

Quality Report



Generated with Pix4Dmapper Pro version 4.1.25



Important: Click on the different icons for:



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Additional information about the sections



Click [here](#) for additional tips to analyze the Quality Report

Summary



Project	F11_12bit_120magl_Make
Processed	2019-02-18 10:42:45
Camera Model Name(s)	Altum_8.0_2064x1544 (Blue), Altum_8.0_2064x1544 (Green), Altum_8.0_2064x1544 (Red), Altum_8.0_2064x1544 (NIR), Altum_8.0_2064x1544 (Red edge), Altum_1.8_160x120 (LWIR)
Rig name(s)	«Altum»
Average Ground Sampling Distance (GSD)	5.73 cm / 2.26 in
Area Covered	0.286 km ² / 28.6379 ha / 0.11 sq. mi. / 70.8025 acres

Quality Check



Images	median of 10864 keypoints per image	
Dataset	1530 out of 1560 images calibrated (98%), all images enabled	
Camera Optimization	1.34% relative difference between initial and optimized internal camera parameters	
Matching	median of 3384.84 matches per calibrated image	
Georeferencing	yes, no 3D GCP	

Preview

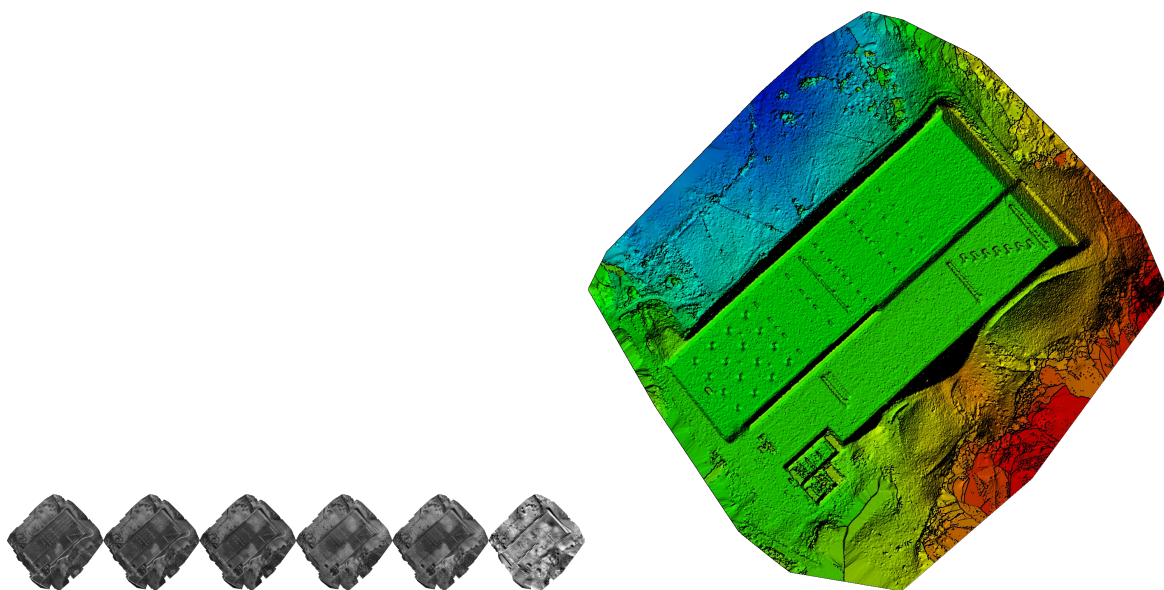


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details



Number of Calibrated Images	1530 out of 1560
Number of Geolocated Images	1560 out of 1560

