Quality Report

Generated with Pix4Dmapper version 4.6.4

Important: Click on the different icons for:

Help to analyze the results in the Quality Report

Additional information about the sections

Click here for additional tips to analyze the Quality Report

Summary

Project	319Crew4_041921
Processed	2021-04-26 14:07:35
Camera Model Name(s)	L1D-20c_10.3_5472x3648 (RGB)
Average Ground Sampling Distance (GSD)	2.33 cm / 0.92 in
Area Covered	0.079 km^2 / 7.8892 ha / 0.03 sq. mi. / 19.5048 acres

Quality Check

Images	median of 74581 keypoints per image	✓
Dataset	85 out of 85 images calibrated (100%), all images enabled	✓
Camera Optimization	72.06% relative difference between initial and optimized internal camera parameters	⚠
Matching	median of 31446 matches per calibrated image	✓
Georeferencing	yes, 6 GCPs (6 3D), mean RMS error = 0.105 m	⚠

Preview

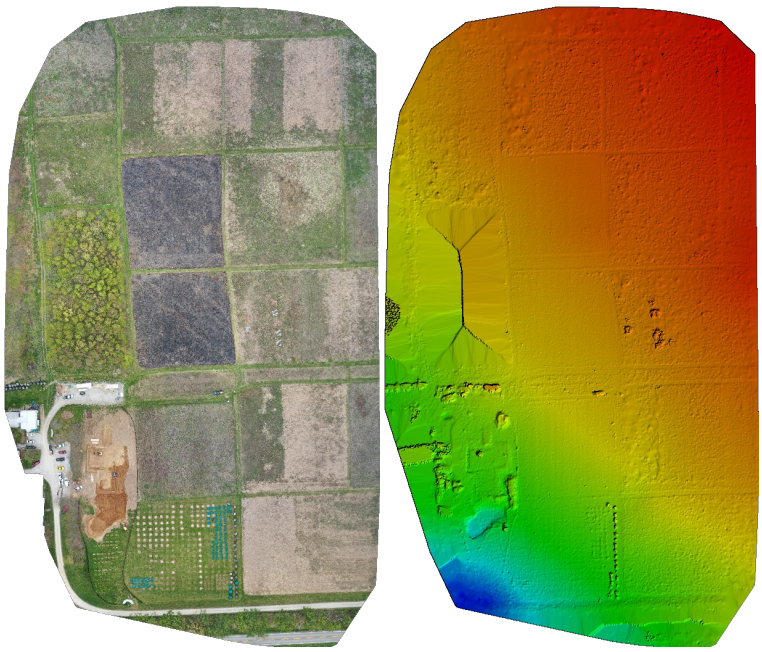


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details

Number of Calibrated Images	85 out of 85
Number of Geolocated Images	85 out of 85

