Research group: Jacobs Robotics Group
Head of group: Prof. Dr. Andreas Birk

Contact Information

Postal address: Jacobs University Bremen
School of Engineering and Science
Electrical Engineering and Computer Science (EECS)
Robotics

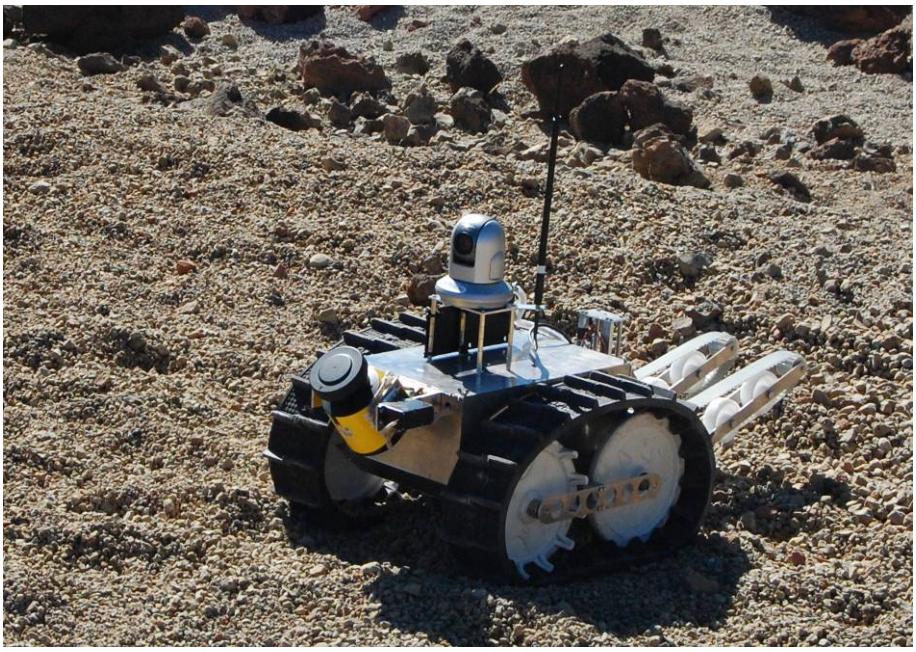
28759 Bremen
Germany
Street address: Campus Ring 1
28759 Bremen

Tel.: +49 421 200 3113
Fax.: +49 421 200 3103

Email: a.birk@jacobs-university.de
URL: http://robotics.jacobs-university.de

Abstract:

The Jacobs University Robotics Group investigates autonomous intelligent systems. The related research in the context of Unmanned Ground Vehicles (UGV) deals with intelligent methods to support the operation of UGV, ranging from tele-operation - including single operator control of multi vehicle teams - up to full autonomy. Especially, the group has high expertise in 3D Perception and Mapping, which are relevant for UGV control in unstructured environments and for mission deliverables. Jacobs Robotics has a.o. developed a new method for online 3D Simultaneous Localization and Mapping (SLAM).

