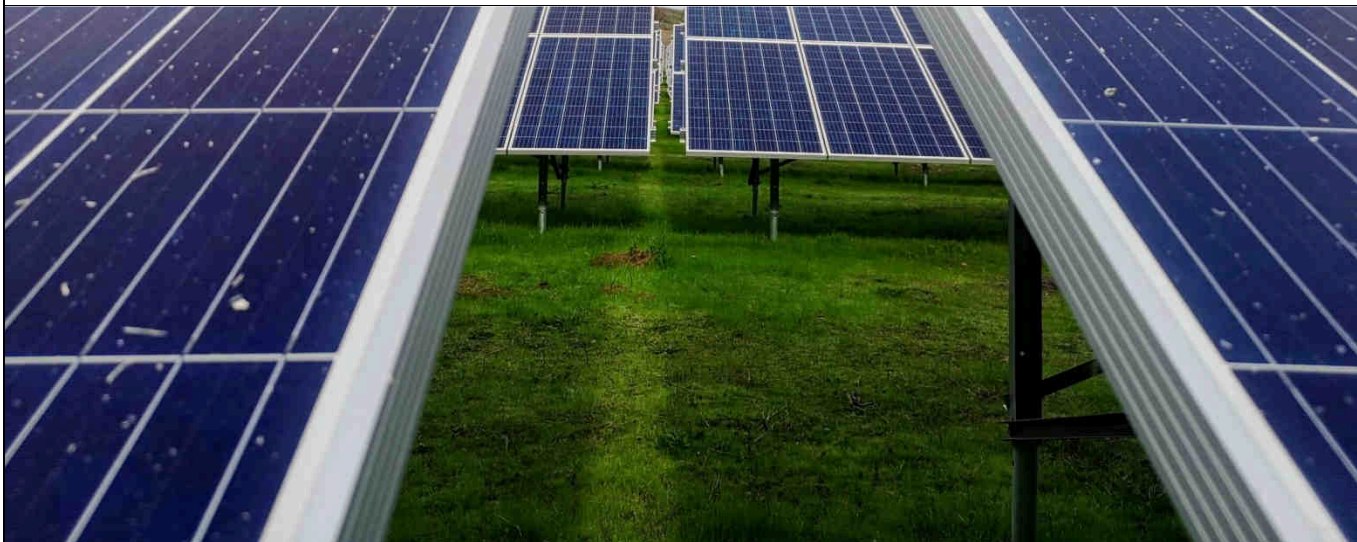


LOCALIZZAZIONE

**REGIONE SICILIA  
PROVINCIA DI TRAPANI  
COMUNI DI TRAPANI, MARSALA E SALEMI**



TITOLO BREVE

**AGRIVOLTAICO "ARYA TRAPANI"**

SPAZIO PER ENTI (VISTI, PROTOCOLLI, APPROVAZIONI, ALTRO)

<b>REVISIONI</b>						
	00	24/03/2023	PRIMA EMISSIONE ELABORATO	Vincenzo Ruvolo	Dario D'Angelo	Claudio Rizzo
REV	DATA	DESCRIZIONE	REDATTO	VERIFICATO	APPROVATO	

PROPONENTE



Arya Solar SRL

**Arya Solar S.r.l.**

Sede Legale: Viale Croce Rossa, 25 - 90144 Palermo  
C.F. e P. IVA n. 11944660965 - R.E.A. Palermo: 433406  
PEC: aryasolarsrl@legalmail.it

PROGETTAZIONE E SERVIZI



ENVLAB s.r.l.s. - C.F./P. IVA 02920050842  
Piazza Capelvenere n. 2 - 92016 RIBERA (AG)  
T 0925 096280 - envlab@pec.it - www.envlab.it

CODICE ELABORATO

GE-ARYASOLARTP-AFV-PD-R-1.1.2.0-r0A-R00

FOGLIO

1/48

FORMATO

A4

SCALA

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IL DIRETTORE TECNICO DI ENVLAB



PROGETTO

**IMPIANTO AGRIVOLTAICO "ARYA TRAPANI"**  
PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO AGRIVOLTAICO  
DELLA POTENZA DI 62,54 MW<sub>dc</sub> (46,00 MW<sub>ac</sub> IN IMMISIONE) CON SISTEMA DI ACCUMULO  
DA 10,00 MW/20 MWh E RELATIVE OPERE DI CONNESSIONE ALLA RTN  
RICADENTE NEI COMUNI DI TRAPANI, MARSALA E SALEMI (TP)

OGGETTO ELABORATO

PROGETTO DEFINITIVO  
**REPORT RILIEVO E RESTITUZIONE  
AEROFOTOGRAMMETRICA DELLE AREE DI PROGETTO**

Progettazione e Consulenza Ambientale	ELABORATO	PROPONENTE
	<p style="text-align: center;"><b>REPORT RILIEVO E RESTITUZIONE AEROFOTOGRAMMETRICA DELLE AREE DI PROGETTO</b></p>	 Arya Solar SRL Arya Solar S.r.l. Viale Croce Rossa, 25 - 90144 Palermo C.F. e P. IVA n. 11944660965
<p><i>IMPIANTO AGRIVOLTAICO "ARYA TRAPANI"</i>  PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO AGRIVOLTAICO DELLA POTENZA DI 62,54 MWp (46,00 MW IN IMMISSIONE) CON SISTEMA DI ACCUMULO DA 10MW / 20MWh E RELATIVE OPERE DI CONNESSIONE ALLA RTN RICADENTE NEI COMUNI DI TRAPANI, MARSALA E SALEMI (TP)</p>		

## 1. PREMESSA

Il presente documento costituisce il Report relativo alle operazioni di rilievo e restituzione ortofotogrammetrica delle aree entro cui è stato elaborato il progetto del progetto dell'impianto agrivoltaico "ARYA TRAPANI" della potenza di 62,54 MWp (46,00 MW in immissione) con sistema di accumulo da 10MW / 20MWh e delle relative opere di connessione alla RTN che la società ARYA SOLAR S.r.l. intende realizzare nei Comuni di Trapani, Marsala e Salemi in provincia di Trapani.

Il soggetto proponente dell'iniziativa è la Società ARYA SOLAR S.r.l. avente sede legale ed operativa in PALERMO, VIALE CROCE ROSSA n. 25, iscritta nella Sezione Ordinaria della Camera di Commercio Industria Agricoltura ed Artigianato di Palermo, C.F. e P.IVA N. 11944660965 – REA – PA 433406.

In particolare il rilievo aero-topografico o fotogrammetrico di prossimità è operato mediante Sistemi Aeromobili a Pilotaggio Remoto (SAPR, comunemente denominati "droni") registrati presso ENAC: la finalità è quella di fornire, attraverso l'attività di tecnici qualificati ed abilitati, un modello fotogrammetrico, ovvero un modello tridimensionale misurabile, in scala, dell'area rilevata, che ne riporta tutte le caratteristiche geometriche, cromatiche e materiche e che rappresenta un database sempre interrogabile.

La ENVLAB è operatore regolarmente abilitato da ENAC con codice "ITEFZcUeXi" verificabile nell'elenco operatori raggiungibile al seguente link [https://www.d-flight.it/new\\_portal/elenco-operatori/](https://www.d-flight.it/new_portal/elenco-operatori/).

La pianificazione del volo del SAPR consta della definizione dei parametri necessari all'esecuzione del rilievo fotogrammetrico di prossimità da SAPR che sono:

- *Ts tempo di scatto (espresso in secondi);*
- *Fs frequenza di scatto (n° foto al secondo);*
- *Vs velocità di volo del SAPR (metri/secondo);*
- *GSD (Ground Simple Distance).*

Il rilievo dell'area oggetto del progetto è stato eseguito mediante l'ausilio di sistemi aerofotogrammetrici, con apposito aeromobile a pilotaggio remoto o APR, dotato di camera digitale ad alta risoluzione.

L'impianto topografico generale e il rilievo dei relativi Ground Control Point (GCP) posizionati secondo il piano di volo programmato, è stato condotto mediante strumentazione GPS (NRTK-GNSS) e successiva acquisizione, interpretazione, elaborazione e restituzione finale di dati.

I dati risultanti dai rilievi acquisiti con sistemi APR costituiscono il dato di input per le successive analisi di caratterizzazione dell'area indagata.

L'APR è condotto da un pilota in possesso del riconoscimento della competenza (Attestato/Licenza di Pilota di APR), in stato di validità di cui alla Sezione IV del Regolamento ENAC vigente.

Il rilievo si è svolto secondo le seguenti attività:

1. *pianificazione piano di volo in funzione delle condizioni climatiche;*
2. *rilievo aerofotogrammetrico mediante sistema APR;*
3. *elaborazione big data da rilievo;*
4. *restituzione di cartografia di base in scala di dettaglio in proiezione planoaltimetrica;*
5. *realizzazione di un modello tridimensionale in formato mesh;*
6. *produzione di un dettagliato Modello Digitale del Terreno (DTM);*

Progettazione e Consulenza Ambientale	ELABORATO	PROPONENTE
	<p align="center"><b>REPORT RILIEVO E RESTITUZIONE AEROFOTOGRAMMETRICA DELLE AREE DI PROGETTO</b></p>	 Arya Solar SRL Arya Solar S.r.l. Viale Croce Rossa, 25 - 90144 Palermo C.F. e P. IVA n. 11944660965
<p align="center"><i>IMPIANTO AGRIVOLTAICO "ARYA TRAPANI"</i>  PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO AGRIVOLTAICO DELLA POTENZA DI 62,54 MWp (46,00 MW IN IMMISSIONE) CON SISTEMA DI ACCUMULO DA 10MW / 20MWh E RELATIVE OPERE DI CONNESSIONE ALLA RTN RICADENTE NEI COMUNI DI TRAPANI, MARSALA E SALEMI (TP)</p>		

7. *elaborazione di un ortofotopiano in formato TFF/TFW e sua sovrapposizione alla CTR regionale o alla aerofotogrammetria pubblica esistente;*
8. *estrapolazione di curve di livello del terreno sull'intera area indagata in formato DWG/SHP, UTM dato ERTS 89/WGS84;*
9. *estrapolazione di punti quotati;*
10. *produzione di ortofoto in formato .kml da importare direttamente in Google Earth.*

Le informazioni acquisite con metodo fotogrammetrico sono state integrate da rilievi in campo con strumentazione topografica e/o GNSS per garantire la corretta definizione della geometria del terreno oggetto di studio.

