

# Quality Report



Generated with Pix4Dmapper version 4.3.33



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## Summary



Project	Nedvedice_komplet
Processed	2019-05-08 09:19:58
Camera Model Name(s)	FC6310R_8.8_5472x3648 (b7718d4df0f24cd44b6dd7690a9ed701) (RGB)(1), FC6310R_8.8_5472x3648 (b7718d4df0f24cd44b6dd7690a9ed701) (RGB)(2)
Average Ground Sampling Distance (GSD)	3.36 cm / 1.32 in
Area Covered	0.323 km <sup>2</sup> / 32.2632 ha / 0.12 sq. mi. / 79.7654 acres

## Quality Check



Images	median of 55947 keypoints per image	
Dataset	356 out of 357 images calibrated (99%), all images enabled	
Camera Optimization	0.09% relative difference between initial and optimized internal camera parameters	
Matching	median of 9519.9 matches per calibrated image	
Georeferencing	yes, 6 GCPs (6 3D), mean RMS error = 0.014 m	

## Preview

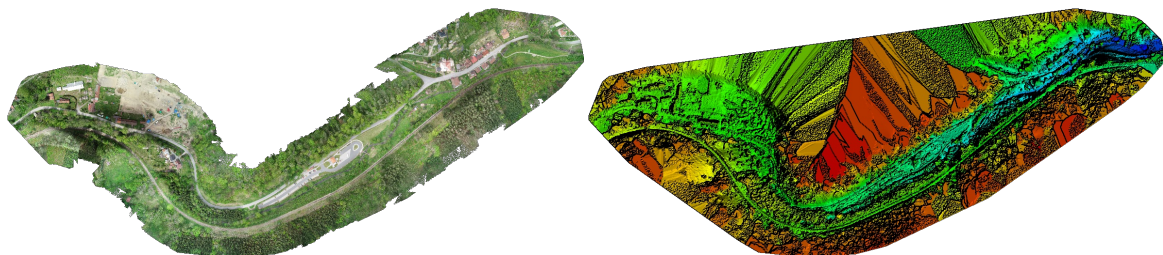


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

## Calibration Details



Number of Calibrated Images	356 out of 357
Number of Geolocated Images	357 out of 357

## Initial Image Positions



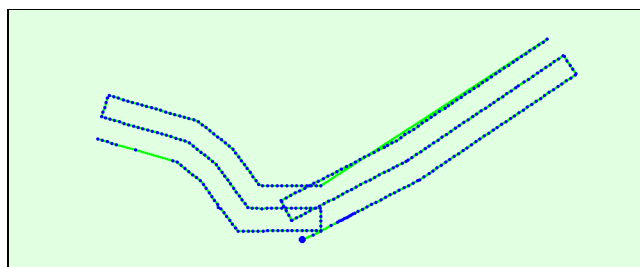
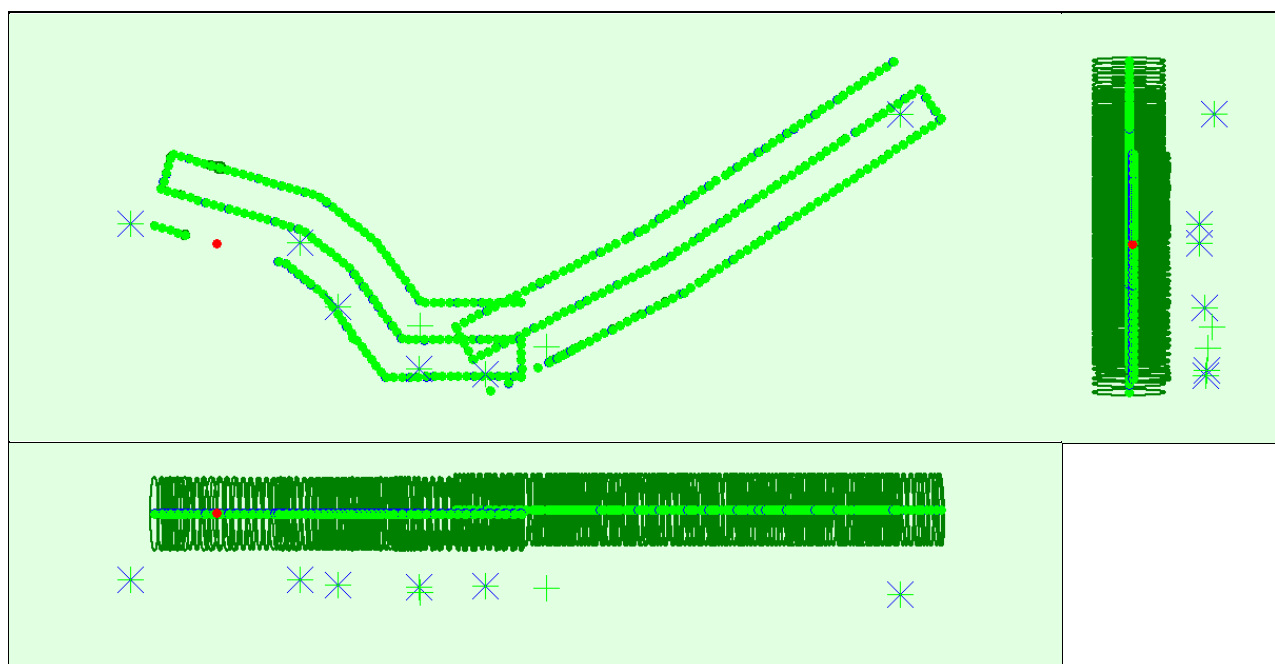


