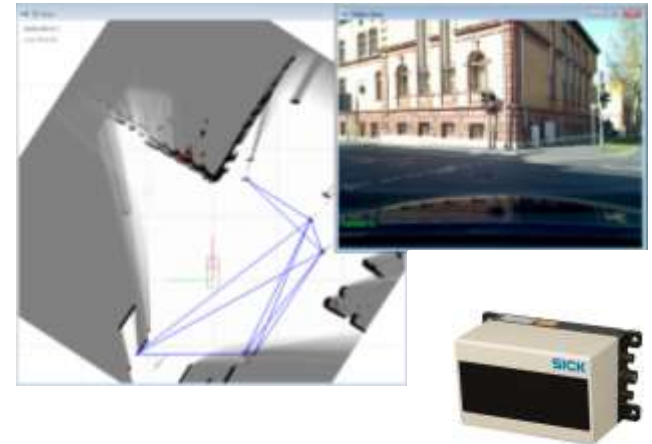


Vehicle self-localization using Laserscanners

Fahrzeug-Eigenlokalisierung mit Laserscannern

Dr. Roland Krzikalla
SICK AG



Supported by:

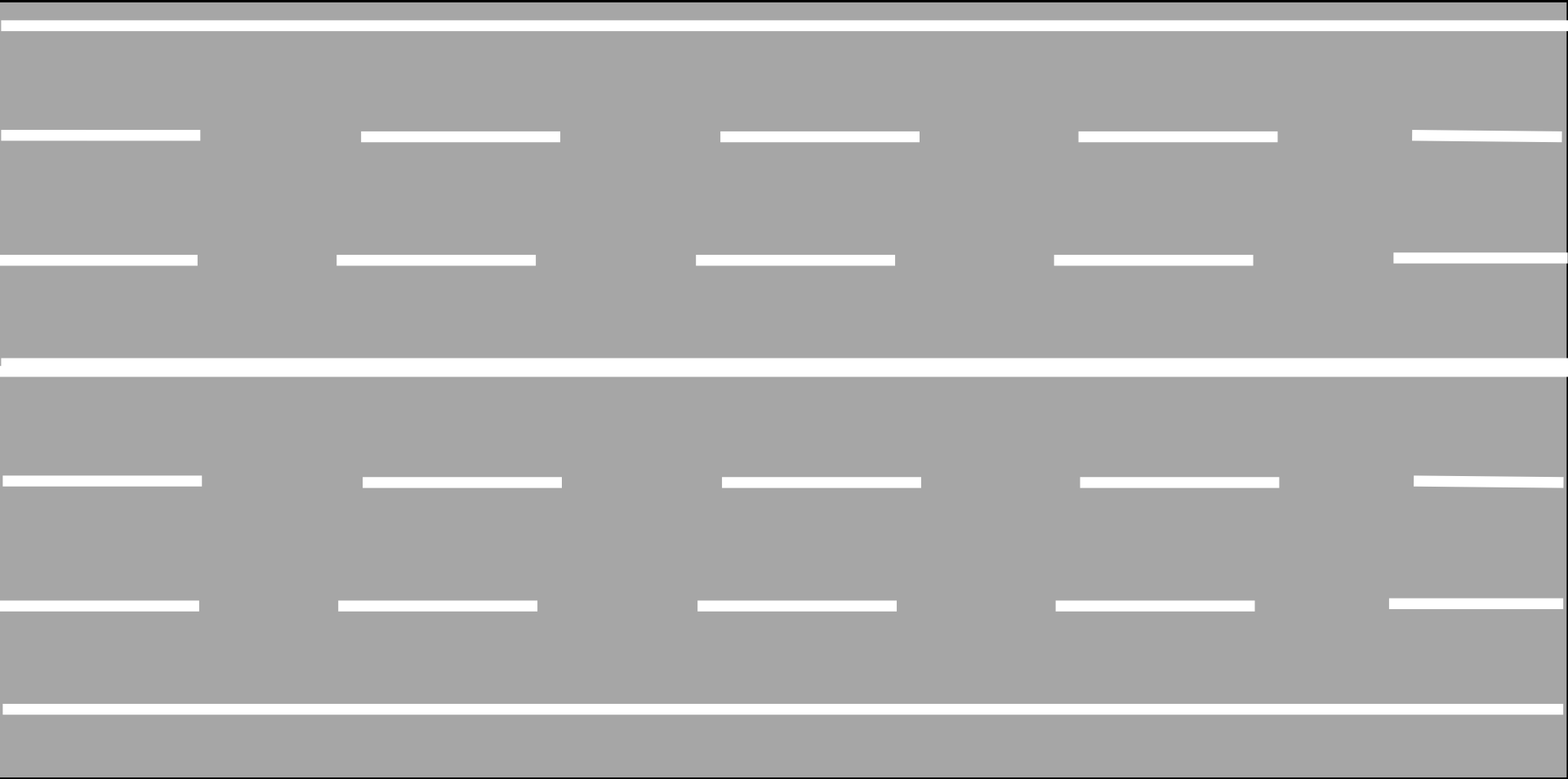


on the basis of a decision
by the German Bundestag

Motivation



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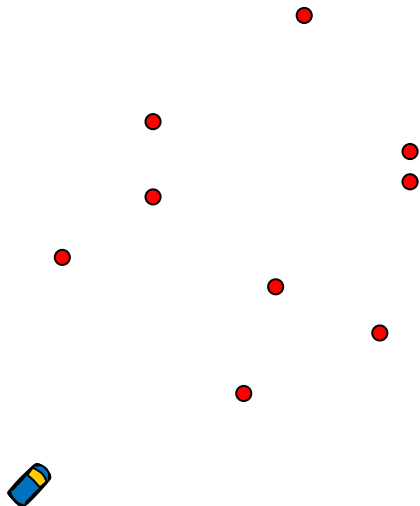


General Working Principle

General working principle (1)



1. Extraction of landmarks from Laserscanner data
2. Use of digital maps
3. Association and matching for precision self-localisation including landmarks



