

3D Maps – from geometry to semantics

(and the application thereof)

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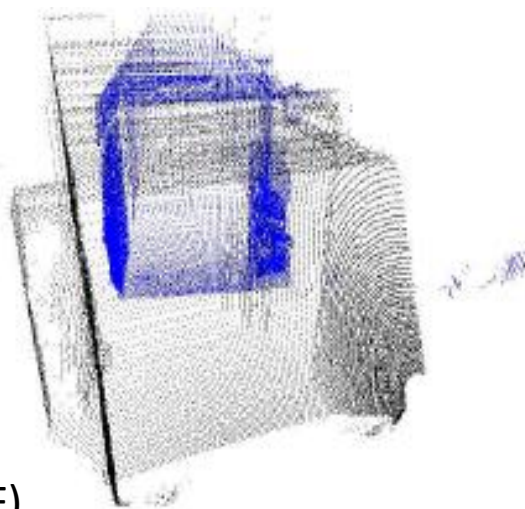
Part I

*map generation:
a step towards environment understanding*

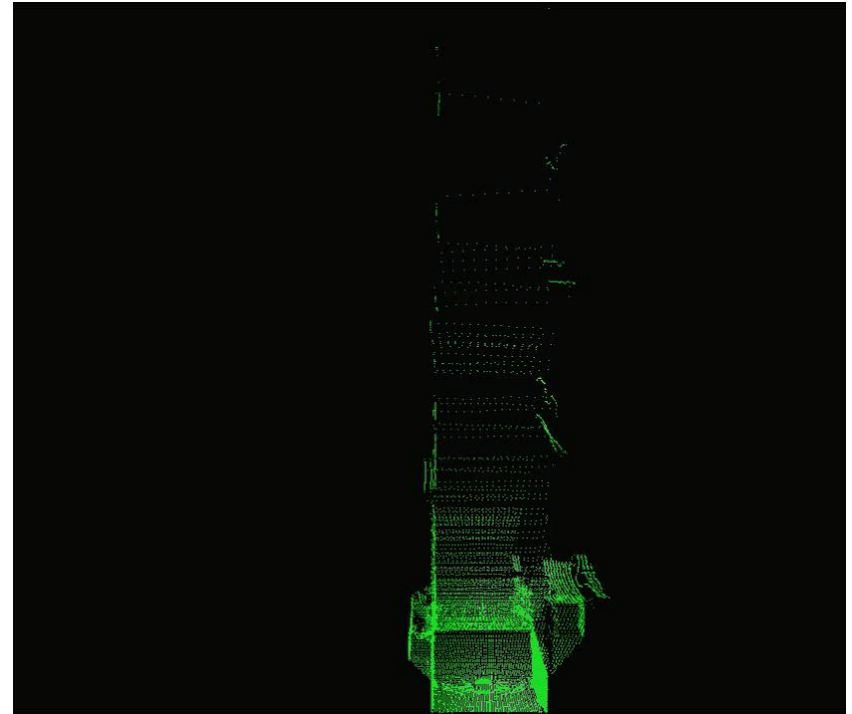
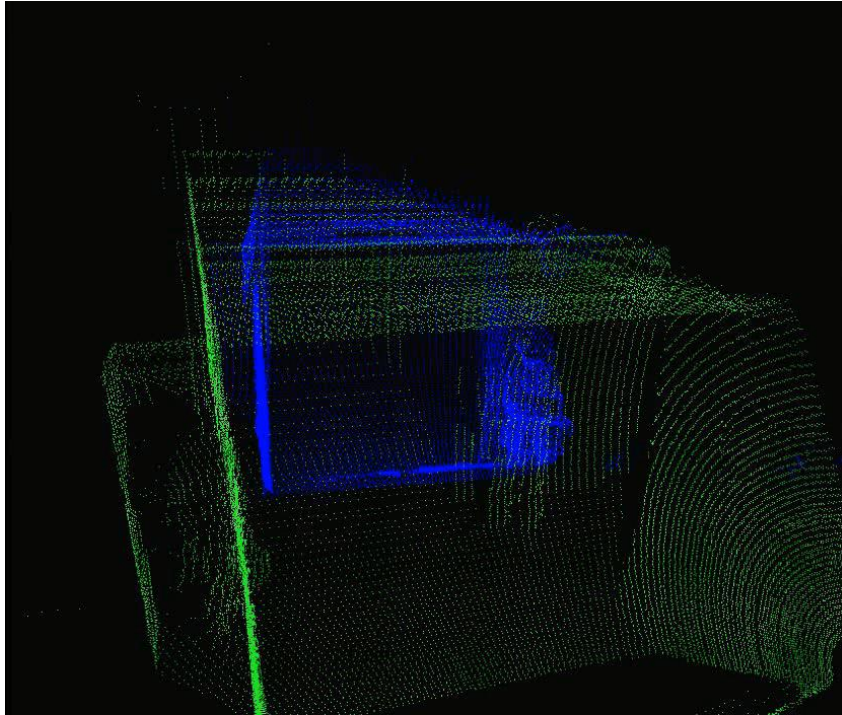
- Localization within a given map: ✓
Mapping in case of stable localization: ✓
Neither a-priori map nor localization is given: ✗
- Solution:
SLAM (*simultaneous localization and mapping*)
[CML (*concurrent mapping* *[and]* *localization*)]
- Generally based on:
Scan registration