Initial Image Positions

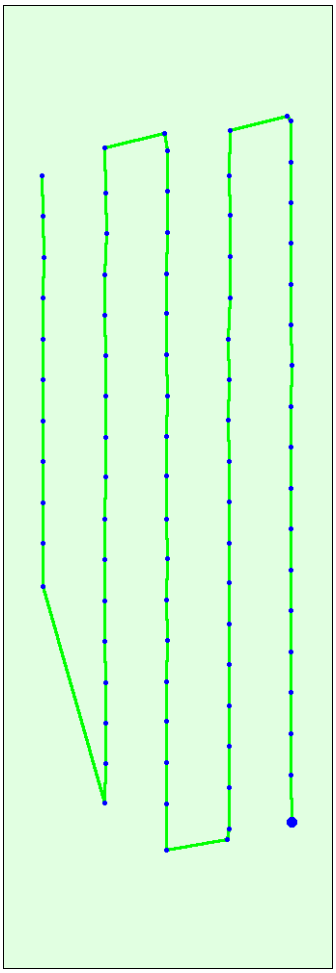
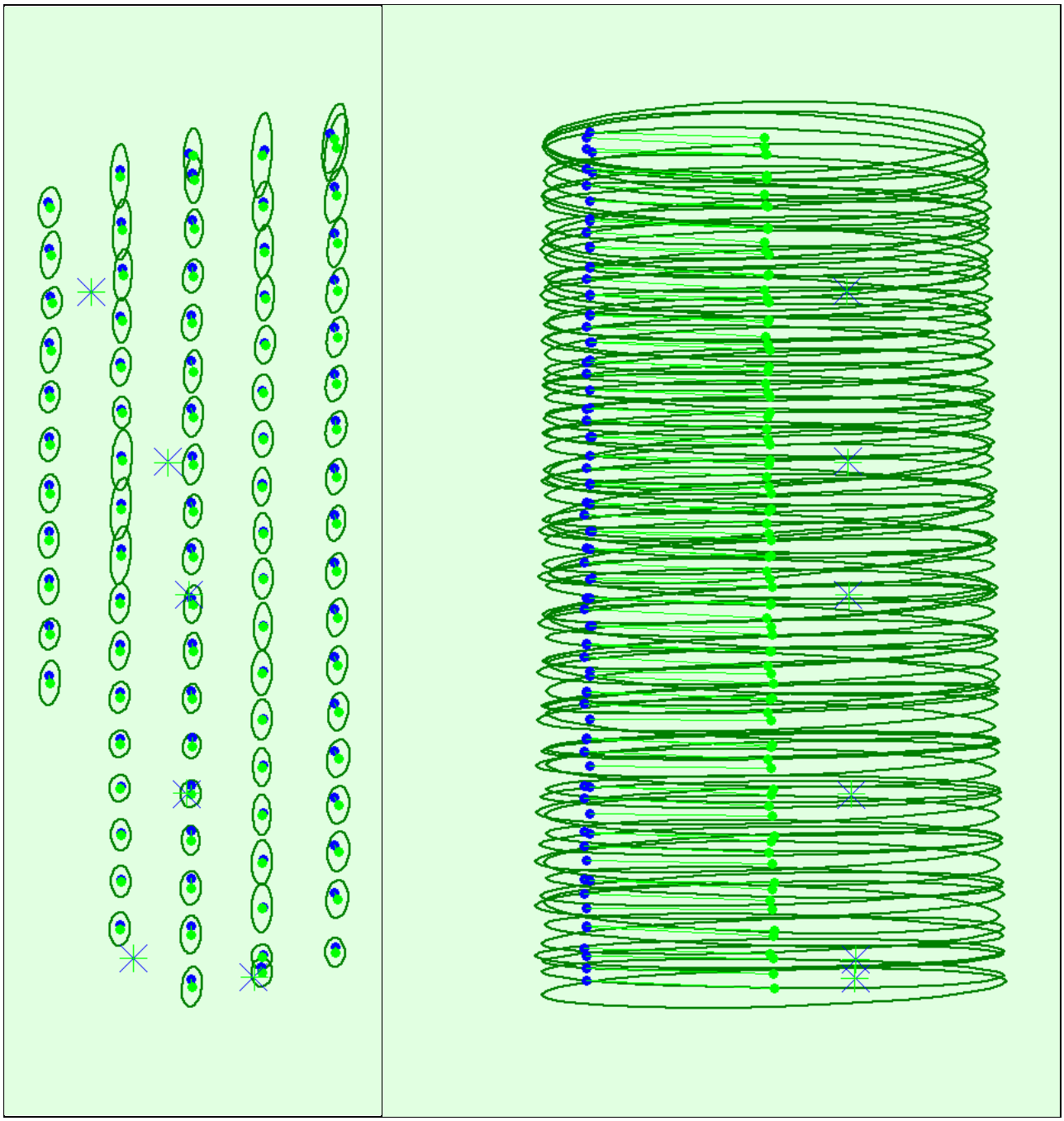
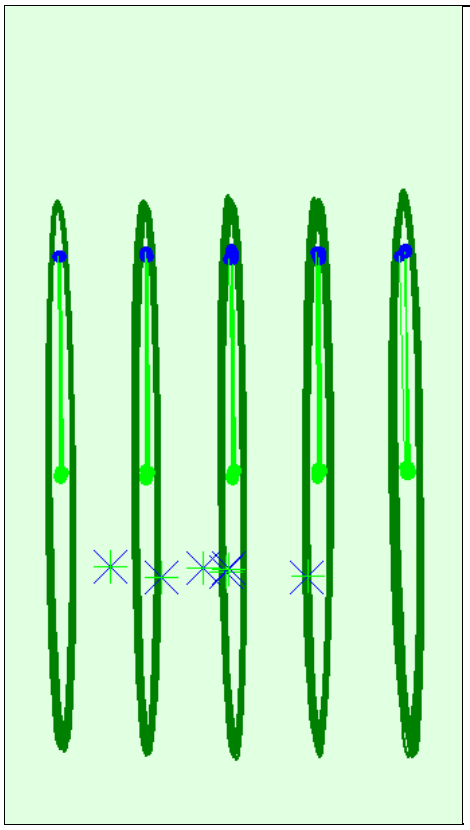