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

### Computed Image/GCPs/Manual Tie Points Positions



Uncertainty ellipses 1000x 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]	Camera Displacement X [m]	Camera Displacement Y [m]	Camera Displacement Z [m]
Mean	0.005	0.005	0.050	0.003	0.004	0.003	0.004	0.004	0.007
Sigma	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.003

### Overlap

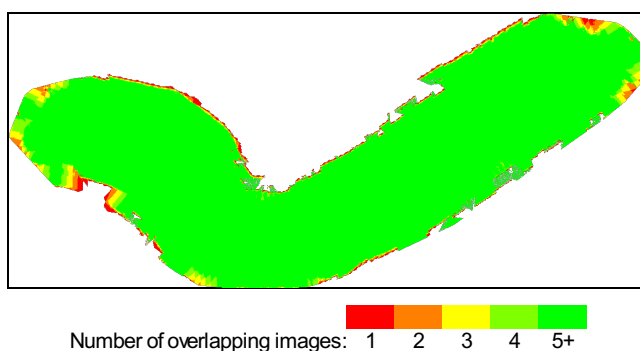


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good

# Bundle Block Adjustment Details



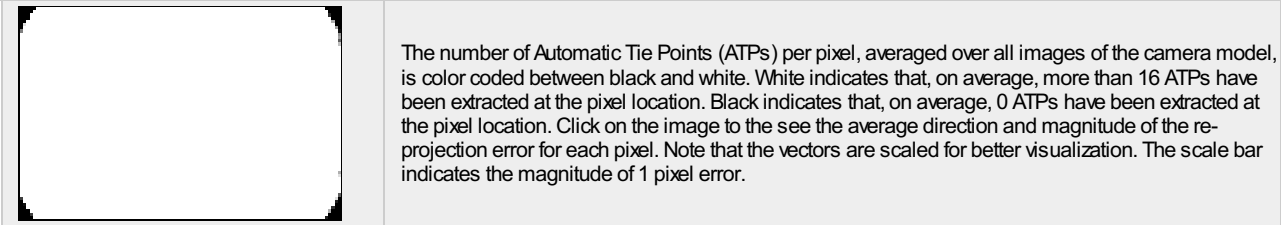
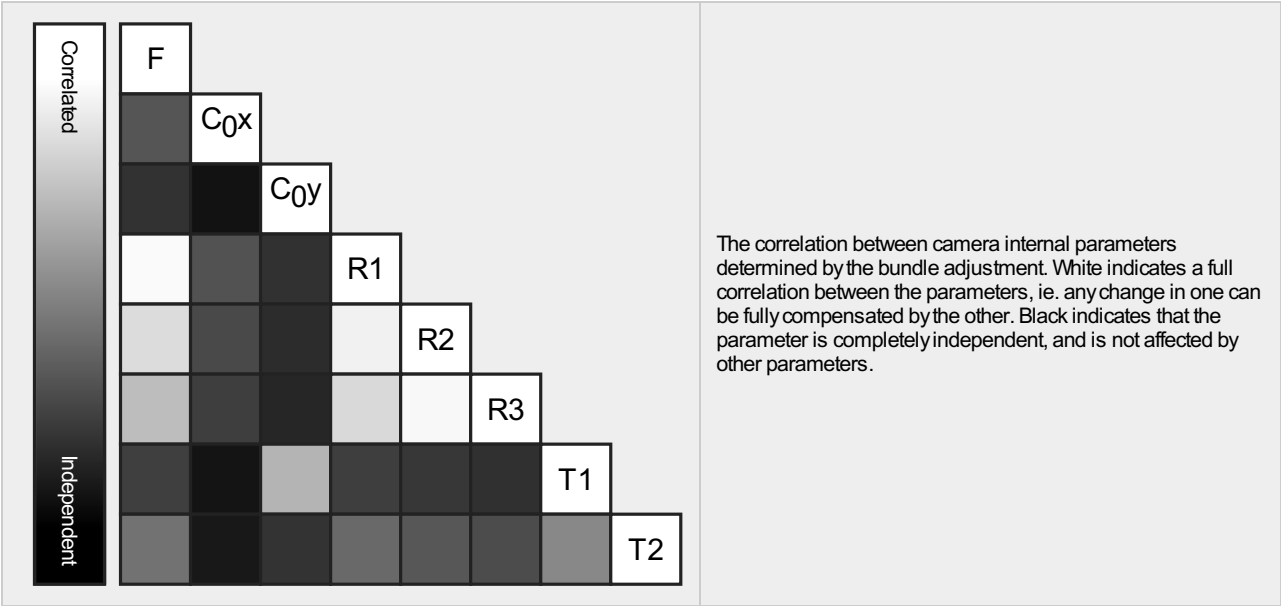
Number of 2D Keypoint Observations for Bundle Block Adjustment	3876090
Number of 3D Points for Bundle Block Adjustment	1230638
Mean Reprojection Error [pixels]	0.139

## Internal Camera Parameters

**FC6310R\_8.8\_5472x3648 (b7718d4df0f24cd44b6dd7690a9ed701) (RGB)(1). Sensor Dimensions: 12.833 [mm] x 8.556 [mm]**

EXIF ID: FC6310R\_8.8\_5472x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3646.580 [pixel] 8.552 [mm]	2727.980 [pixel] 6.398 [mm]	1831.810 [pixel] 4.296 [mm]	0.001	-0.013	0.013	0.000	-0.000
Optimized Values	3642.348 [pixel] 8.542 [mm]	2728.545 [pixel] 6.399 [mm]	1833.939 [pixel] 4.301 [mm]	-0.264	0.103	-0.027	0.000	0.000
Uncertainties (Sigma)	1.723 [pixel] 0.004 [mm]	0.083 [pixel] 0.000 [mm]	0.176 [pixel] 0.000 [mm]	0.000	0.000	0.000	0.000	0.000