Initial Image Positions

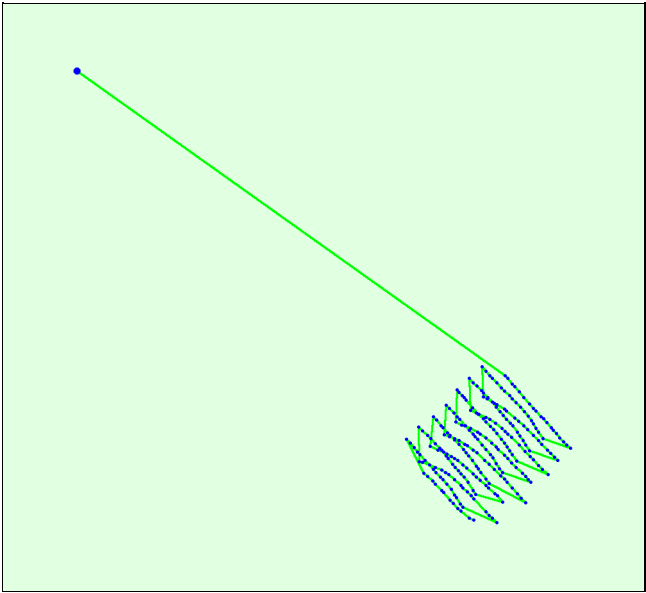
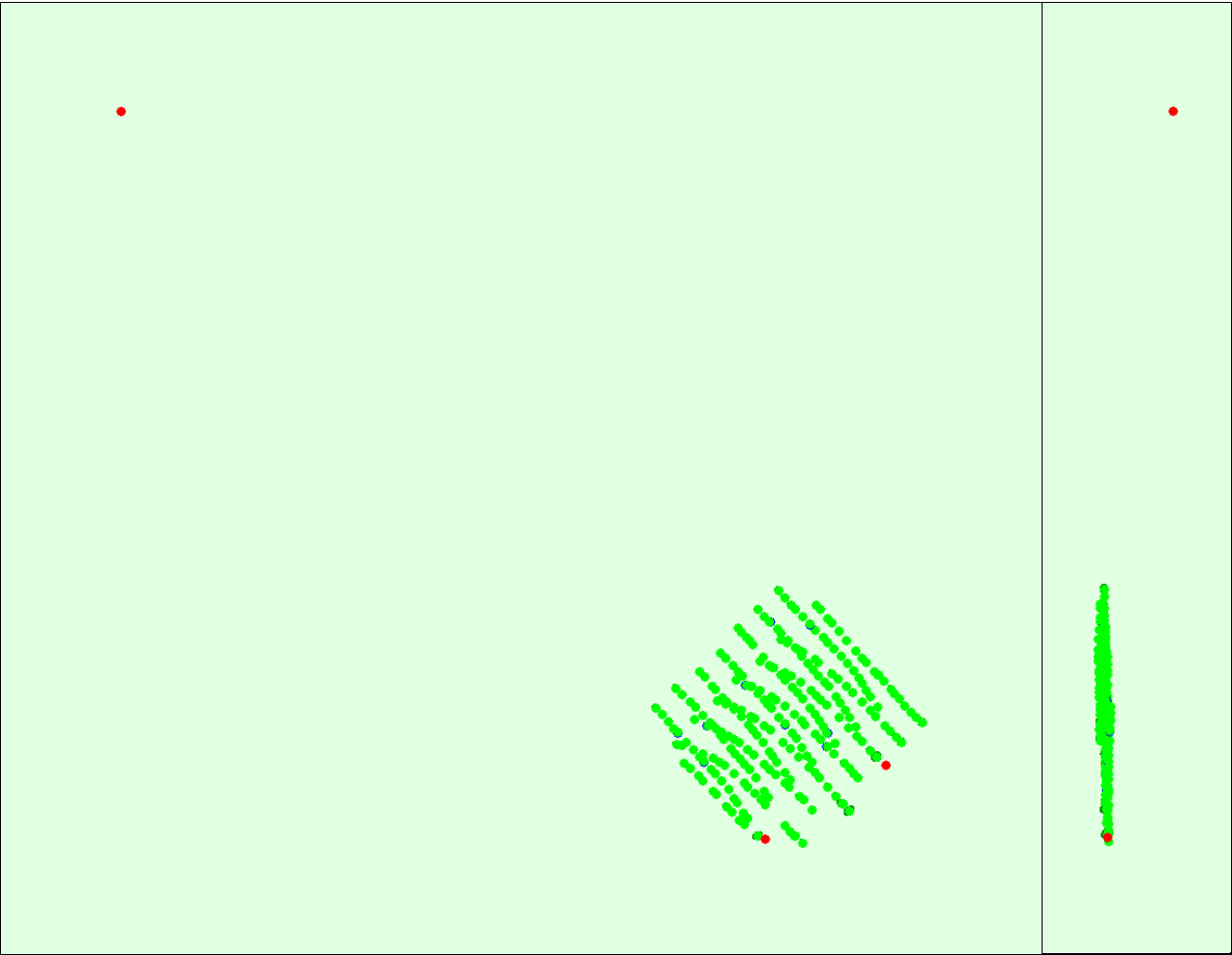
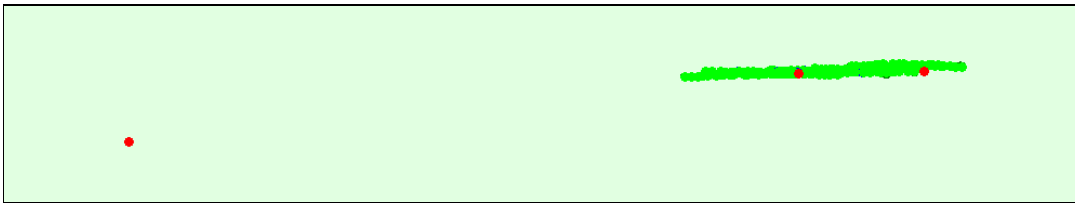


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

Computed Image/GCPs/Manual Tie Points Positions





Uncertainty ellipses 500x 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). Red dots indicate disabled or uncalibrated images. 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]
Mean	0.010	0.010	0.006	0.005	0.005	0.002
Sigma	0.002	0.002	0.002	0.001	0.001	0.002

? Overlap

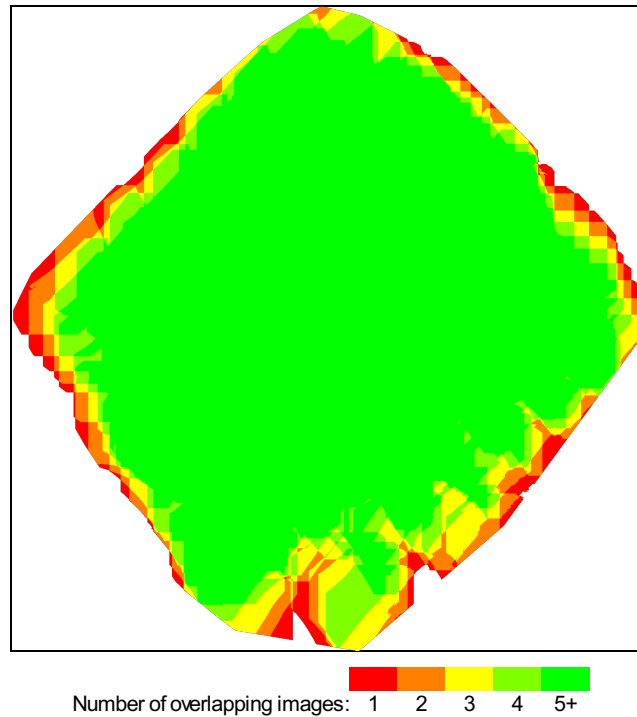


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint 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	4989421
Number of 3D Points for Bundle Block Adjustment	388167
Mean Reprojection Error [pixels]	0.187