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

Computed Image/GCPs/Manual Tie Points Positions





Uncertainty ellipses 100x magnified

Figure 3: Offset between initial (blue dots) and computed (green dots) image positions as well as the offset between the GCPs initial positions (blue crosses) and their computed positions (green crosses) in the top-view (XY plane), front-view (XZ plane), and side-view (YZ plane). Dark green ellipses indicate the absolute position uncertainty of the bundle block adjustment result.

Absolute camera position and orientation uncertainties

	X [m]	Y [m]	Z [m]	Omega [degree]	Phi [degree]	Kappa [degree]	Camera Displacement X [m]	Camera Displacement Y [m]	Camera Displacement Z [m]
Mean	0.037	0.075	0.834	0.136	0.042	0.020	0.016	0.010	0.101
Sigma	0.002	0.020	0.013	0.037	0.005	0.008	0.006	0.002	0.026

Overlap

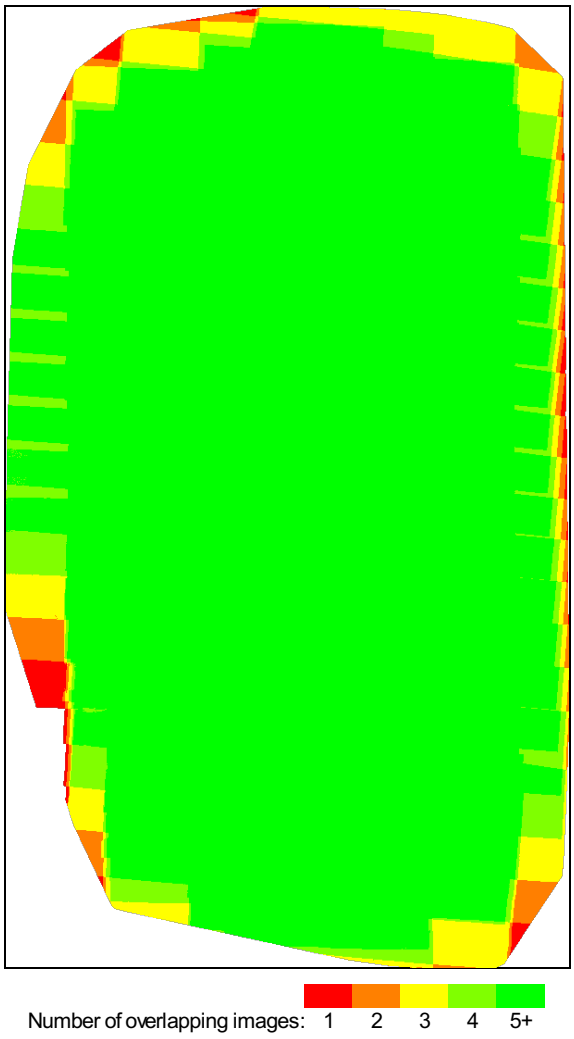


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic.
Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint matches is also sufficient for these areas (see Figure 5 for keypoint matches).