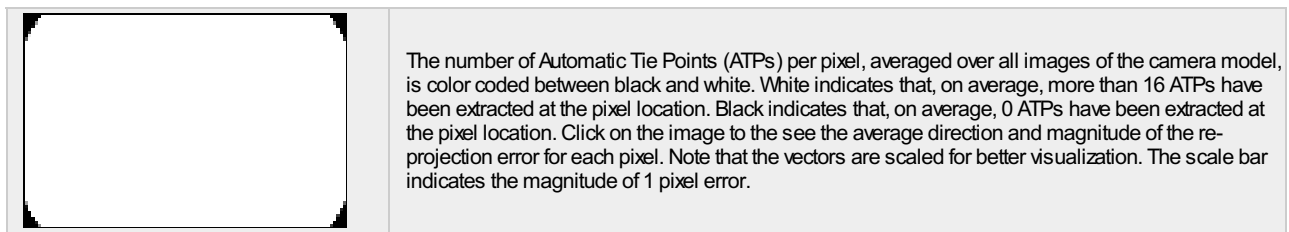
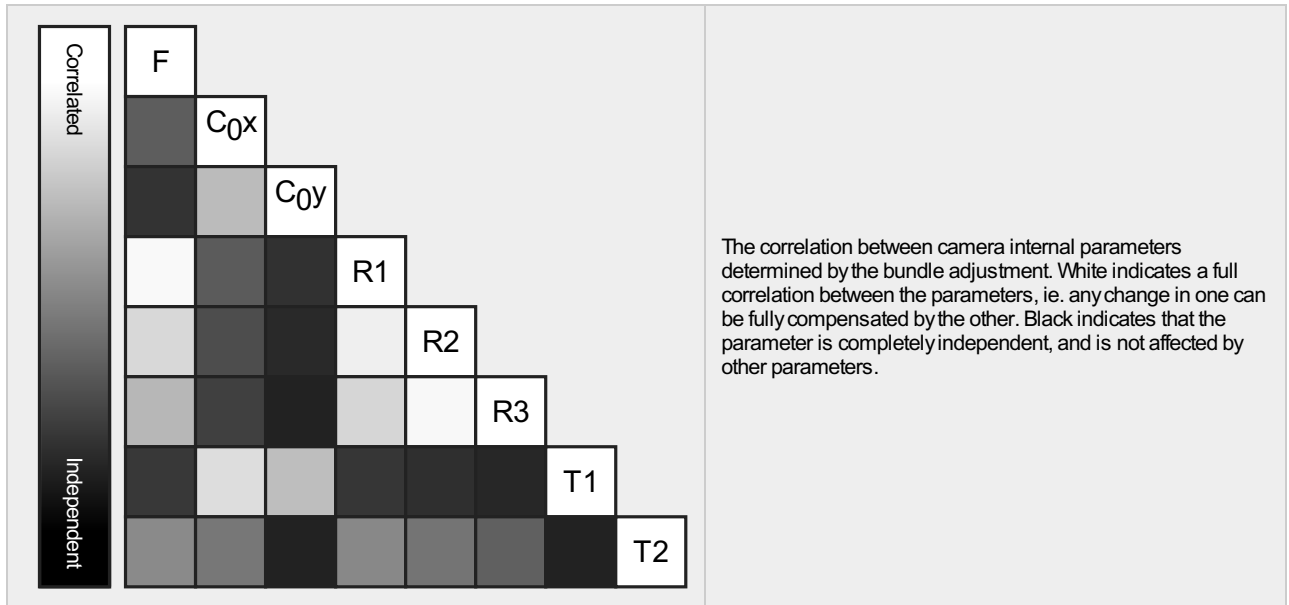
## Internal Camera Parameters

**FC6310R\_8.8\_5472x3648 (b7718d4df0f24cd44b6dd7690a9ed701) (RGB)(2). Sensor Dimensions: 12.833 [mm] x 8.556 [mm]**

EXIF ID: FC6310R\_8.8\_5472x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3646.580 [pixel] 8.552 [mm]	2727.980 [pixel] 6.398 [mm]	1831.810 [pixel] 4.296 [mm]	0.001	-0.013	0.013	0.000	-0.000

Optimized Values	3643.611 [pixel] 8.545 [mm]	2728.341 [pixel] 6.399 [mm]	1833.293 [pixel] 4.300 [mm]	-0.263	0.102	-0.026	0.000	0.000
Uncertainties (Sigma)	1.849 [pixel] 0.004 [mm]	0.092 [pixel] 0.000 [mm]	0.179 [pixel] 0.000 [mm]	0.000	0.000	0.000	0.000	0.000



## ? 2D Keypoints Table



	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	55947	9520
Mn	31537	870
Max	69534	27870
Mean	56231	10888

### 2D Keypoints Table for Camera FC6310R\_8.8\_5472x3648 (b7718d4df0f24cd44b6dd7690a9ed701) (RGB)(1)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	55199	8793
Mn	39435	870
Max	69044	23578
Mean	55623	9981

