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Automatic Registration of Laser Scanner Point Clouds with Genetic Algorithms

During a terrestrial laser scan, usually different scanning positions are necessary to avoid hidden parts on the object. The resulting scans are then merged into one single point cloud in a registration procedure.

Surveying is an indispensable companion of every excavation. Modern documentation techniques allow for complete and precise data acquisition with laser scanners leading to full textured 3D models of the excavation. As the recording and representation of such complex structures and surfaces needs scanning from several scan positions, the single point clouds have to be registered to each other to be transformed into a common coordinate framework. Only after determining and applying the transformation parameters, the merging and final modelling of the point clouds can take place. Generally the registration problem is solved by scanning additional spherical or cylindrical marks, at least three of which have to be visible also from other positions to guarantee a six parameter (relative) spatial transformation. These tie-features should be well distributed in space around the object and lead to a high effort for additional measurements.

Another possibility to establish the registration is based on the manual assignment of assumed coincident points in the point clouds. However it is often hard to identify such points. Due to the fact that point clouds are discrete representations of the original object's surface only, one can imagine that in most cases there won't even be any exact point-to-point correspondences. As this procedure is, with a high number of single point clouds, very time-consuming and also fairly error-prone, there was made an attempt to develop a robust and automatic approach avoiding any manual interaction. Hereby there are already combined well-established registration strategies such as coarse registration using features, the application of Genetic Algorithms as well as ICP-algorithms for fine registration. Contrary to other popular approaches, however, there were no attempts to identify the position of the global optimum already after coarse registration. This is reasonable as, due to the necessary approximations during coarse registration, the correct solution may appear worse than those that are actually wrong. Thus it is proposed to introduce a Genetic Algorithm in between coarse and fine registration to both optimize and reduce the number of possible solutions at the same time. Further it used imperfect and subdivided features to enhance the robustness of the registration of point clouds which are partially occluded and/or characterized by a significant noise level or imperfect geometry. Summarized, the positive aspects of different approaches were elaborated and their drawbacks are minimized.