General working principle (2)



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1. Landmark candidate extraction from Laserscanner data
2. Association of landmarks from digital map with candidates
3. Calculation of vehicle position and orientation using “Extended Kalman-Filter with known associations”

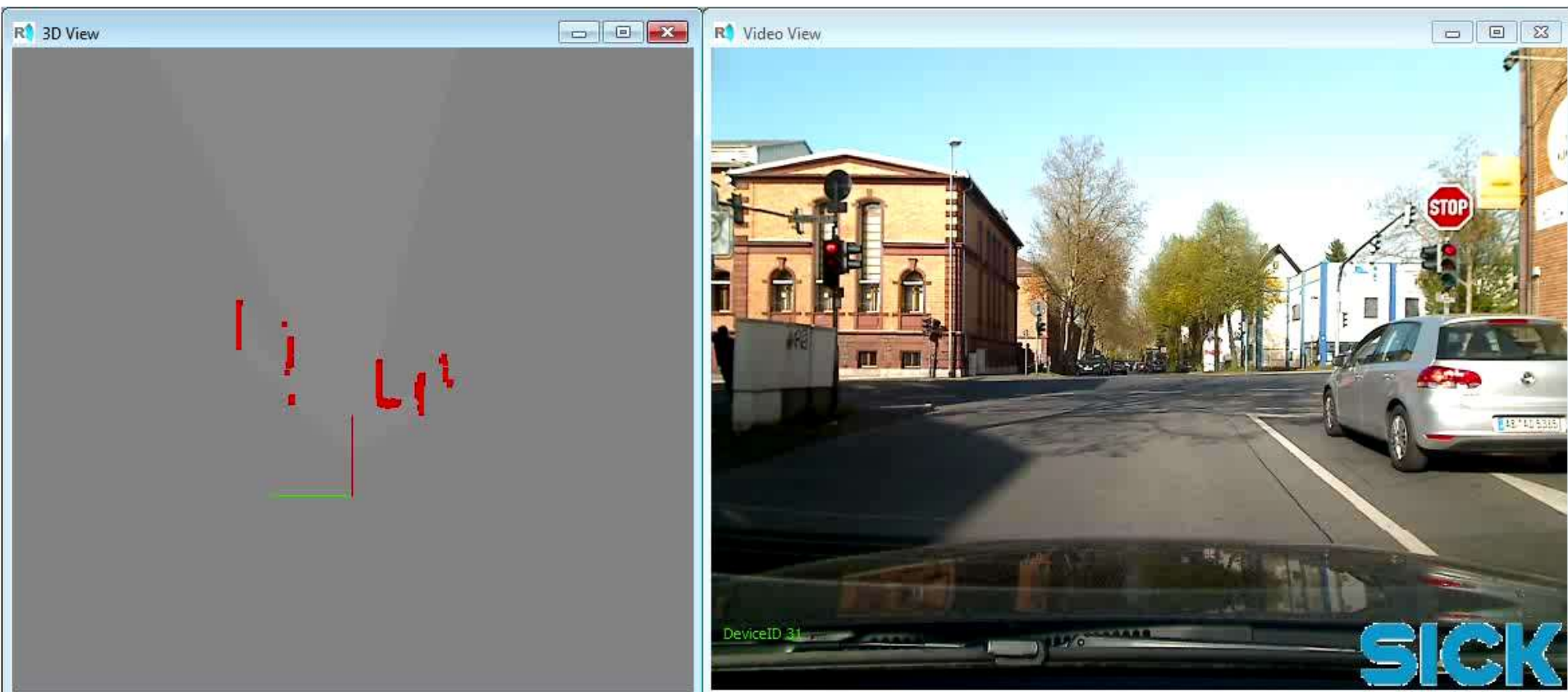
Landmark candidate extraction from Laserscanner data

Landmark candidate extraction (1)



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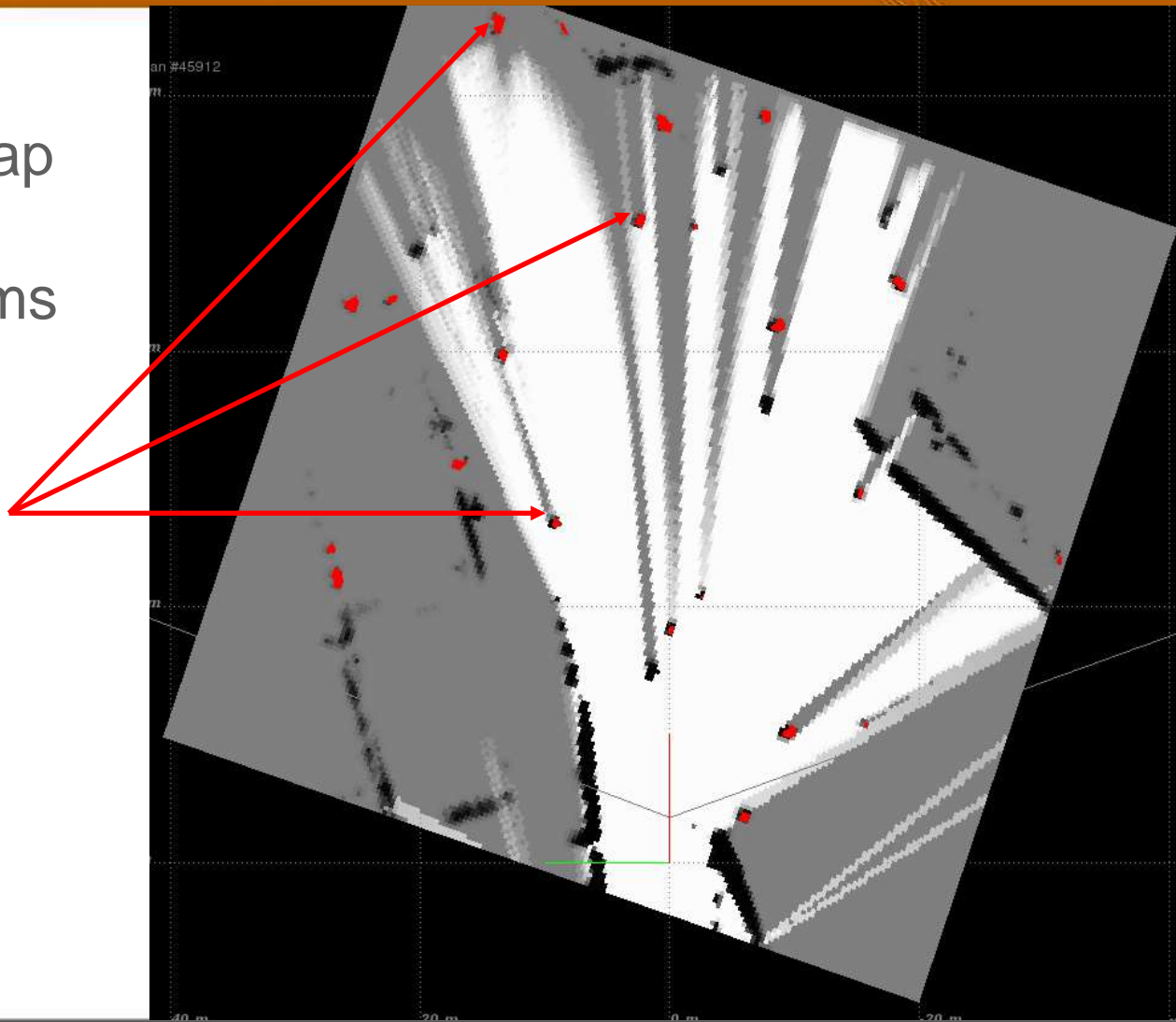
Create a history map of Laserscanner data



