FACULTY
OF MATHEMATICS
AND PHYSICS

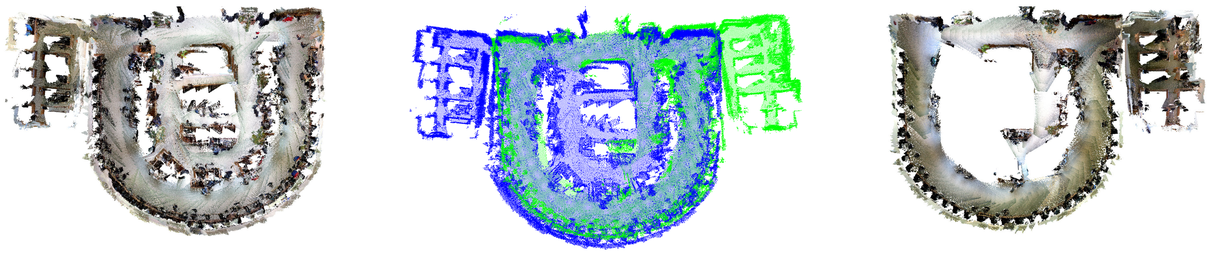
Automatic Point Clouds Merging

Jiří Hörner

Advisor: RNDr. David Obdržálek, Ph.D. | Department of Theoretical Computer Science and Mathematical Logic

Motivation

- A group of robots needs to coordinate to be efficient.
- An efficient coordination of robots requires a global map.
- How to create the global map with unknown initial positions of robots?
- The implementation needs to be easily deployable, work with different communication systems and have low requirements on robot equipment.
- The algorithm must work with existing robust Simultaneous Localization and Mapping (SLAM) algorithms.



Contribution

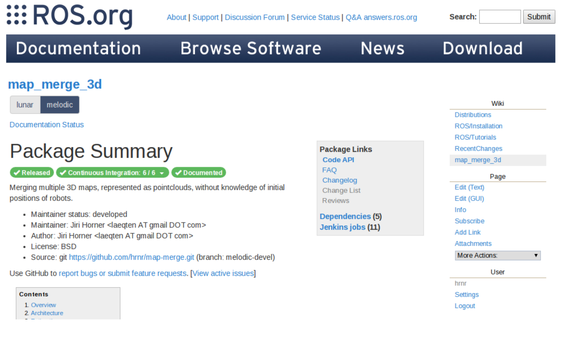
- The presented approach is the first implemented map-merging algorithm working directly on **point clouds without any auxiliary information**.
- The presented implementation is the **first implementation** of a three-dimensional (3D) map-merging algorithm for multi-robot systems within the Robot Operating System (ROS) ecosystem.
- A **new reciprocal descriptor matching algorithm** was introduced for estimating the initial transformation using feature-matching.

ROS package

The implementation presented in this work leverages modularity of the widely-used ROS framework and respects community established standards. This allows easy integration with existing planning, mapping and communication algorithms enabling quick development of multi-robot systems suited for the particular task.

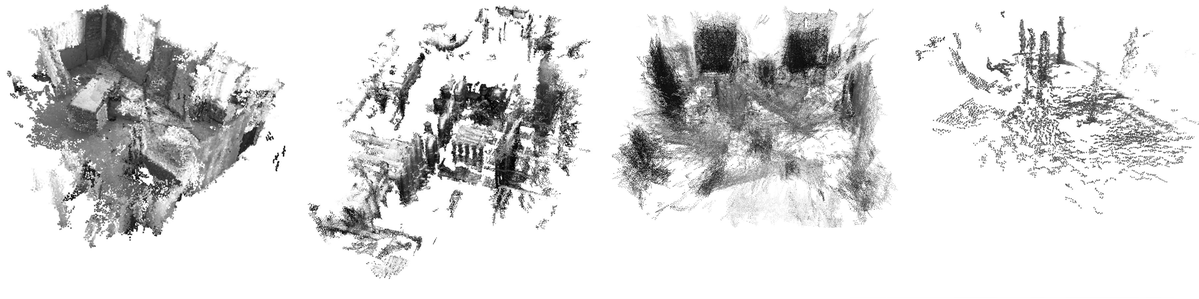
This work has been accepted to the official ROS distribution. It is available from ROS Melodic.