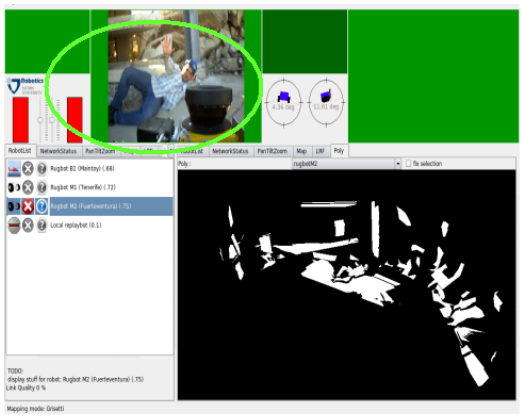


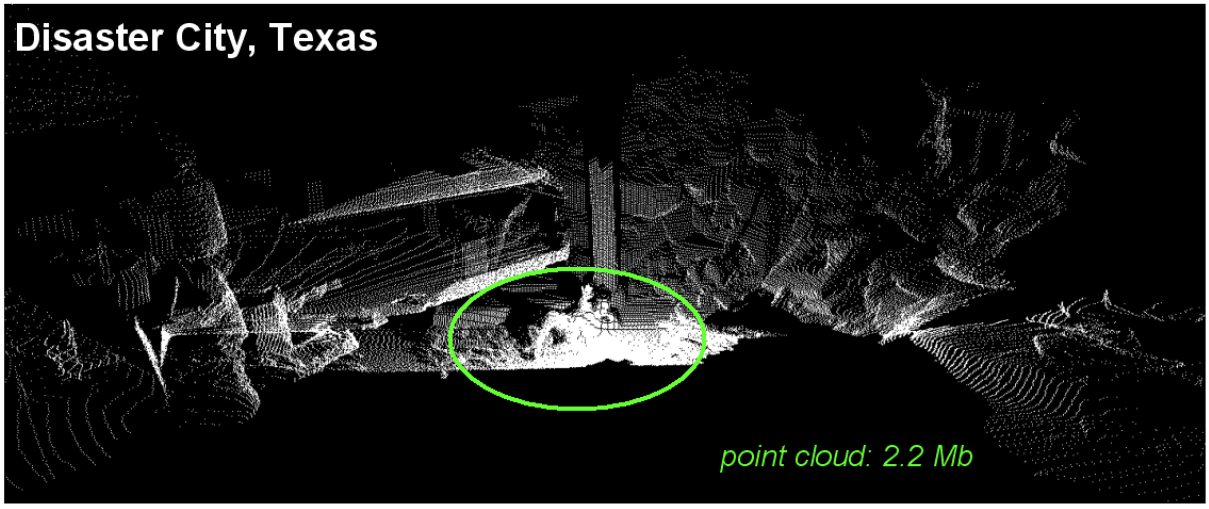
Detailed research information:

The Robotics Group at Jacobs University takes an integrated approach to Safety, Security, and Rescue Robotics (SSRR). The group develops the system from scratch, ranging from the electronics over the mechanics up to the higher software levels.

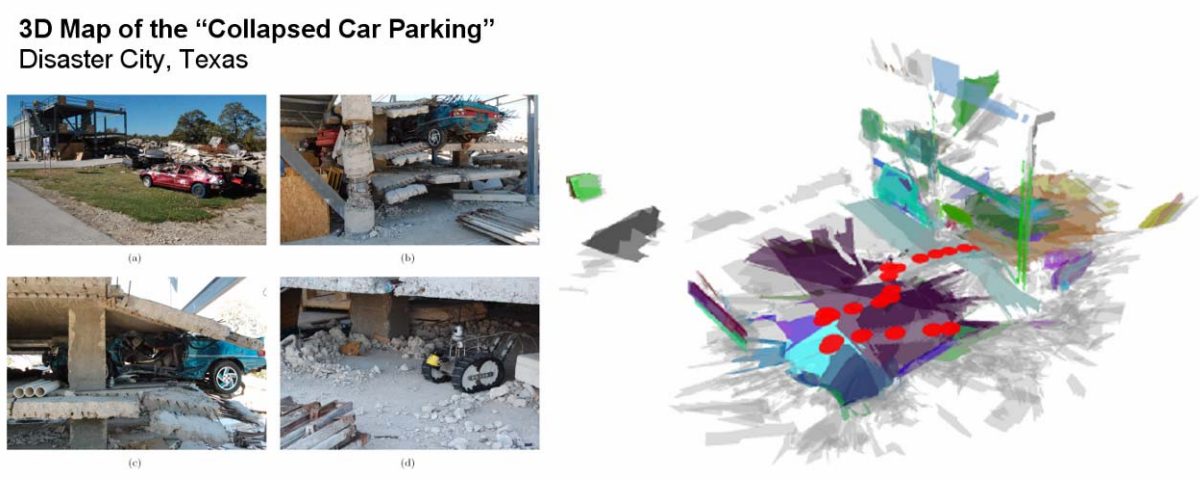
The Rugbot – derived from rugged robot – type is one result of these efforts. The Rugbots are tracked vehicles. They are relatively lightweight (about 25 kg) and have a small footprint (approximately 50 cm x 50 cm). They are very agile and fast in unstructured environments and they also perform well on open terrain. A special feature of Rugbot is an active flipper mechanism that allows negotiating rubble piles and stairs. Rugbots have significant computation power in form of an onboard PC and they can be equipped with a large variety of sensors. The intelligent software on the Rugbots is designed to support the whole range from teleoperation to full autonomy.