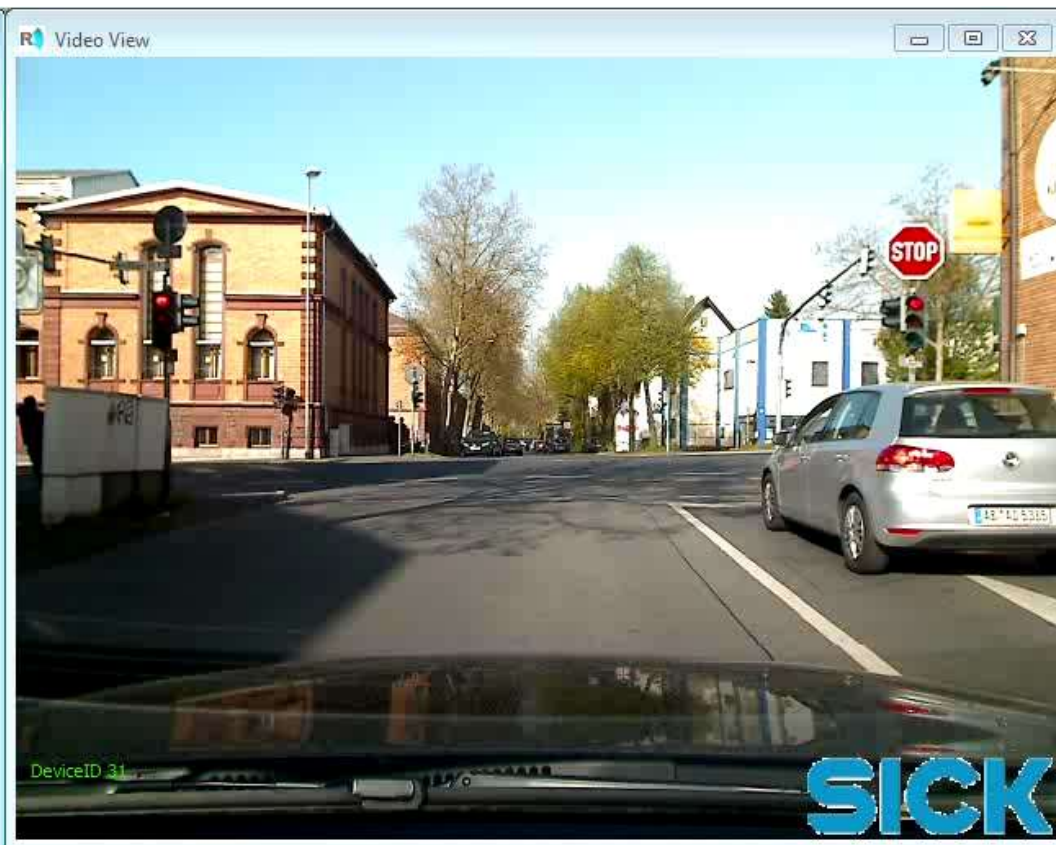
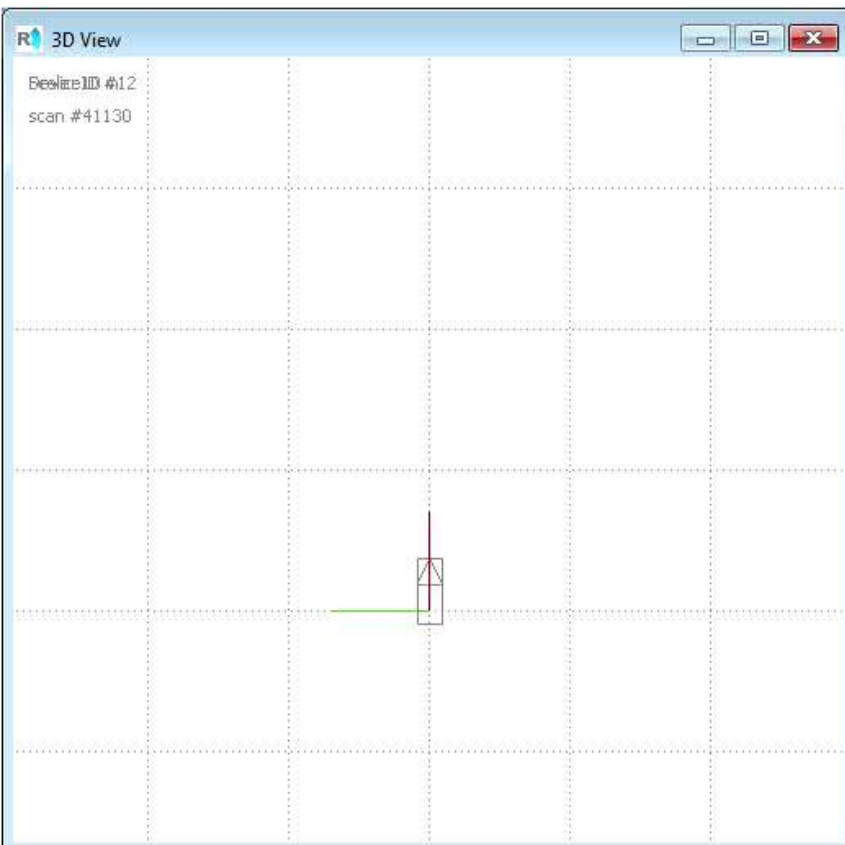
Landmark candidate extraction (2)