Bundle Block Adjustment Details

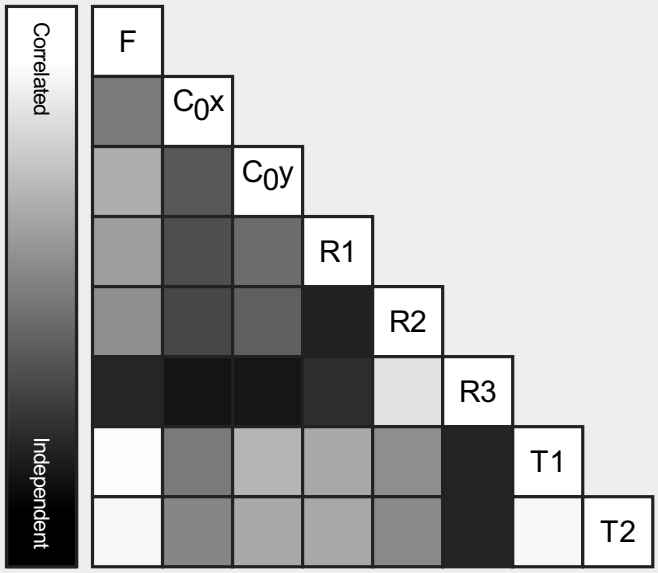
Number of 2D Keypoint Observations for Bundle Block Adjustment	2658821
Number of 3D Points for Bundle Block Adjustment	612576
Mean Reprojection Error [pixels]	0.169

Internal Camera Parameters

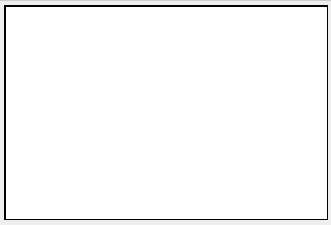
L1D-20c_10.3_5472x3648 (RGB). Sensor Dimensions: 12.825 [mm] x 8.550 [mm]

EXIF ID: L1D-20c_10.3_5472x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	4470.830 [pixel] 10.479 [mm]	2736.000 [pixel] 6.412 [mm]	1824.000 [pixel] 4.275 [mm]	0.009	0.040	-0.050	-0.003	0.002
Optimized Values	1248.739 [pixel] 2.927 [mm]	2852.695 [pixel] 6.686 [mm]	1700.902 [pixel] 3.986 [mm]	0.001	0.000	-0.000	-0.001	-0.000
Uncertainties (Sigma)	35.673 [pixel] 0.084 [mm]	1.443 [pixel] 0.003 [mm]	1.817 [pixel] 0.004 [mm]	0.000	0.000	0.000	0.000	0.000



The correlation between camera internal parameters determined by the bundle adjustment. White indicates a full correlation between the parameters, ie. any change in one can be fully compensated by the other. Black indicates that the parameter is completely independent, and is not affected by other parameters.



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to the see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

