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Sensor Technology at the Smart Public Intersection Aschaffenburg

Sensorik und Intelligenz der
öffentlichen Testkreuzung Aschaffenburg

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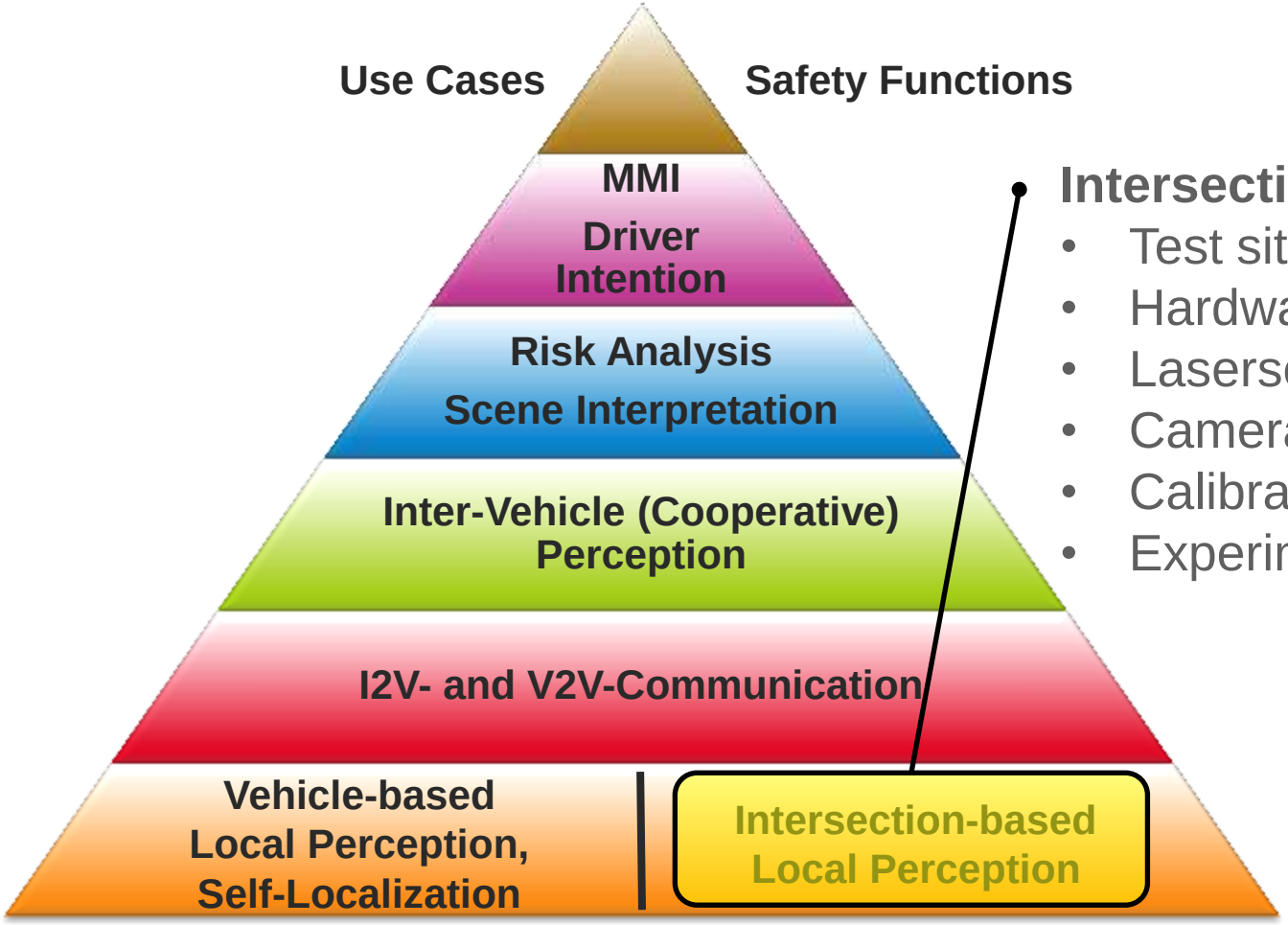
Supported by:
Federal Ministry of Economics and Technology
on the basis of a decision by the German Bundestag

Overview

- Cooperative perception - Concept
- Test setup at public intersection
- Sensors
- Experimental results