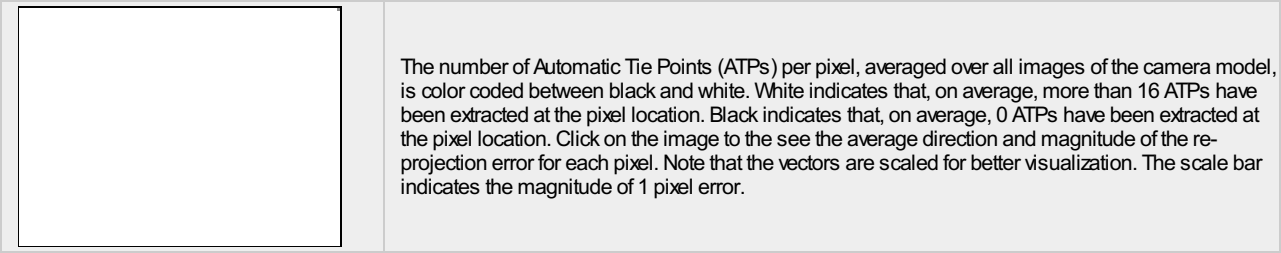
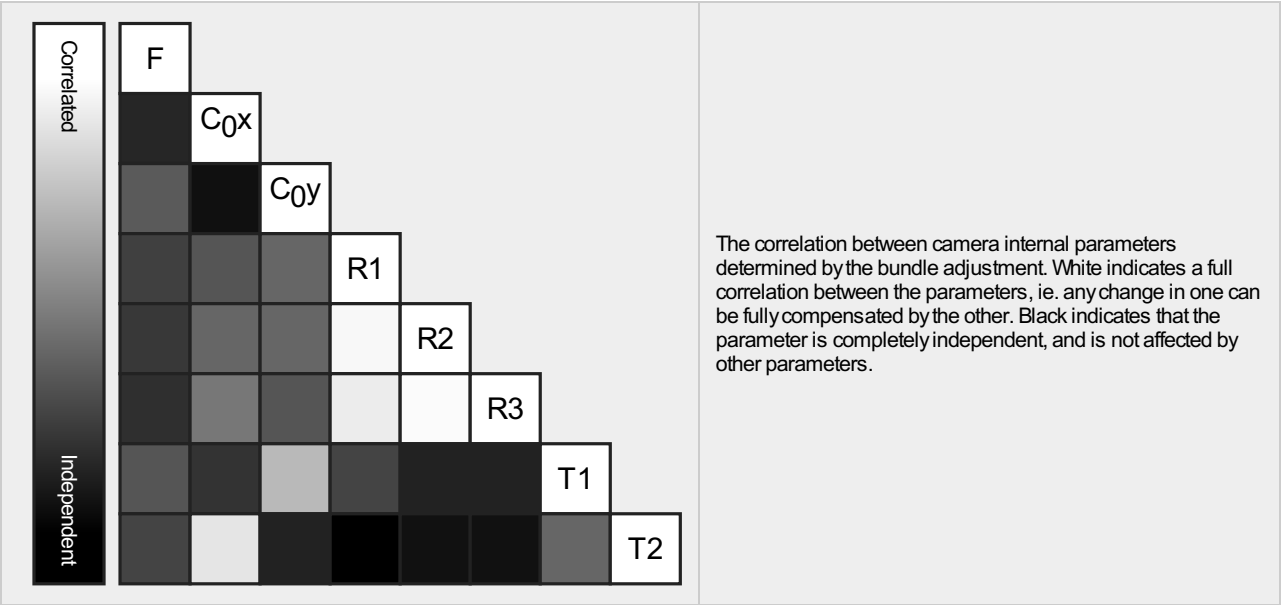
? Internal Camera Parameters

Altum_8.0_2064x1544 (Blue). Sensor Dimensions: 7.121 [mm] x 5.327 [mm]



EXIF ID: Altum_8.0_2064x1544

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	2286.190 [pixel] 7.887 [mm]	988.170 [pixel] 3.409 [mm]	762.065 [pixel] 2.629 [mm]	-0.129	0.227	-0.125	0.000	-0.001
Optimized Values	2263.876 [pixel] 7.810 [mm]	991.807 [pixel] 3.422 [mm]	760.394 [pixel] 2.623 [mm]	-0.110	0.167	-0.011	-0.000	-0.001
Uncertainties (Sigma)	0.167 [pixel] 0.001 [mm]	0.090 [pixel] 0.000 [mm]	0.073 [pixel] 0.000 [mm]	0.000	0.002	0.005	0.000	0.000



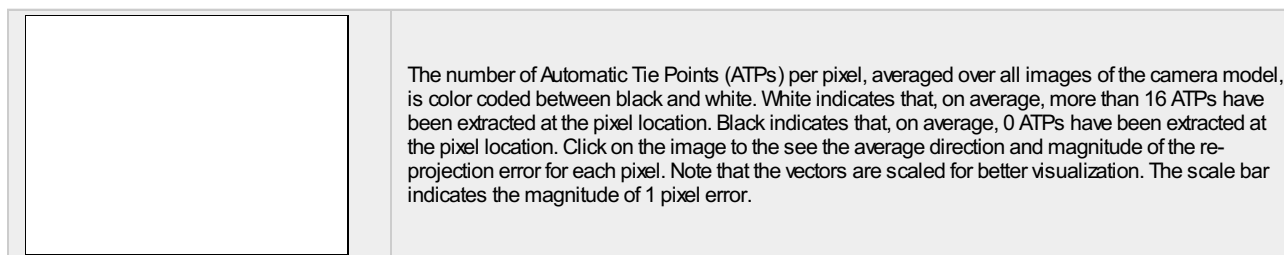
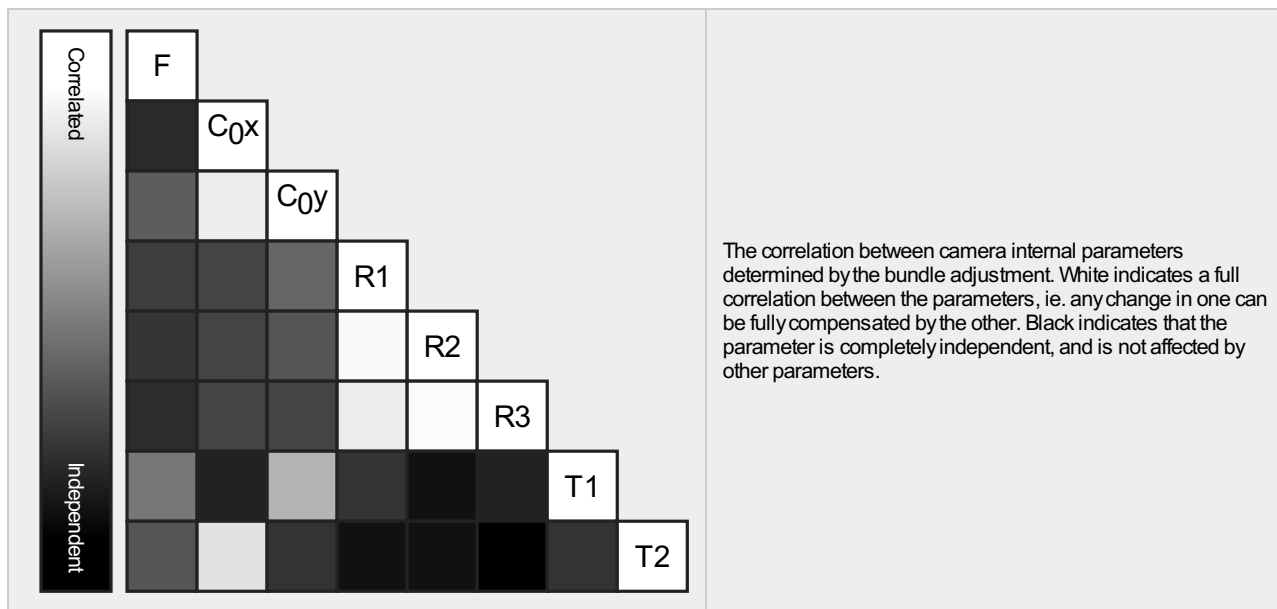
Internal Camera Parameters