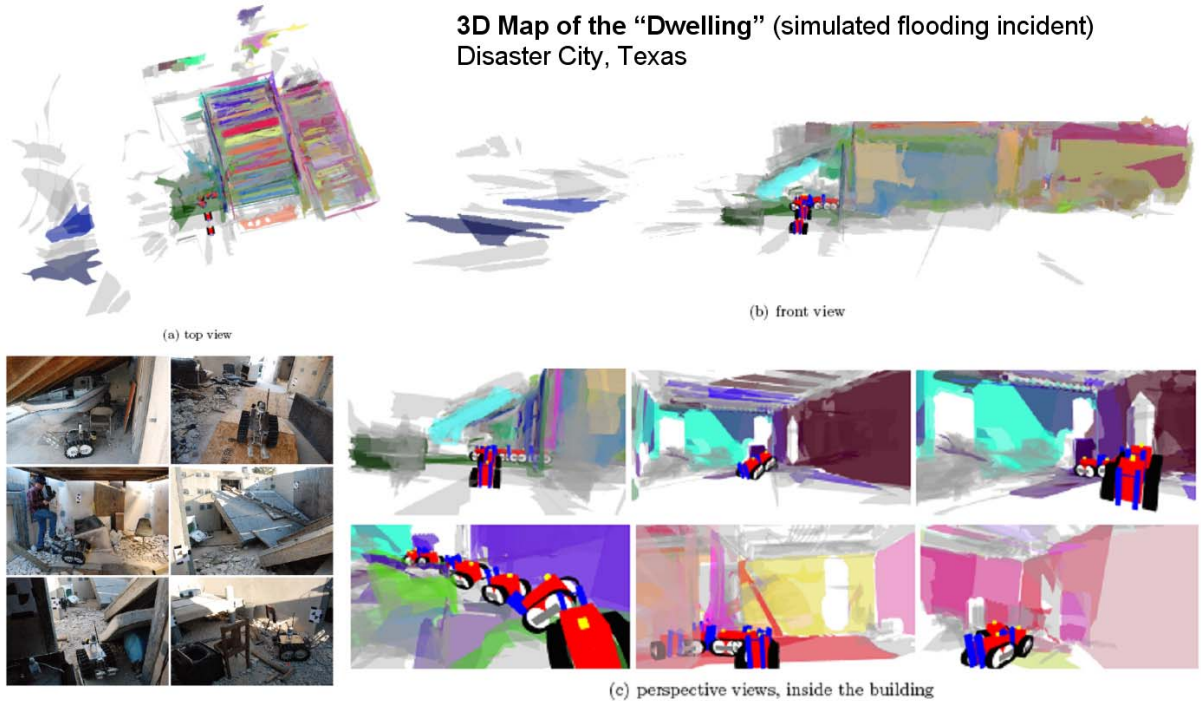
The main expertise of Jacobs Robotics is the intelligent autonomous functions onboard of their robots. This includes contributions to 3D Perception and Mapping, which are an important basis for UGV control in unstructured environments and for mission deliverables. The group has developed among others a new method for 3D Simultaneous Localization and Mapping (SLAM), which is suited for online generation of 3D maps in highly unstructured environments.

