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Jacobs Robotics

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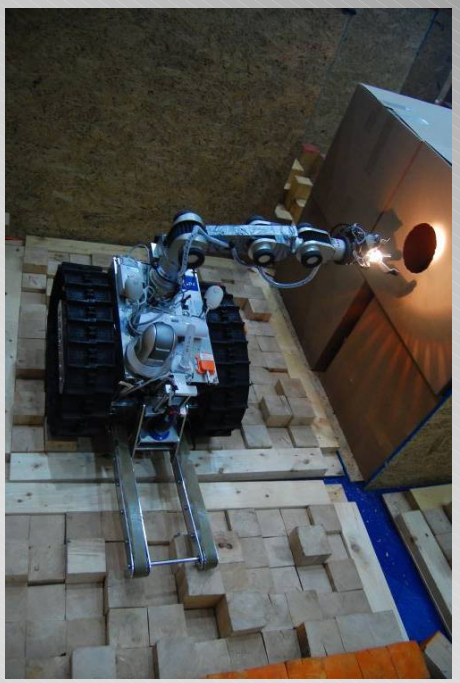
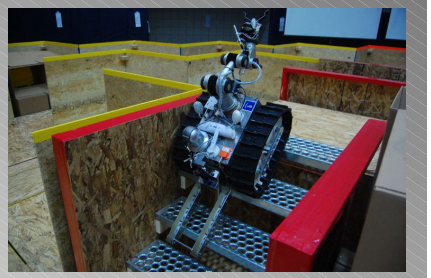
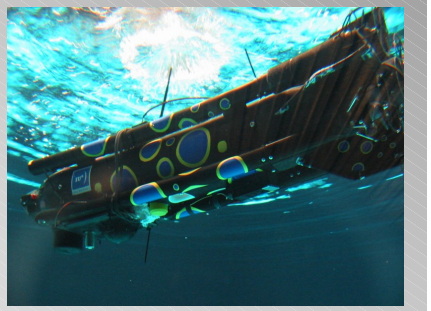
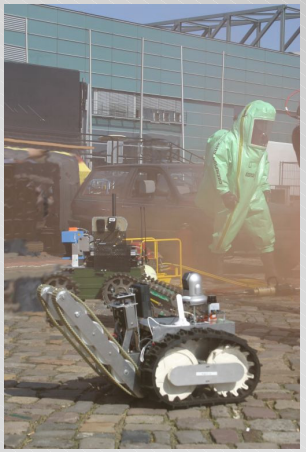
http://robotics.jacobs-university.de



Relevant Expertise: **3D Perception and Mapping**

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in various application domains, incl.

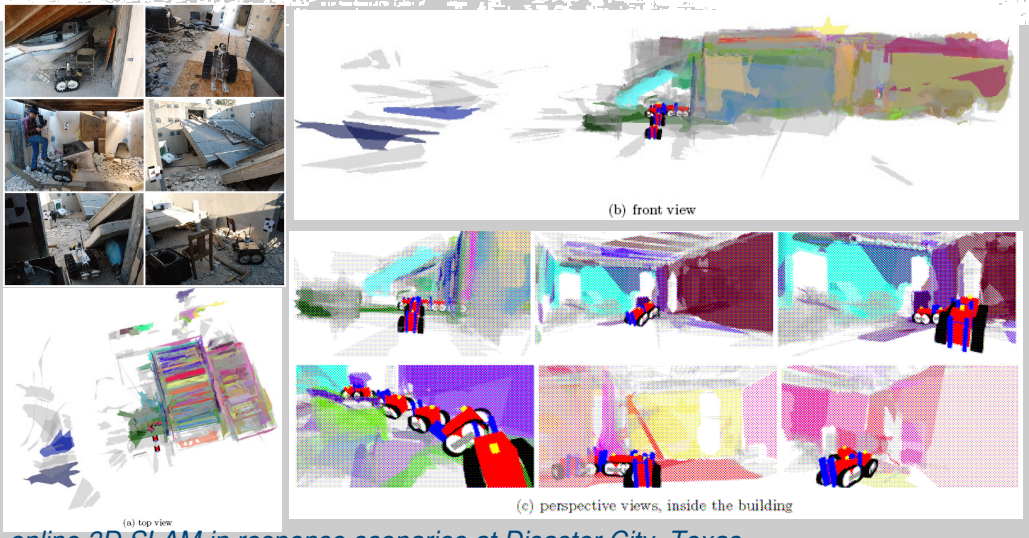
- highly unstructured environments
  - ***safety, security, rescue***
  - ***underwater robotics***
- but also
  - ***logistics, manufacturing***