Altum_8.0_2064x1544 (Green). Sensor Dimensions: 7.121 [mm] x 5.327 [mm]



EXIF ID: Altum_8.0_2064x1544

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	2286.190 [pixel] 7.887 [mm]	1014.009 [pixel] 3.498 [mm]	762.142 [pixel] 2.629 [mm]	-0.132	0.224	-0.132	0.000	-0.001
Optimized Values	2255.618 [pixel] 7.782 [mm]	1017.055 [pixel] 3.509 [mm]	761.286 [pixel] 2.626 [mm]	-0.113	0.166	-0.019	-0.000	-0.000
Uncertainties (Sigma)	0.166 [pixel] 0.001 [mm]	0.082 [pixel] 0.000 [mm]	0.067 [pixel] 0.000 [mm]	0.000	0.002	0.005	0.000	0.000



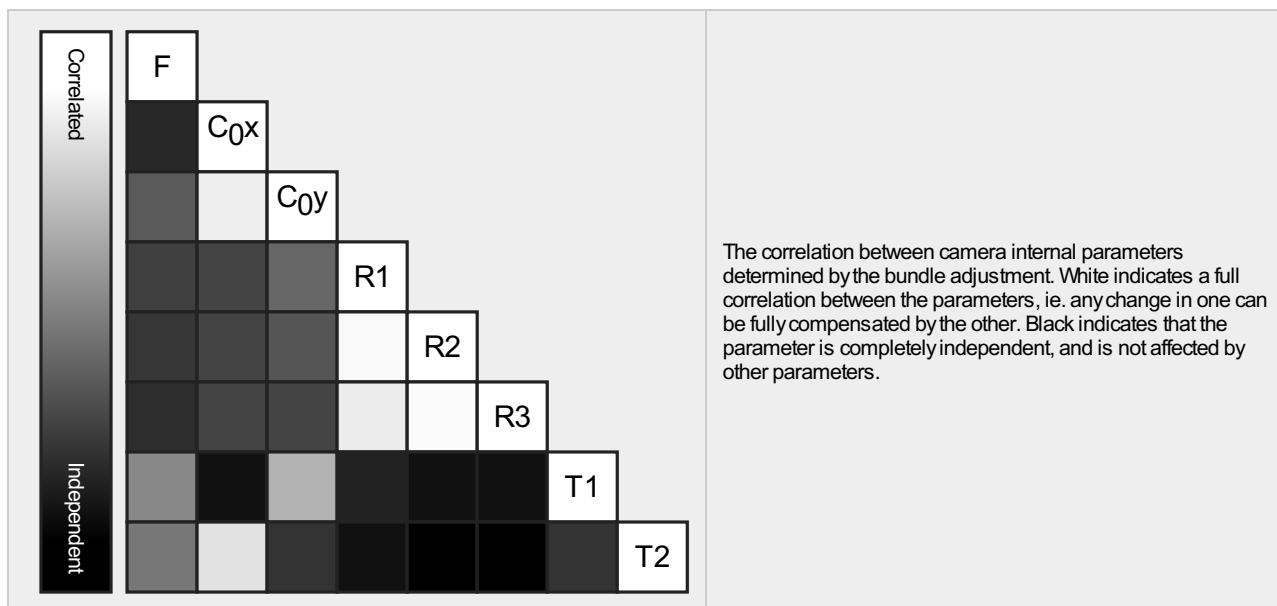
Internal Camera Parameters

Altum_8.0_2064x1544 (Red). Sensor Dimensions: 7.121 [mm] x 5.327 [mm]



EXIF ID: Altum_8.0_2064x1544

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	2286.190 [pixel] 7.887 [mm]	1008.307 [pixel] 3.479 [mm]	758.758 [pixel] 2.618 [mm]	-0.137	0.225	-0.133	0.000	-0.000
Optimized Values	2261.310 [pixel] 7.802 [mm]	1010.819 [pixel] 3.487 [mm]	763.712 [pixel] 2.635 [mm]	-0.119	0.172	-0.027	-0.000	-0.000
Uncertainties (Sigma)	0.167 [pixel] 0.001 [mm]	0.085 [pixel] 0.000 [mm]	0.069 [pixel] 0.000 [mm]	0.000	0.002	0.005	0.000	0.000



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 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.