Cooperative perception - Concept



Intersection based perception

- Test site
- Hardware architecture
- Laserscanners
- Cameras
- Calibration
- Experiments and results

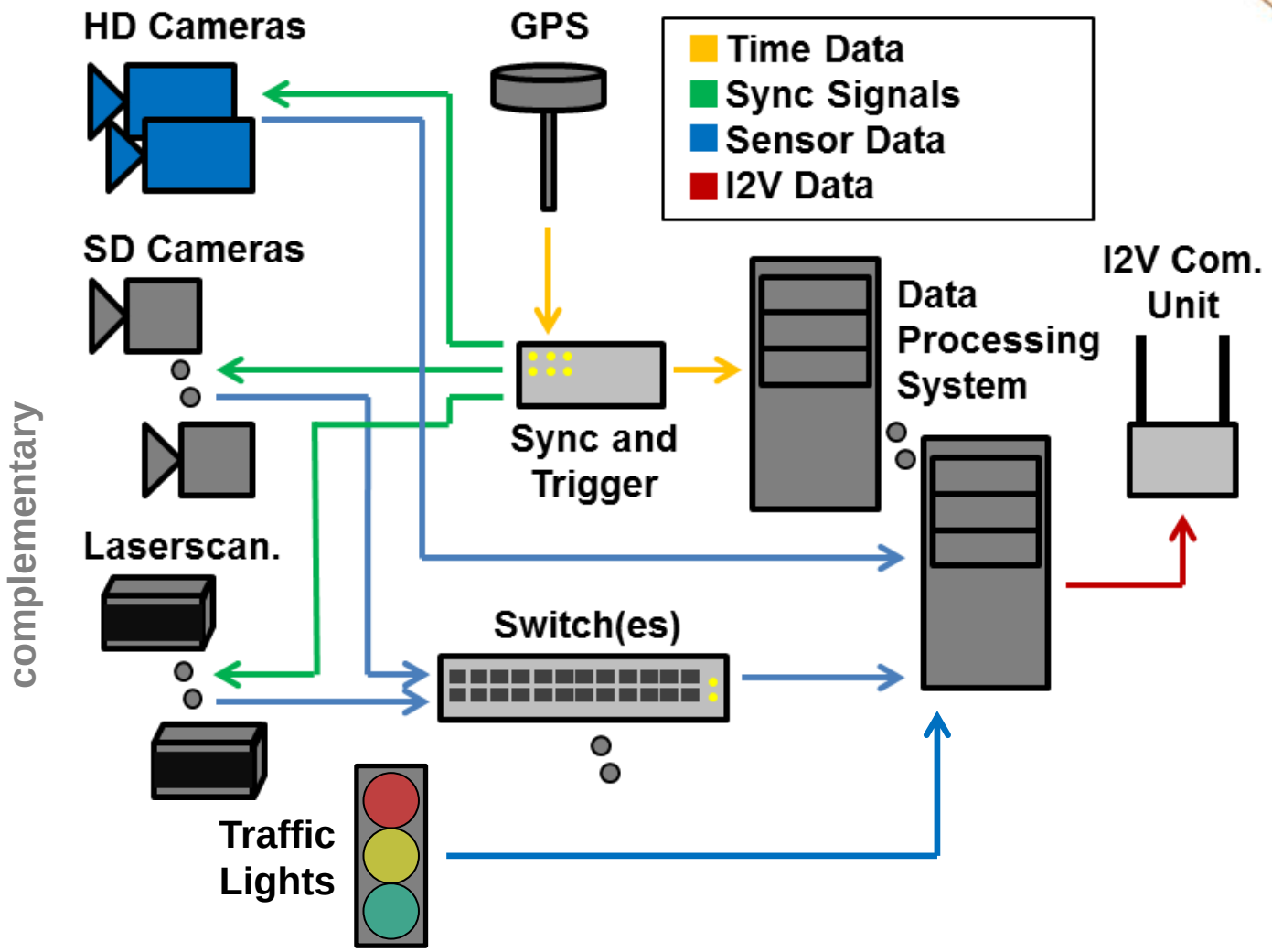
Test setup at public intersection

Intersection in an urban area

- 5 and 3 lanes
- 3 crosswalks
- Bicycle lane

- Approx. 23,000 vehicles per day

Architecture of perception system