2D Keypoints Table

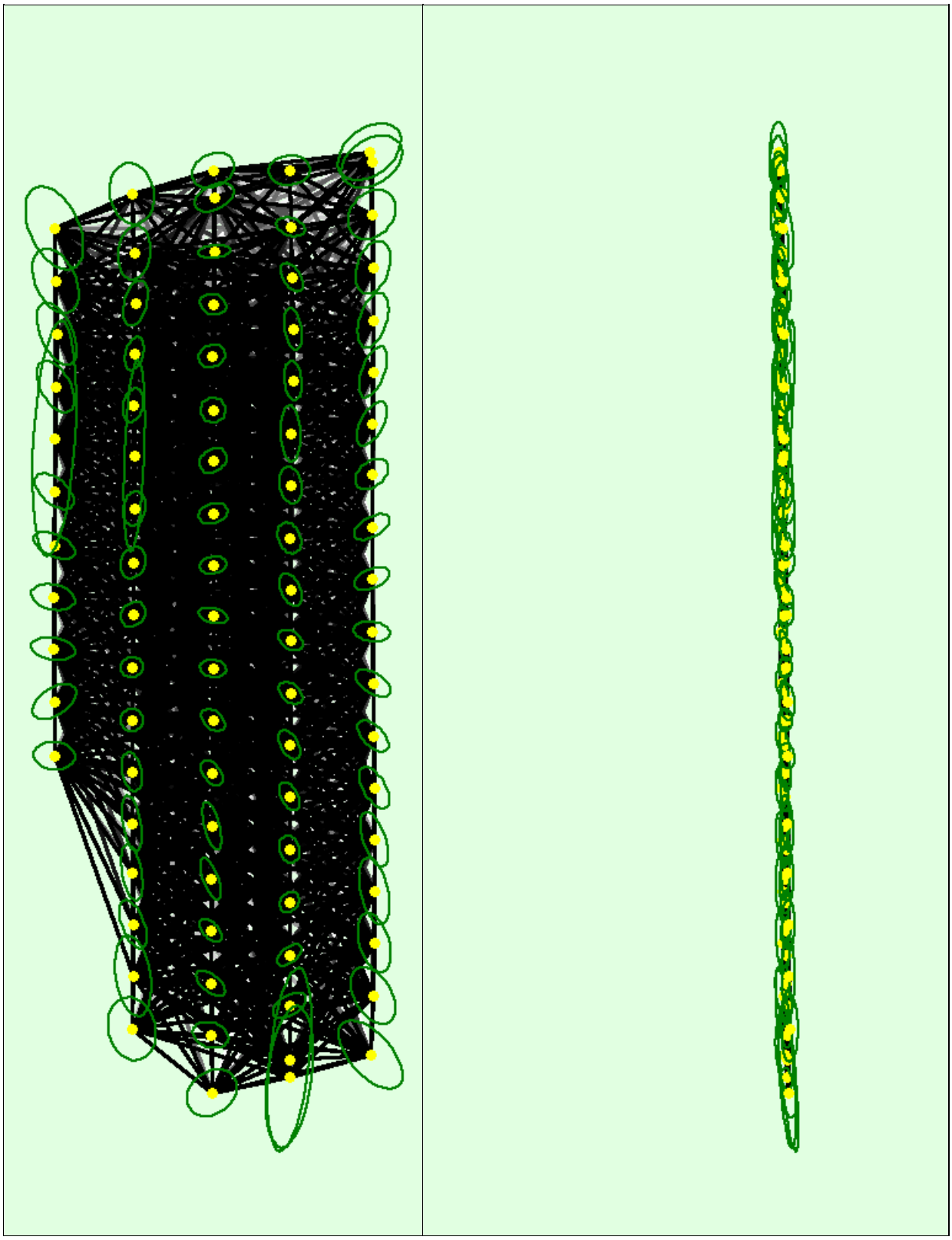
	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	74581	31446
Min	58363	16623
Max	79951	41626
Mean	73845	31280

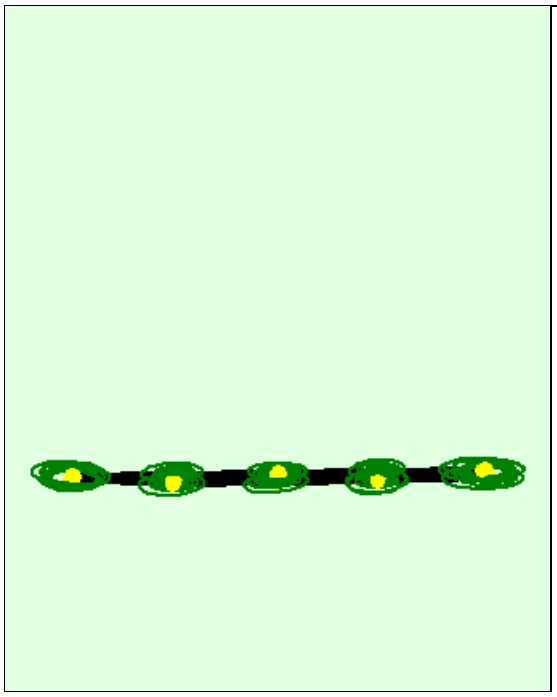
3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	258506
In 3 Images	115655
In 4 Images	63724
In 5 Images	41156
In 6 Images	27131
In 7 Images	20220
In 8 Images	15935
In 9 Images	13138
In 10 Images	10397
In 11 Images	8226
In 12 Images	7029
In 13 Images	6139
In 14 Images	5304
In 15 Images	4236
In 16 Images	3597
In 17 Images	3190
In 18 Images	2861
In 19 Images	2432
In 20 Images	1723
In 21 Images	819
In 22 Images	474
In 23 Images	363

In 24 Images	236
In 25 Images	85

2D Keypoint Matches





Uncertainty ellipses 5000x magnified

Number of matches

25 222 444 666 888 1111 1333 1555 1777 2000

Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images. Dark green ellipses indicate the relative camera position uncertainty of the bundle block adjustment result.