Nel seguito è riportato integralmente il Report generato dal software PIX4D impiegato per l'elaborazione delle immagini georeferenziate acquisite da Drone.

Le migliaia immagini in alta risoluzione, la grande quantità di dati generata e le elaborazioni di modelli 3D, DEM ed ortomosaici sono disponibili presso gli archivi digitali di Envlab per eventuale consultazione su richiesta.

- !** **Important:** Click on the different icons for:
  - ?** Help to analyze the results in the Quality Report
  - i** Additional information about the sections

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

## Summary



Project	gncr_nor_new
Processed	2023-02-23 22:52:44
Camera Model Name(s)	FC6310_8.8_5472x3648 (RGB)
Average Ground Sampling Distance (GSD)	3.17 cm / 1.25 in
Area Covered	1.454 km <sup>2</sup> / 145.4096 ha / 0.56 sq. mi. / 359.5010 acres
Time for Initial Processing (without report)	03h:17m:55s

## Quality Check



<b>?</b> Images	median of 72906 keypoints per image	
<b>?</b> Dataset	1567 out of 1567 images calibrated (100%), all images enabled	
<b>?</b> Camera Optimization	4.26% relative difference between initial and optimized internal camera parameters	
<b>?</b> Matching	median of 32363.4 matches per calibrated image	
<b>?</b> Georeferencing	yes, no 3D GCP	

## **?** Preview

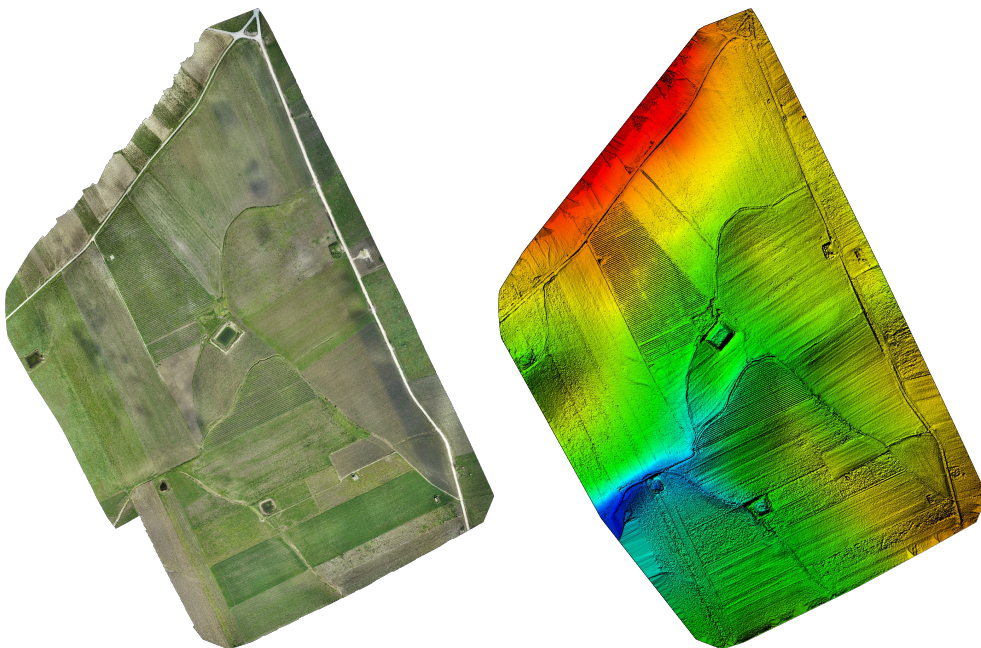


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.



# Calibration Details



Number of Calibrated Images	1567 out of 1567
Number of Geolocated Images	1567 out of 1567

## Initial Image Positions

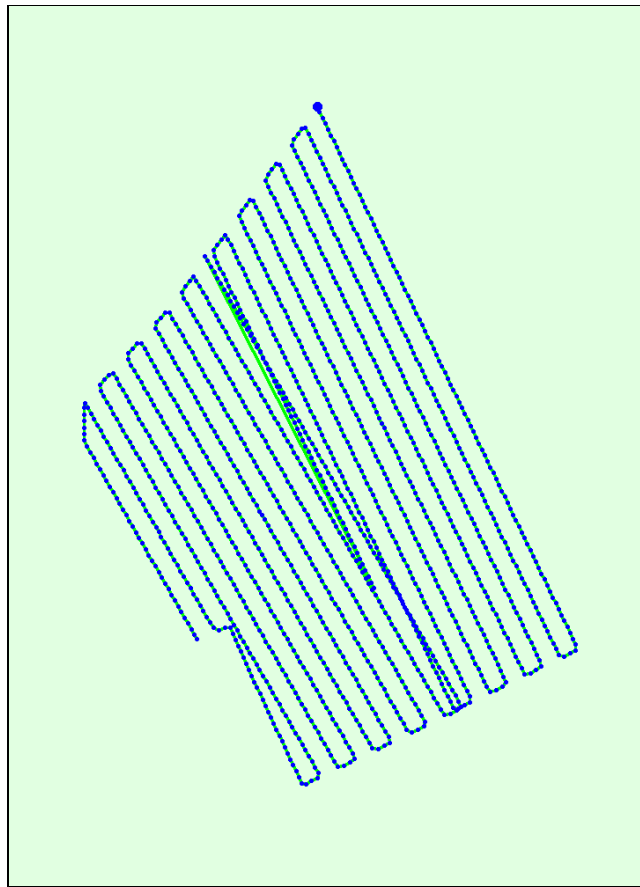
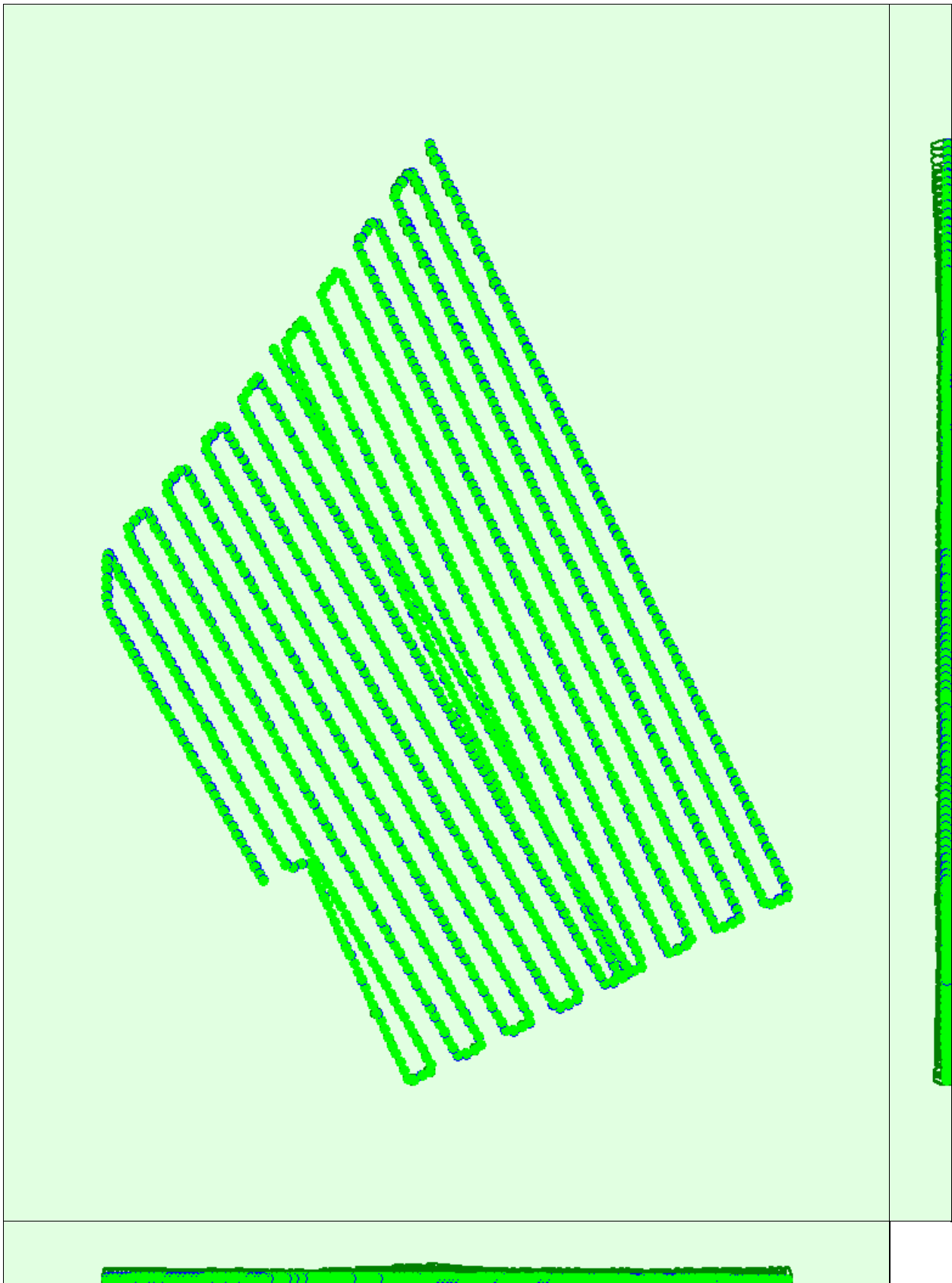


