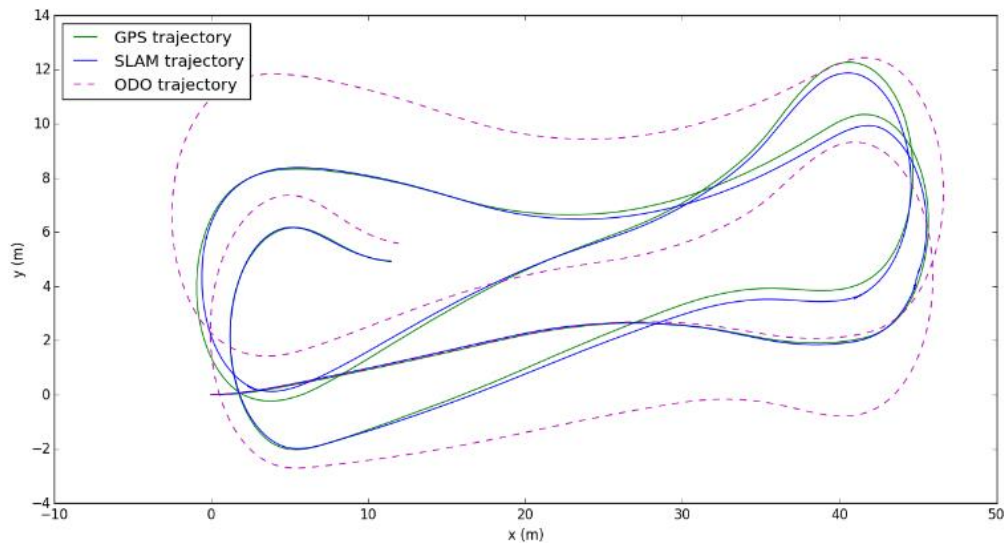
— Line features
- - - - - Extracted lines at current time step



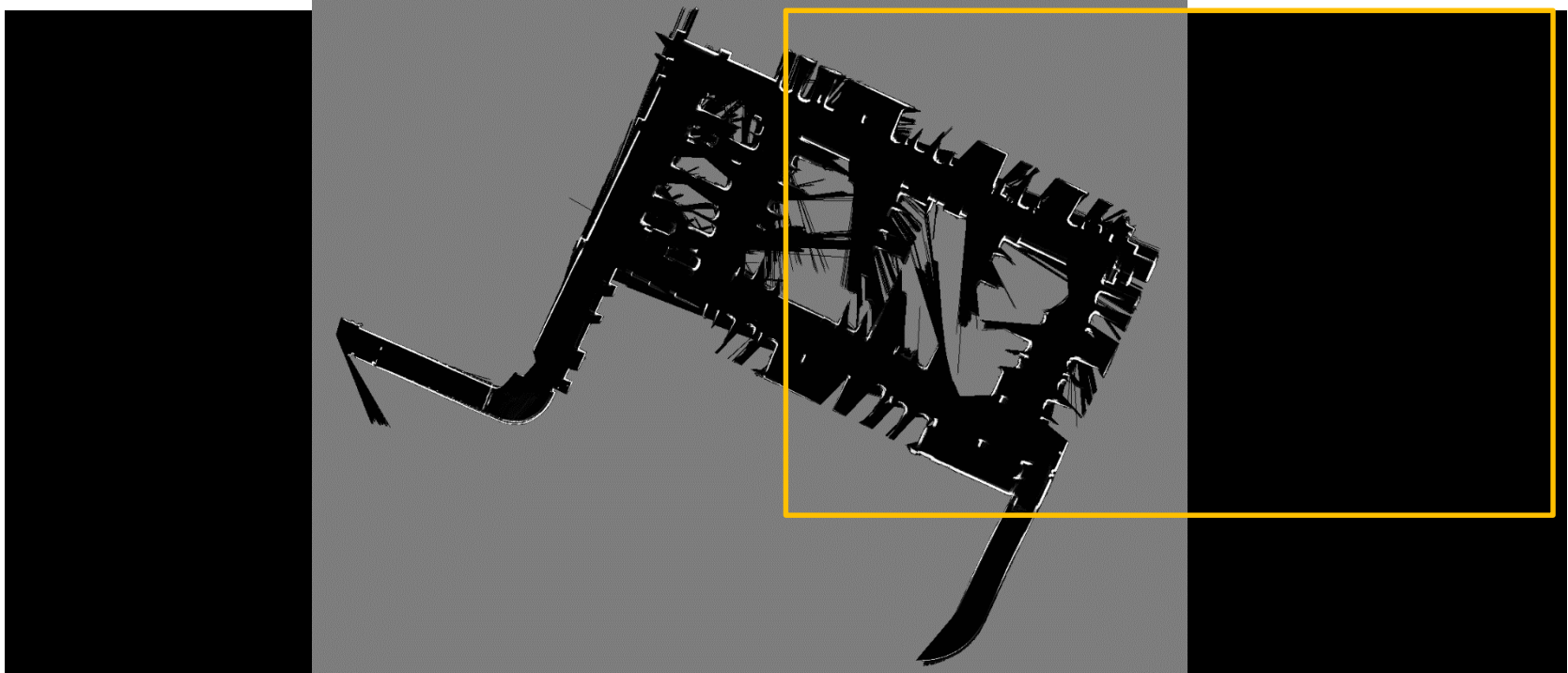
// Zoom-in 3: Localization accuracy

(open air, against d-GPS traces)

