Direct Geo-Referencing of 3d Point Clouds in a Multi-Sensor System Approach

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SUMMARY

The use of terrestrial laser scanners (TLS) for areal capturing of the environment has been an established procedure in geodesy for several years. In order to transform the TLS-captured 3D point cloud from its local sensor-defined coordinate system to a global coordinate system, one has to geo-reference the 3D point cloud, i.e. to determine the in minimum six transformation parameters. Despite all technical developments in the TLS domain, the geo-referencing of 3D point clouds is quite often still be done by artificial, signalized reference points, e.g., with planar targets or spheres. The main reason here is that this classical approach enables to achieve the highest accuracy and the highest reliability for geo-referencing.

In the case of a comparatively static environment characterized by minor change over time, the reference point network usually needs to be created only once at the beginning of the data capturing. However, some additional challenges arise for significantly changing environments due to construction processes or environments with a poor distribution of vertical objects. An exemplarily scenario can be a construction site, e.g., with the aim of frequent updates of the construction progress with respect to building information modeling (BIM). The scenario may start quite featureless at the beginning to a winding structure with short views and occlusions at the end. Therefore, the reference point field must be continuously adapted and expanded throughout the construction progress, which is time- and cost- intensive. In this case, an alternative approach for geo-referencing of 3D point clouds without an artificial reference point field is desirable. Such an approach is called direct geo-referencing of 3D point clouds. In this approach, the TLS is fused with other sensors, e.g., GNSS sensors, to form a multi-sensor system (MSS), whereby the 3D point clouds can be immediately transformed from the local sensor-defined coordinate system to a global coordinate

system.

This paper introduces a MSS established by a TLS (Zoller+Fröhlich IMAGER5016), a consumer grade GNSS equipment (ublox M8T or F9P) and a MEMS-based navigation sensor (SBG Ellipse-D). The TLS is used for the object capturing while the consumer grade GNSS and MEMS-based navigation sensor are used for positioning and navigation. In order to achieve by means of this MSS the project specific geo-referencing accuracy, several challenges need to be solved. These include the development of a suitable adaptation to accommodate the sensors, the development of a calibration strategy for the MSS, and an appropriate evaluation strategy for deriving the geo-referencing parameters. This paper focuses on the calibration of the MSS, which here refers to the determination of the transformation parameters, i.e. translation and rotation, between the local sensor-defined coordinate system of the TLS and those of the sensors used for geo-referencing. Besides, presenting the calibration concept, the uncertainty propagation to the 3D point cloud is also discussed and shown for a real data set. The paper concludes with a suitable visualization of the geo-referenced 3D point cloud, whose initial stochastic model, e.g., solely intensity-based stochastic model, is enhanced by the uncertainty budget of the geo-referencing.