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Additional information about the sections



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Summary



Project	PSY-01-29-20
Processed	2020-02-03 11:24:52
Camera Model Name(s)	FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB)(1), FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB)(2), FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB)(3)
Average Ground Sampling Distance (GSD)	2.06 cm / 0.81 in
Area Covered	0.226 km ² / 22.5994 ha / 0.09 sq. mi. / 55.8734 acres
Time for Initial Processing (without report)	49m:52s

Quality Check



Images	median of 36607 keypoints per image	
Dataset	318 out of 318 images calibrated (100%), all images enabled	
Camera Optimization	0% relative difference between initial and optimized internal camera parameters	
Matching	median of 17306 matches per calibrated image	
Georeferencing	yes, 4 GCPs (4 3D), mean RMS error = 0.003 US survey foot	

Preview

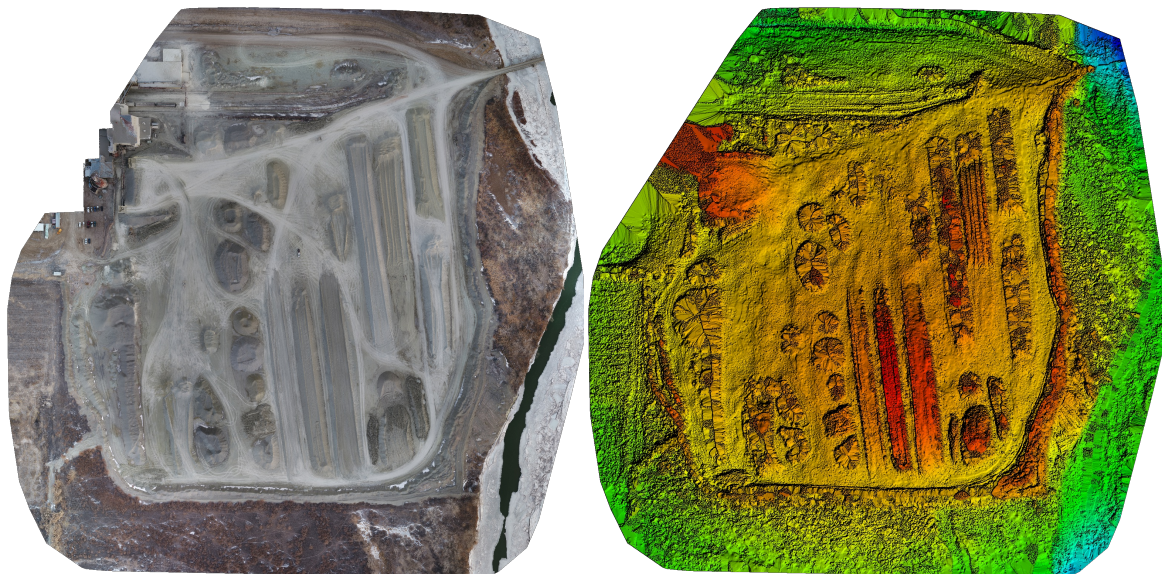


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details



Number of Calibrated Images	318 out of 318
Number of Geolocated Images	318 out of 318