high relevance for ***ECHORD scenarios***

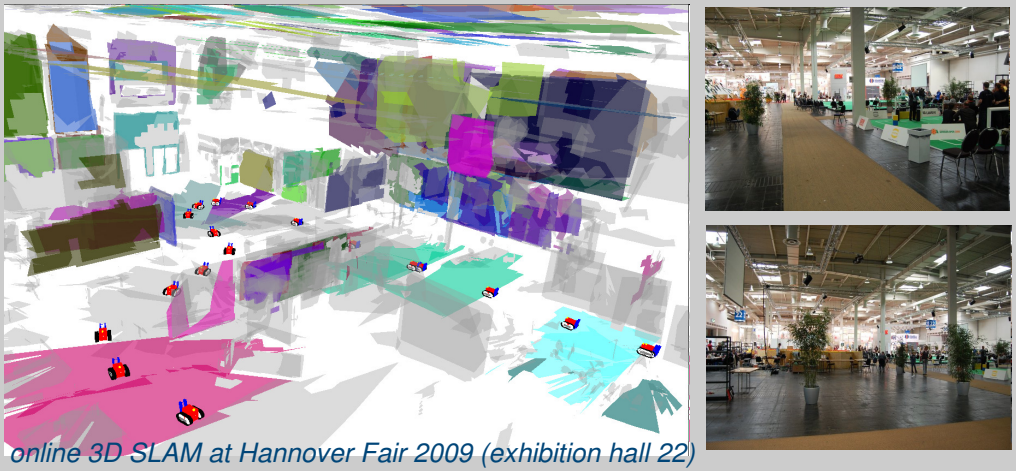
- human-robot co-worker
- hyper-flexible manufacturing cells
- cognitive factory

particular expertise of Jacobs Robotics

- experience with wide range of ***3D sensors*** and with system integration
- own developments of fast, online extraction of ***3D models and SLAM***



online 3D SLAM in response scenarios at Disaster City, Texas



online 3D SLAM at Hannover Fair 2009 (exhibition hall 22)

Surface Based 3D SLAM

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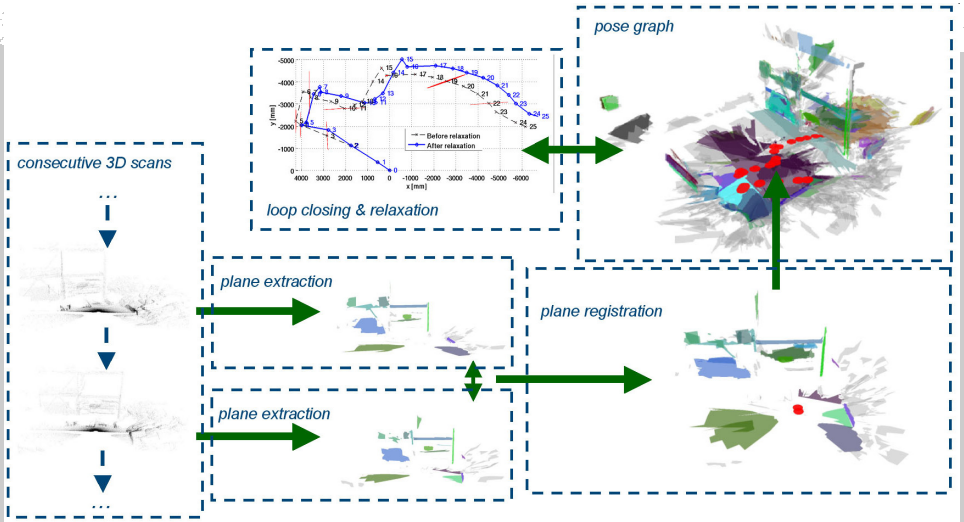
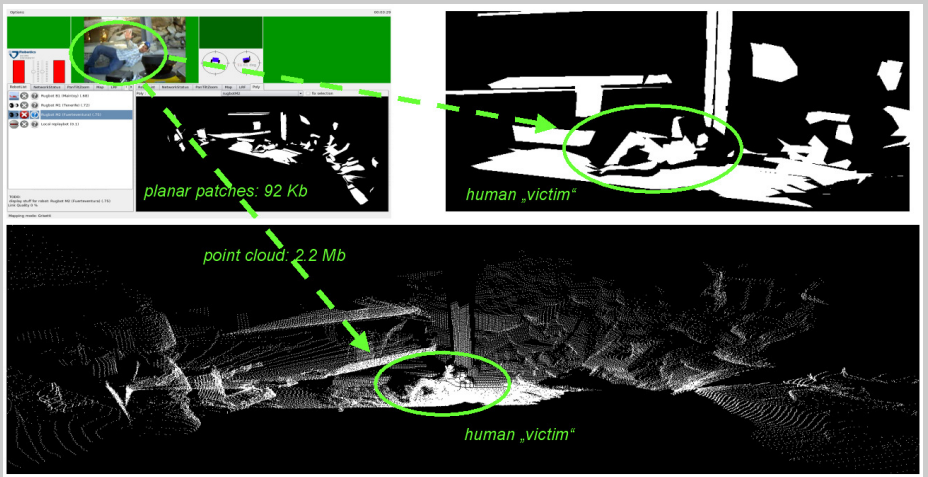
processing steps:

1. consecutive acquisition of 3D range scans
2. extraction of planes including uncertainties
3. registration of scans based on plane sets
4. embedding of the registrations in a pose graph
5. loop detection and relaxation, i.e., 3D SLAM proper

- very fast, i.e., suited for ***online processing***
- very ***robust***, i.e.,
  - outperforms ICP, NDT
  - no vehicle motion estimates needed even with larger distances between scans
- ***surface representation*** advantages (over point clouds)
  - ***compact***: large patches with boundaries
  - well suited for ***computational geometry***, e.g.,
    - 3D obstacle avoidance and pathplanning,
    - semantic mapping, and
    - object recognition
  - higher order surfaces are work in progress



overview of 3D Plane SLAM



large planar patches are widely usable for environment and object representation

Selected Publications
(please see also ***http://robotics.jacobs-university.de***)

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Kaustubh Pathak, Andreas Birk, Narunas Vaskevicius, Max Pfingsthorn, Soeren Schwertfeger, Jann Poppinga
Online 3D Mapping in an Unstructured Environment by Registration of Large Planar Surface Segments and Closed Form Pose-Graph Relaxation
Journal of Field Robotics, Special Issue on 3D Mapping, Wiley, *(in press)*

K. Pathak, N. Vaskevicius, J. Poppinga, Max Pfingsthorn, S. Schwertfeger, A. Birk
Fast 3D Mapping by Matching Planes Extracted from Range Sensor Point-Clouds
International Conference on Intelligent Robots and Systems (IROS), IEEE Press, 2009

Kaustubh Pathak, Narunas Vaskevicius, and Andreas Birk
Revisiting Uncertainty Analysis for Optimum Planes Extracted from 3D Range Sensor Point-Clouds
International Conference on Robotics and Automation (ICRA), IEEE Press, 2009

Kaustubh Pathak, Andreas Birk, and Jann Poppinga
Subpixel Depth Accuracy with a Time of Flight Sensor using Multimodal Gaussian Analysis
International Conference on Intelligent Robots and Systems (IROS), IEEE Press, 2008

Jann Poppinga, Narunas Vaskevicius, Andreas Birk, and Kaustubh Pathak
Fast Plane Detection and Polygonalization in noisy 3D Range Images
International Conference on Intelligent Robots and Systems (IROS), IEEE Press, 2008

Soeren Schwertfeger, Jann Poppinga and Andreas Birk
Towards Object Classification using 3D Sensor Data
ECSIS Symposium on Learning and Adaptive Behaviors for Robotic Systems (LAB-RS), IEEE, 2008

Kaustubh Pathak, Andreas Birk, Sören Schwertfeger, Jann Poppinga
3D Forward Sensor Modeling and Application to Occupancy Grid Based Sensor Fusion
International Conference on Intelligent Robots and Systems (IROS), IEEE Press, 2007