Relative camera position and orientation uncertainties

	X [m]	Y [m]	Z [m]	Omega [degree]	Phi [degree]	Kappa [degree]	Camera Displacement X [m]	Camera Displacement Y [m]	Camera Displacement Z [m]
Mean	0.001	0.002	0.000	0.003	0.001	0.002	0.002	0.001	0.002
Sigma	0.000	0.001	0.000	0.002	0.000	0.001	0.001	0.000	0.002

Geolocation Details

Ground Control Points

GCP Name	Accuracy XY/Z [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
1 (3D)	0.020/ 0.020	-0.023	-0.074	-0.545	0.557	2 / 2
2 (3D)	0.020/ 0.020	0.001	-0.005	0.013	0.510	2 / 2
3 (3D)	0.020/ 0.020	-0.046	-0.038	0.020	0.392	2 / 2
4 (3D)	0.020/ 0.020	-0.036	0.049	0.240	0.127	2 / 2
5 (3D)	0.020/ 0.020	-0.040	0.088	-0.120	0.005	2 / 2
6 (3D)	0.020/ 0.020	0.028	-0.004	-0.024	0.552	2 / 2
Mean [m]		-0.019175	0.002508	-0.069259		
Sigma [m]		0.026023	0.053277	0.238522		
RMS Error [m]		0.032324	0.053336	0.248373		

Localisation accuracy per GCP and mean errors in the three coordinate directions. The last column counts the number of calibrated images where the GCP has been automatically verified vs. manually marked.

Absolute Geolocation Variance

Min Error [m]	Max Error [m]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%]
-	-15.00	0.00	0.00	0.00
-15.00	-12.00	0.00	0.00	0.00
-12.00	-9.00	0.00	0.00	0.00
-9.00	-6.00	0.00	0.00	0.00
-6.00	-3.00	0.00	0.00	0.00
-3.00	0.00	45.88	42.35	48.24
0.00	3.00	54.12	57.65	51.76
3.00	6.00	0.00	0.00	0.00
6.00	9.00	0.00	0.00	0.00
9.00	12.00	0.00	0.00	0.00
12.00	15.00	0.00	0.00	0.00
15.00	-	0.00	0.00	0.00
Mean [m]		-0.450012	2.327560	66.981043
Sigma [m]		0.565026	1.003377	1.258259
RMS Error [m]		0.722333	2.534620	66.992860

Min Error and Max Error represent geolocation error intervals between -1.5 and 1.5 times the maximum accuracy of all the images. Columns X, Y, Z show the percentage of images with geolocation errors within the predefined error intervals. The geolocation error is the difference between the initial and computed image positions. Note that the image geolocation errors do not correspond to the accuracy of the observed 3D points.

Geolocation Bias	X	Y	Z
Translation [m]	-0.450013	2.327560	66.981052

Bias between image initial and computed geolocation given in output coordinate system.