Initial Image Positions

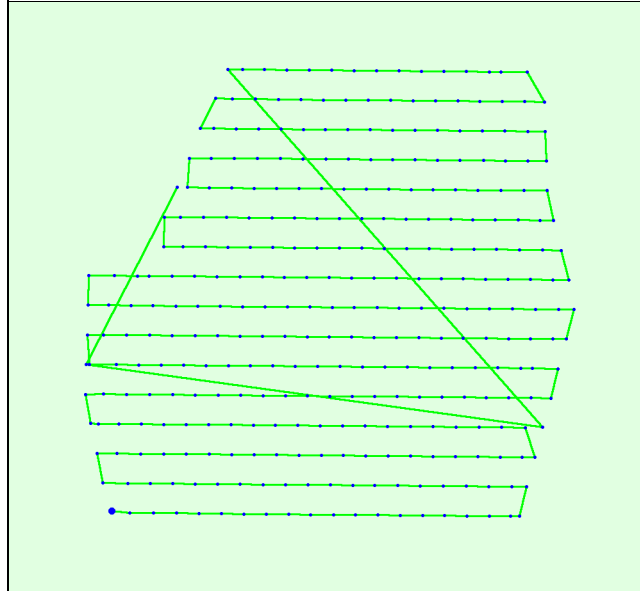
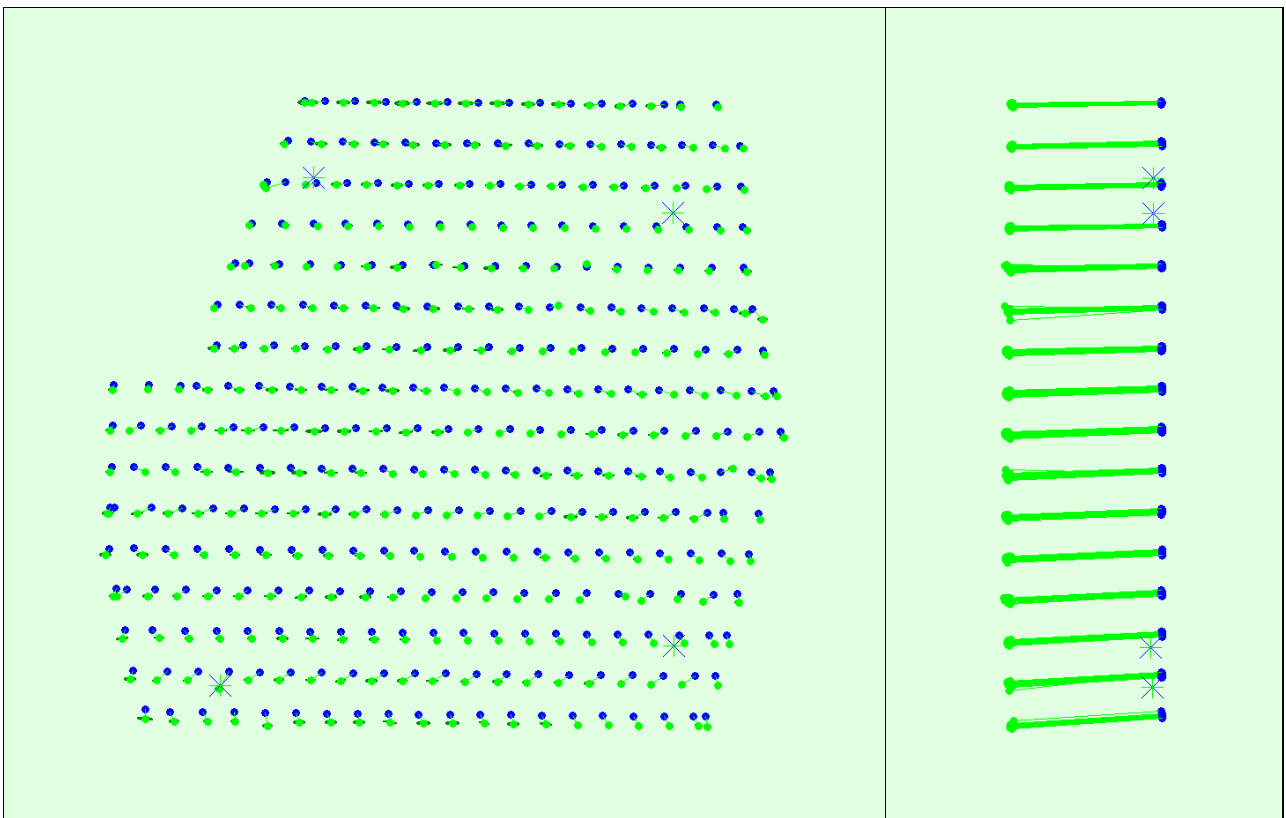
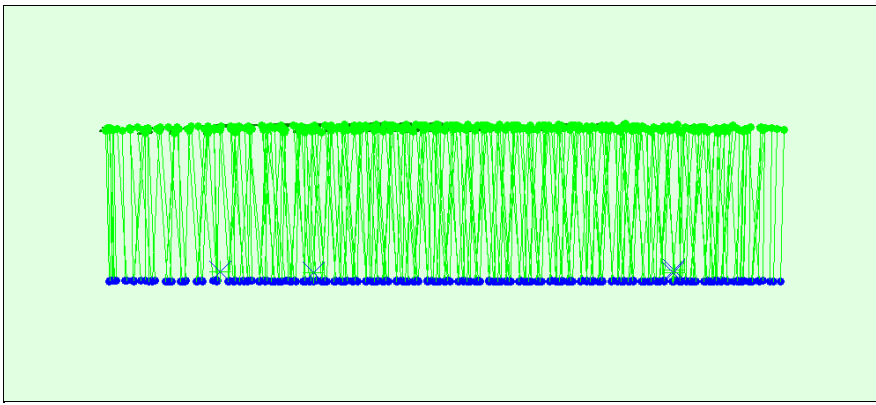


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

Computed Image/GCPs/Manual Tie Points Positions





Uncertainty ellipses 1x 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 [US survey foot]	Y [US survey foot]	Z [US survey foot]	Omega [degree]	Phi [degree]	Kappa [degree]	Camera Displacement X [US survey foot]	Camera Displacement Y [US survey foot]	Camera Displacement Z [US survey foot]
Mean	8.523	1.252	1.409	0.227	1.582	0.204	0.565	0.555	3.692
Sigma	2.879	0.437	0.362	0.065	0.537	0.081	0.199	0.192	1.265