Iterative Closest Point (ICP) algorithm

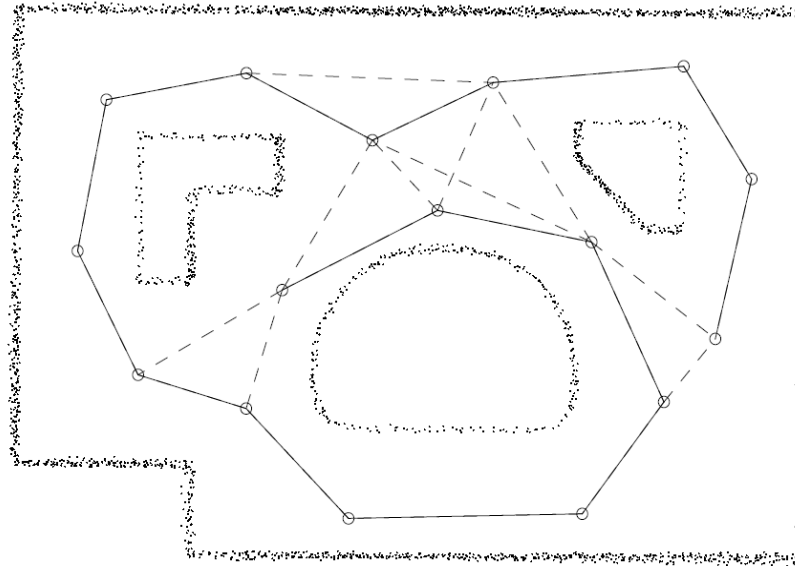
- For prior point set M (“model set”) and “data set” D :
 1. Select point correspondences $w_{i,j}$ in $\{0,1\}$
 2. Iteratively minimize for rotation $\mathbf{R}$, translation $\mathbf{t}$
$$E(\mathbf{R}, \mathbf{t}) = \sum_{i=1}^{N_m} \sum_{j=1}^{N_d} w_{i,j} \|\mathbf{m}_i - (\mathbf{R}\mathbf{d}_j + \mathbf{t})\|^2$$
 3. transform D , back to 1., until convergence
- works in 3 translation plus 3 rotation dimensions (6 DoF)
- registration of 2 3D scans with 100.000 points: 1 sec



Scan registration (example)