Find small sized objects in history map using image processing algorithms

- Street light
- Road signs
- Reflector posts
- Tree trunks...



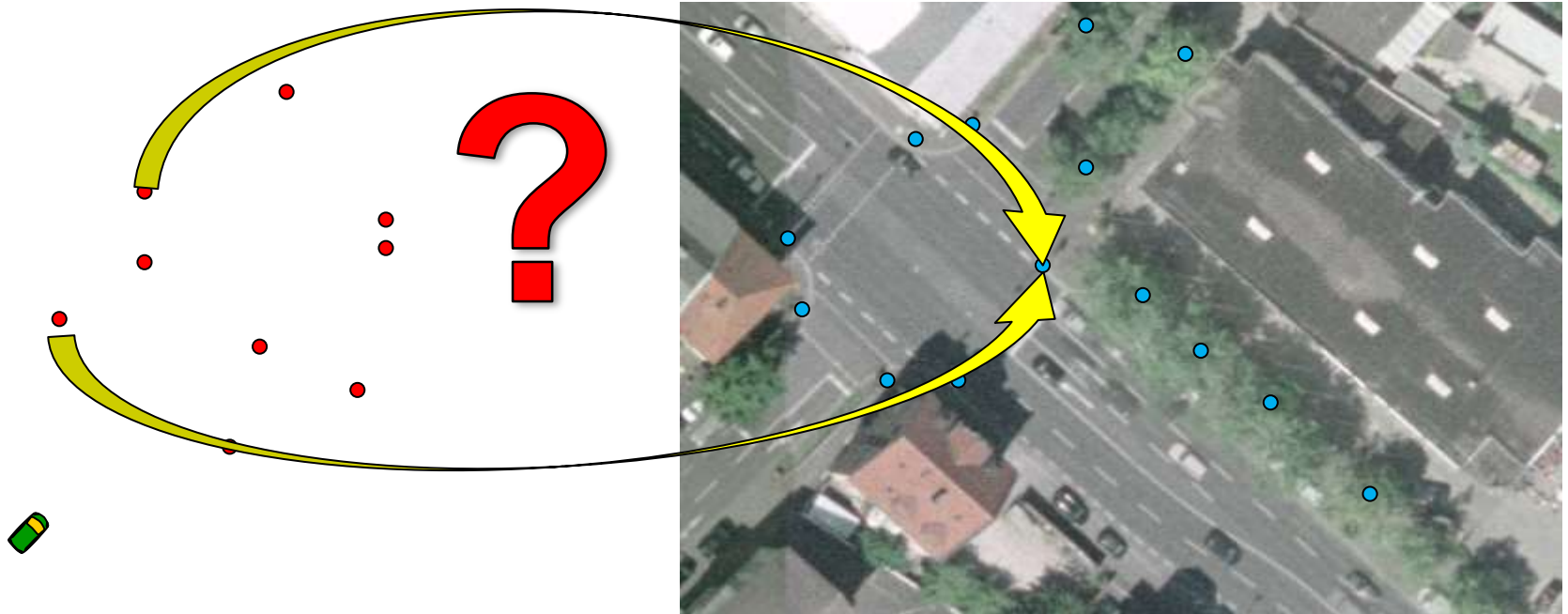
Landmark candidate extraction (3)



Landmark association

- Question:

Which landmark candidates from the Laserscanner data correspond to which landmarks from the digital map?



