Point cloud based geomonitoring using automatically recognized natural objects as landmarks

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1 Current focus
The general goal of this thesis is to answer the question whether and how natural objects can be automatically identified in point clouds, classified as stable or unstable, and used as landmarks in geomonitoring for both establishing a stable reference frame and representing the surface changes. The current research concentrates on determining changes between different point clouds in a controlled environment.

The idea is to use the ICProx algorithm developed by Wujanz et. al (2014) to get a fine registration of scans which contain changes. They first apply the iterative closest point algorithm (ICP) in order to align the scans sufficiently precise. Then areas with existing deformation are detected and excluded from the further processing. Next the transformation parameters for the scans based on the largest unchanged region between the epochs are calculated.

2 Experiment set-up
In order to know the exact changes within the acquired scans an indoor experiment was set up. Small objects were placed on a table and scanned from different views. Next some of the objects were moved and the displacements with respect to an introduced coordinate system were measured. Then another set of scans was acquired. This process was repeated with different movement types (e.g. translation only or translation and rotation).

3 Implemented Workflow
The current implementation starts at the point where the two point clouds are already coarsely aligned which in this case was done manually. Then an octree-based segmentation is carried out and for each octree cell its centroid is calculated. In a next step the corresponding octree cells in both scans are determined to be determined. To achieve this, for each centroid the nearest neighbor of the centroids in the other cloud is searched for with a kdtree-filter. Finally for each cell pair a transformation is calculated by applying the iterative closest point algorithm.

4 Results & Discussion
The first results are not yet satisfying but they show the importance of assigning the appropriate cell size to the octree filter. If the size is too small the ICP fails completely as one can see in the reconstructed point cloud at the bottom. This might be caused by the regular structures of the objects or by not enough points within the cells to estimate the transformation parameters with a good accuracy.

5 Current and next steps
- Finding an automated method to determine the appropriate cell size for the octree filter based on the input data
- Removal of the points of the table in order to get rid of a part regular structure
- Clustering of the cells with similar transformations

6 References