? Overlap

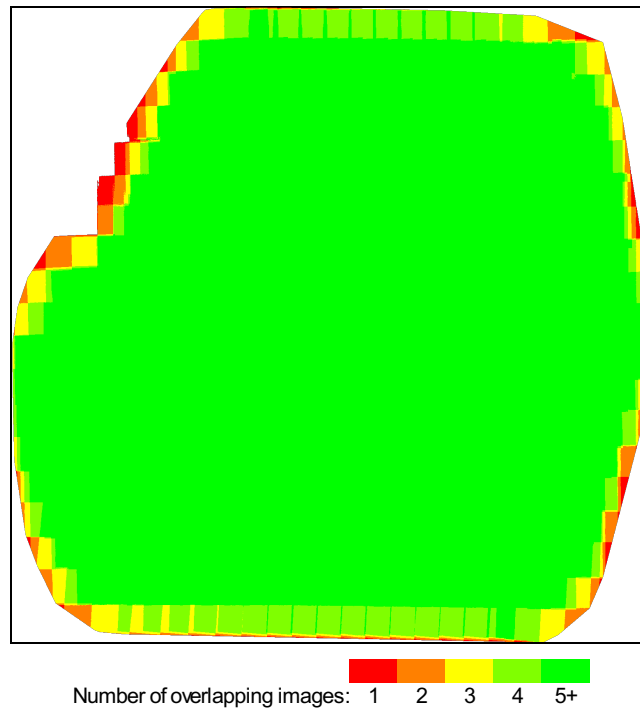


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint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

Bundle Block Adjustment Details



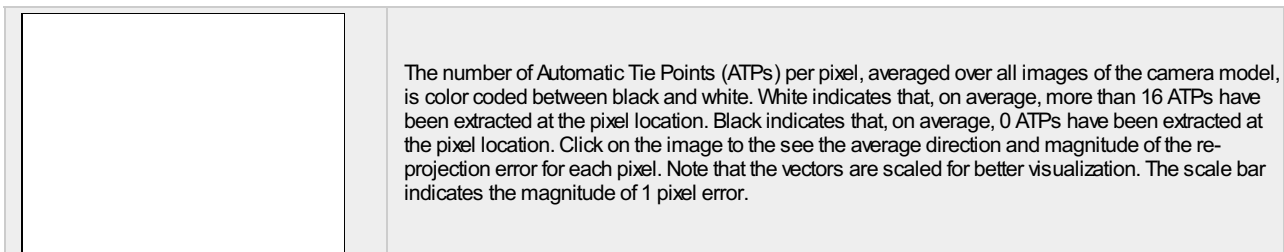
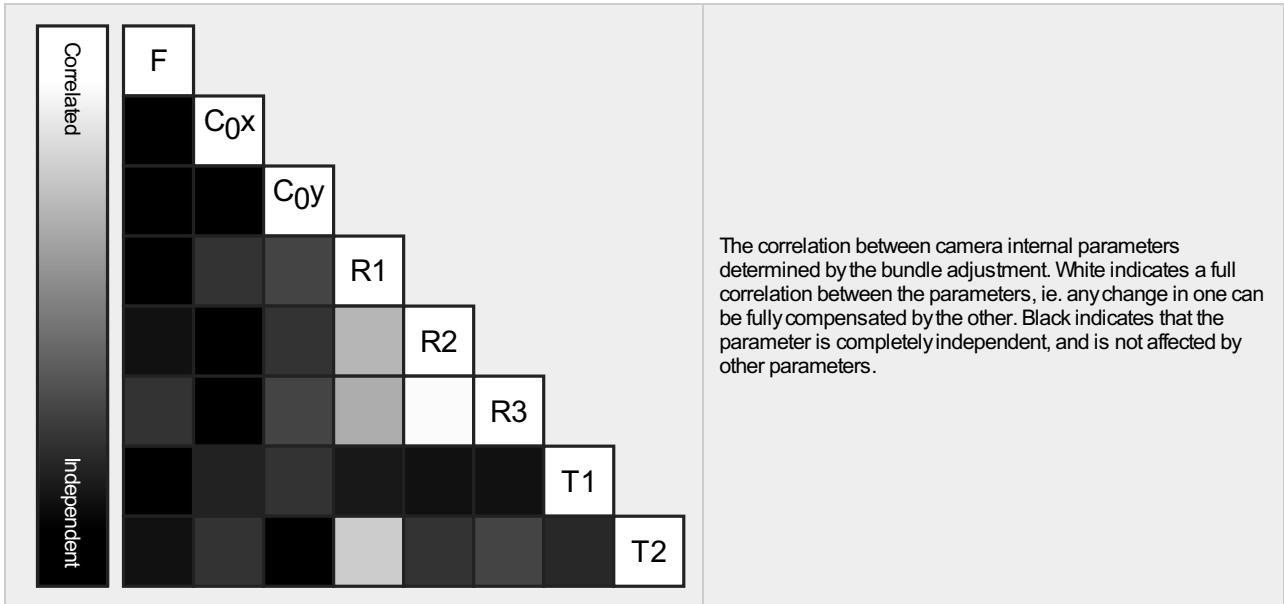
Number of 2D Keypoint Observations for Bundle Block Adjustment	5594424
Number of 3D Points for Bundle Block Adjustment	1348637
Mean Reprojection Error [pixels]	0.251

Internal Camera Parameters

FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB)(1). Sensor Dimensions: 17.500 [mm] x 13.112 [mm]