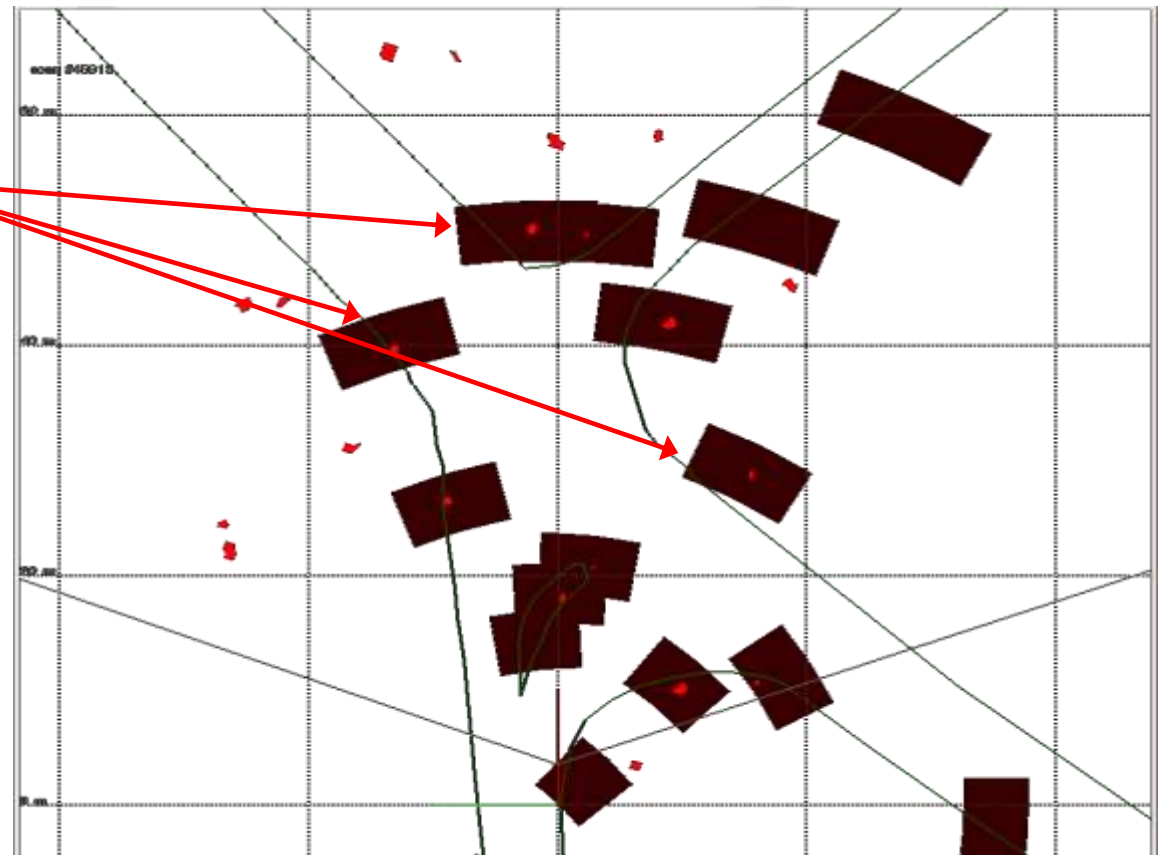
Landmark association (2)



Create an association area surrounding a landmark from the digital map and associate all candidates in this area

Association areas

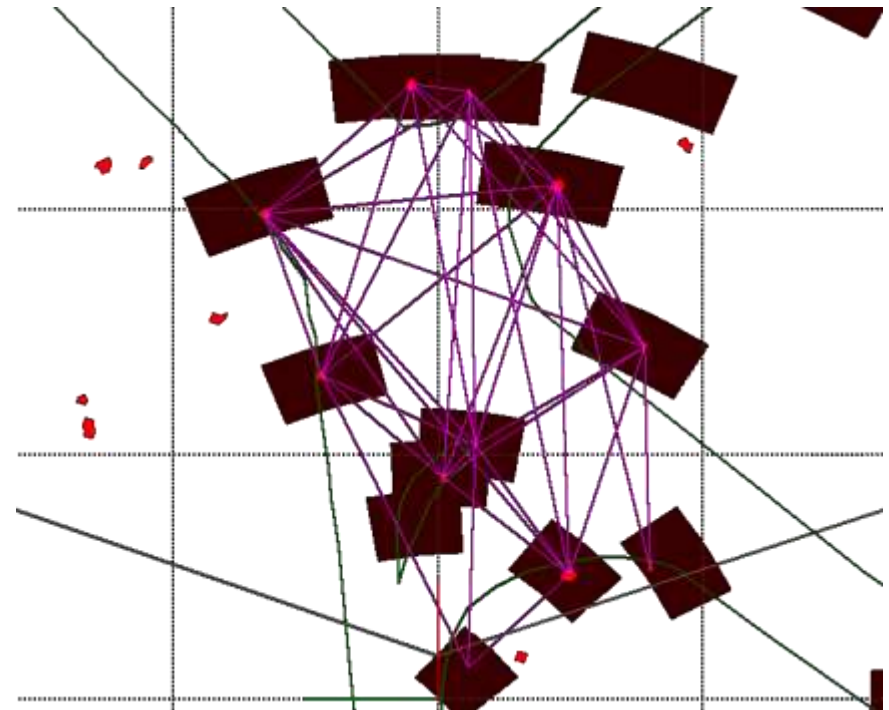
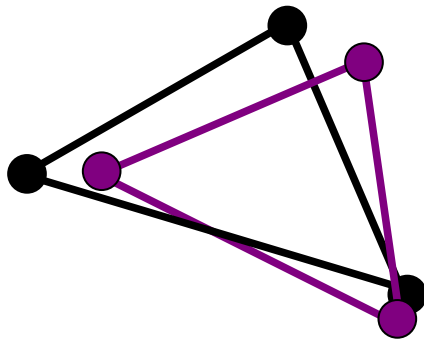
- Centre is a landmark from the digital map
- Size depends on the current Kalman covariance



Landmark association (3)



Perform triangle comparisons of landmarks and **landmark candidates** and disassociate mismatched triangles