### 2D Keypoints Table for Camera FC6310R\_8.8\_5472x3648 (b7718d4df0f24cd44b6dd7690a9ed701) (RGB)(2)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	58156	11665
Mn	31537	2003
Max	69534	27870
Mean	57011	12050

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

	FC6310R_8.8_5472x3648 (b7718d4df0f24cd44b6dd7690a9ed701) (RGB) (1)...(b7718d4df0f24cd44b6dd7690a9ed701) (RGB)(1)	FC6310R_8.8_5472x3648 (b7718d4df0f24cd44b6dd7690a9ed701) (RGB) (2)...(b7718d4df0f24cd44b6dd7690a9ed701) (RGB)(2)
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FC6310R_8.8_5472x3648 (b7718d4df0f24cd44b6dd7690a9ed701) (RGB)(1)	264 / 726 / 13280	
FC6310R_8.8_5472x3648 (b7718d4df0f24cd44b6dd7690a9ed701) (RGB)(2)		143 / 760 / 16369

### ? 3D Points from 2D Keypoint Matches



	Number of 3D Points Observed
In 2 Images	777382
In 3 Images	190170
In 4 Images	87038
In 5 Images	51307
In 6 Images	32839
In 7 Images	23601
In 8 Images	17147
In 9 Images	13153
In 10 Images	9350
In 11 Images	6195
In 12 Images	4140
In 13 Images	3231
In 14 Images	2638
In 15 Images	2269
In 16 Images	1891
In 17 Images	1688
In 18 Images	1301
In 19 Images	1108
In 20 Images	867
In 21 Images	702
In 22 Images	542
In 23 Images	385
In 24 Images	301
In 25 Images	228
In 26 Images	190
In 27 Images	164
In 28 Images	138
In 29 Images	118
In 30 Images	122
In 31 Images	95
In 32 Images	82
In 33 Images	70
In 34 Images	55
In 35 Images	57
In 36 Images	27
In 37 Images	22
In 38 Images	10
In 39 Images	4
In 40 Images	3
In 41 Images	5
In 42 Images	2
In 44 Images	1