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

## 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]
Mean	0.057	0.058	0.133	0.018	0.018	0.005
Sigma	0.010	0.010	0.028	0.004	0.004	0.000

## Overlap

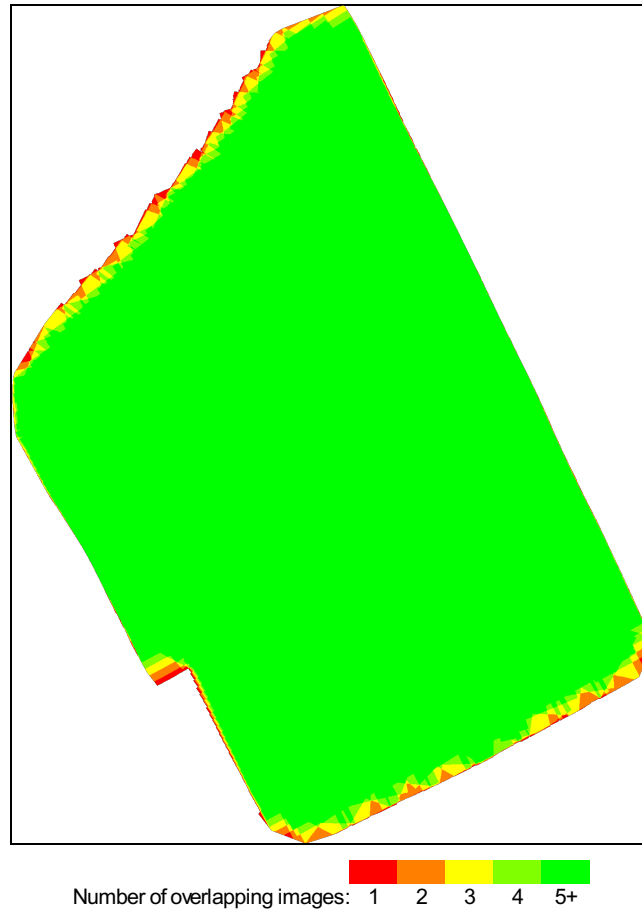


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint 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	50351018
Number of 3D Points for Bundle Block Adjustment	15720243
Mean Reprojection Error [pixels]	0.119

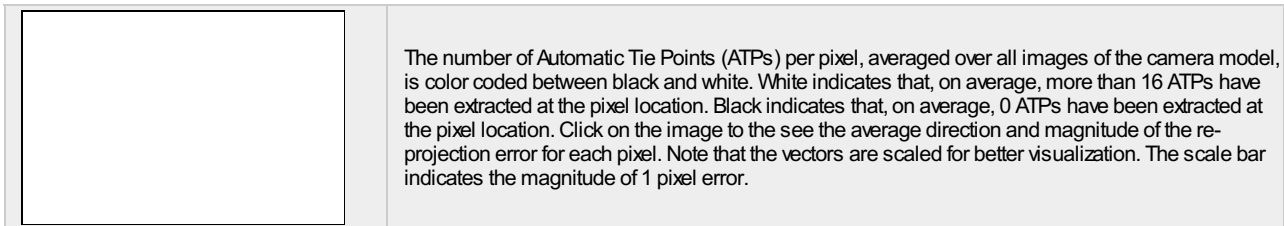
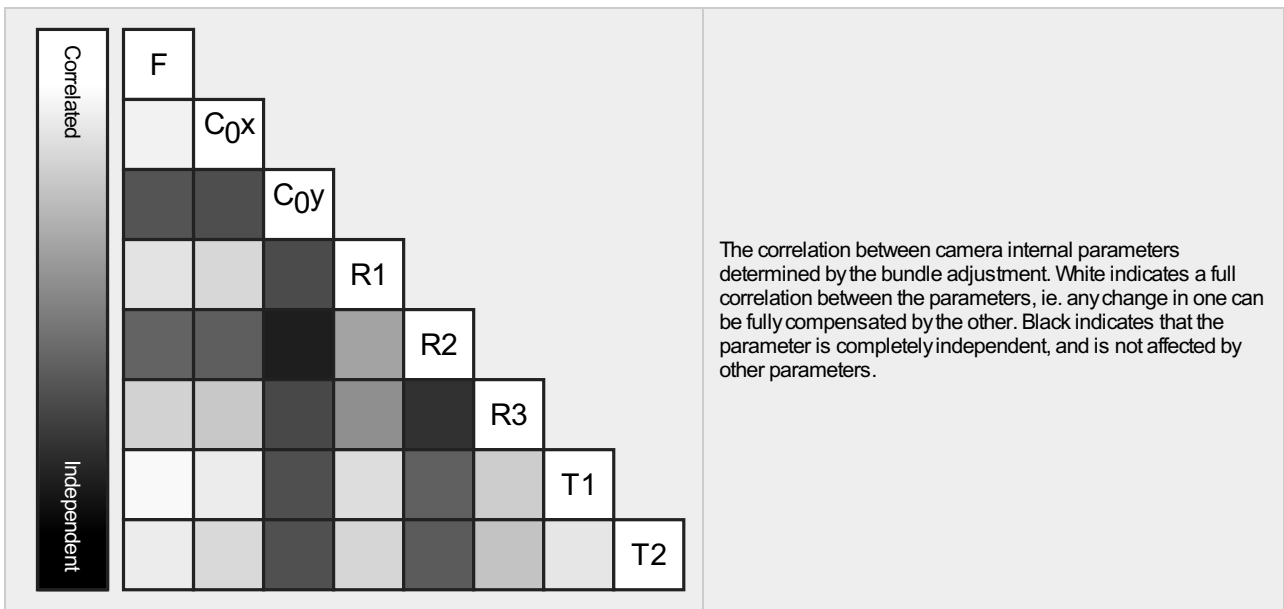
## Internal Camera Parameters

FC6310\_8.8\_5472x3648 (RGB). Sensor Dimensions: 12.833 [mm] x 8.556 [mm]



EXIF ID: FC6310S\_8.8\_5472x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3668.759 [pixel] 8.604 [mm]	2736.001 [pixel] 6.417 [mm]	1823.999 [pixel] 4.278 [mm]	0.003	-0.008	0.008	-0.000	0.000
Optimized Values	3825.140 [pixel] 8.971 [mm]	2715.493 [pixel] 6.369 [mm]	1806.071 [pixel] 4.236 [mm]	-0.015	0.004	0.007	-0.002	-0.002
Uncertainties (Sigma)	13.847 [pixel] 0.032 [mm]	0.287 [pixel] 0.001 [mm]	0.093 [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	72906	32363
Mn	54242	16894
Max	85116	43759
Mean	72439	32132

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



	Number of 3D Points Observed
In 2 Images	8815468
In 3 Images	3144906
In 4 Images	1450774
In 5 Images	782347
In 6 Images	469807
In 7 Images	298298
In 8 Images	187739
In 9 Images	133976
In 10 Images	98468
In 11 Images	74554
In 12 Images	57190
In 13 Images	44097
In 14 Images	33782
In 15 Images	25958
In 16 Images	20456
In 17 Images	16488
In 18 Images	13624
In 19 Images	10971
In 20 Images	8884
In 21 Images	6753
In 22 Images	5218
In 23 Images	4555



In 24 Images	3608
In 25 Images	3013
In 26 Images	2346
In 27 Images	1855
In 28 Images	1383
In 29 Images	961
In 30 Images	698
In 31 Images	536
In 32 Images	479
In 33 Images	321
In 34 Images	251
In 35 Images	203
In 36 Images	129
In 37 Images	68
In 38 Images	40
In 39 Images	20
In 40 Images	10
In 41 Images	2
In 42 Images	2
In 43 Images	4
In 44 Images	1