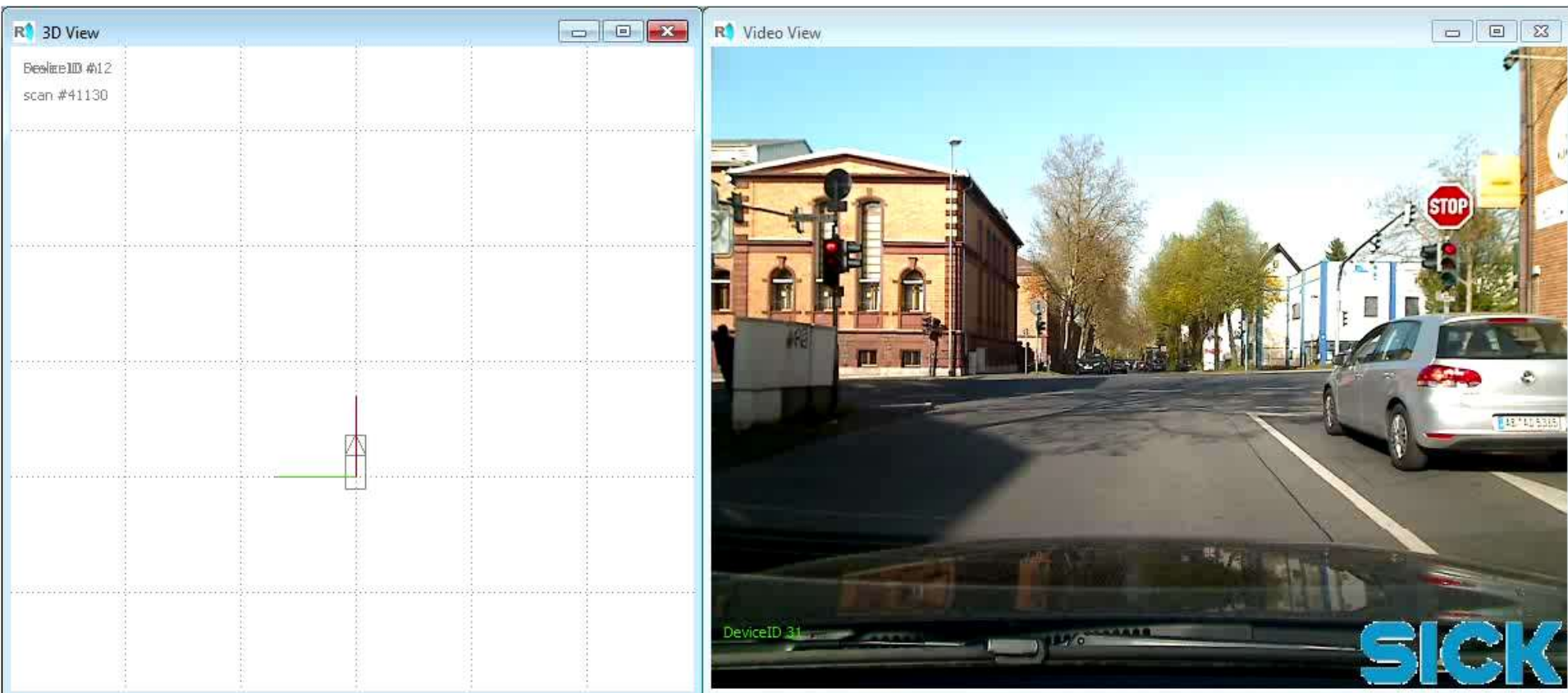


Reduction of multiple or mismatched pairs of landmarks and candidates

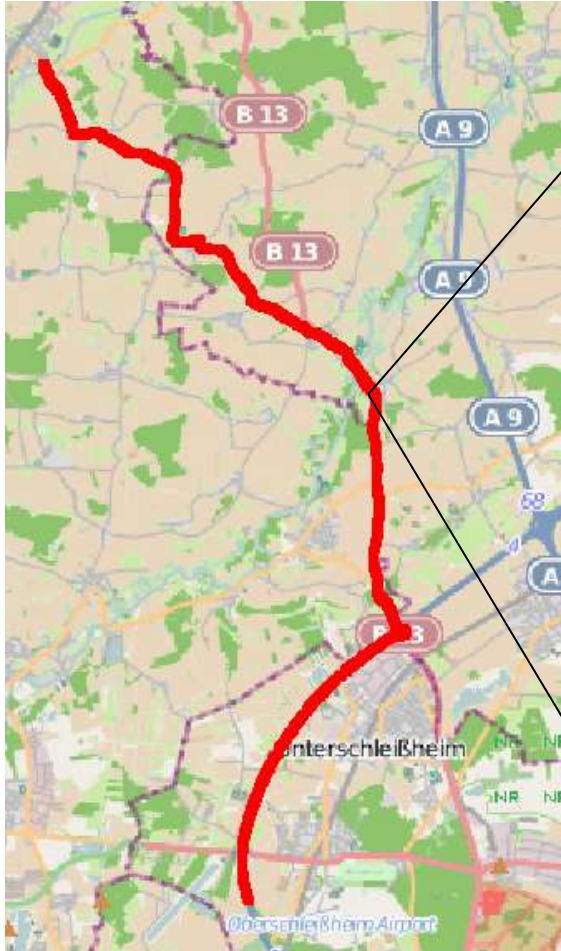
Landmark association (4)



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Tests at Munich rural road site





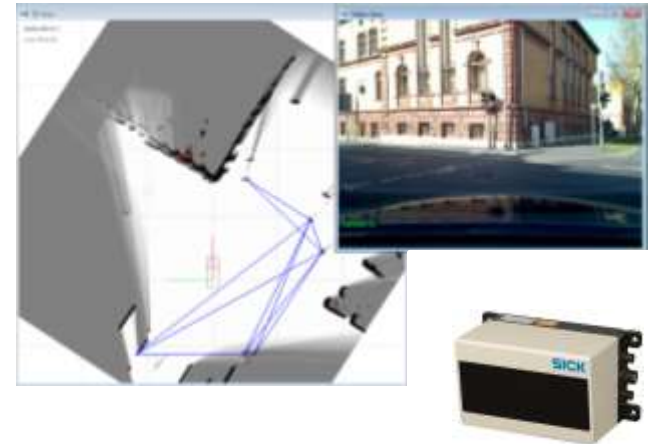
	Munich road site	Ko-PER intersection
Longitudinal error [m]	$\mu = 0,10 \text{ m}$ $\sigma = 0,07 \text{ m}$	$\mu = 0,07 \text{ m}$ $\sigma = 0,43 \text{ m}$
Lateral error [m]	$\mu = 0,23 \text{ m}$ $\sigma = 0,28 \text{ m}$	$\mu = 0,34 \text{ m}$ $\sigma = 0,22 \text{ m}$
Orientation error [°]	$\mu = 0,58^\circ$ $\sigma = 0,83^\circ$	$\mu = 0,15^\circ$ $\sigma = 0,53^\circ$

- Vehicle self-localization approach based **only on Laserscanners** has been realized to provide a basis of safety applications in vehicles.
- Method is capable to provide very precise vehicle self-localization at intersections, rural road sites and highways with road track precision.
- Stand-alone system or add-on for already built-in environment perception systems