Internal Camera Parameters

Altum_8.0_2064x1544 (NIR). Sensor Dimensions: 7.121 [mm] x 5.327 [mm]



EXIF ID: Altum_8.0_2064x1544

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	2286.190 [pixel] 7.887 [mm]	1005.068 [pixel] 3.467 [mm]	745.893 [pixel] 2.573 [mm]	-0.140	0.229	-0.151	-0.000	-0.001
Optimized Values	2270.897 [pixel] 7.835 [mm]	1004.313 [pixel] 3.465 [mm]	748.670 [pixel] 2.583 [mm]	-0.121	0.171	-0.033	-0.000	-0.001
Uncertainties (Sigma)	0.169 [pixel] 0.001 [mm]	0.098 [pixel] 0.000 [mm]	0.078 [pixel] 0.000 [mm]	0.000	0.003	0.006	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 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.

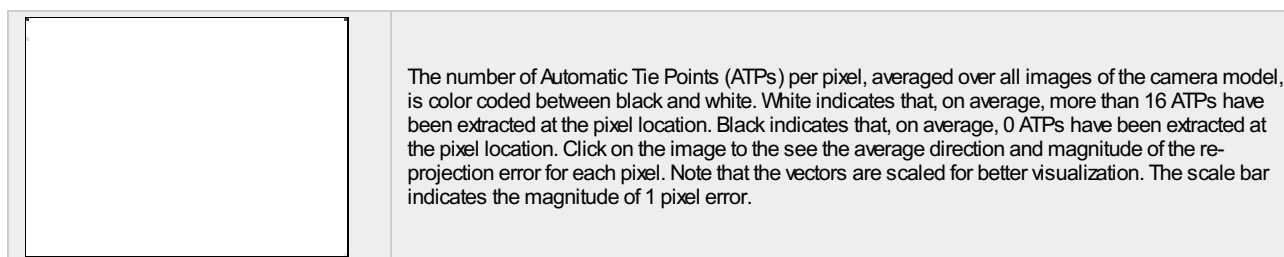
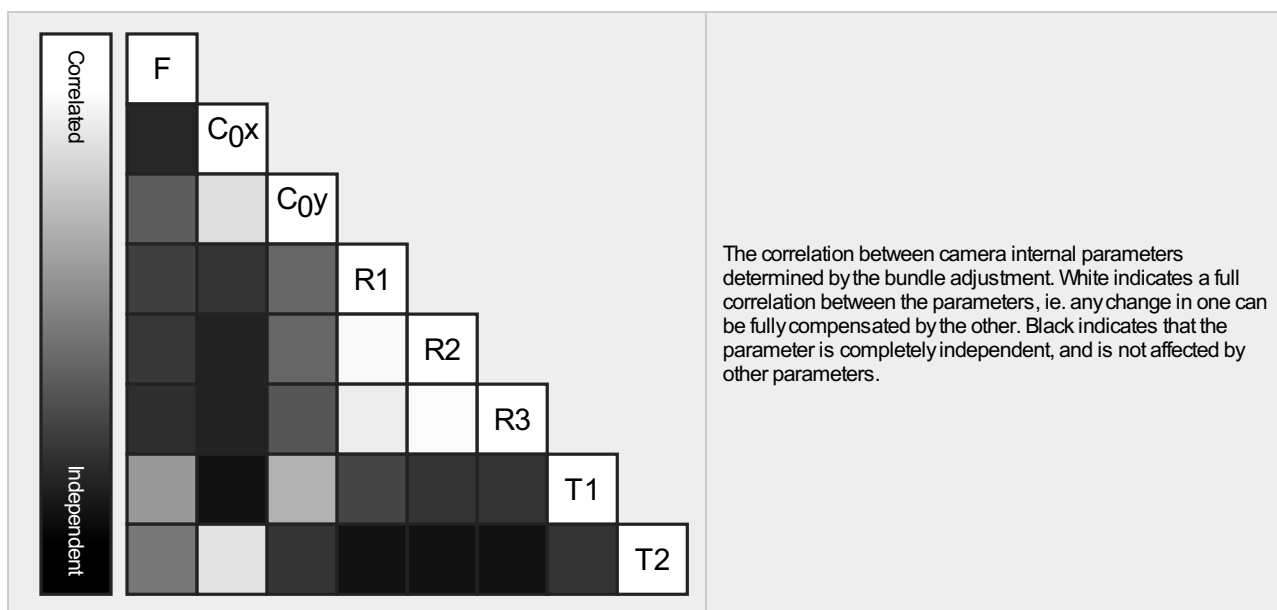
Internal Camera Parameters

Altum_8.0_2064x1544 (Red edge). Sensor Dimensions: 7.121 [mm] x 5.327 [mm]



EXIF ID: Altum_8.0_2064x1544

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	2286.190 [pixel] 7.887 [mm]	1019.367 [pixel] 3.517 [mm]	754.581 [pixel] 2.603 [mm]	-0.139	0.236	-0.168	-0.000	-0.000
Optimized Values	2269.969 [pixel] 7.831 [mm]	1020.445 [pixel] 3.521 [mm]	756.832 [pixel] 2.611 [mm]	-0.118	0.166	-0.029	-0.001	0.000
Uncertainties (Sigma)	0.168 [pixel] 0.001 [mm]	0.089 [pixel] 0.000 [mm]	0.072 [pixel] 0.000 [mm]	0.000	0.003	0.005	0.000	0.000