 **2D Keypoint Matches**



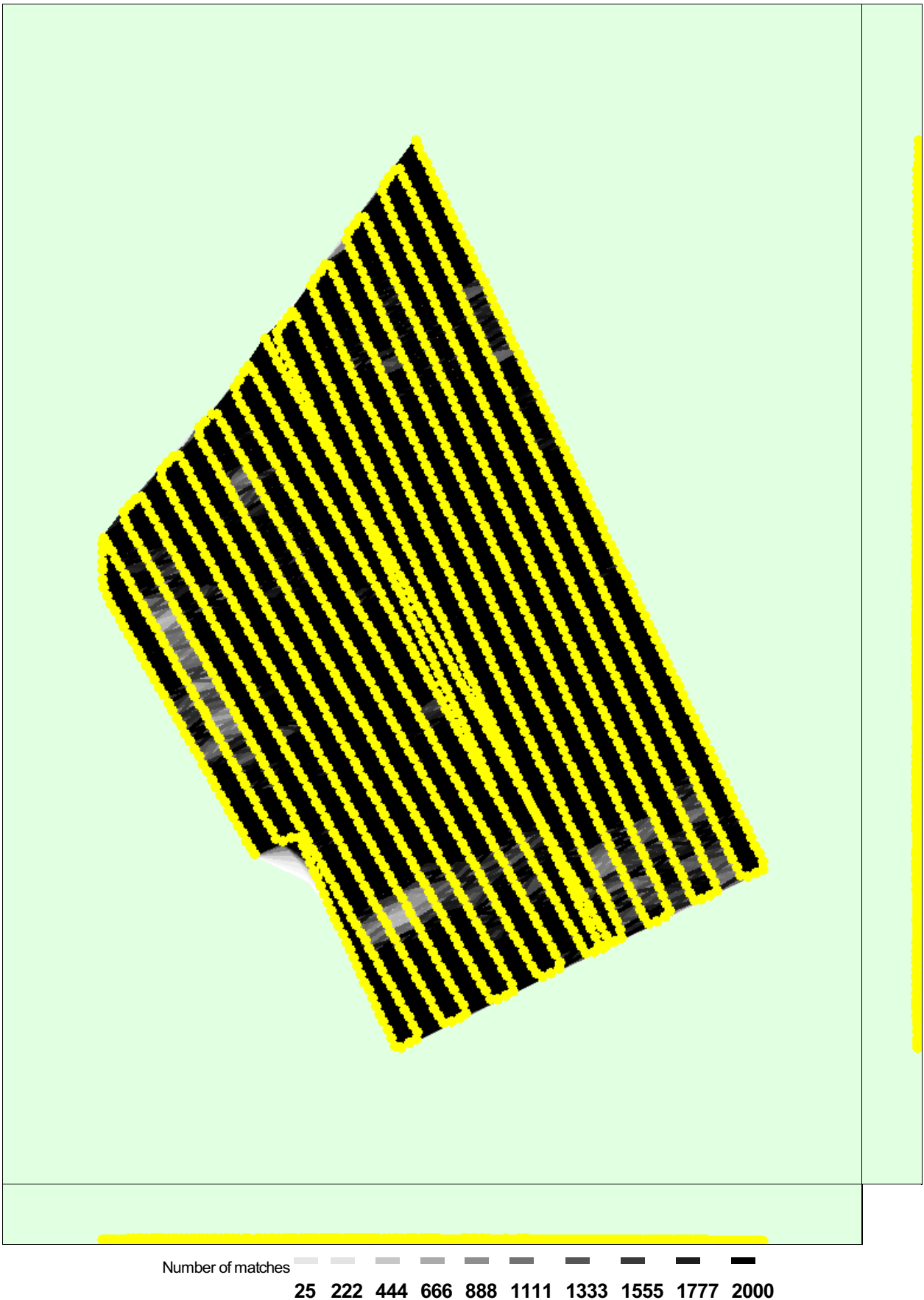


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

## Geolocation Details

## ? 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	49.65	54.95	51.56
0.00	3.00	50.35	45.05	48.44
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
<b>Mean [m]</b>		-0.000000	-0.000000	-0.000000
<b>Sigma [m]</b>		0.805758	1.412288	0.601225
<b>RMS Error [m]</b>		0.805758	1.412288	0.601225

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]	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
<b>Mean of Geolocation Accuracy [m]</b>	5.000000	5.000000	10.000000
<b>Sigma of Geolocation Accuracy [m]</b>	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	0.222
Phi	0.632
Kappa	7.122

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) Core(TM) i7-10700 CPU @2.90GHz RAM: 16GB GPU: NVIDIA Quadro P1000 (Driver: 31.0.15.1740), Intel(R) UHD Graphics 630 (Driver: 27.20.100.8190), Virtual MonitorX (Driver: 17.10.42.834)
Operating System	Windows 10 Pro, 64-bit

### Coordinate Systems



Image Coordinate System	WGS 84 (EGM96 Geoid)
Output Coordinate System	WGS 84 / UTMzone 33N (EGM96 Geoid)

## Processing Options



Detected Template	CUDDIA CURVE OK*
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, no

## 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	01h:26m:32s
Time for Point Cloud Classification	13m:59s
Time for 3D Textured Mesh Generation	28m:24s

### Results



Number of Processed Clusters	59
Number of Generated Tiles	6
Number of 3D Densified Points	134714057
Average Density (per m <sup>3</sup> )	142.26

## DSM, Orthomosaic and Index Details



### Processing Options



DSM and Orthomosaic Resolution	1 x GSD (3.17 [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: yes
Grid DSM	Generated: yes, Spacing [cm]: 100
Raster DTM	Generated: yes Merge Tiles: yes
DTM Resolution	5 x GSD (3.17 [cm/pixel])



Contour Lines Generation	Generated: yes Contour Base [m]: 0 Elevation Interval [m]: 0.5 Resolution [cm]: 300 Minimum Line Size [vertices]: 10
Time for DSM Generation	54m:31s
Time for Orthomosaic Generation	03h:04m:15s
Time for DTM Generation	01h:11m:05s
Time for Contour Lines Generation	08s
Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s

# 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	gncr_pala
Processed	2023-02-22 11:19:52
Camera Model Name(s)	FC6310_8.8_5472x3648 (RGB)
Average Ground Sampling Distance (GSD)	3.52 cm / 1.39 in
Area Covered	0.290 km <sup>2</sup> / 28.9816 ha / 0.11 sq. mi. / 71.6521 acres
Time for Initial Processing (without report)	29m:29s

## Quality Check



Images	median of 76536 keypoints per image	
Dataset	179 out of 179 images calibrated (100%), all images enabled	
Camera Optimization	0.57% relative difference between initial and optimized internal camera parameters	
Matching	median of 47416.1 matches per calibrated image	
Georeferencing	yes, no 3D GCP	

## Preview

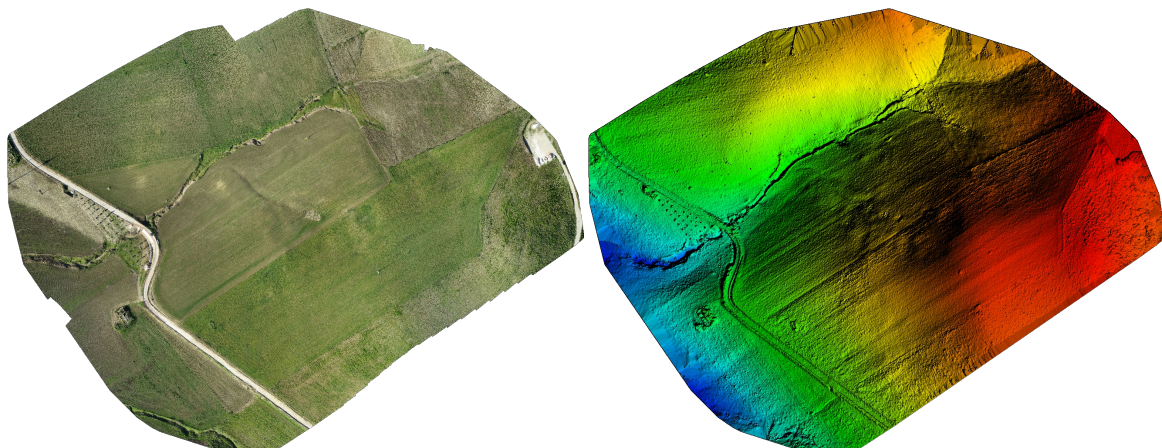


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

## Calibration Details



Number of Calibrated Images	179 out of 179
Number of Geolocated Images	179 out of 179

## Initial Image Positions

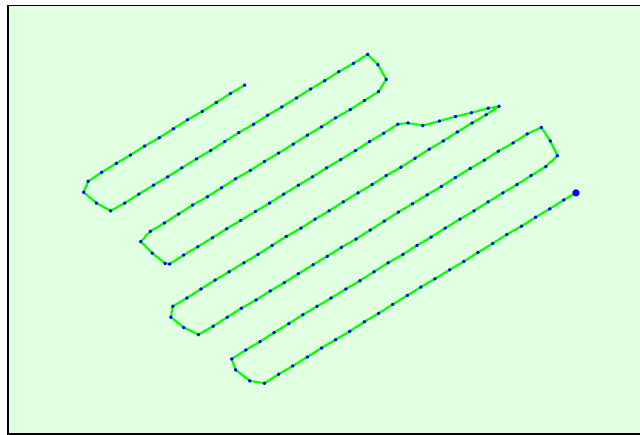
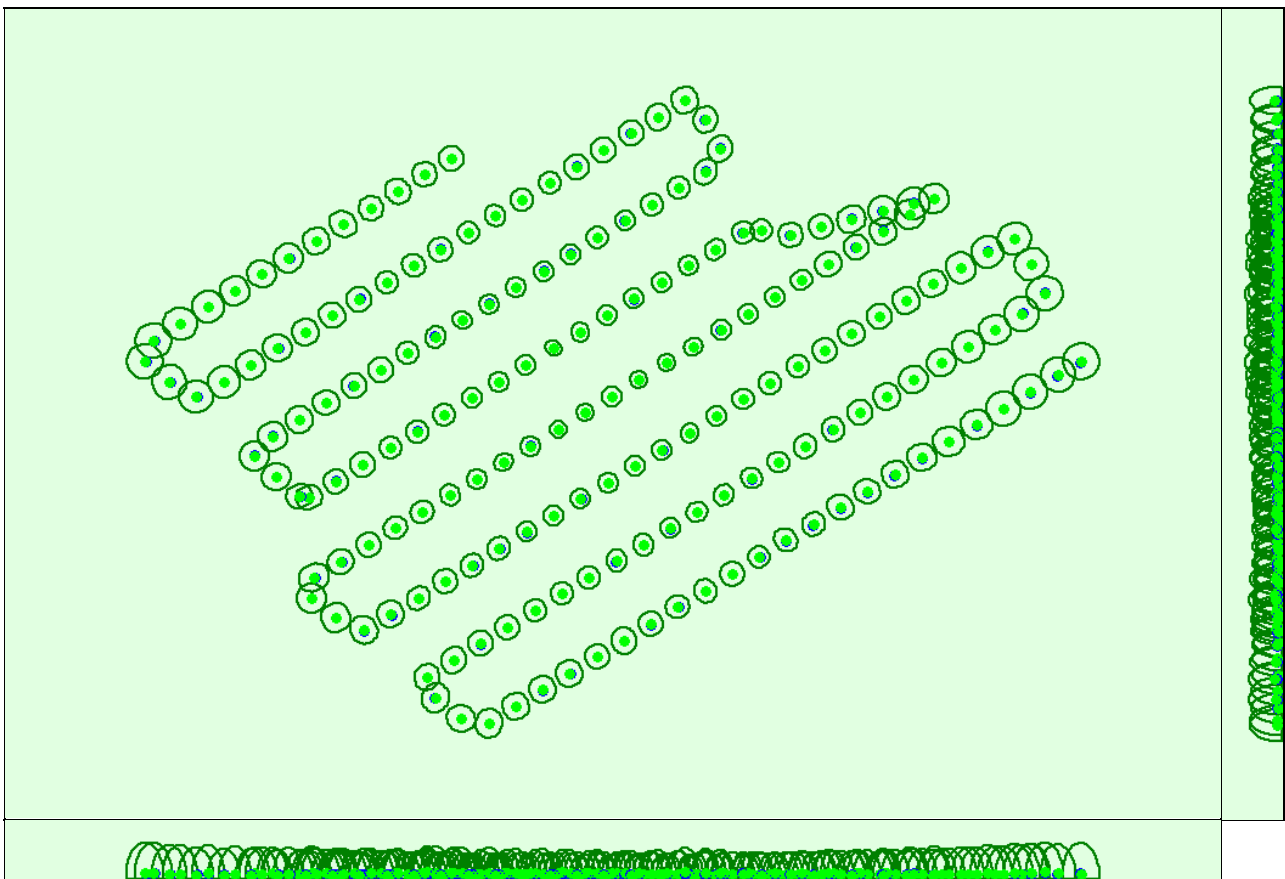