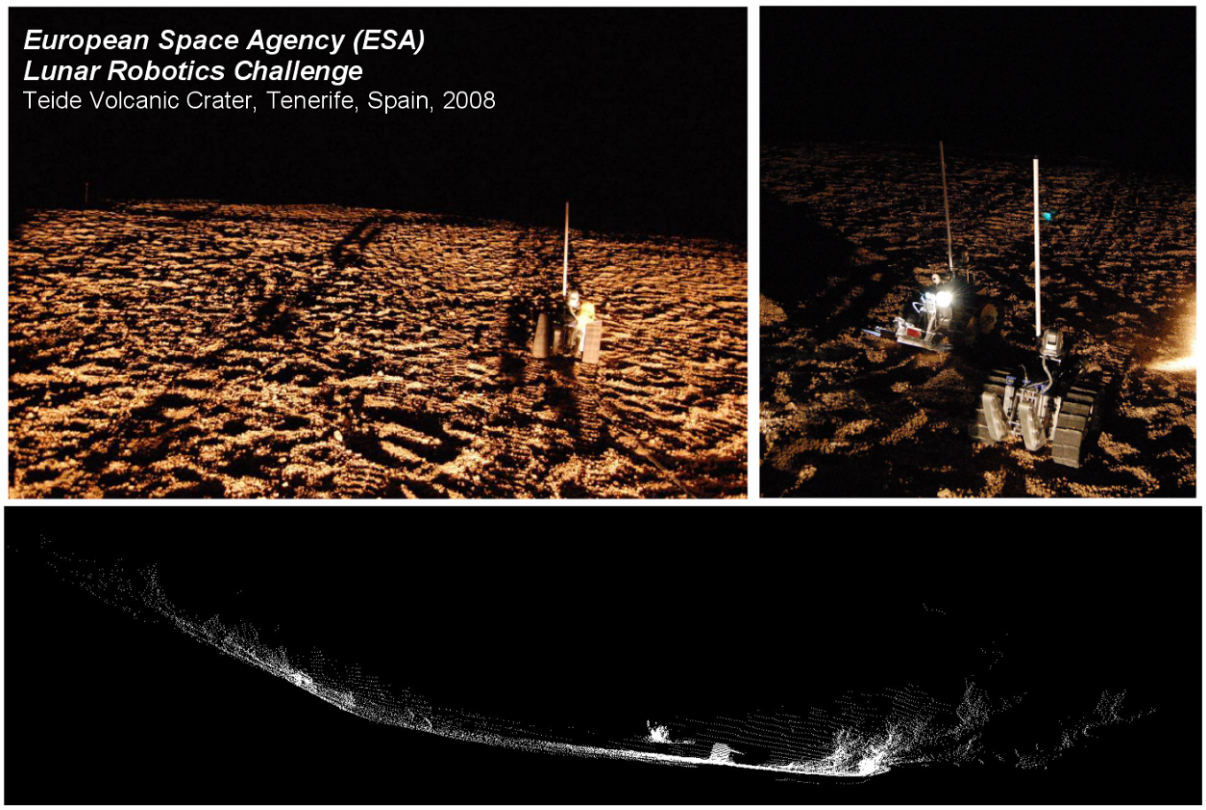




This approach called 3D Plane SLAM features an extraction of planes with uncertainties from 3D range scans. Two scans can then be registered by determining the correspondence set that maximizes the global rigid body motion constraint while finding the related optimal decoupled rotations and translations with their underlying uncertainties. The registered scans are embedded in pose-graph SLAM for loop closing and relaxation.







The approach is suited for an online generation of large 3D maps in complex environments. Especially, it is very fast and robust, i.e., no motion or localization estimates from GPS, odometry, or an Inertial Navigation System are needed. The surface representation by large planar patches has the fringe benefit that the generated 3D maps are very compact. The benefits of 3D-Plane-SLAM were already demonstrated in several unstructured scenarios, including operations during the NIST Response Robot Evaluation Exercise (RREE) in Disaster City and the Lunar Robotics Challenge of the European Space Agency (ESA) at the Teide volcanic crater on Tenerife, Spain.

Selected Publications:

K. Pathak, A. Birk, N. Vaskevicius, M. Pfingsthorn, S. Schwertfeger, and J. Poppinga, *Online 3D SLAM by Registration of Large Planar Surface Segments and Closed Form Pose-Graph Relaxation,* Journal of Field Robotics, Spec.Iss. on 3D Mapping, Wiley, 2009

Kaustubh Pathak, Narunas Vaskevicius and Andreas Birk, *Uncertainty Analysis for Optimum Plane Extraction from Noisy 3D Range-Sensor Point-Clouds,* Journal of Intelligent Service Robotics, Springer, 2009

K.Pathak, A.Birk, N.Vaskevicius, and J.Poppinga, *Fast Registration Based on Noisy Planes with Unknown Correspondences for 3D Mapping,* IEEE Transactions on Robotics, (cond. accepted)

A. Birk, N. Vaskevicius, K. Pathak, S. Schwertfeger, J. Poppinga, and H. Buelow, *Intelligent Autonomous Functions for Planetary Exploration: 3D Perception and Modeling in the context of the 2008 ESA Lunar Robotics Challenge,* IEEE Robotics and Automation Magazine (RAM), 2009