KOPPEL ENGINEERING

MESSDIENSTLEISTUNGEN

Agisoft PhotoScan:

Point Cloud accuracy in close range configuration

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Introduction:

Agisoft PhotoScan (www.agisoft.com) is a software product that computes a spatial 3D reconstruction of any scene out of digital images as input data. The simple automated way to arrange the camera alignment up to a detailed 3D model makes the software user friendly, even for non-specialists.

Figure 1: PhotoScan logo [1]

PhotoScan uses well implemented algorithms to analyze each input image for special features in order to create a relation between the images of the entire scene. Photogrammetric operations like bundle adjustment are used to solve the inner- and outer orientation of each camera, reconstructing their spatial position/orientation to each other. Once the camera alignment is solved, a dense point cloud and a subsequent textured 3D model of the captured scene can be computed and exported. Aerial mapping and close range scans of faces, bodies and structures are part of the task field of this software.

Motivation:

The main motivation for this short article came with the question, if this software can be used for precise reverse engineering issues, like as-built documentations in close range field. Is photogrammetry using PhotoScan an alternative to terrestrial laser scanners?

Test object:

The following test results as a byproduct of a real deformation analysis of a converter cone. There was no permission from the contractor to share final results or any information about the recent situation of the cone. This study deals only with the quality analysis of the presented software. In order to investigate the precision of Agisoft PhotoScan and its results, the surface of a simple cone was chosen ($\emptyset \approx 10$ m) for the quality analysis. This object provides a smooth geometry and simplifies the deviations between test and reference object.

Figure 2: Reference Object [2]

Realization:

21 markers have been placed in regularly distances to perform model optimization. These markers were coordinated with a reflector-less total station (σ3D = 2 mm).
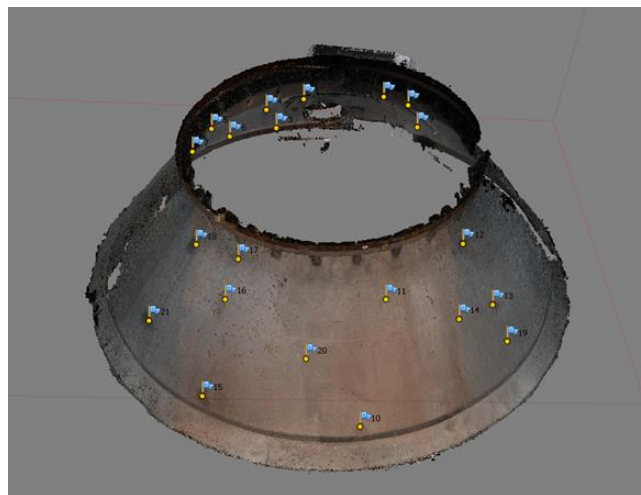

Figure 3: Marker distribution

Due the inaccessibility of the converter unit, both sides have been scanned separately and merged in the further processing step.

The input data was captured from a hydraulic platform in three different levels. The mean distance to object surface was ≈ 4 m. Used Camera is a CANON EOS 6D with a full frame sensor and a zoom lens fixed at 24mm (focal length). Due the insufficient illumination a flash was mounted on the camera. The mean ISO-Value for each photo is 1600 by shutter 1/60.
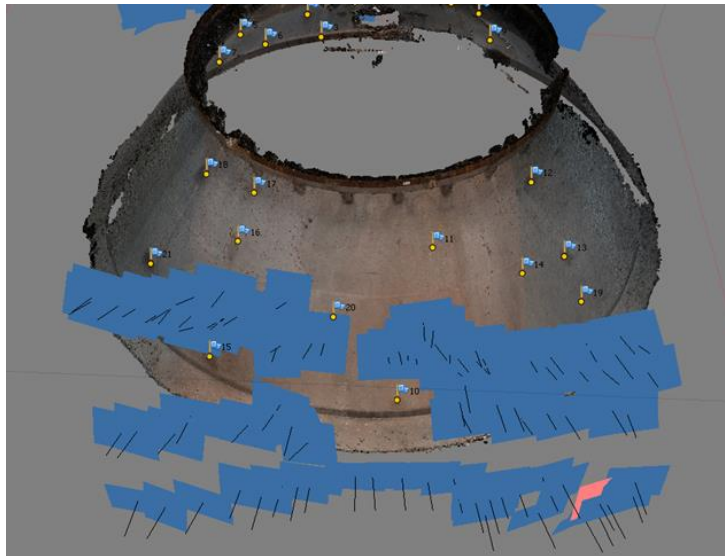
Figure 4: Image capture configuration

During the image capture, 800 points have been measured with a laser total station, which are referenced in the exactly same system as the point cloud computed with PhotoScan. These points form the reference for the further quality analysis of photogrammetric scan (σ3D = 2 mm).