### ? 2D Keypoint Matches



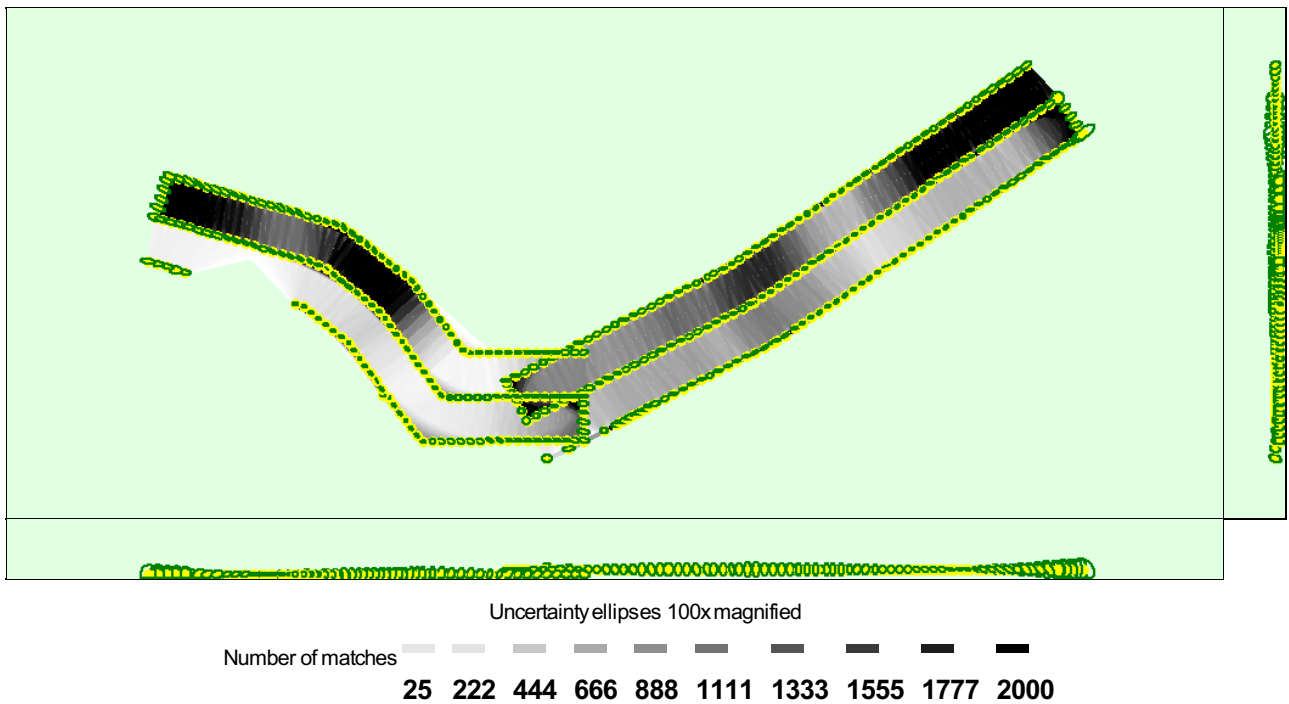


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images. Dark green ellipses indicate the relative camera position uncertainty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

## Relative camera position and orientation uncertainties

	X[m]	Y[m]	Z[m]	Omega [degree]	Phi [degree]	Kappa [degree]	Camera Displacement X[m]	Camera Displacement Y[m]	Camera Displacement Z[m]
Mean	0.046	0.028	0.047	0.038	0.030	0.007	0.008	0.007	0.014
Sigma	0.015	0.009	0.023	0.011	0.009	0.002	0.002	0.003	0.005

## Manual Tie Points

MTP Name	Projection Error [pixel]	Verified/Marked
4015	0.361	5 / 5
5013	0.419	12 / 12

Projection errors for manual tie points. The last column counts the number of images where the manual tie point has been automatically verified vs. manually marked.

# 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
655 (3D)	0.040/ 0.050	-0.008	-0.010	-0.019	0.246	9 / 9
657 (3D)	0.040/ 0.050	0.011	-0.009	-0.037	0.393	9 / 9
941 (3D)	0.040/ 0.050	0.002	-0.004	0.002	0.204	4 / 4
943 (3D)	0.040/ 0.050	-0.003	0.001	0.027	0.146	6 / 6
945 (3D)	0.040/ 0.050	0.016	0.017	0.019	0.255	10 / 10
946 (3D)	0.040/ 0.050	-0.017	-0.001	0.016	0.533	6 / 6