EXIF ID: FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	4564.399 [pixel] 15.128 [mm]	2698.159 [pixel] 8.943 [mm]	1910.765 [pixel] 6.333 [mm]	-0.004	-0.043	0.087	-0.003	0.004
Optimized Values	4564.310 [pixel] 15.128 [mm]	2695.748 [pixel] 8.935 [mm]	1907.317 [pixel] 6.322 [mm]	0.002	-0.006	0.016	-0.003	-0.003
Uncertainties (Sigma)	4.825 [pixel] 0.016 [mm]	4.773 [pixel] 0.016 [mm]	4.818 [pixel] 0.016 [mm]	0.002	0.006	0.008	0.001	0.001

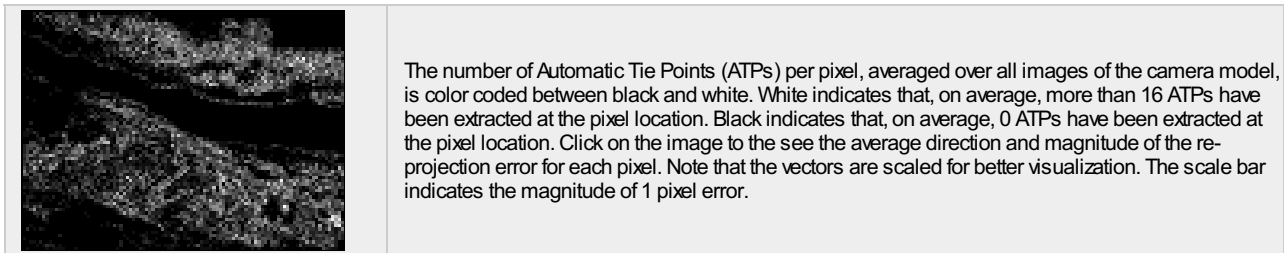
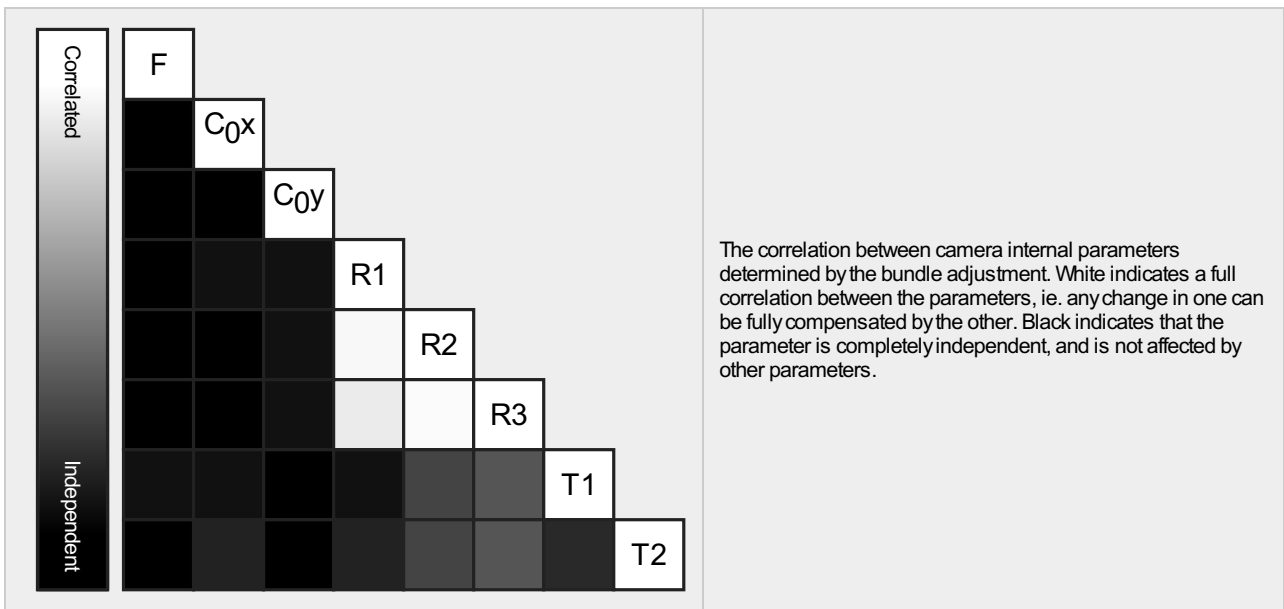


Internal Camera Parameters

FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB)(2). Sensor Dimensions: 17.500 [mm] x 13.112 [mm]

EXIF ID: FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	4564.399 [pixel] 15.128 [mm]	2698.159 [pixel] 8.943 [mm]	1910.765 [pixel] 6.333 [mm]	-0.004	-0.043	0.087	-0.003	0.004
Optimized Values	4564.331 [pixel] 15.128 [mm]	2698.169 [pixel] 8.943 [mm]	1910.792 [pixel] 6.333 [mm]	-0.001	0.010	-0.009	-0.002	-0.002
Uncertainties (Sigma)	4.832 [pixel] 0.016 [mm]	4.823 [pixel] 0.016 [mm]	4.833 [pixel] 0.016 [mm]	0.028	0.126	0.170	0.002	0.002