The main idea is to compare the spatial differences between the test object (Model computed with PhotoScan) and the arbitrary ordered control points measured with a reflector-less total station.

Results:

The resulting Dense Point Cloud computed with PhotoScan consists of ≈ 60.000.000 points at quality setting "High" (Original input data downscaled by factor two).

For the further analysis, the entire point cloud was meshed and imported in the software "Cloud Compare" (http://www.cloudcompare.org/). Cloud Compare is an Open Source software for point clouds and meshes that allows analyzes of external data in various formats.

Figure 5: CloudCompare logo [3]

Once the mesh and the reference points loaded, a signed difference between reference and test object can be computed. The deviation (signed distance) to the reference will be applied to the scalar value of each control point.
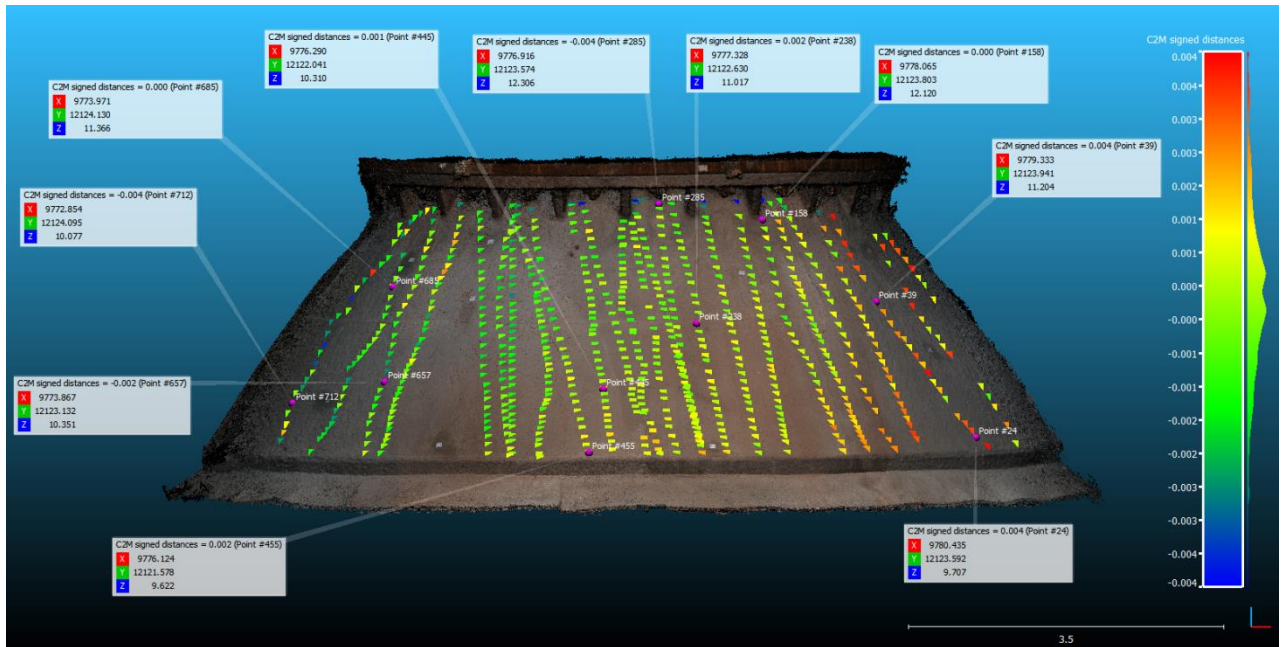

Figure 6: Deviations of control points (back)