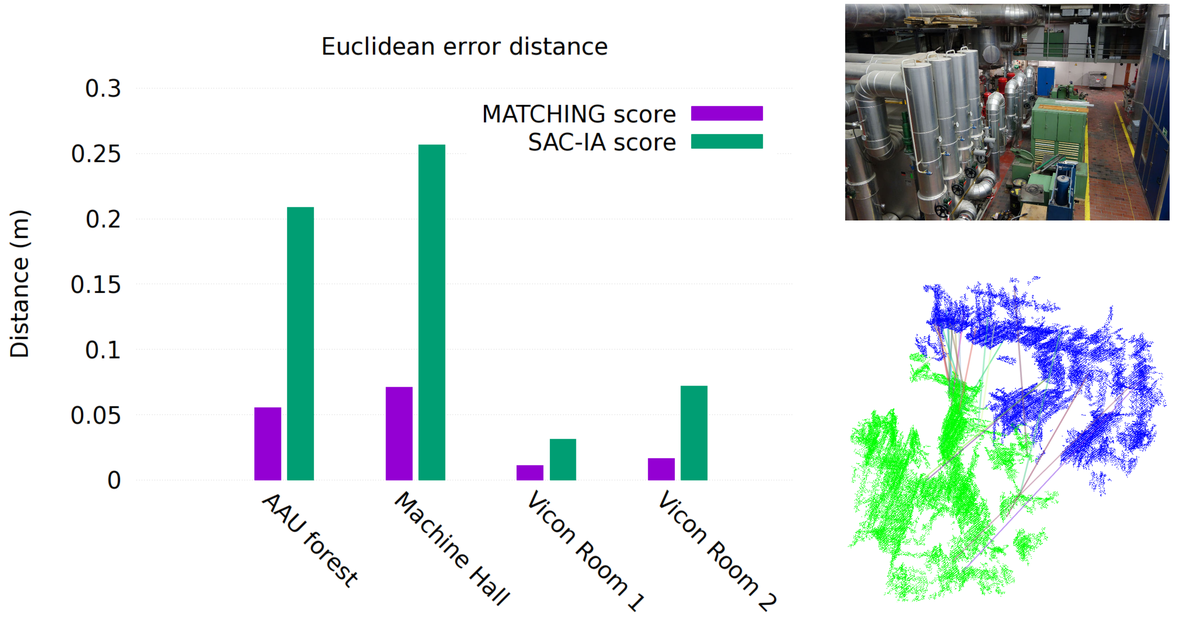
Source: `https://github.com/hrnr/map-merge`
Wiki: `http://wiki.ros.org/map_merge_3d`



Experiments and Results

The map-merging algorithm has been evaluated on real-world datasets captured by both aerial and ground-based robots with a variety of stereo rig cameras and active Red-Green-Blue-Depth (RGB-D) cameras. It has been evaluated in both indoor and outdoor environments ranging from forest to a single furnished room. The datasets used for evaluation include both well-established benchmark robotics datasets and my own experiments.





In the most configurations, my new reciprocal matching scheme introduced in this work outperforms Sample Consensus Initial Alignment (SAC-IA) algorithm for initial alignment available in the Point Cloud Library (PCL).

The work showed the feasibility of the feature-matching approach for registration of low-density point cloud maps produced by SLAM algorithms while using 3D point cloud features typically employed with high-density sensor data. The presented algorithm is applicable in heterogeneous multi-robot systems and the algorithm can work with different SLAM approaches and sensor types.