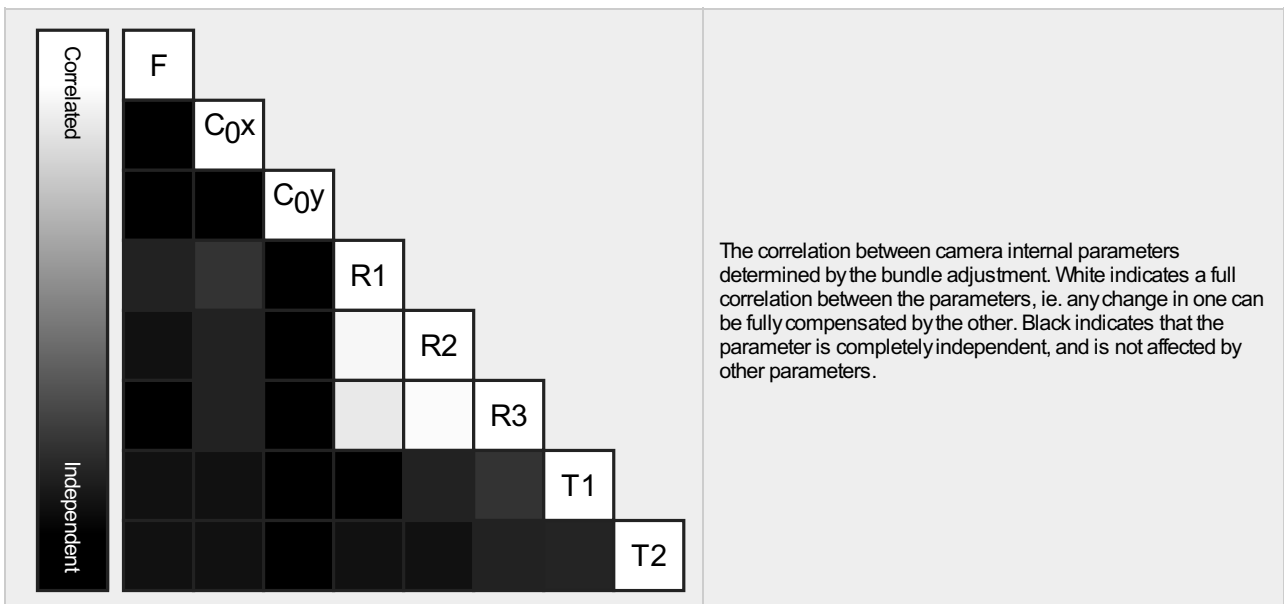


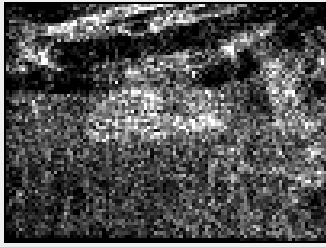
Internal Camera Parameters

FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB)(3). Sensor Dimensions: 17.500 [mm] x 13.112 [mm]

EXIF ID: FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	4564.399 [pixel] 15.128 [mm]	2698.159 [pixel] 8.943 [mm]	1910.765 [pixel] 6.333 [mm]	-0.004	-0.043	0.087	-0.003	0.004
Optimized Values	4564.486 [pixel] 15.128 [mm]	2698.053 [pixel] 8.942 [mm]	1910.695 [pixel] 6.333 [mm]	0.008	-0.031	0.048	-0.003	-0.003
Uncertainties (Sigma)	4.828 [pixel] 0.016 [mm]	4.808 [pixel] 0.016 [mm]	4.833 [pixel] 0.016 [mm]	0.017	0.078	0.106	0.001	0.002





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.

2D Keypoints Table



	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	36607	17306
Min	20397	1108
Max	87423	39490
Mean	40393	17593

2D Keypoints Table for Camera FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB)(1)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	36548	17265
Min	20397	1108
Max	87423	39490
Mean	40348	17545

2D Keypoints Table for Camera FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB)(2)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	43086	0
Min	43086	21456
Max	43086	21456
Mean	43086	21456

2D Keypoints Table for Camera FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB)(3)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	56768	0
Min	35413	13380
Max	56768	33038
Mean	46091	23209

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

	FC6520_DJIMF...(RGB) (1)	FC6520_DJIMF...(RGB) (2)	FC6520_DJIMF...(RGB) (3)
FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB) (1)	874 / 2631 / 30806	1284 / 3384 / 12009	890 / 3261 / 23592
FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB) (2)			
FC6520_DJIMFT15mmF1.7ASPH_15.0_5280x3956 (RGB) (3)			

3D Points from 2D Keypoint Matches



	Number of 3D Points Observed
In 2 Images	590785
In 3 Images	230849
In 4 Images	139503
In 5 Images	89630
In 6 Images	66104