Relative Geolocation Variance

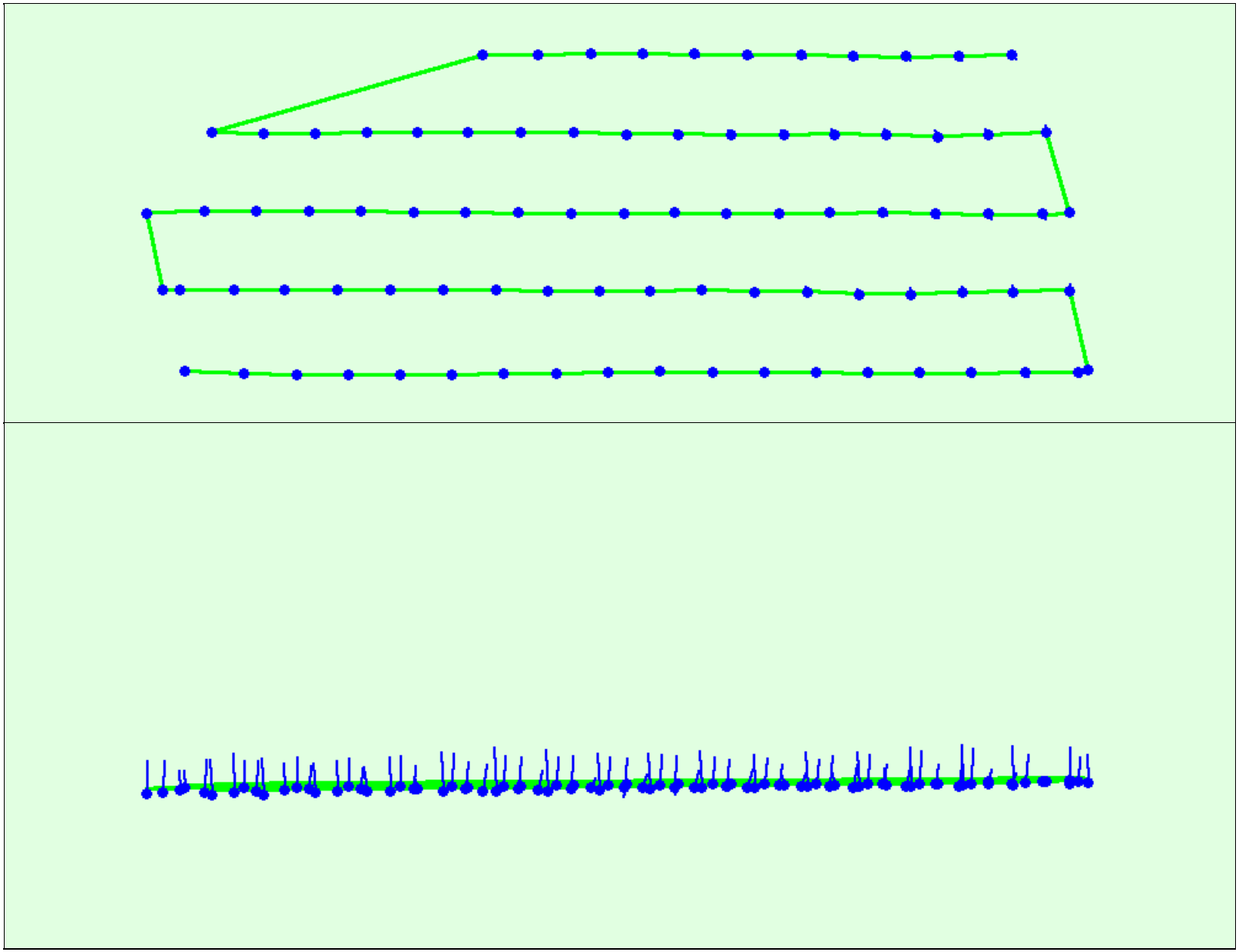
Relative Geolocation Error	Images X [%]	Images Y [%]	Images Z [%]
[-1.00, 1.00]	100.00	100.00	100.00
[-2.00, 2.00]	100.00	100.00	100.00
[-3.00, 3.00]	100.00	100.00	100.00
Mean of Geolocation Accuracy [m]	5.000000	5.000000	10.000000
Sigma of Geolocation Accuracy [m]	0.000000	0.000000	0.000000

Images X, Y, Z represent the percentage of images with a relative geolocation error in X, Y, Z.

Geolocation Orientational Variance	RMS [degree]
Omega	1.824
Phi	0.734
Kappa	31.475

Geolocation RMS error of the orientation angles given by the difference between the initial and computed image orientation angles.