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

## 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]
Mean	0.083	0.083	0.153	0.032	0.033	0.018
Sigma	0.015	0.014	0.019	0.001	0.001	0.000

## Overlap



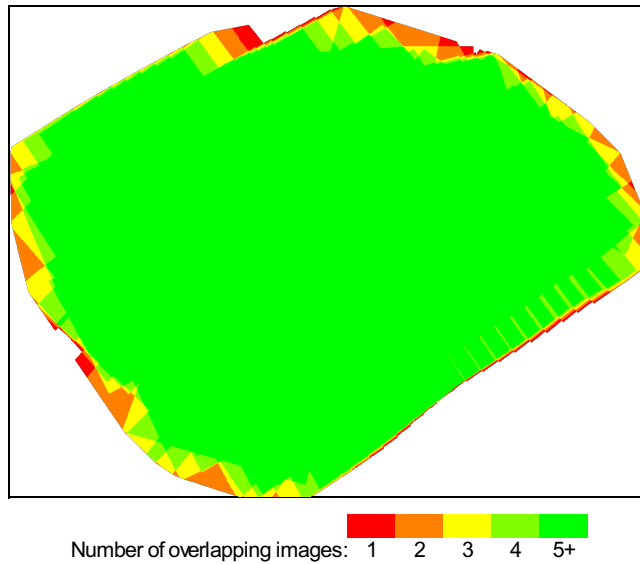


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint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

## Bundle Block Adjustment Details

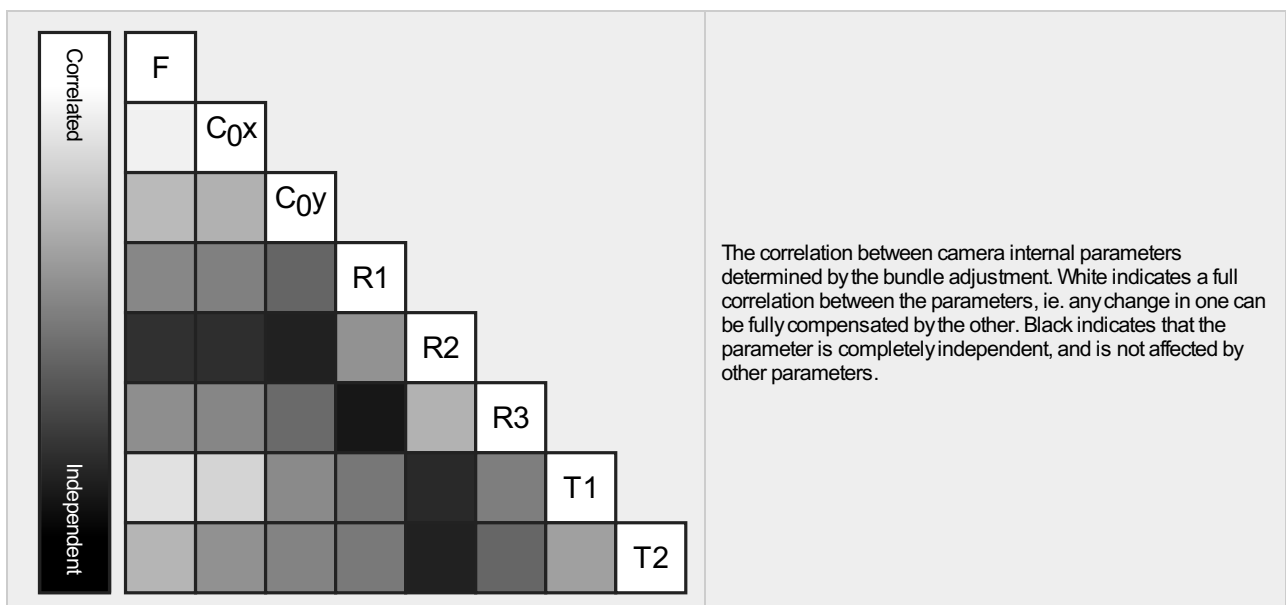
Number of 2D Keypoint Observations for Bundle Block Adjustment	8594558
Number of 3D Points for Bundle Block Adjustment	2563396
Mean Reprojection Error [pixels]	0.146

### Internal Camera Parameters

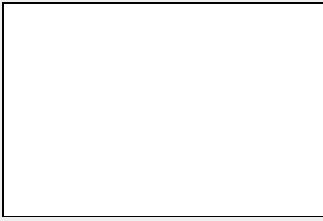
FC6310\_8.8\_5472x3648 (RGB). Sensor Dimensions: 12.833 [mm] x 8.556 [mm]

EXIF ID: FC6310S\_8.8\_5472x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3668.759 [pixel] 8.604 [mm]	2736.001 [pixel] 6.417 [mm]	1823.999 [pixel] 4.278 [mm]	0.003	-0.008	0.008	-0.000	0.000
Optimized Values	3689.776 [pixel] 8.654 [mm]	2713.126 [pixel] 6.363 [mm]	1805.268 [pixel] 4.234 [mm]	-0.014	0.003	0.006	-0.002	-0.001
Uncertainties (Sigma)	6.959 [pixel] 0.016 [mm]	0.169 [pixel] 0.000 [mm]	0.072 [pixel] 0.000 [mm]	0.000	0.000	0.000	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.

## ? 2D Keypoints Table



	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	76536	47416
Mn	62683	36974
Max	92170	64369
Mean	77038	48014

## ? 3D Points from 2D Keypoint Matches



	Number of 3D Points Observed
In 2 Images	1403908
In 3 Images	483950
In 4 Images	234769
In 5 Images	136626
In 6 Images	84424
In 7 Images	56961
In 8 Images	40402
In 9 Images	29878
In 10 Images	22481
In 11 Images	16358
In 12 Images	12425
In 13 Images	9728
In 14 Images	7557
In 15 Images	5828
In 16 Images	4412
In 17 Images	3342
In 18 Images	2604
In 19 Images	2005
In 20 Images	1538
In 21 Images	1167
In 22 Images	832
In 23 Images	646
In 24 Images	432
In 25 Images	305
In 26 Images	242
In 27 Images	171
In 28 Images	134
In 29 Images	86
In 30 Images	68
In 31 Images	46
In 32 Images	32
In 33 Images	18
In 34 Images	9
In 35 Images	9
In 36 Images	1
In 37 Images	1
In 39 Images	1

## 2D Keypoint Matches

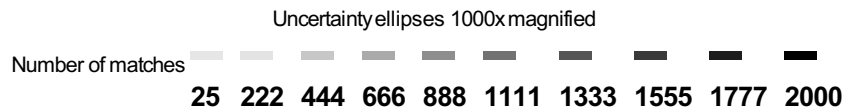
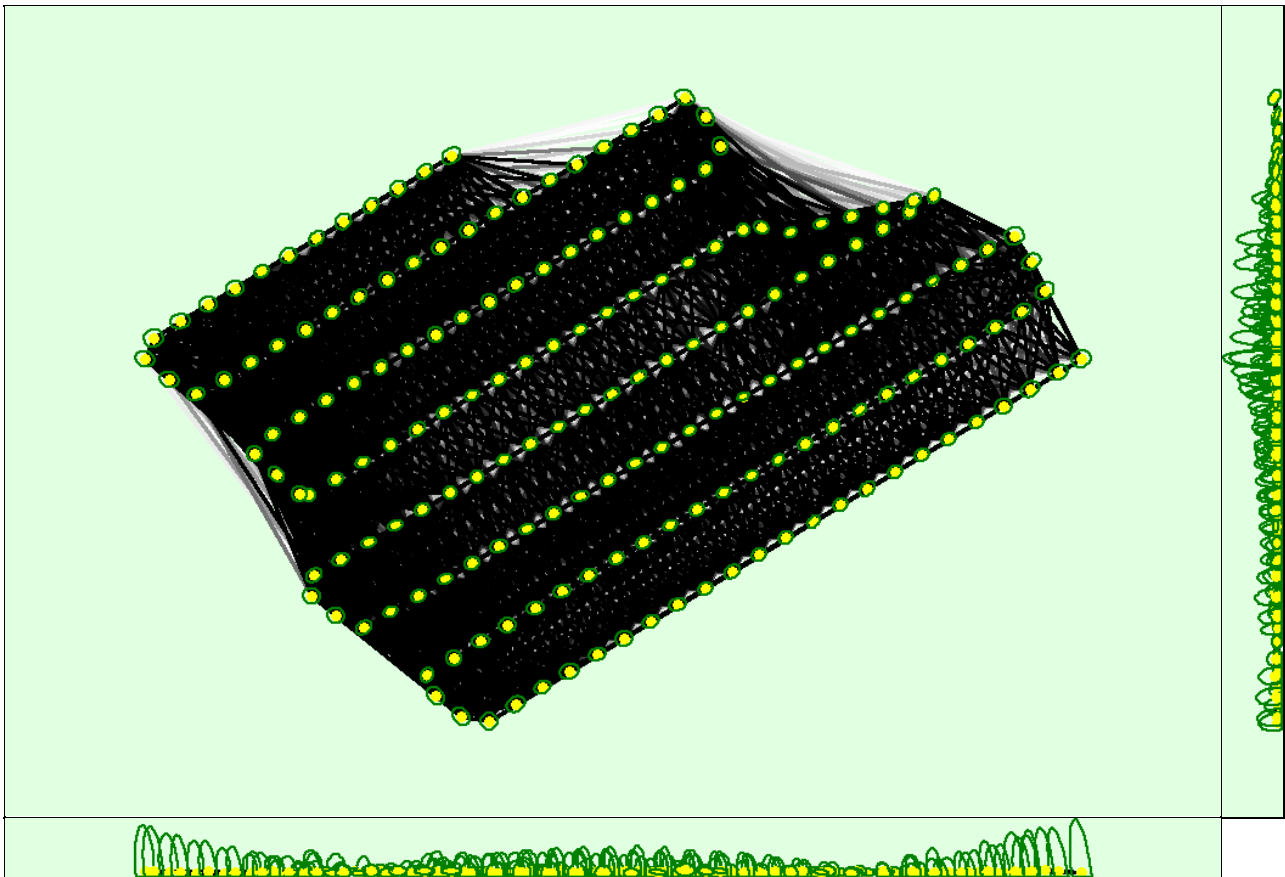