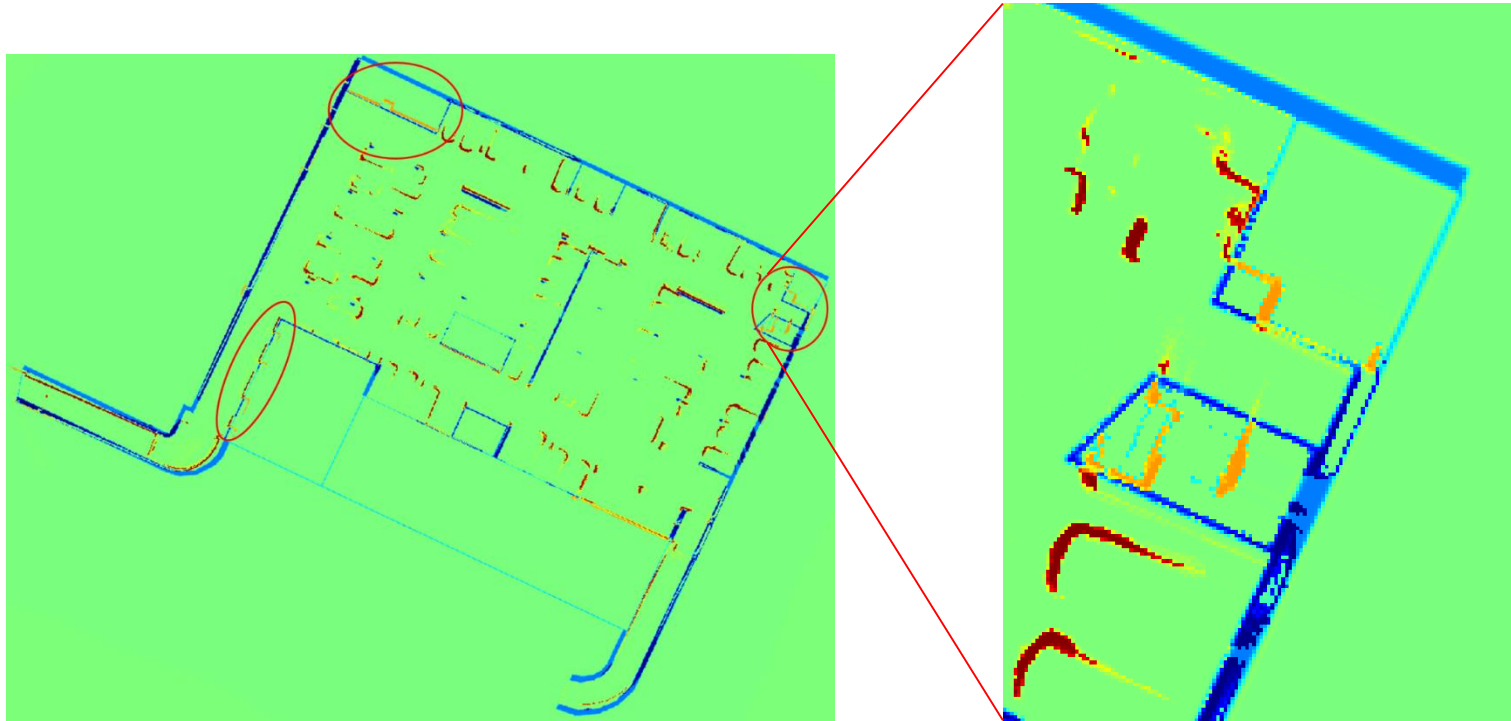
- Mean odometry error: 1.90 meters
- Mean SLAM error: 0.27 meters



// Result II (DAI indoor garage - cluttered)

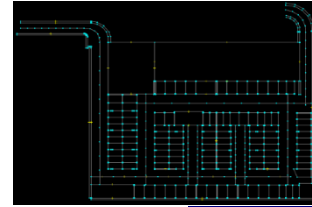


// Zoom-in 1: Lidar map vs. static map



//Take-home messages

- Method for fusion of SLAM generated map with static apriori map is missing (maps' alignment crucial)
- Quantitative mapping evaluation not easy; could be replaced by localization evaluation if dGPS available in a SLAM setting



...beyond parking

- SLAM in low velocities can provide accurate maps
- SLAM does not scale easily
 - Activate SLAM locally when positioning confidence diminishes or a global reference map is needed



Co-funded by
the European Union

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Thank you.

Qs?