Laserscanner subsystem

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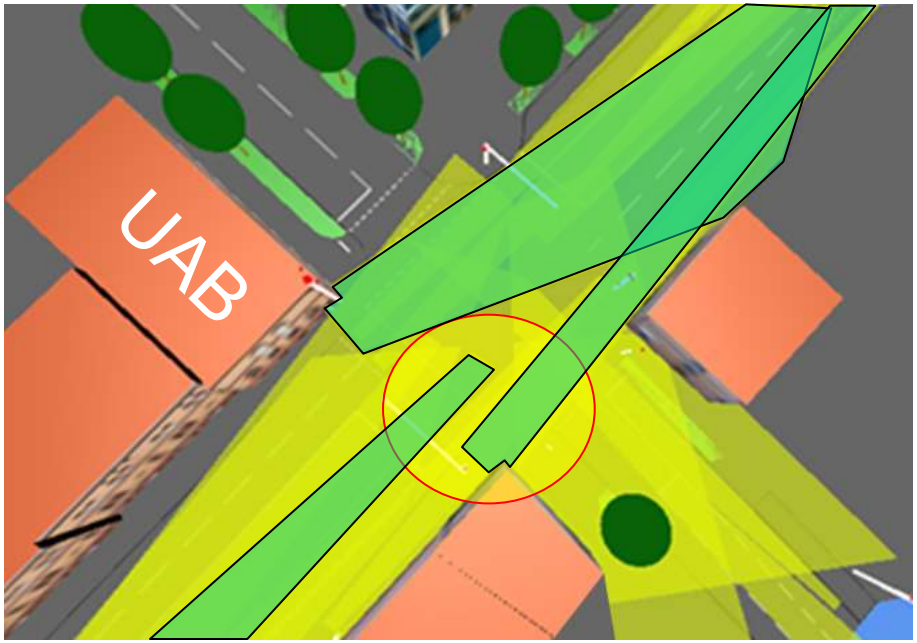
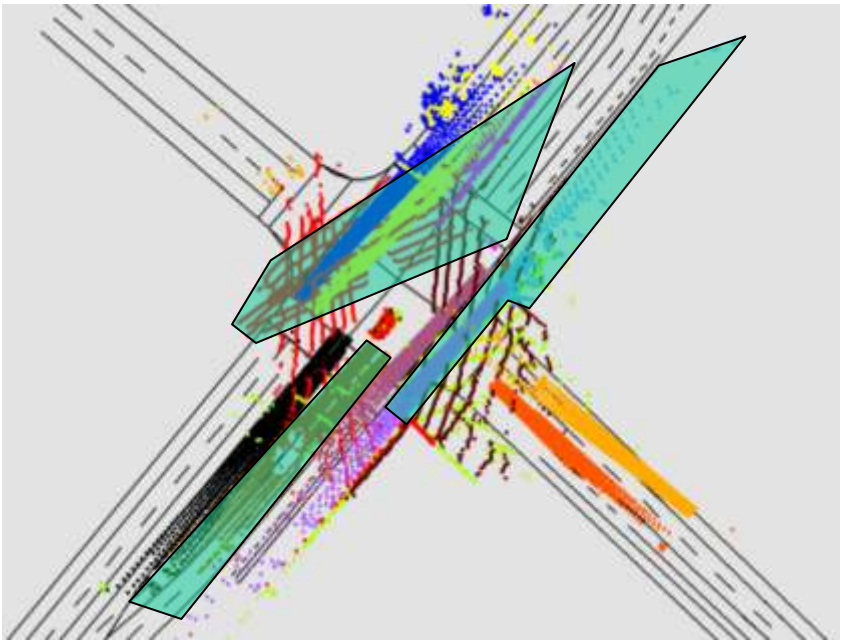
14 SICK LD-MRS research multilayer laserscanners:

- 4 horizontally aligned for central intersection area and crosswalks
- 8 vertically aligned for incoming lanes, range up to 100m
- 2 for sidewalks, crosswalks and bicycle lane