Mean [m]		0.000310	-0.000888	0.001406		
Sigma [m]		0.011143	0.009043	0.022653		
RMS Error [m]		0.011147	0.009086	0.022697		

0 out of 7 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
658		-0.0072	-0.0149	0.0437	0.3808	5 / 5
944		-0.0339	-0.0223	-0.1208	0.2352	6 / 6
4005		-0.0452	-0.0224	-0.2512	0.3542	4 / 4
4006		-0.0223	-0.0171	-0.0577	0.2385	6 / 6
4007		-0.0313	-0.0231	-0.0315	0.3013	11 / 11
4008		-0.0981	-0.0245	-0.0030	0.3491	3 / 3
4009		-0.0516	-0.0303	-0.0446	0.0722	5 / 5
Mean [m]		-0.041381	-0.022094	-0.066443		
Sigma [m]		0.026801	0.004665	0.088652		
RMS Error [m]		0.049301	0.022581	0.110787		

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



Mn Error [m]	Max Error [m]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%]
-	-0.11	0.00	0.00	0.00
-0.11	-0.09	0.00	0.00	0.00
-0.09	-0.07	0.00	0.00	0.00
-0.07	-0.04	0.00	0.00	0.00
-0.04	-0.02	0.00	0.00	1.12
-0.02	-0.00	52.81	48.31	49.72
-0.00	0.02	47.19	51.69	48.03
0.02	0.04	0.00	0.00	1.12
0.04	0.07	0.00	0.00	0.00
0.07	0.09	0.00	0.00	0.00
0.09	0.11	0.00	0.00	0.00
0.11	-	0.00	0.00	0.00
Mean [m]		-0.221840	-0.039715	0.945658
Sigma [m]		0.002414	0.002709	0.008485
RMS Error [m]		0.221853	0.039807	0.945696