In 7 Images	51195
In 8 Images	40957
In 9 Images	30728
In 10 Images	24935
In 11 Images	20488
In 12 Images	17620
In 13 Images	13446
In 14 Images	10897
In 15 Images	9186
In 16 Images	7987
In 17 Images	3034
In 18 Images	649
In 19 Images	374
In 20 Images	194
In 21 Images	67
In 22 Images	8
In 23 Images	1

2D Keypoint Matches

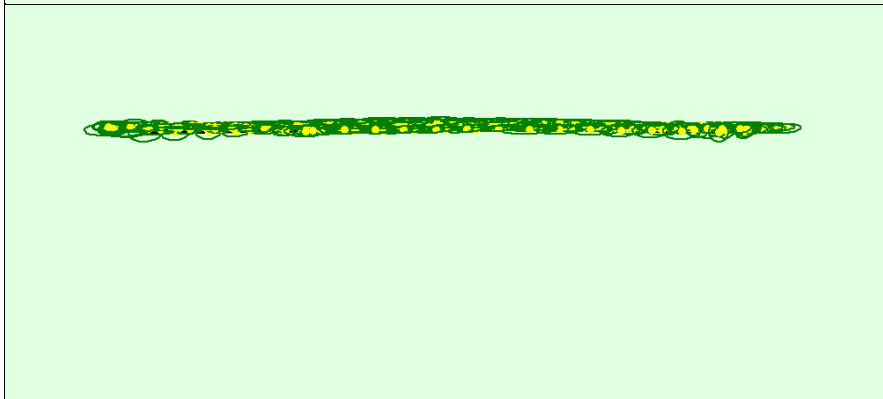
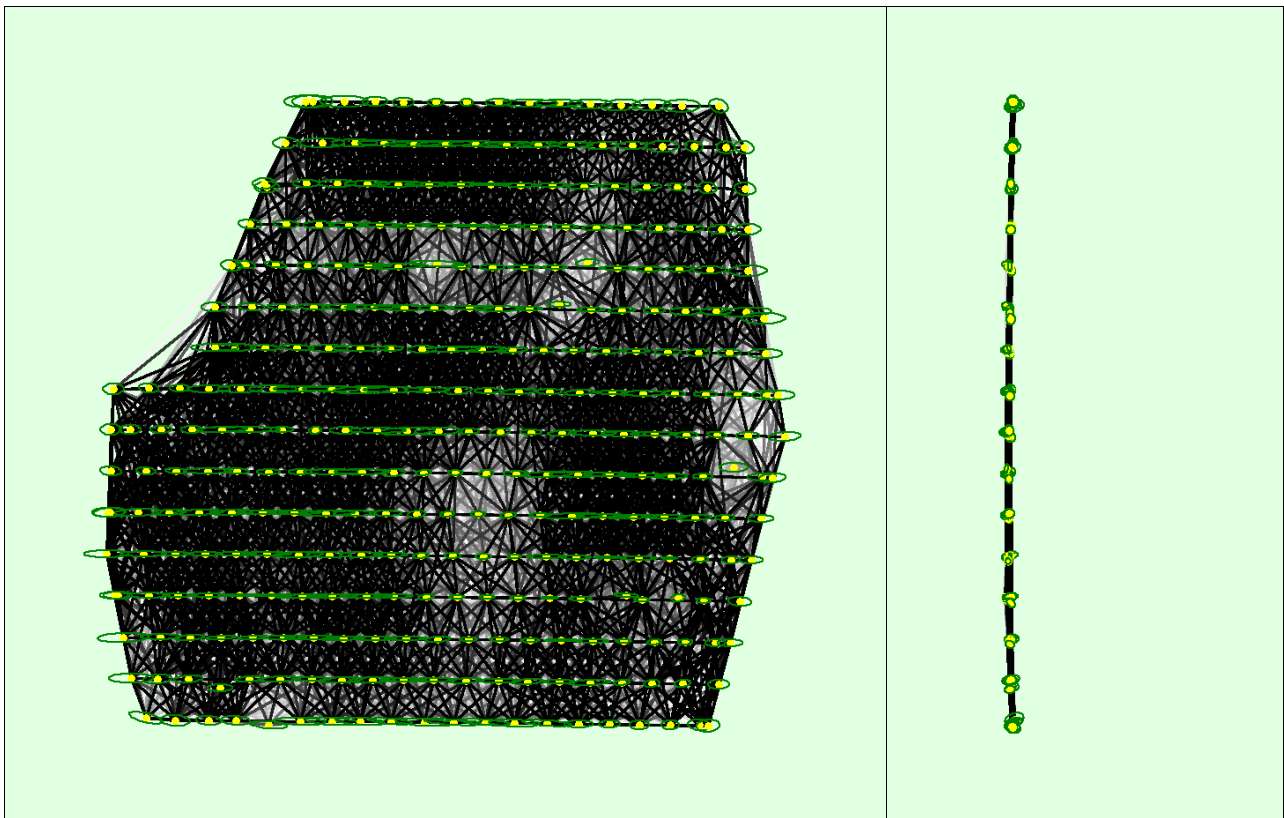