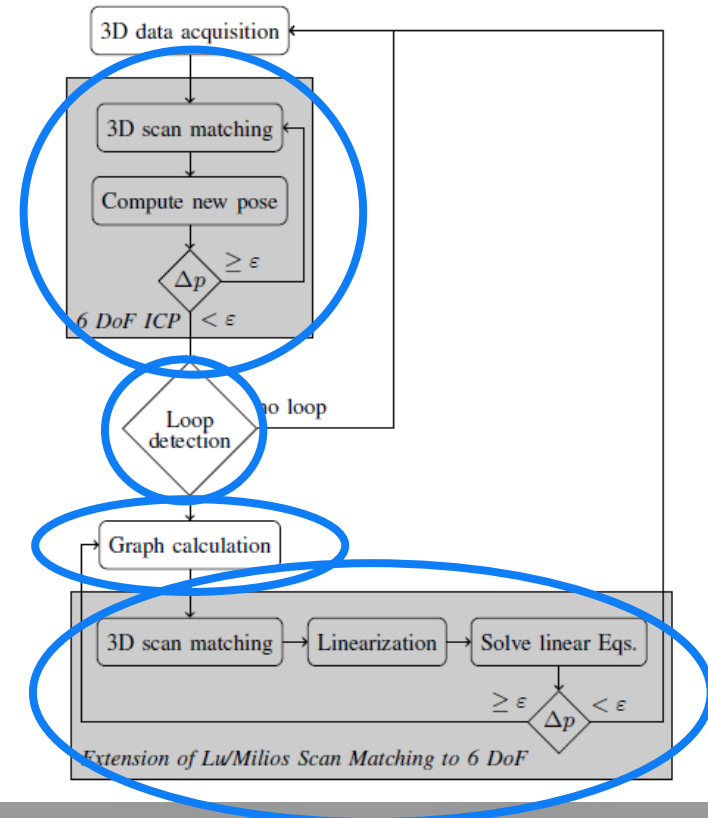


Constraint network – idea in 2D

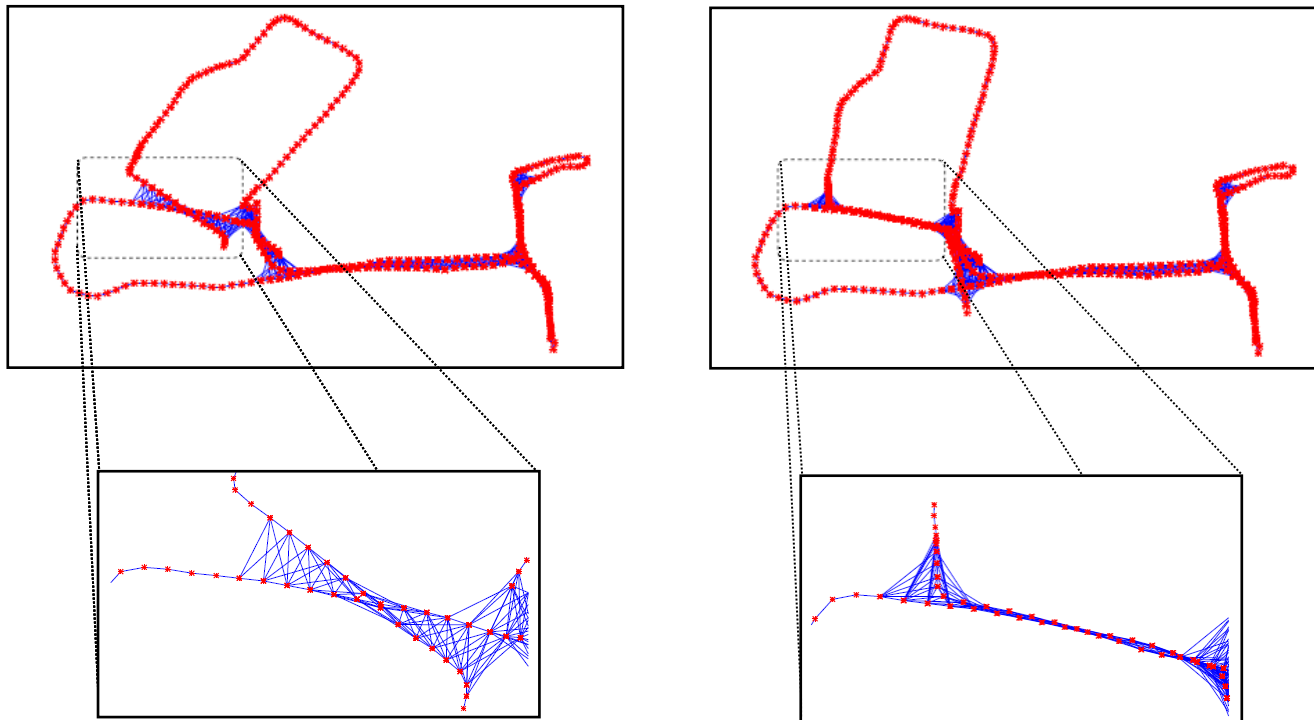


Globally consistent 3D maps