The result shows that the precision of the model becomes worse in the inaccessible border regions, due lower amount of photo information and poor illumination.
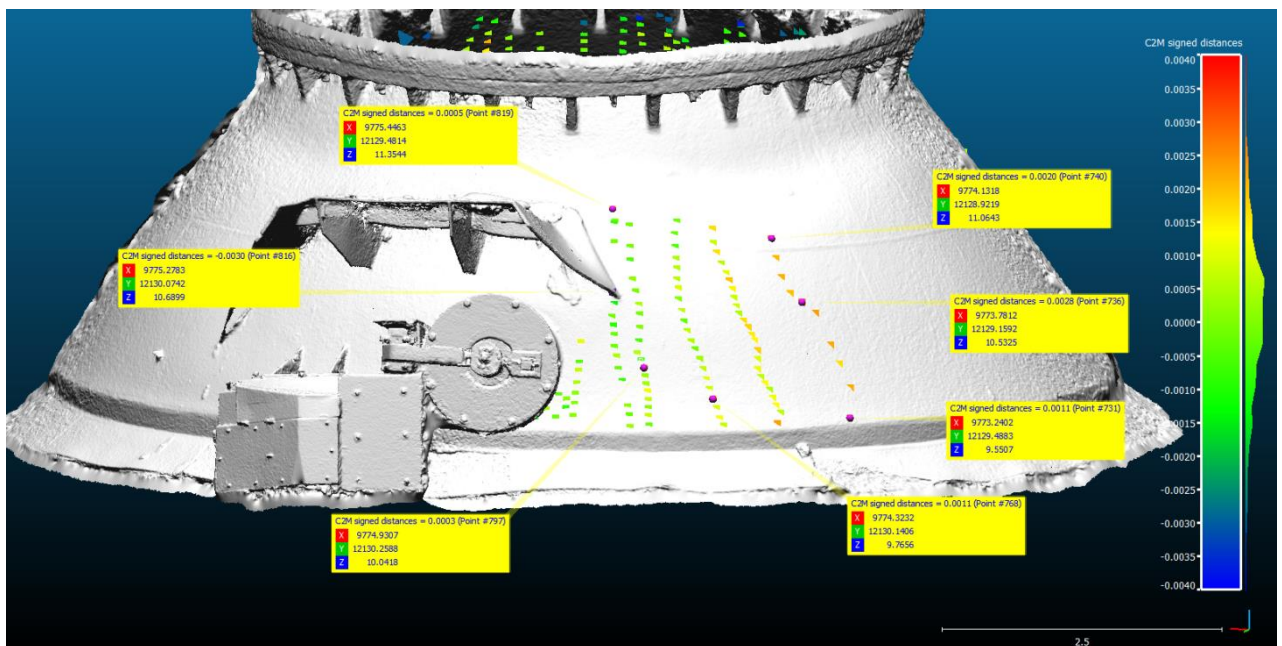

Figure 7: Deviations of control points (front)

Due reasons of time, it was not possible to measure the same amount of control points on the other side of the converter.

In the final step, the Gaussian-Curve shows the global error distribution and the reached standard deviation of the measured control points.
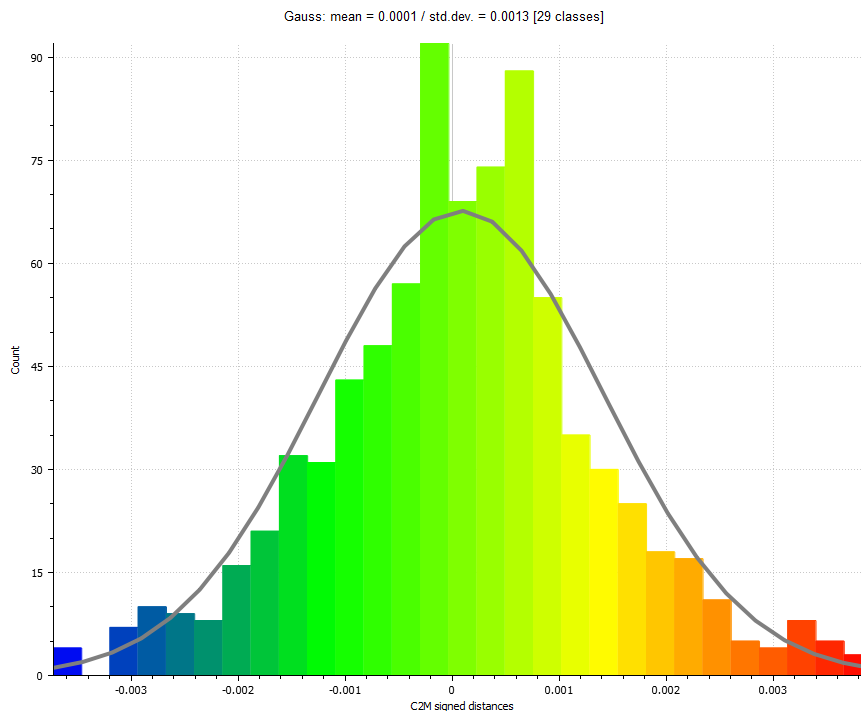

Figure 8: Gaussian-Curve and standard deviation

Conclusion:

The reached overall deviation of 1.3 mm shows a reasonable accuracy of the dense point cloud and the resulting model. Using a free-hand camera it is possible to reach even regions with poor access availability. It should be noted that the illumination conditions were not overall adequate, what causes noise in the border regions. Regarding to this project there is still space for optimizations to prevent such interferences.

Compared to a terrestrial laser-scanner (taking the costs of Hard- and Software into account), it is possible to reach similar accuracy results with Agisoft PhotoScan and CloudCompare.

Source directory:

[1] www.agisoft.com

[2] www.siemens.com

[3] www.danielgm.net