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]	-0.221847	-0.039703	0.945354

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	99.72	99.16
[-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]	0.011279	0.011279	0.023957
Sigma of Geolocation Accuracy [m]	0.001608	0.001608	0.004520

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

Geolocation Orientational Variance	RMS [degree]
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Omega	0.752
Phi	0.953
Kappa	3.466

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

### ? Rolling Shutter Statistics

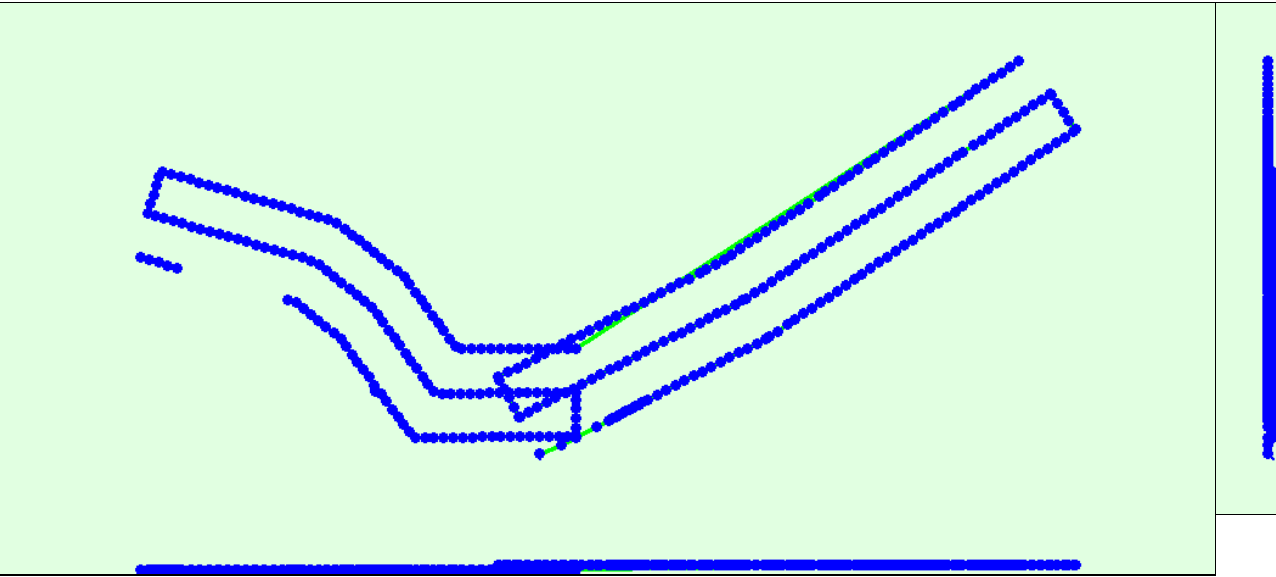


Figure 6: Camera movement estimated by the rolling shutter camera model. The green line follows the computed image positions. The blue dots represent the camera position at the start of the exposure. The blue lines represent the camera motion during the rolling shutter readout, re-scaled by a project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

Median Camera Speed	3.9428 [m/s]
Median Camera Displacement During Sensor Readout)	0.0567 [m]
Median Rolling Shutter Readout Time	14.6455 [ms]

## Initial Processing Details

### System Information

Hardware	CPU: Intel(R) Core(TM) i7-6700 CPU @3.40GHz RAM: 64GB GPU: NMDIA GeForce GTX 1080 (Driver: 23.21.13.8813)
Operating System	Windows 10 Pro, 64-bit

### Coordinate Systems

Image Coordinate System	WGS 84 (EGM96 Geoid)
Ground Control Point (GCP) Coordinate System	S-JTSK / Krovak East North (+45.35m)
Output Coordinate System	S-JTSK / Krovak East North (+45.35m)

### 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: 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
Mnimum 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	04h:26m:29s
Time for Point Cloud Classification	NA
Time for 3D Textured Mesh Generation	NA

## Results



Number of Generated Tiles	3
Number of 3D Densified Points	42454826
Average Density (per m <sup>3</sup> )	62.14