Politecnico di Milano - Courses on Photogrammetry
Laboratory report

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Lab Topic:	Laser Scanner		

Description of the performed activity *(max 50 lines)*

Laser Scanner Lab Workflow

Introduction

In this photogrammetry course section, laser scanning for 3D modelling is emphasized, covering the survey workflow to comparing the laser scanning method. New data on alignment errors and ground control points further enrich our understanding of the 3D modelling process.

Survey Process

Multiple scans of the façade were conducted using a terrestrial laser scanner (TLS) from different positions to account for potential obstructions, shadows, instrument range accuracy, and choice of accuracy. The resolution (or Ground Sampling Distance - GSD) used in the survey was set in the order of centimetres to maintain consistency with previous surveys.

Point Cloud Alignment

One common challenge in TLS surveys is non-uniform resolution point acquisition. This is mitigated by merging scans from different positions using the CloudCompare software. The iterative closest point (ICP) algorithm is employed for aligning the scans. This pair-wise alignment process ensures that the final cloud consists of all merged scans.

Down sampling and Resolution Adjustment

To compare laser scanning with a drone survey, the laser scan is aligned to a reference system, and a decimation technique adjusts point distribution for coherence with a chosen 1mm resolution.

Alignment and GCP Information

New data on alignment errors and ground control points (GCPs) were analysed. The alignment errors between Model 1 and Model 2 were found to be within an acceptable range, with a maximum error of 0.006. When Model 3 was introduced into the alignment process with Models 1 and 2, the maximum align error increased to 0.018. The final RMS error for the alignment between Model 1 and Model 2, without considering Model 3, was recorded at 0.004. When Model 3 was included in the alignment process, the final RMS error increased to 0.013. The maximum alignment error when considering all three models with GCPs was measured at 0.149. When aligning all three models with GCPs, the final RMS error was calculated to be 0.082.

Discussion of Errors

Millimetre-level errors were observed in transformations, aligning with the survey's centimetre-scale order of magnitude. The ICP algorithm introduced centimetre-level errors, deemed acceptable, while the inclusion of the third model and GCPs emphasized the need for meticulous alignment quality control.

Comparison with Drone Photogrammetry

Although a drone survey was carried out for the project, the 3D model was created exclusively using laser scanner data. It's important to note potential differences between the model generated from laser scanner data and the drone photo data.

Key Differences Between Laser Scanning and Drone Photogrammetry

- Edge Performance: Laser scanning excelled in capturing sharp edges, outperforming the noisier photogrammetry technique.
- Visibility of Unseen High Edges: While the terrestrial laser scanner struggled with unseen high edges, the drone photogrammetry method mapped every corner without any blind spots.

- Cost: Laser scanning was found to be orders of magnitude more expensive than drone photogrammetry.
- Computational Complexity: Laser scanning proved to be computationally more demanding during the processing stage.

Conclusion

The alignment and GCP data enhance our understanding of 3D modeling, revealing acceptable alignment quality despite slight errors with the third model and GCPs. These insights emphasize the importance of meticulous data management and inform future decisions in survey scenarios, encompassing factors like cost and accuracy. The final laser scanning point cloud, exportable in CAD formats (DXF and DWG), is provided in the submission folder.

List of attachments