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the

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[US survey foot]	Y[US survey foot]	Z[US survey foot]	Omega [degree]	Phi [degree]	Kappa [degree]	Camera Displacement X[US survey foot]	Camera Displacement Y[US survey foot]	Camera Displacement Z[US survey foot]
Mean	7.121	1.294	1.461	0.457	1.558	0.288	0.741	0.714	3.528
Sigma	2.766	0.468	0.762	0.132	0.450	0.066	0.154	0.153	1.102

Geolocation Details

Ground Control Points

GCP Name	Accuracy XYZ [US survey foot]	Error X[US survey foot]	Error Y[US survey foot]	Error Z[US survey foot]	Projection Error [pixel]	Verified/Marked
GCP5 (3D)	0.020/ 0.020	0.000	0.001	-0.004	0.255	14 / 15
GCP4 (3D)	0.020/ 0.020	-0.001	0.001	0.008	0.420	9 / 11
GCP3 (3D)	0.020/ 0.020	0.000	0.000	0.000	-1.000	1 / 10
GCP2 (3D)	0.020/ 0.020	-0.001	0.000	-0.008	0.423	12 / 12
GCP1 (3D)	0.020/ 0.020	0.001	-0.001	0.013	0.467	12 / 12
Mean [US survey foot]		-0.000144	0.000167	0.002256		
Sigma [US survey foot]		0.000836	0.000758	0.008610		
RMS Error [US survey foot]		0.000849	0.000776	0.008900		

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 [US survey foot]	Max Error [US survey foot]	Geolocation Error X[%]	Geolocation Error Y[%]	Geolocation Error Z[%]
-	-49.21	0.00	0.00	0.00
-49.21	-39.37	0.00	0.00	0.00
-39.37	-29.53	1.89	0.00	0.00
-29.53	-19.69	19.18	0.00	0.00
-19.69	-9.84	15.09	1.26	0.00
-9.84	0.00	16.04	54.72	52.83
0.00	9.84	10.38	41.19	45.28
9.84	19.69	12.58	2.52	1.89
19.69	29.53	23.58	0.31	0.00
29.53	39.37	0.94	0.00	0.00
39.37	49.21	0.31	0.00	0.00
49.21	-	0.00	0.00	0.00
Mean [US survey foot]		1.481466	10.575043	-326.565728
Sigma [US survey foot]		18.722959	5.456991	4.383513
RMS Error [US survey foot]		18.781478	11.900012	326.595147

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 [US survey foot]	1.481466	10.575043	-326.565728

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

Relative Geolocation Variance



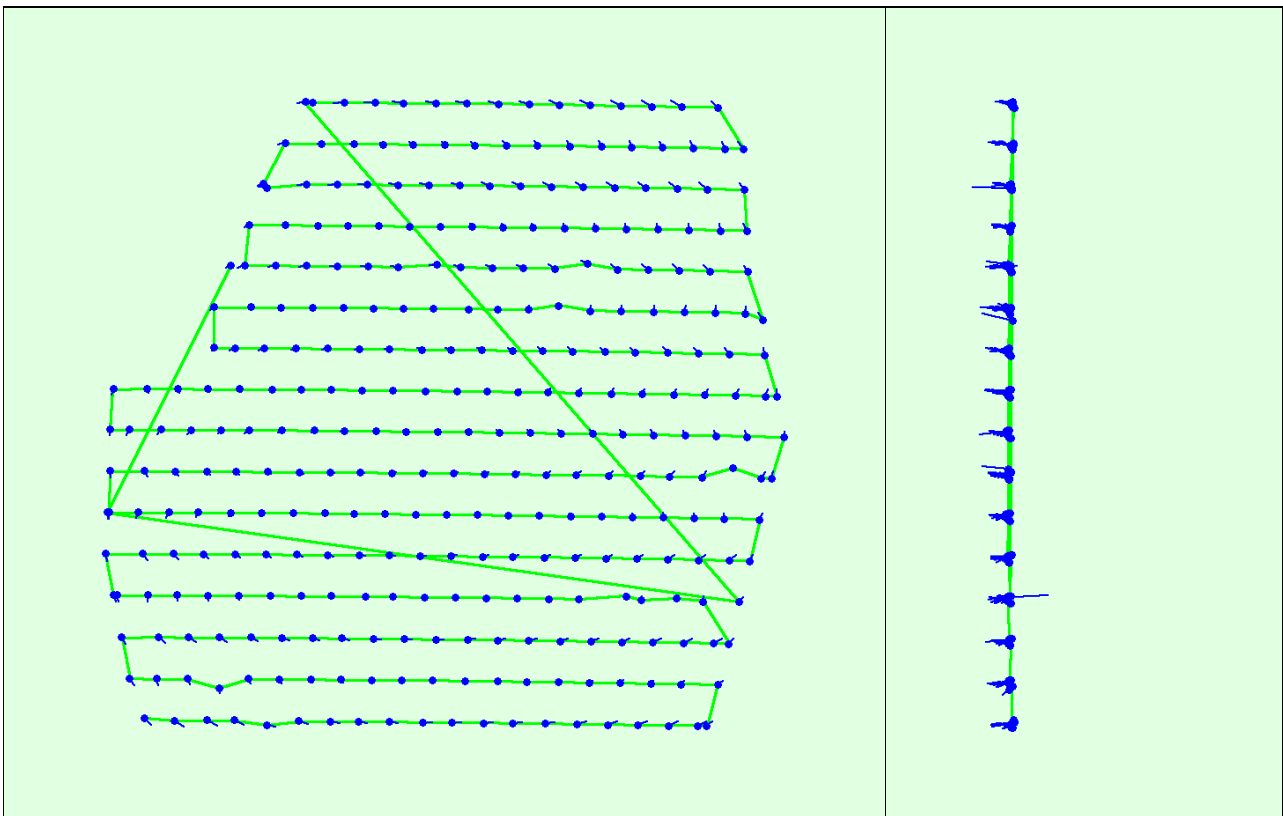
Relative Geolocation Error	Images X[%]	Images Y[%]	Images Z[%]
[-1.00, 1.00]	44.34	99.06	100.00
[-2.00, 2.00]	99.06	100.00	100.00
[-3.00, 3.00]	100.00	100.00	100.00
Mean of Geolocation Accuracy [US survey foot]	16.404167	16.404167	32.808333
Sigma of Geolocation Accuracy [US survey foot]	0.000002	0.000002	0.000003

