Terrestrial Laser Scanner Self-calibration for Geosciences Applications

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Motivation and Background

Terrestrial Laser Scanning (TLS) is often used nowadays to address the challenging accuracy requirement for many applications in the geosciences and engineering (see Figure 1). As the variety of applications increases, so does the need for increased accuracy and resolution.

TLS instruments often present manufacturing imperfections, leading to systematic errors that deteriorate its performance (e.g., Lichti 2007). Therefore, an instrument self-calibration would be beneficial before using it for real case studies to better understand the performance and potential capabilities of the instrument.

Objectives

The goal of this project is to:

- Assess and improve the performance of the Topcon GLS-1500 terrestrial laser scanner
- Illustrate the impact of the refined accuracy in real application cases

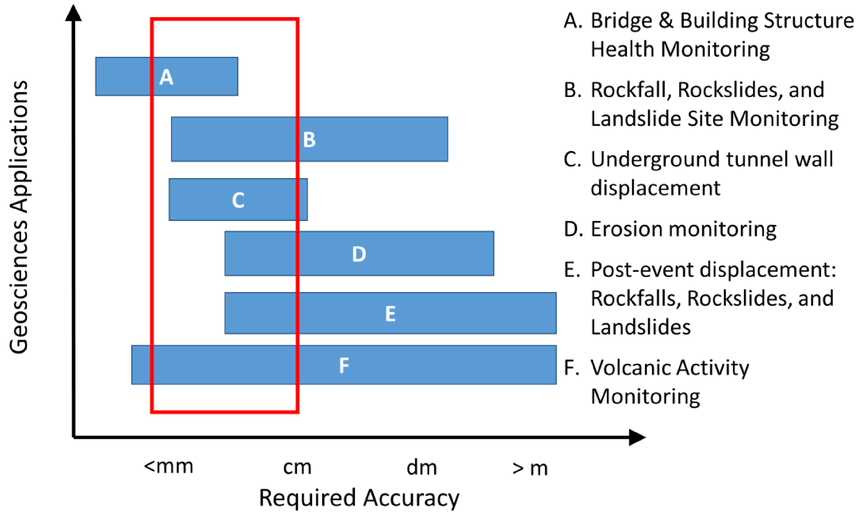

Figure 1. Graph of laser scanning application versus required accuracy. The red box depicts the region where a TLS calibration is important

Methodology

To perform the self-calibration, 140 targets were placed on the walls and ceiling of room TC 19 (see Figure 2). The room was surveyed from 6 different positions (one for each of the four room corners, and two along on the room diagonals) using the GLS-1500 laser scanner (see Figure 3).

Currently, work is being done on extracting the point cloud for these targets from each scanning position (~840 targets in total). Figure 4a shows an image for one of the targets, while Figure 4b shows the corresponding extracted point cloud.

Figure 2. Target distribution on TC19; 140 targets are placed on all four walls and the ceiling

Figure 3. Point Cloud of Classroom: TC-19 (~600,000 points)

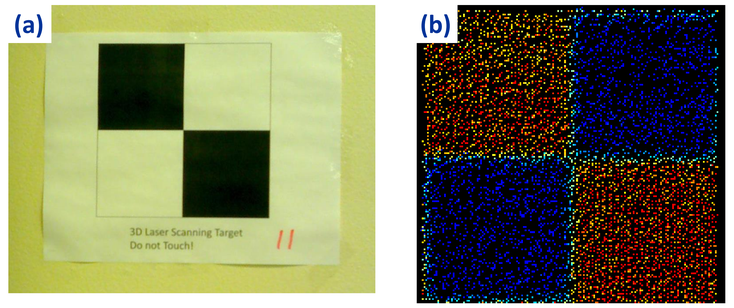

Figure 4. (a) Image of target 1 (b) the corresponding point

Plane-Target Analysis

The self-calibration will be performed using the plane-based approach (e.g., Chow et al., 2013). This approach is based on conditioning the target points to lie on the surface of planes. The residuals resulting from this condition will be used to detect and model systematic errors. The analysis and modeling of these systematic errors will be done in Matlab with code developed by the students and supervised instructor.

At this point of the project the Matlab code is at the development process, while targets are being extracted. More scans are planned to be acquired in the future to test how the modeling parameters change in time.

Conclusions and Future Work

- A self-calibration of the GLS-1500 is important for ensuring high and reliable instrument performance
- Real application cases will be studied in the future to illustrate the impact of the self-calibration for quantitative analysis.

References

Chow, J. C., Lichti, D. D., Glennie, C., & Hartzell, P. (2013). Improvements to and comparison of static terrestrial LiDAR self-calibration methods.*Sensors*, *13*(6), 7224-7249.

Lichti, D. D. (2007). Error modelling, calibration and analysis of an AM–CW terrestrial laser scanner system. ISPRS Journal of Photogrammetry and Remote Sensing, *61*(5), 307-324.