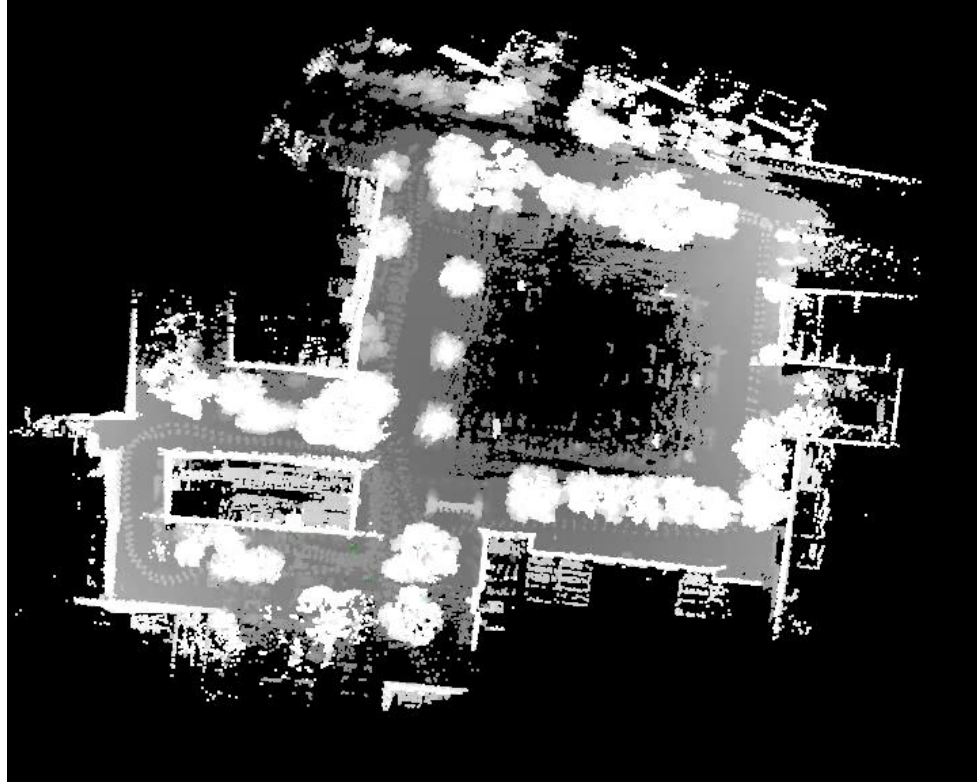
- Extension to 3D
- Allows arbitrary graph topology
- Edges: weighed by covariance
- Innovation price for free software