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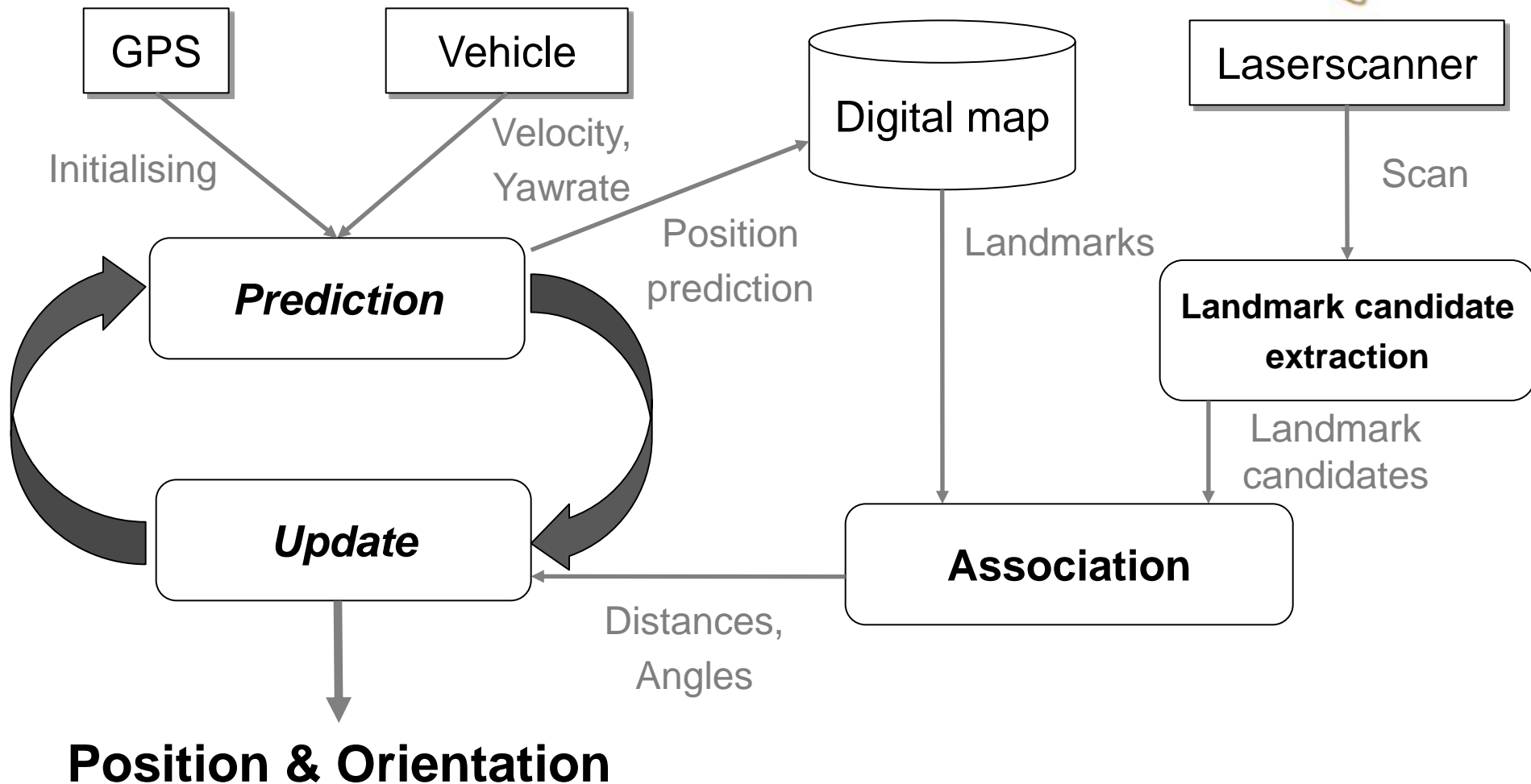


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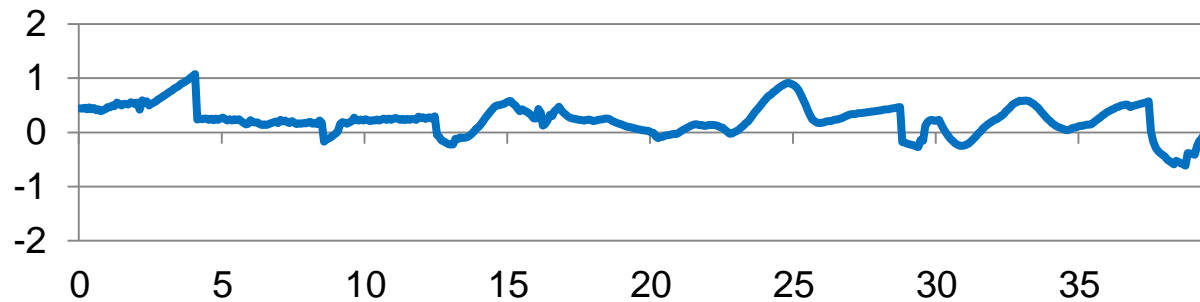
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Algorithm (EKF with known associations)



Tests + Results (2)

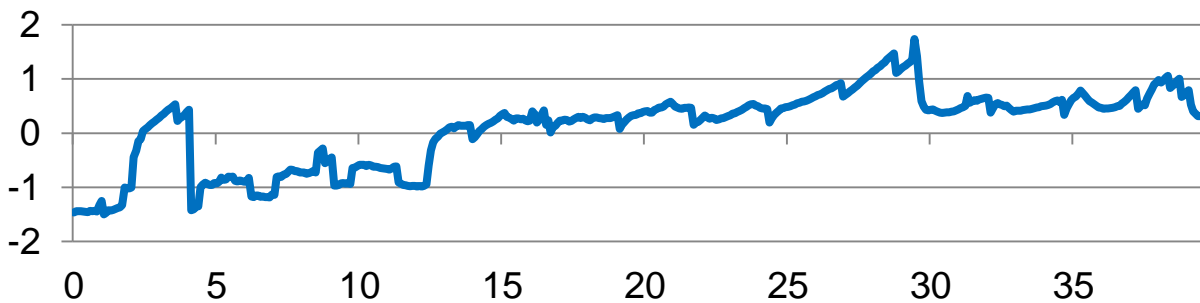
Munich rural road site



Lateral position error [m]