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images. Dark green ellipses indicate the relative camera position uncertainty 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	0.005	0.005	0.010	0.007	0.006	0.001
Sigma	0.001	0.001	0.006	0.005	0.003	0.000

## Geolocation Details

### Absolute Geolocation Variance

Mn 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	52.51	46.93	48.04
0.00	3.00	47.49	53.07	51.96
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
<b>Mean [m]</b>		0.000013	0.000001	-0.004916
<b>Sigma [m]</b>		0.175200	0.237433	0.563651
<b>RMS Error [m]</b>		0.175200	0.237433	0.563673

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]	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
<b>Mean of Geolocation Accuracy [m]</b>	5.000000	5.000000	10.000000
<b>Sigma of Geolocation Accuracy [m]</b>	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	0.754
Phi	0.250
Kappa	4.743

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) Core(TM) i7-10700 CPU @2.90GHz RAM: 16GB GPU: NVIDIA Quadro P1000 (Driver: 31.0.15.1740), Intel(R) UHD Graphics 630 (Driver: 27.20.100.8190), Virtual MonitorX (Driver: 17.10.42.834)
Operating System	Windows 10 Pro, 64-bit

### Coordinate Systems

Image Coordinate System	WGS 84 (EGM96 Geoid)
Output Coordinate System	WGS 84 / UTMzone 33N (EGM96 Geoid)

### Processing Options

Detected Template	 CUDDIA CURVE OK*
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	11m:11s
Time for Point Cloud Classification	01m:33s
Time for 3D Textured Mesh Generation	06m:10s

## Results



Number of Generated Tiles	1
Number of 3D Densified Points	17111692
Average Density (per m <sup>3</sup> )	89.08

# DSM, Orthomosaic and Index Details



## Processing Options



DSM and Orthomosaic Resolution	1 x GSD (3.52 [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: yes
Grid DSM	Generated: yes, Spacing [cm]: 100
Raster DTM	Generated: yes Merge Tiles: yes
DTM Resolution	5 x GSD (3.52 [cm/pixel])
Contour Lines Generation	Generated: yes Contour Base [m]: 0 Elevation Interval [m]: 0.5 Resolution [cm]: 300 Minimum Line Size [vertices]: 10
Time for DSM Generation	08m:10s
Time for Orthomosaic Generation	21m:36s
Time for DTM Generation	07m:28s
Time for Contour Lines Generation	02s
Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s





**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	gncr_piccolo
Processed	2023-02-22 16:15:57
Camera Model Name(s)	FC6310_8.8_5472x3648 (RGB)
Average Ground Sampling Distance (GSD)	2.98 cm / 1.17 in
Area Covered	0.161 km <sup>2</sup> / 16.0574 ha / 0.06 sq. mi. / 39.6992 acres
Time for Initial Processing (without report)	12m:12s

## Quality Check



<b>Images</b>	median of 71372 keypoints per image	
<b>Dataset</b>	114 out of 114 images calibrated (100%), all images enabled	
<b>Camera Optimization</b>	4.62% relative difference between initial and optimized internal camera parameters	
<b>Matching</b>	median of 45582.2 matches per calibrated image	
<b>Georeferencing</b>	yes, no 3D GCP	

## Preview

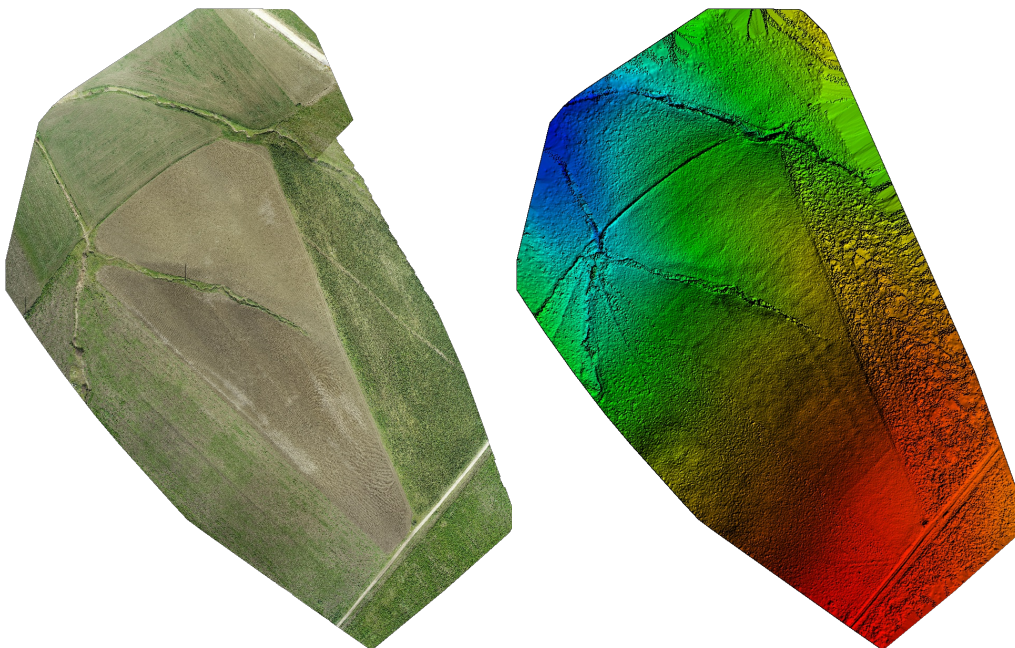


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

# Calibration Details



Number of Calibrated Images	114 out of 114
Number of Geolocated Images	114 out of 114

## Initial Image Positions

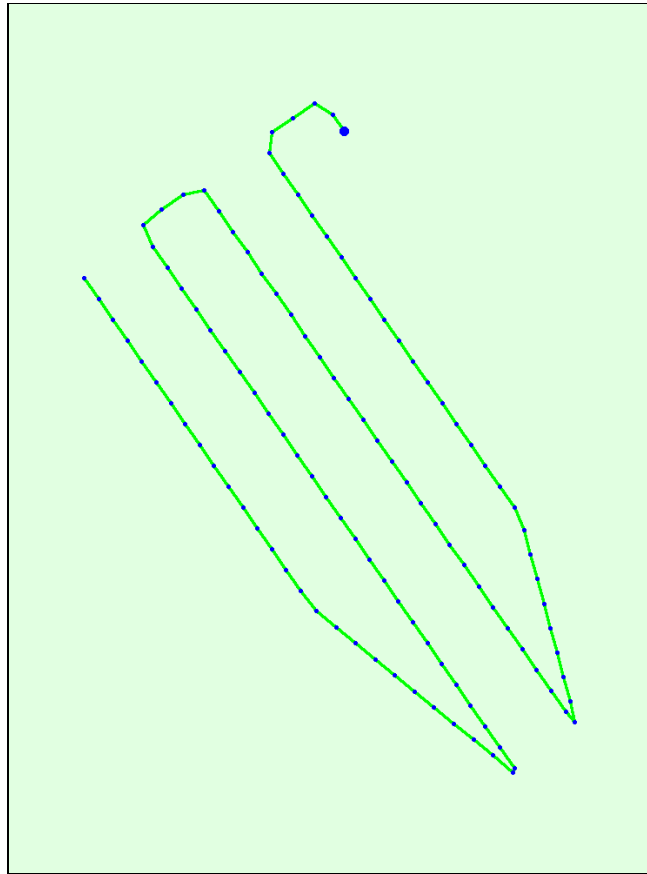
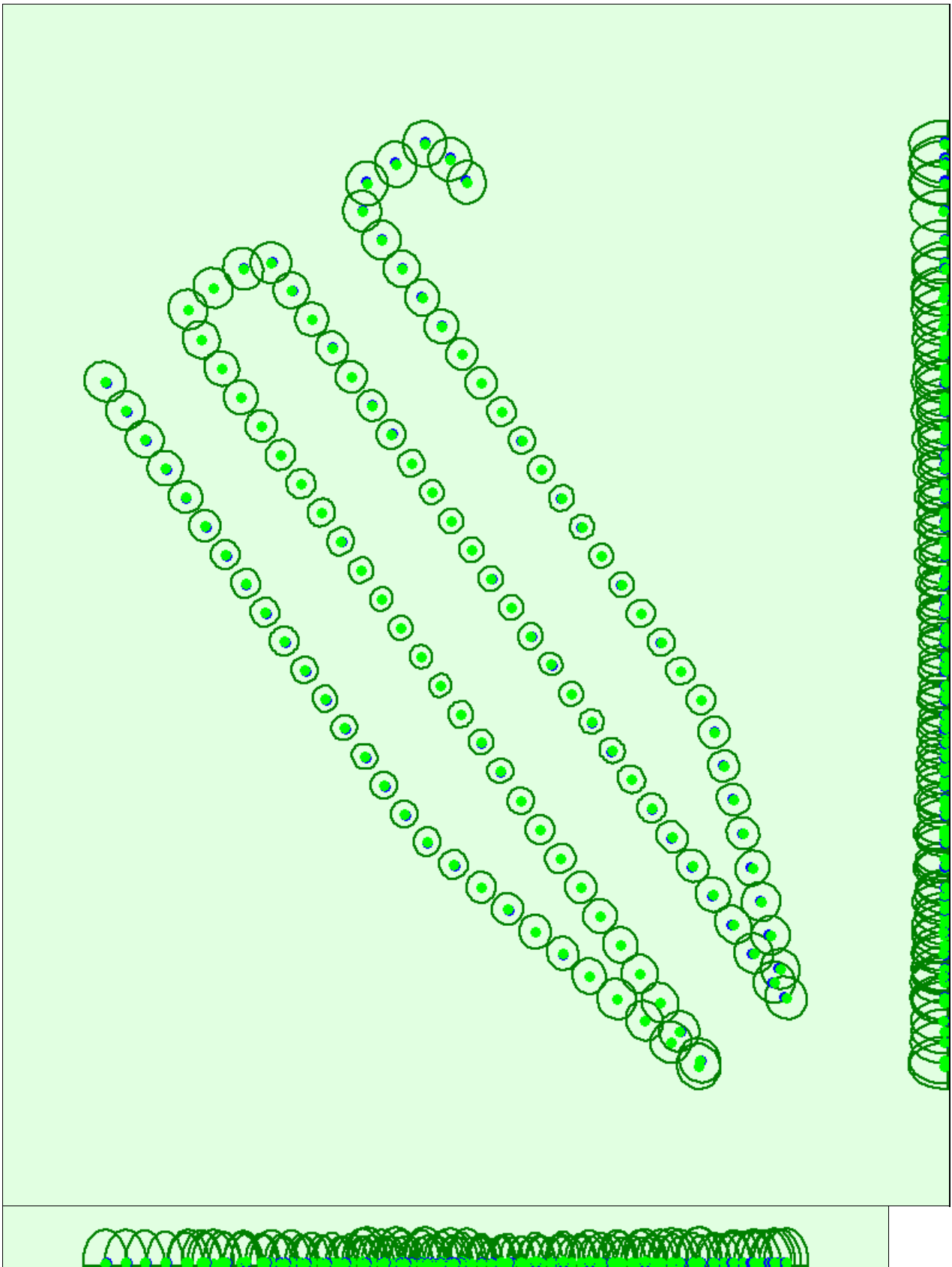