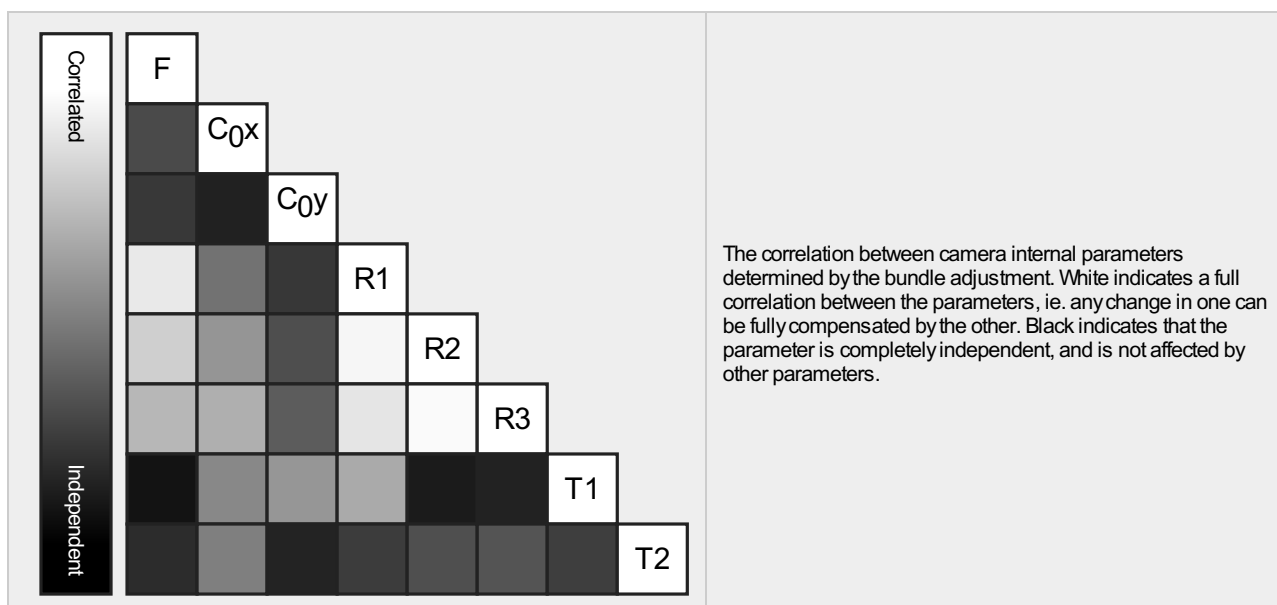
Internal Camera Parameters

Altum_1.8_160x120 (LWIR). Sensor Dimensions: 1.920 [mm] x 1.440 [mm]



EXIF ID: Altum_1.8_160x120

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	163.072 [pixel] 1.957 [mm]	81.512 [pixel] 0.978 [mm]	61.643 [pixel] 0.740 [mm]	-0.351	0.409	-0.412	0.003	0.001
Optimized Values	168.442 [pixel] 2.021 [mm]	94.687 [pixel] 1.136 [mm]	45.813 [pixel] 0.550 [mm]	-2.214	10.087	-16.988	0.027	-0.012
Uncertainties (Sigma)	0.762 [pixel] 0.009 [mm]	0.630 [pixel] 0.008 [mm]	0.584 [pixel] 0.007 [mm]	0.090	0.631	1.302	0.002	0.001





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 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.

Camera Rig «Altum» Relatives. Images: 1560



	Transl X[m]	Transl Y[m]	Transl Z[m]	Rot X[degree]	Rot Y[degree]	Rot Z[degree]
Altum_8.0_2064x1544 (Green)	Reference Camera					
Altum_8.0_2064x1544 (Blue)						
Initial Values	0.043	0.000	0.000	0.270	0.055	-0.084
Optimized values	0.043	0.000	0.000	0.274	-0.025	-0.084
Uncertainties (sigma)				0.002	0.003	0.000
Altum_8.0_2064x1544 (Red)						
Initial Values	0.000	0.026	0.000	0.117	0.010	0.017
Optimized values	0.000	0.026	0.000	0.025	-0.015	0.017
Uncertainties (sigma)				0.002	0.003	0.000
Altum_8.0_2064x1544 (NIR)						
Initial Values	0.043	0.026	0.000	0.182	0.000	-0.111
Optimized values	0.043	0.026	0.000	0.111	-0.109	-0.109
Uncertainties (sigma)				0.002	0.003	0.000
Altum_8.0_2064x1544 (Red edge)						
Initial Values	0.022	0.013	0.000	0.313	0.041	0.005
Optimized values	0.021	0.013	0.000	0.255	-0.039	0.006
Uncertainties (sigma)				0.002	0.003	0.000
Altum_1.8_160x120 (LWIR)						
Initial Values	0.022	-0.009	0.018	1.015	-0.508	-0.166
Optimized values	0.021	-0.009	0.018	4.377	5.251	-0.354
Uncertainties (sigma)				0.220	0.234	0.059

2D Keypoints Table



	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	10864	3385
Min	83	0
Max	16269	8442
Mean	9493	3261

2D Keypoints Table for Camera Altum_8.0_2064x1544 (Blue)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	11130	4207
Min	9400	11
Max	14450	5681
Mean	11296	4035

2D Keypoints Table for Camera Altum_8.0_2064x1544 (Green)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	10907	6705
Min	8963	142
Max	14482	8442
Mean	11091	6366

2D Keypoints Table for Camera Altum_8.0_2064x1544 (Red)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	10759	4711
Min	9007	21
Max	14514	6355
Mean	11001	4492

2D Keypoints Table for Camera Altum_8.0_2064x1544 (NIR)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	11143	1597
Min	9164	11
Max	16149	4058
Mean	11490	1731

2D Keypoints Table for Camera Altum_8.0_2064x1544 (Red edge)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	11644	2935
Min	9807	18
Max	16269	5317
Mean	11968	2941

2D Keypoints Table for Camera Altum_1.8_160x120 (LWIR)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	111	1
Min	83	0
Max	165	6
Mean	113	1

Median / 75% / Maximal Number of Matches Between Camera Models

	Altum_8.0_2064... (Blue)	Altum_8.0_206... (Green)	Altum_8.0_2064x1544 (Red)	Altum_8.0_2064x1544 (NIR)	Altum_8.0_... (Red edge)	Altum_1.8_160x120 (LWIR)
Altum_8.0_2064x1544 (Blue)	281 / 726 / 3514	340 / 870 / 4399	295 / 742 / 3577	109 / 275 / 2258	189 / 471 / 2934	1 / 1 / 4
Altum_8.0_2064x1544 (Green)		415 / 1064 / 5271	374 / 944 / 4861	145 / 371 / 3029	253 / 637 / 3922	1 / 1 / 5
Altum_8.0_2064x1544 (Red)			336 / 851 / 3922	126 / 322 / 2726	221 / 553 / 3573	1 / 1 / 4
Altum_8.0_2064x1544 (NIR)				123 / 319 / 2512	146 / 376 / 3097	1 / 1 / 3
Altum_8.0_2064x1544 (Red edge)					220 / 566 / 3424	1 / 1 / 3
Altum_1.8_160x120 (LWIR)						1 / 1 / 3