Example of a global optimization – poses



Example of a global optimization – scans



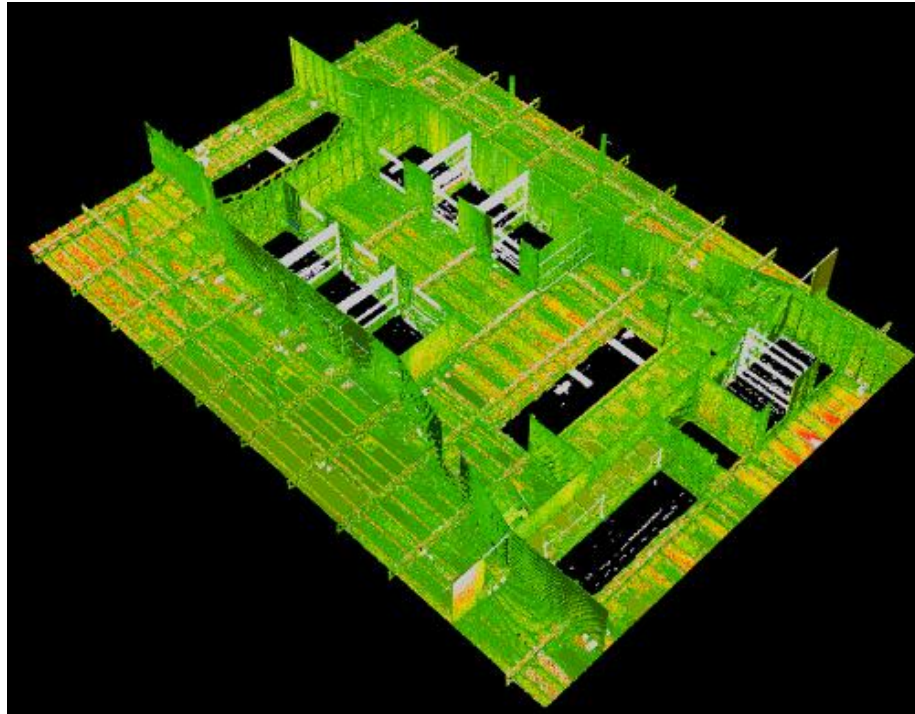
Part II

*industry application /
system development*

System: MEYER WERFT



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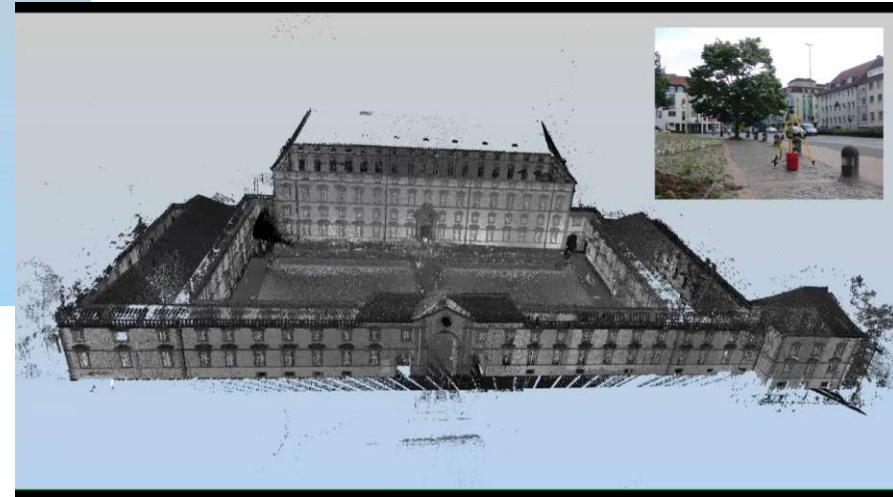
System: Robocup Rescue



Further applications



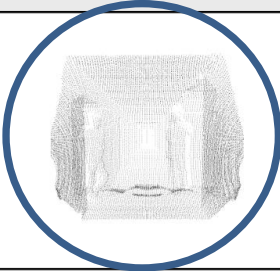
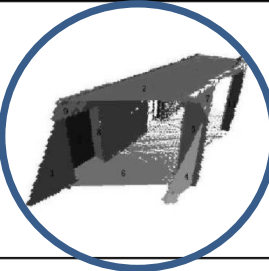
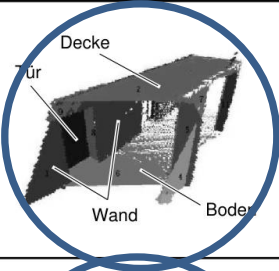
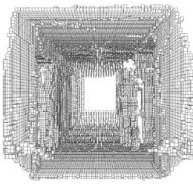
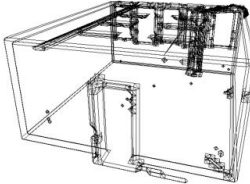
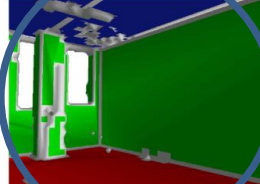
(in charge: Thomas Wiemann)



Part III

adding semantics...

From sensor data to semantic maps

3D		
Sensordaten	syntaktische Merkmale	semantische Merkmale
		
		

(from: *Mobile Roboter – Eine Einführung aus Sicht der Informatik*. Joachim Hertzberg, Kai Lingemann, Andreas Nüchter)



(in charge: Sven Albrecht)

Part IV

*further development /
current projects*

... now, 9 project leads and 80 publications later 😊 ...

Further developments in our group:

- Object recognition (many projects, mostly agricultur use-cases)
- Localization + map building
 - Search & Rescue, incl. SLAM (research & industry)
 - Long term autonomy (e.g., a robot on a field)
- Planning & Reasoning (projects that require some kind of „understanding“ of the environment)

Some current projects from that realm...