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

## 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]
Mean	0.077	0.077	0.134	0.033	0.033	0.021
Sigma	0.014	0.014	0.015	0.001	0.001	0.000

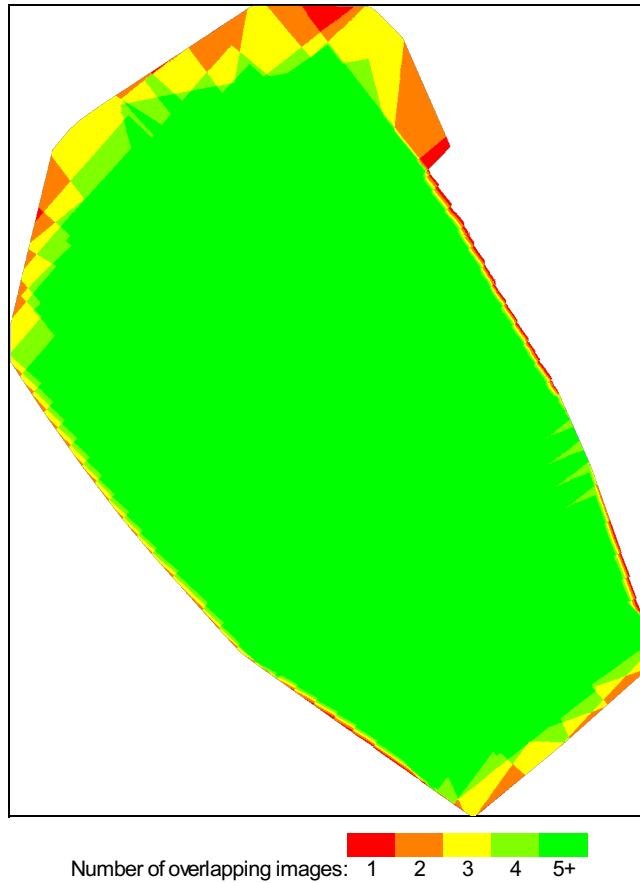


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint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

## Bundle Block Adjustment Details

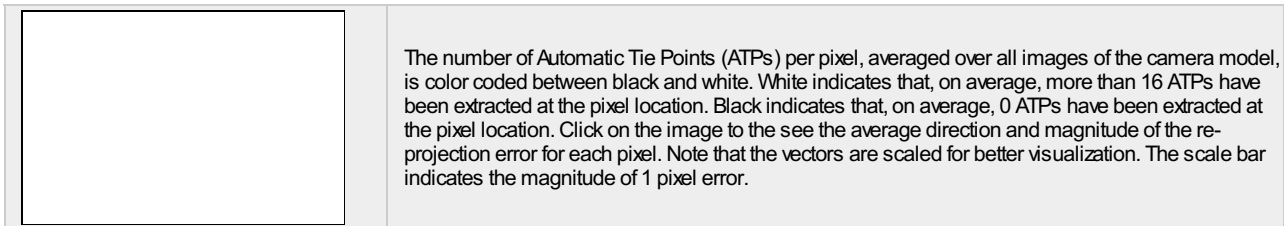
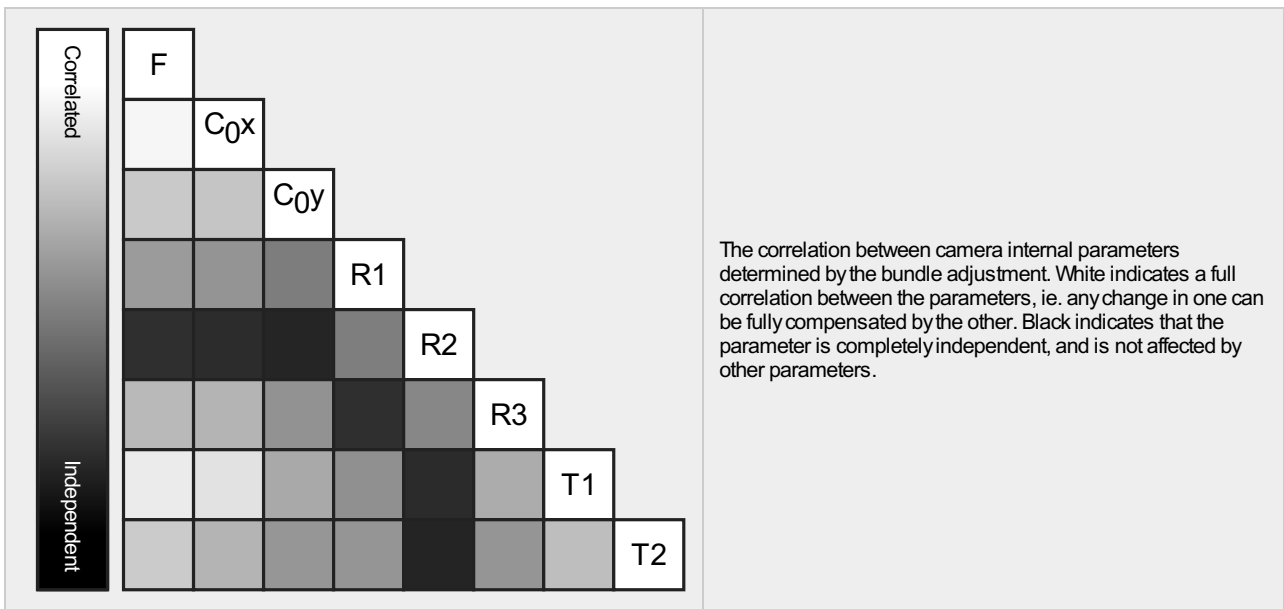
Number of 2D Keypoint Observations for Bundle Block Adjustment	4832267
Number of 3D Points for Bundle Block Adjustment	1452297
Mean Reprojection Error [pixels]	0.140

### Internal Camera Parameters

FC6310\_8.8\_5472x3648 (RGB). Sensor Dimensions: 12.833 [mm] x 8.556 [mm]

EXIF ID: FC6310S\_8.8\_5472x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3668.759 [pixel] 8.604 [mm]	2736.001 [pixel] 6.417 [mm]	1823.999 [pixel] 4.278 [mm]	0.003	-0.008	0.008	-0.000	0.000
Optimized Values	3838.315 [pixel] 9.002 [mm]	2716.750 [pixel] 6.372 [mm]	1806.827 [pixel] 4.237 [mm]	-0.014	0.003	0.008	-0.002	-0.001
Uncertainties (Sigma)	10.175 [pixel] 0.024 [mm]	0.233 [pixel] 0.001 [mm]	0.092 [pixel] 0.000 [mm]	0.000	0.000	0.000	0.000	0.000