? 3D Points from 2D Keypoint Matches



	Number of 3D Points Observed
In 2 Images	38233
In 3 Images	29708
In 4 Images	27521
In 5 Images	25205
In 6 Images	23188
In 7 Images	21179
In 8 Images	19186
In 9 Images	17397
In 10 Images	15736
In 11 Images	14152

In 12 Images	12823
In 13 Images	11653
In 14 Images	10810
In 15 Images	10011
In 16 Images	8923
In 17 Images	8111
In 18 Images	7374
In 19 Images	6855
In 20 Images	6469
In 21 Images	5518
In 22 Images	5106
In 23 Images	4808
In 24 Images	4473
In 25 Images	4156
In 26 Images	3748
In 27 Images	3504
In 28 Images	3193
In 29 Images	3017
In 30 Images	2859
In 31 Images	2518
In 32 Images	2405
In 33 Images	2220
In 34 Images	2083
In 35 Images	2014
In 36 Images	1751
In 37 Images	1607
In 38 Images	1520
In 39 Images	1372
In 40 Images	1328
In 41 Images	1167
In 42 Images	1079
In 43 Images	1055
In 44 Images	980
In 45 Images	890
In 46 Images	692
In 47 Images	741
In 48 Images	751
In 49 Images	651
In 50 Images	616
In 51 Images	515
In 52 Images	494
In 53 Images	436
In 54 Images	382
In 55 Images	370
In 56 Images	339
In 57 Images	301
In 58 Images	283
In 59 Images	236
In 60 Images	255
In 61 Images	213
In 62 Images	197
In 63 Images	200
In 64 Images	151
In 65 Images	161
In 66 Images	132
In 67 Images	121
In 68 Images	119
In 69 Images	105

In 70 Images	96
In 71 Images	89
In 72 Images	74
In 73 Images	64
In 74 Images	61
In 75 Images	62
In 76 Images	43
In 77 Images	39
In 78 Images	44
In 79 Images	35
In 80 Images	22
In 81 Images	27
In 82 Images	29
In 83 Images	23
In 84 Images	10
In 85 Images	9
In 86 Images	11
In 87 Images	17
In 88 Images	5
In 89 Images	12
In 90 Images	13
In 91 Images	5
In 92 Images	2
In 93 Images	2
In 94 Images	1
In 95 Images	3
In 96 Images	1
In 97 Images	1
In 98 Images	1

2D Keypoint Matches



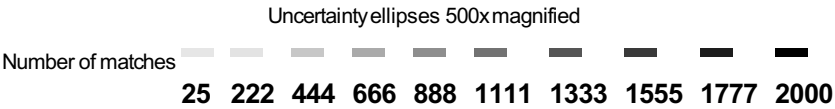
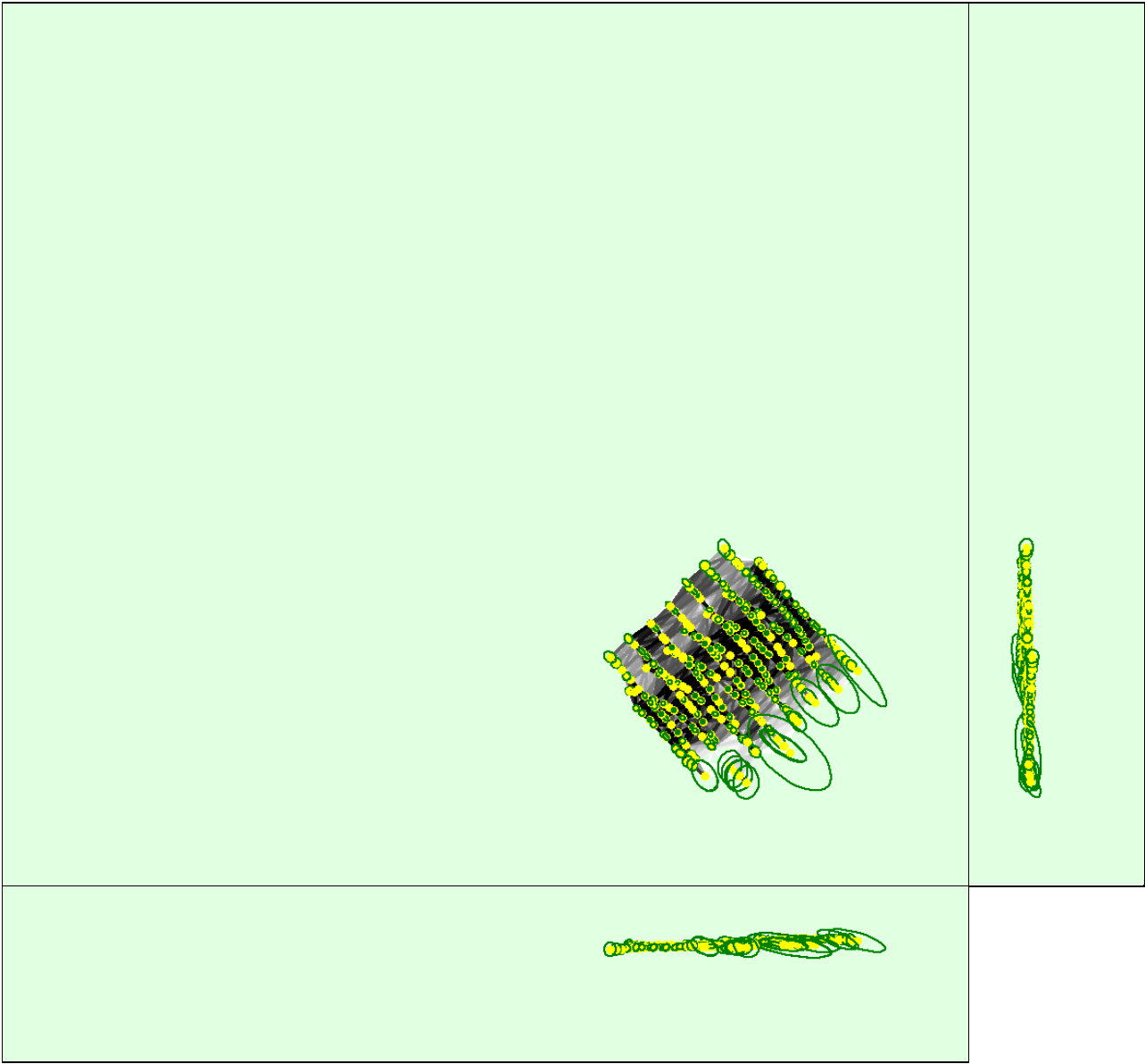