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

Geolocation Orientational Variance	RMS [degree]
Omega	1.027
Phi	3.815
Kappa	1.157

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

Rolling Shutter Statistics



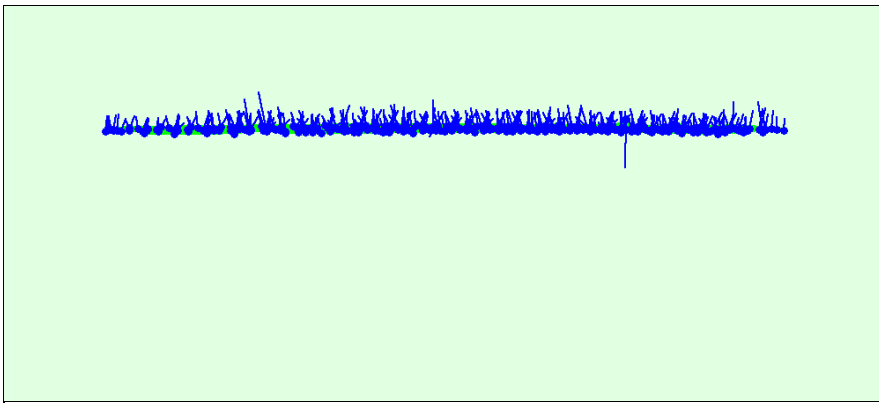


Figure 6: Camera movement estimated by the rolling shutter camera model. The green line follows the computed image positions. The blue dots represent the camera position at the start of the exposure. The blue lines represent the camera motion during the rolling shutter readout, re-scaled by a project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

Median Camera Speed	32.8105 [US survey foot/s]
Median Camera Displacement During Sensor Readout)	5.7149 [US survey foot]
Median Rolling Shutter Readout Time	178.0457 [ms]

Initial Processing Details

System Information

Hardware	CPU: Intel(R) Xeon(R) CPU E5-2643 0 @ 3.30GHz RAM: 12GB GPU: NVDIA Quadro K4000 (Driver: 23.21.13.8816)
Operating System	Windows 10 Enterprise, 64-bit

Coordinate Systems

Image Coordinate System	WGS 84
Ground Control Point (GCP) Coordinate System	NAD83(2011) / Wyoming East Central (ftUS)
Output Coordinate System	NAD83(2011) / Wyoming East Central (ftUS)

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 prior External Parameters Optimization: All Rematch: Auto, yes

Point Cloud Densification details

Processing Options

Image Scale	multiscale, 1/2 (Half image size, Default)
Point Density	Low (Fast)
Minimum Number of Matches	3
3D Textured Mesh Generation	no
LOD	Generated: no

Advanced: Image Groups	group1
Advanced: Use Processing Area	yes
Advanced: Use Annotations	yes
Time for Point Cloud Densification	01h:28m:13s
Time for Point Cloud Classification	NA
Time for 3D Textured Mesh Generation	NA

Results



Number of Processed Clusters	2
Number of Generated Tiles	1
Number of 3D Densified Points	10511637
Average Density (per US survey foot ³)	3.17

DSM, Orthomosaic and Index Details



Processing Options



DSM and Orthomosaic Resolution	4 x GSD (2.06 [cm/pixel])
DSM Filters	Noise Filtering: yes Surface Smoothing: yes, Type: Sharp
Raster DSM	Generated: yes Method: Triangulation Merge Tiles: yes
Orthomosaic	Generated: yes Merge Tiles: yes GeoTIFF Without Transparency: no Google Maps Tiles and KML: no
Time for DSM Generation	03m:46s
Time for Orthomosaic Generation	29m:42s
Time for DTM Generation	00s
Time for Contour Lines Generation	00s
Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s