

Homework 2: Coordinate Transformation of TLS Data

A Learning objectives

Applying coordinate transformations to data acquired by geodetic sensors (terrestrial laser scanner). Understanding the concepts of data registration and data georeferencing.

B Task overview

The task of this exercise is to use the provided local transformation parameters to combine all point clouds acquired with a terrestrial laser scanner (TLS) from multiple positions (scanner stations) into a single point cloud (registration). The point clouds have a decreased point density to approximately 20.000 points each. The coordinates are given as original measurements in spherical (polar) coordinates (d, φ, θ) . The registration solution should be computed into 3D Cartesian coordinate system (x, y, z) . Afterward, it should be transformed into a global Cartesian coordinate system (X, Y, Z) WGS84 using the provided global transformation parameters (georeferencing).

C Prior knowledge and references

- Chapter 1 of lecture , GE-01, Coordinate Systems
- Chapter 3 of lecture , GE-01, Coordinate Systems
- Ogundare, J. O. Precision Surveying: The Principles and Geomatics Practice, Wiley: London, UK, 2015
- Förstner, W., Worbel, P. B. Photogrammetric Computer Vision, Springer: Cham, Switzerland, 2016

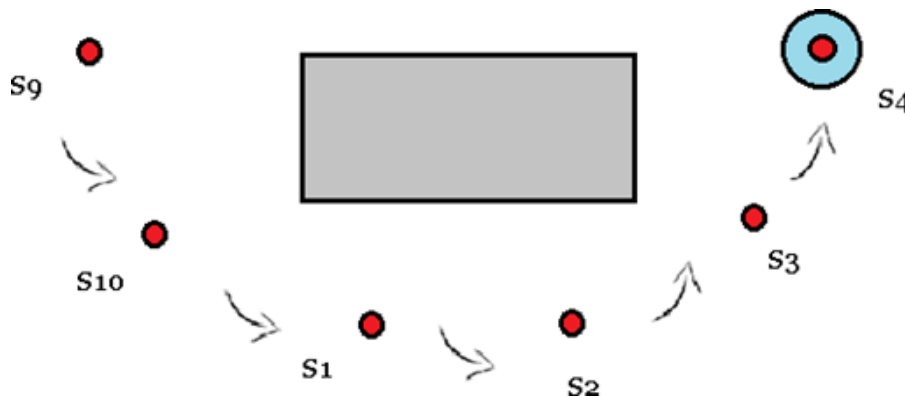


Figure 1: Sketch of the measurement setup used to collect TLS measurements stored in the “Data” folder.

D Detailed description of the task

1. Convert spherical coordinates (d, φ, θ) of each point cloud (Data/S1...S10_PointCloud.txt) into Cartesian coordinates (x, y, z) . Store the resulting point clouds and visualize them all together using the open source software CloudCompare (download link: <http://www.danielgm.net/cc/>). Attach this visualization as Figure 1 in your homework assignment.
2. Use the provided local transformation parameters (Data/ Transformation_parameters.txt) to consecutively combine all neighboring scanner stations (see Figure 1). The results of the registration process should be a single point cloud in the local instrument-related coordinate system of the scanner station 4 (S4). Again, store and visualize the results using the CloudCompare software, and attach this visualization as Figure 2 in your homework assignment. Important notes: Consider if there is a need for a scale parameter λ . The rotations are defined with Axis-angle representation, where the values in the brackets define the rotation vector, while the value behind the brackets is the rotation magnitude. Compute

the Rotation Matrix elements using the Rodrigues formula (see GE-01, Coordinate Systems; Coordinate Transformations & Representations for Rotations).

3. Use the provided global transformation parameters (`Data/ Transformation_parameters.txt`) to georeference the results of the registration process in a global reference system (WGS84). Using the provided translation parameters and Google Maps, find the location of the measured object and store the visualization as Figure 3 of your homework assignment. Answer the following question: “Which building was measured with the terrestrial laser scanner in this task?”.

E Upload to eCampus

- Programming code (preferred MatLab or Python) used for solving the task.
- Homework assignment as a single PDF document with required figures and answers to the previously stated questions.
- Both items should be zipped and named by your name: e.g., `Exercise_2_Meltem_Cantuerk.zip`