Simulated fields of view



Measured Lidar reflections

Camera subsystem

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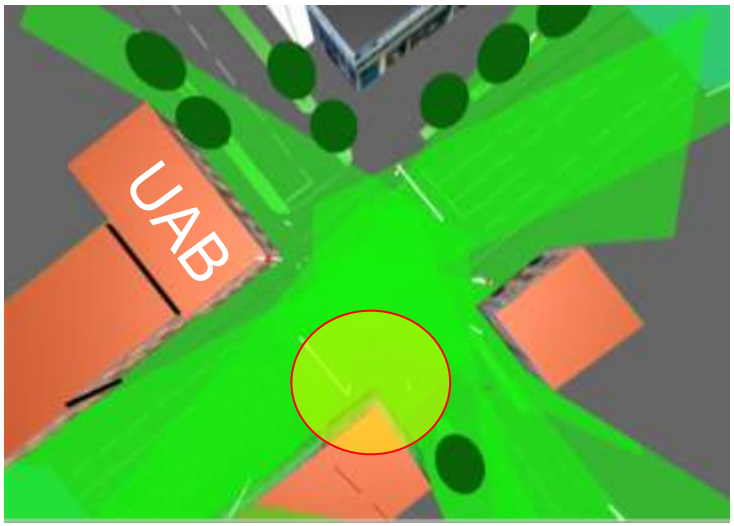
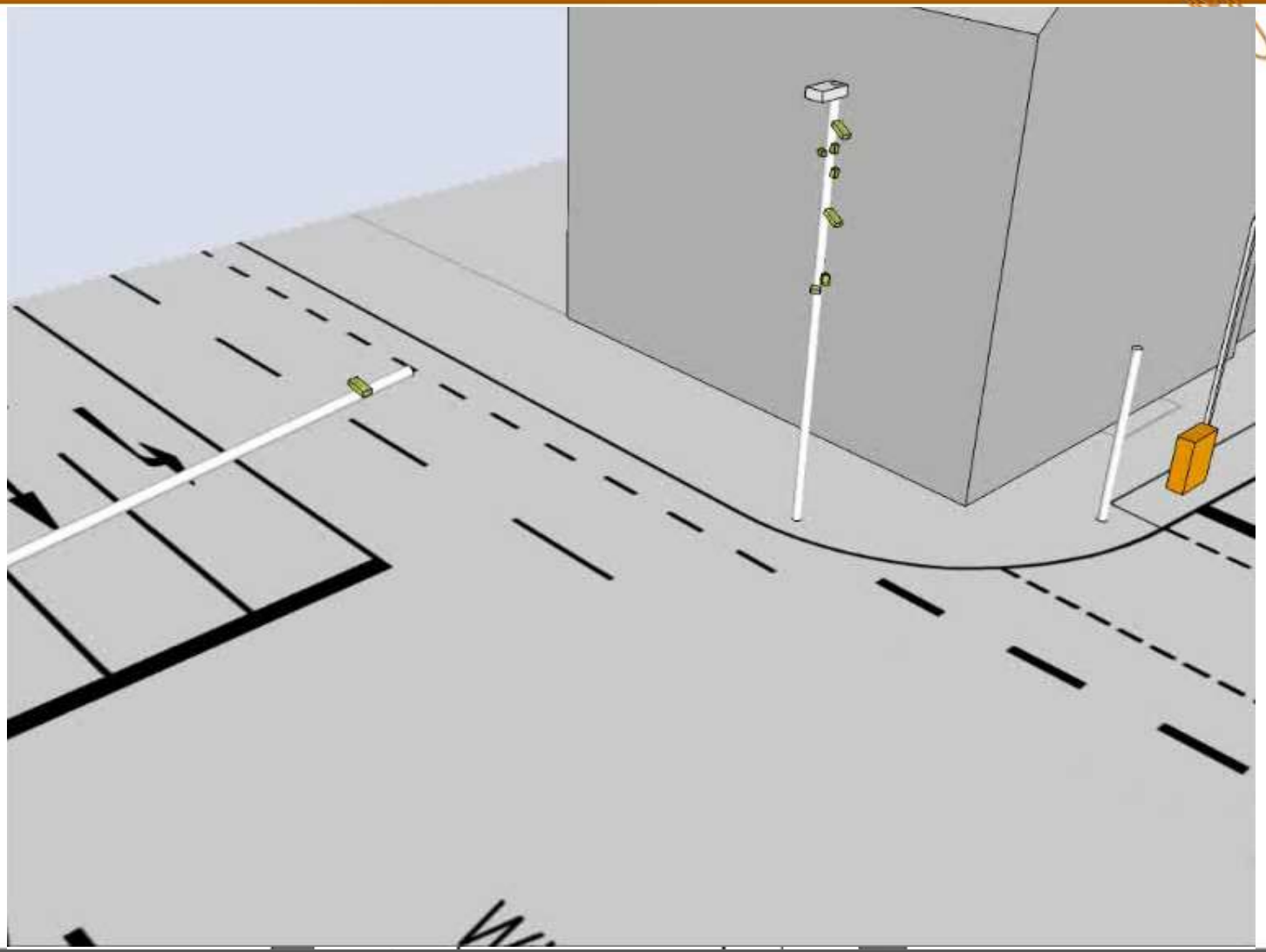
10 monochrome cameras:

- 4 wide angle cameras for central intersection area
- 3 cameras for intersection approaches
- 1 top view camera for critical area
- 2 high definition cameras for crosswalks and critical area, representing a wide angle stereo system



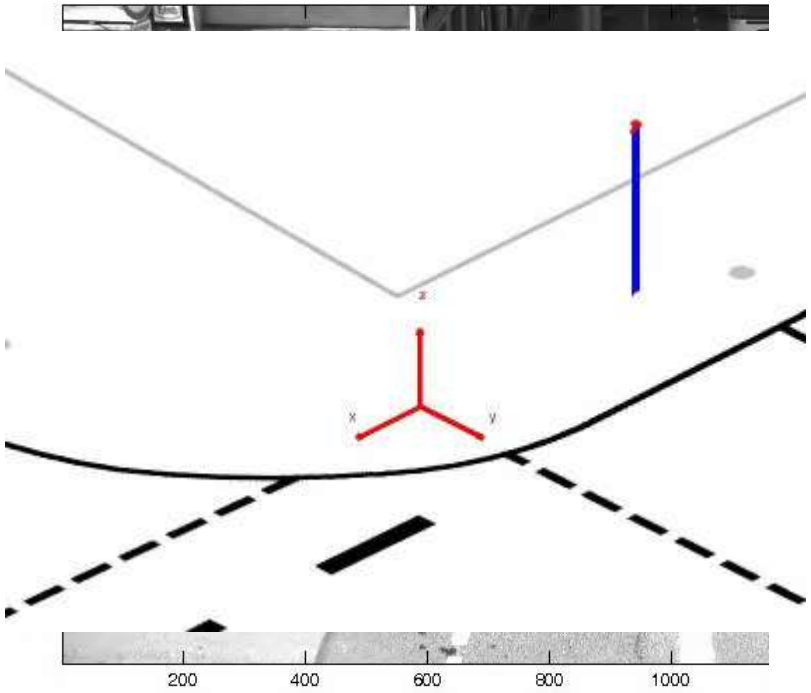
Simulated fields of view

Sensor mounting positions

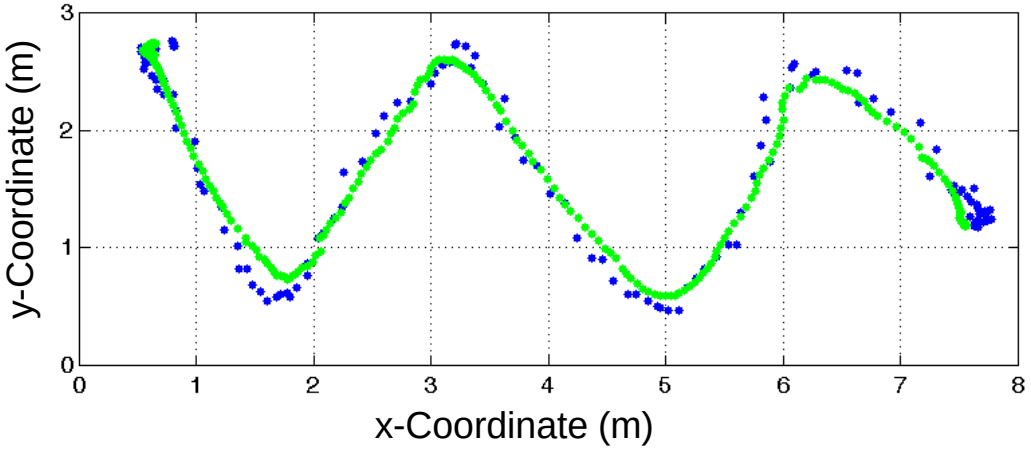


Experimental results: Evaluation of cross calibration

Spatial alignment



Tracking of camera reference target



Target position by standard camera system (green) and person‘s position by laserscanner system (blue) (extract)