Rolling Shutter Statistics



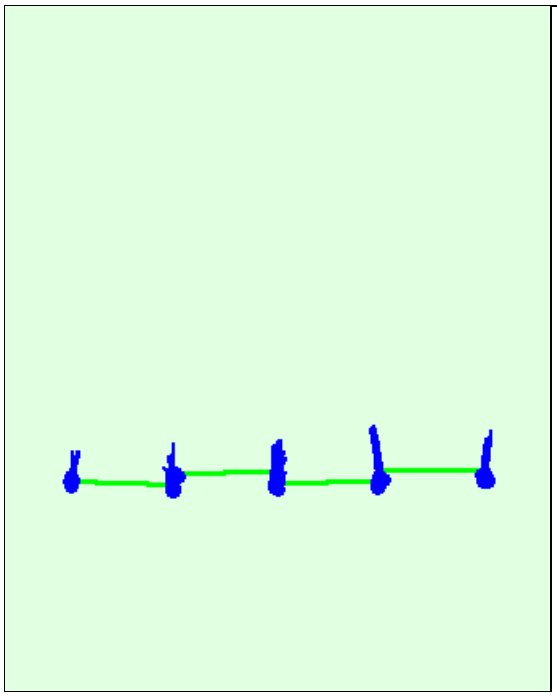


Figure 6: Camera movement estimated by the rolling shutter camera model. The green line follows the computed image positions. The blue dots represent the camera position at the start of the exposure. The blue lines represent the camera motion during the rolling shutter readout, re-scaled by a project dependant scaling factor for better visibility.

Median Camera Speed	4.345 [m/s]
Median Camera Displacement During Sensor Readout)	2.6032 [m]
Median Rolling Shutter Readout Time	595.154 [ms]

Initial Processing Details

System Information

Hardware	CPU: Intel(R) Core(TM) i7-6700T CPU @ 2.80GHz RAM: 32GB GPU: Intel(R) HD Graphics 530 (Driver: 26.20.100.8142)
Operating System	Windows 10 Education, 64-bit

Coordinate Systems

Image Coordinate System	WGS 84 (EGM96 Geoid)
Ground Control Point (GCP) Coordinate System	NAD83(2011) / UTM zone 16N (EGM96 Geoid)
Output Coordinate System	NAD83(2011) / UTM zone 16N (EGM96 Geoid)

Processing Options

Detected Template	3D Maps
Keypoints Image Scale	Full, Image Scale: 1
Advanced: Matching Image Pairs	Aerial Grid or Corridor
Advanced: Matching Strategy	Use Geometrically Verified Matching: no
Advanced: Keypoint Extraction	Targeted Number of Keypoints: Automatic
Advanced: Calibration	Calibration Method: Standard Internal Parameters Optimization: All External Parameters Optimization: All Rematch: Auto, yes

Point Cloud Densification details

Processing Options

Image Scale	multiscale, 1/2 (Half image size, Default)
Point Density	Optimal
Minimum Number of Matches	3
3D Textured Mesh Generation	yes
3D Textured Mesh Settings:	Resolution: Medium Resolution (default) Color Balancing: no
LOD	Generated: no
Advanced: 3D Textured Mesh Settings	Sample Density Divider: 1
Advanced: Image Groups	group1
Advanced: Use Processing Area	yes
Advanced: Use Annotations	yes
Time for Point Cloud Densification	48m:04s
Time for Point Cloud Classification	NA
Time for 3D Textured Mesh Generation	05m:45s

Results

Number of Generated Tiles	1
Number of 3D Densified Points	9935800
Average Density (per m^3)	315.9

DSM, Orthomosaic and Index Details

Processing Options

DSM and Orthomosaic Resolution	1 x GSD (2.33 [cm/pixel])
DSM Filters	Noise Filtering: yes Surface Smoothing: yes, Type: Sharp
Raster DSM	Generated: yes Method: Inverse Distance Weighting Merge Tiles: yes
Orthomosaic	Generated: yes Merge Tiles: yes GeoTIFF Without Transparency: no Google Maps Tiles and KML: no
Time for DSM Generation	10m:22s
Time for Orthomosaic Generation	14m:57s
Time for DTM Generation	00s
Time for Contour Lines Generation	00s
Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s