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images. Dark green ellipses indicate the relative camera position uncertainty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

Relative camera position and orientation uncertainties

	X[m]	Y[m]	Z[m]	Omega [degree]	Phi [degree]	Kappa [degree]
Mean	0.019	0.019	0.014	0.012	0.012	0.003
Sigma	0.018	0.019	0.008	0.010	0.011	0.004

Geolocation Details

Ground Control Points

0 out of 8 check points have been labeled as inaccurate.

Check Point Name	Accuracy XY/Z [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
2		0.003	0.004	0.134	0.955	62 / 62

5		0.034	0.012	0.134	0.650	93 / 93
7		0.008	-0.023	0.129	0.605	64 / 64
10		0.006	0.093	0.012	0.729	85 / 85
12		0.042	-0.007	-0.033	0.607	68 / 68
14		0.024	-0.002	0.049	0.371	74 / 74
15		-0.065	0.008	0.007	0.257	51 / 51
18		0.070	-0.025	0.026	0.574	45 / 45
Mean [m]		0.015224	0.007626	0.057138		
Sigma [m]		0.036750	0.034588	0.061827		
RMS Error [m]		0.039778	0.035419	0.084186		

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 v.s. manually marked.

? Absolute Geolocation Variance



Min Error [m]	Max Error [m]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%]
-	-0.21	0.00	0.07	0.00
-0.21	-0.16	0.00	0.39	0.00
-0.16	-0.12	0.07	0.65	0.33
-0.12	-0.08	3.33	4.97	0.78
-0.08	-0.04	17.39	19.74	3.86
-0.04	0.00	30.78	23.46	35.36
0.00	0.04	28.04	20.72	52.81
0.04	0.08	17.32	20.92	6.41
0.08	0.12	2.75	8.50	0.46
0.12	0.16	0.33	0.59	0.00
0.16	0.21	0.00	0.00	0.00
0.21	-	0.00	0.00	0.00
Mean [m]		-0.000996	0.003068	0.004492
Sigma [m]		0.046479	0.058680	0.027350
RMS Error [m]		0.046489	0.058760	0.027717

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.

? Relative Geolocation Variance



Relative Geolocation Error	Images X [%]	Images Y [%]	Images Z [%]
[-1.00, 1.00]	75.82	59.80	99.67
[-2.00, 2.00]	99.08	96.47	100.00
[-3.00, 3.00]	100.00	99.54	100.00
Mean of Geolocation Accuracy [m]	0.055335	0.055335	0.120101
Sigma of Geolocation Accuracy [m]	0.002244	0.002244	0.009362

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

Geolocation Orientational Variance	RMS [degree]
Omega	10.409
Phi	6.210
Kappa	3.109

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

Initial Processing Details



System Information



Hardware	CPU: Intel(R) Xeon(R) CPU E5-2620 0 @ 2.00GHz RAM: 64GB GPU: NVIDIA GeForce GTX 670 (Driver: 23.21.13.8813)
Operating System	Windows 10 Pro, 64-bit

Coordinate Systems



Image Coordinate System	WGS84
Output Coordinate System	Slovenia 1996 / Slovene National Grid (+45.803m)

Processing Options



Detected Template	No Template Available
Keypoints Image Scale	Full, Image Scale: 1
Advanced: Matching Image Pairs	Aerial Grid or Corridor
Advanced: Matching Strategy	Use Geometrically Verified Matching: yes
Advanced: Keypoint Extraction	Targeted Number of Keypoints: Automatic
Advanced: Calibration	Calibration Method: Alternative Internal Parameters Optimization: All External Parameters Optimization: All Lever-Arm Parameters Optimization: Optimize Rematch: Auto, no
Rig «Altum» processing	optimize relative rotation

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	no
LOD	Generated: no
Advanced: Image Groups	Blue, Green, Red, NIR, Red edge, LVMR
Advanced: Use Processing Area	yes
Advanced: Use Annotations	yes

Results



Number of Generated Tiles	2
Number of 3D Densified Points	10448130
Average Density (per m ³)	17.66

DSM, Orthomosaic and Index Details



Processing Options



DSM and Orthomosaic Resolution	1 x GSD (5.73 [cm/pixel])
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DSMFilters	Noise Filtering: yes Surface Smoothing: no
Orthomosaic	Generated: yes Merge Tiles: no GeoTIFF Without Transparency: no Google Maps Tiles and KML: no
Index Calculator: Radiometric Calibration	Generated: yes
Index Calculator: Reflectance Map	Generated: yes Resolution: 1 x GSD (5.73 [cm/pixel]) Merge Tiles: no
Index Calculator: Indices	blue, green, red, nir, red_edge, lwir, ndvi

Camera Radiometric Correction



Camera Name	Band	Radiometric Correction Type
Altum_8.0_2064x1544	Blue	Camera and Sun Irradiance
Altum_8.0_2064x1544	Green	Camera and Sun Irradiance
Altum_8.0_2064x1544	Red	Camera and Sun Irradiance
Altum_8.0_2064x1544	NIR	Camera and Sun Irradiance
Altum_8.0_2064x1544	Red edge	Camera and Sun Irradiance
Altum_1.8_160x120	LWIR	No Correction