Experimental results: Evaluation of cross calibration

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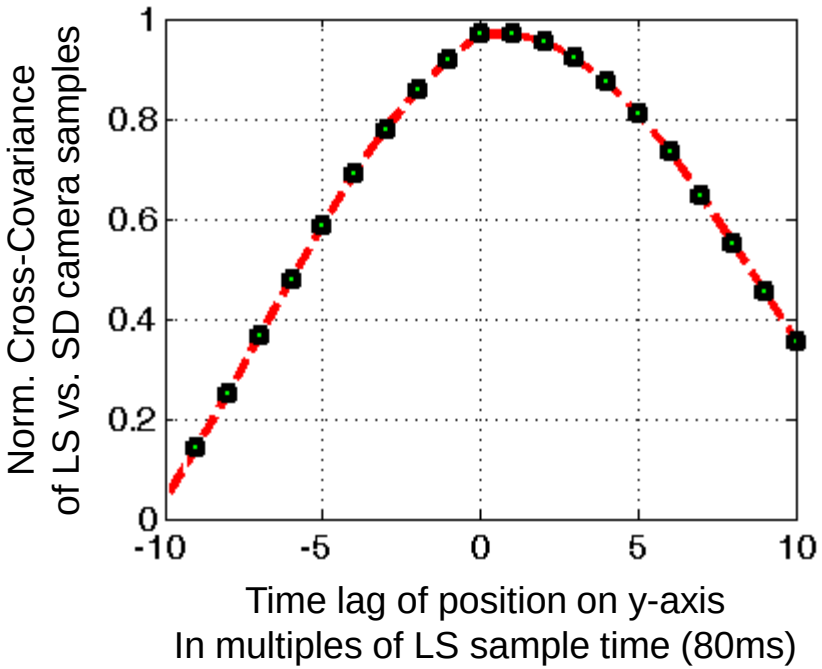
Temporal alignment



Results

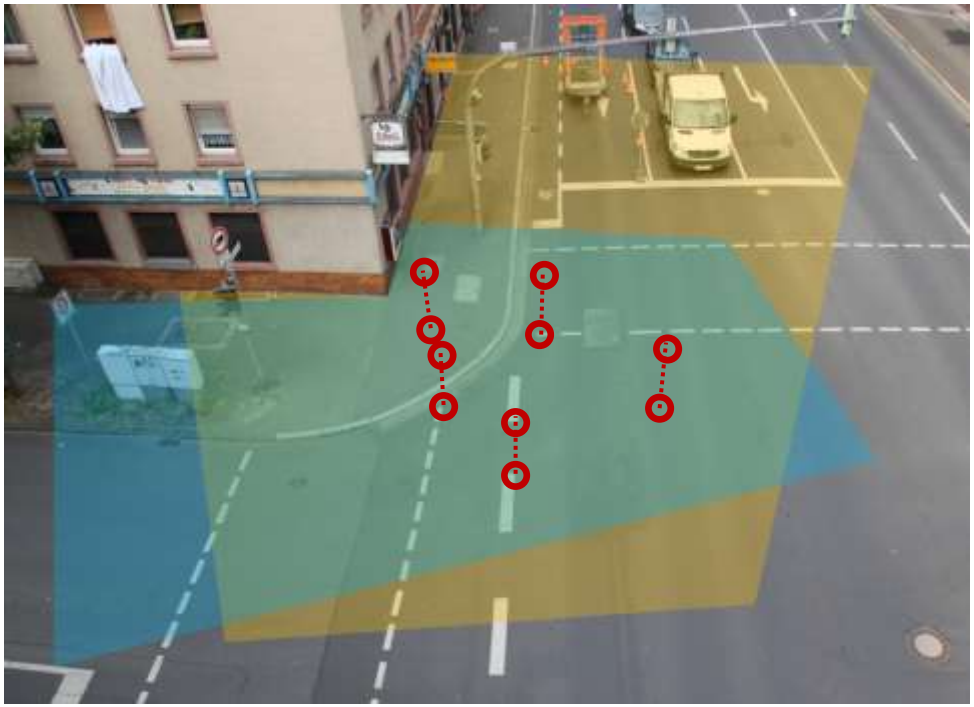
Standard deviation in position

$\sqrt{\Delta x^2 + \Delta y^2} < 17\text{cm}$

Temporal alignment < 80 ms

Experimental results: High definition stereo system

Target device placed at 10 globally measured (DGPS) positions in the fields of view of both cameras