$\mu = 0,23 \text{ m}$

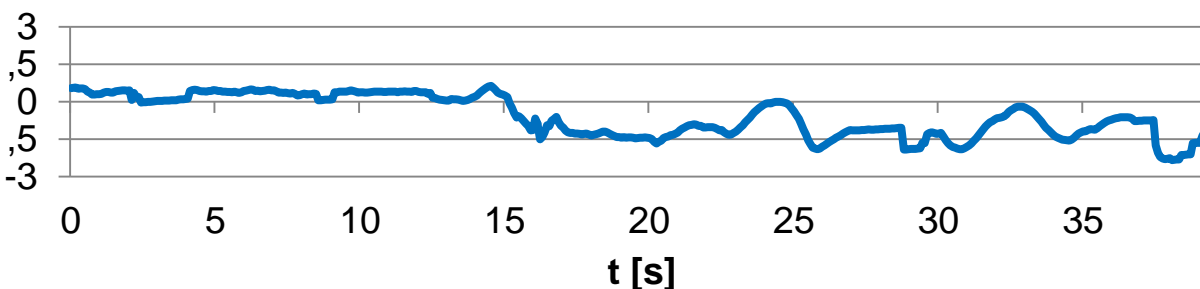
$\sigma = 0,28 \text{ m}$



Longitudinal position error [m]

$\mu = 0,10 \text{ m}$

$\sigma = 0,07 \text{ m}$



Orientation error [°]

$\mu = 0,58^\circ$

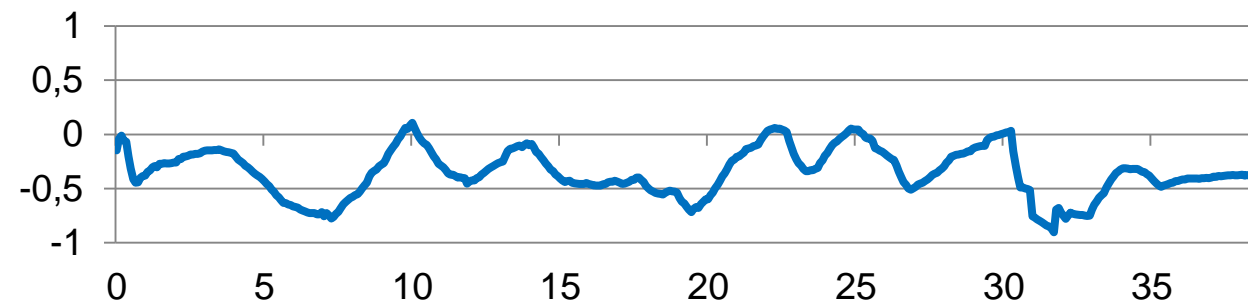
$\sigma = 0,83^\circ$

Tests + Results (4)

Ko-PER Intersection Aschaffenburg



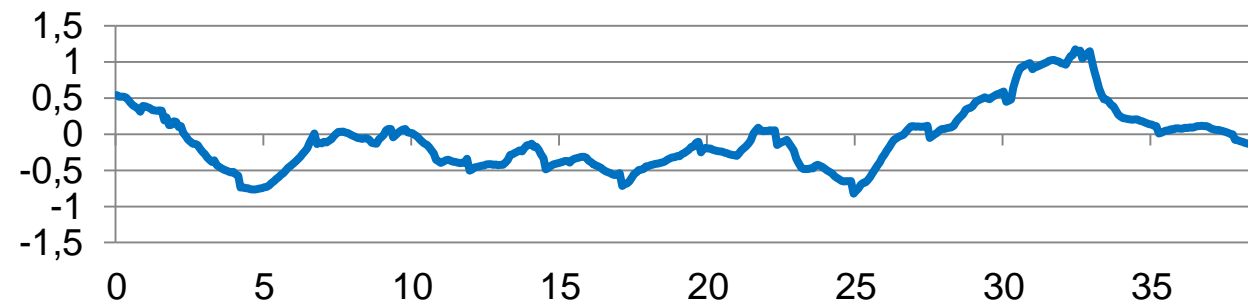
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Lateral position error [m]

$\mu = 0,34 \text{ m}$

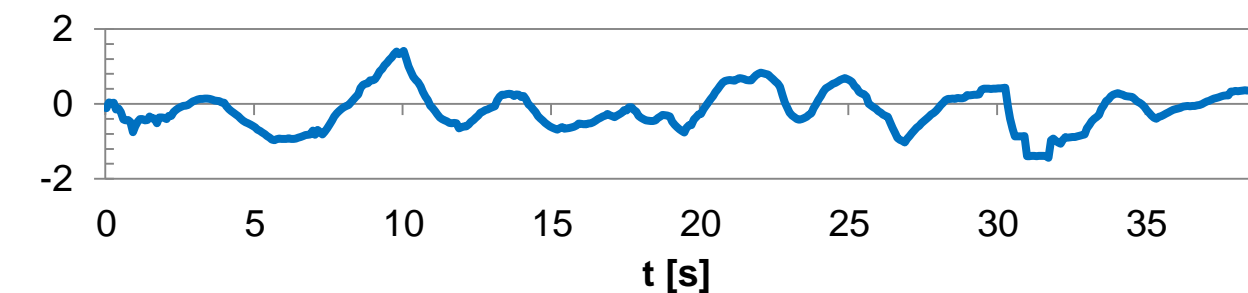
$\sigma = 0,22 \text{ m}$



Longitudinal position error [m]

$\mu = 0,07 \text{ m}$

$\sigma = 0,43 \text{ m}$



Orientation error [°]

$\mu = 0,15^\circ$

$\sigma = 0,53^\circ$