Results

Absolute position error of the HD camera stereo subsystem

$\sqrt{\Delta x^2 + \Delta y^2 + \Delta z^2}$

< 20mm (on ground plane)

< 30mm (2 m above ground)

Application:
Pedestrian intention detection

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Visualization of estimated trajectory (sigmoid model)
(Slow motion 1/10, 0.2 s/div)

Application:
Pedestrian intention detection

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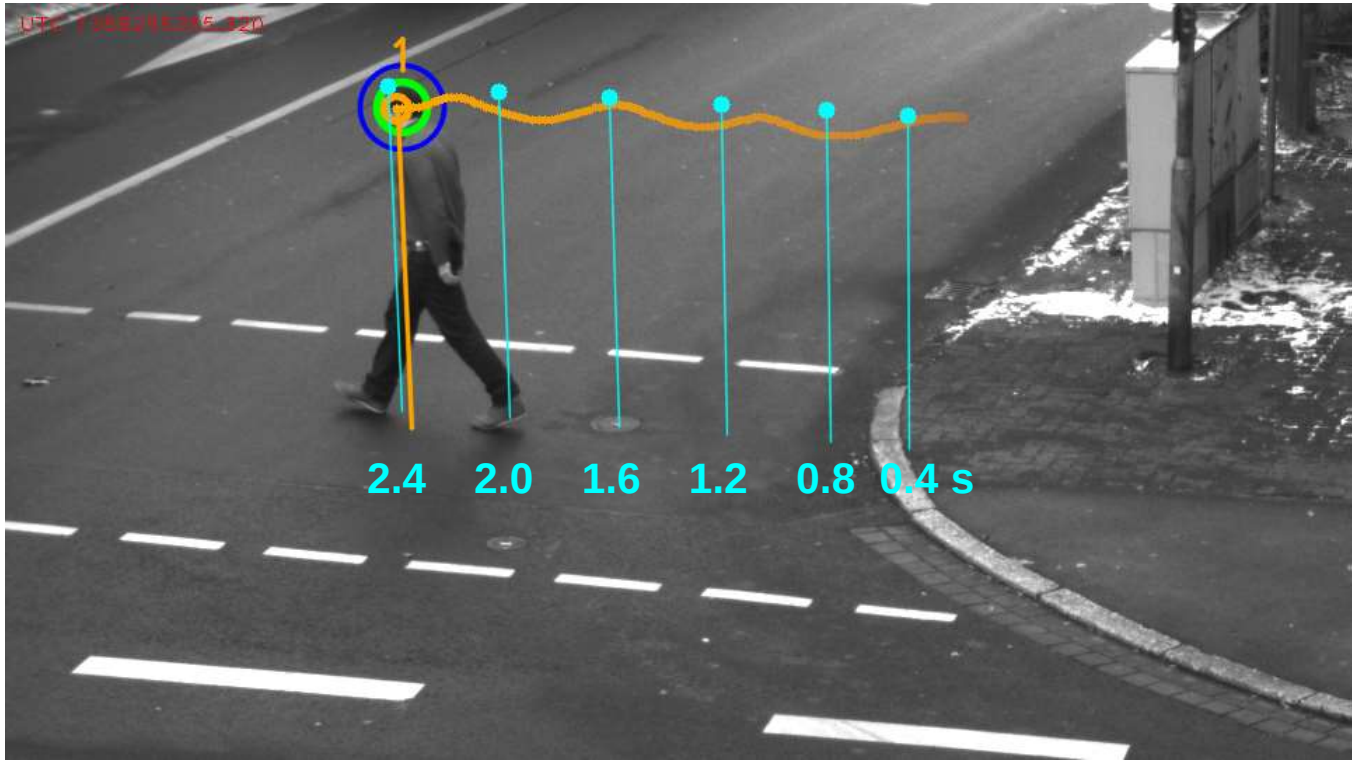
Comparison: Estimation and reference measurement



[1] S. Köhler, M. Goldhammer, S. Bauer, S. Zecha, K. Doll, U. Brunsmann, K. Dietmayer:
"Stationary Detection of the Pedestrian's Intention at Intersections," *accepted for publication in:*
IEEE Intelligent Transportation Systems Magazine ITSC 2012 Special Issue, invited Paper.

Conclusion

- Comprehensive sensor network at public urban intersection
- Adaption to local surroundings by 3D software simulation
- Occlusion resistant vision range
- Calibrated system provides positions in world coordinates

Thank you!

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