### 2D Keypoints Table

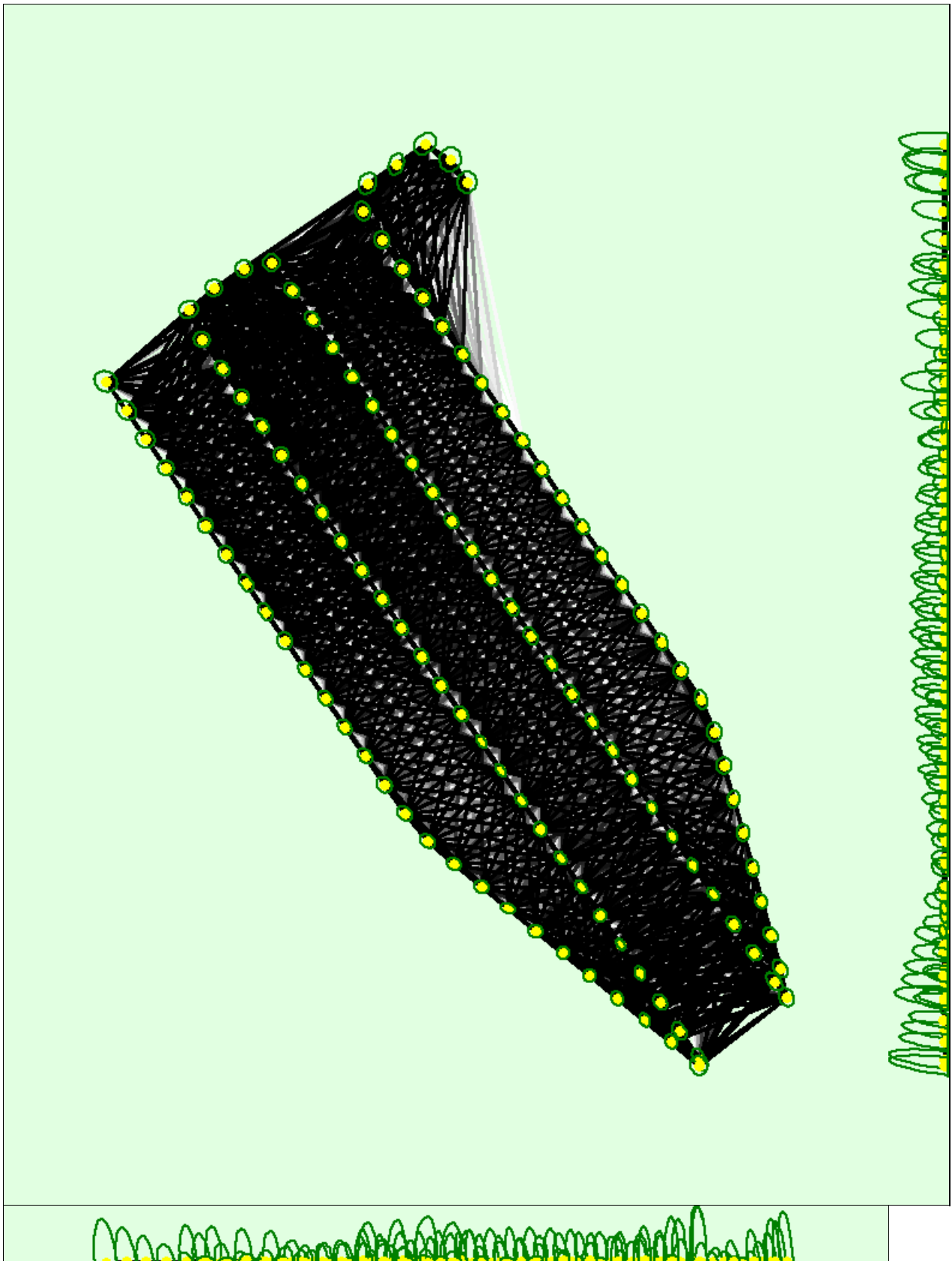
	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	71372	45582
Mn	63609	29834
Max	85367	51134
Mean	72593	42388

### 3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	795649
In 3 Images	269777
In 4 Images	133566
In 5 Images	78296
In 6 Images	50914
In 7 Images	33609
In 8 Images	23258
In 9 Images	17241
In 10 Images	13033
In 11 Images	10211
In 12 Images	7538
In 13 Images	5684
In 14 Images	4031
In 15 Images	2939
In 16 Images	2164
In 17 Images	1557
In 18 Images	1069
In 19 Images	687
In 20 Images	417
In 21 Images	283
In 22 Images	144
In 23 Images	106

In 24 Images	58
In 25 Images	29
In 26 Images	18
In 27 Images	8
In 28 Images	7
In 29 Images	1
In 31 Images	3

## 2D Keypoint Matches



Uncertainty ellipses 1000x 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]
Mean	0.004	0.004	0.010	0.008	0.008	0.001
Sigma	0.001	0.001	0.006	0.005	0.005	0.000

## Geolocation Details

### Absolute Geolocation Variance

Mn 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	40.35	56.14	49.12
0.00	3.00	59.65	43.86	50.88
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
<b>Mean [m]</b>		0.000122	0.000093	-0.020527
<b>Sigma [m]</b>		0.369439	0.369124	0.268925
<b>RMS Error [m]</b>		0.369439	0.369124	0.269707

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]	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
<b>Mean of Geolocation Accuracy [m]</b>	5.000000	5.000000	10.000000
<b>Sigma of Geolocation Accuracy [m]</b>	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	0.350
Phi	0.658
Kappa	7.676

# Initial Processing Details



## System Information



Hardware	CPU: Intel(R) Core(TM) i7-10700 CPU @ 2.90GHz RAM: 16GB GPU: NVIDIA Quadro P1000 (Driver: 31.0.15.1740), Intel(R) UHD Graphics 630 (Driver: 27.20.100.8190), Virtual MonitorX (Driver: 17.10.42.834)
Operating System	Windows 10 Pro, 64-bit

## Coordinate Systems



Image Coordinate System	WGS 84 (EGM96 Geoid)
Output Coordinate System	WGS 84 / UTMzone 33N (EGM96 Geoid)

## Processing Options



Detected Template	CUDDIACURVE OK*
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	06m:48s
Time for Point Cloud Classification	01m:19s
Time for 3D Textured Mesh Generation	03m:32s

## Results



Number of Generated Tiles	1
Number of 3D Densified Points	12793194
Average Density (per m <sup>3</sup> )	126.53



# DSM, Orthomosaic and Index Details



## Processing Options



DSM and Orthomosaic Resolution	1 x GSD (2.98 [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: yes
Grid DSM	Generated: yes, Spacing [cm]: 100
Raster DTM	Generated: yes Merge Tiles: yes
DTM Resolution	5 x GSD (2.98 [cm/pixel])
Contour Lines Generation	Generated: yes Contour Base [m]: 0 Elevation Interval [m]: 0.5 Resolution [cm]: 300 Minimum Line Size [vertices]: 10
Time for DSM Generation	05m:55s
Time for Orthomosaic Generation	15m:54s
Time for DTM Generation	06m:44s
Time for Contour Lines Generation	02s
Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s

- !** **Important:** Click on the different icons for:
- ?** Help to analyze the results in the Quality Report
  - i** Additional information about the sections

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

## Summary



Project	gncr_sud
Processed	2023-02-24 17:28:06
Camera Model Name(s)	FC6310_8.8_5472x3648 (RGB)
Average Ground Sampling Distance (GSD)	3.29 cm / 1.29 in
Area Covered	1.055 km <sup>2</sup> / 105.5084 ha / 0.41 sq. mi. / 260.8518 acres
Time for Initial Processing (without report)	49m:40s

## Quality Check



<b>?</b> Images	median of 84134 keypoints per image	✓
<b>?</b> Dataset	987 out of 987 images calibrated (100%), all images enabled	✓
<b>?</b> Camera Optimization	2.81% relative difference between initial and optimized internal camera parameters	✓
<b>?</b> Matching	median of 38005.2 matches per calibrated image	✓
<b>?</b> Georeferencing	yes, no 3D GCP	⚠

## Preview

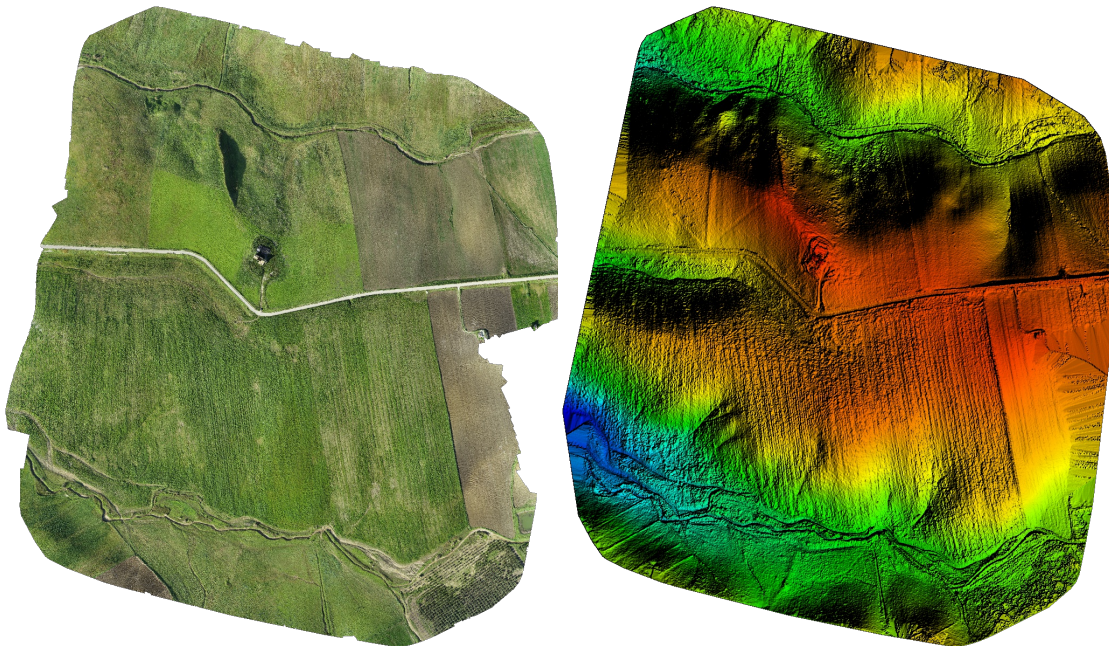


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

# Calibration Details



Number of Calibrated Images	987 out of 987
Number of Geolocated Images	987 out of 987

## Initial Image Positions

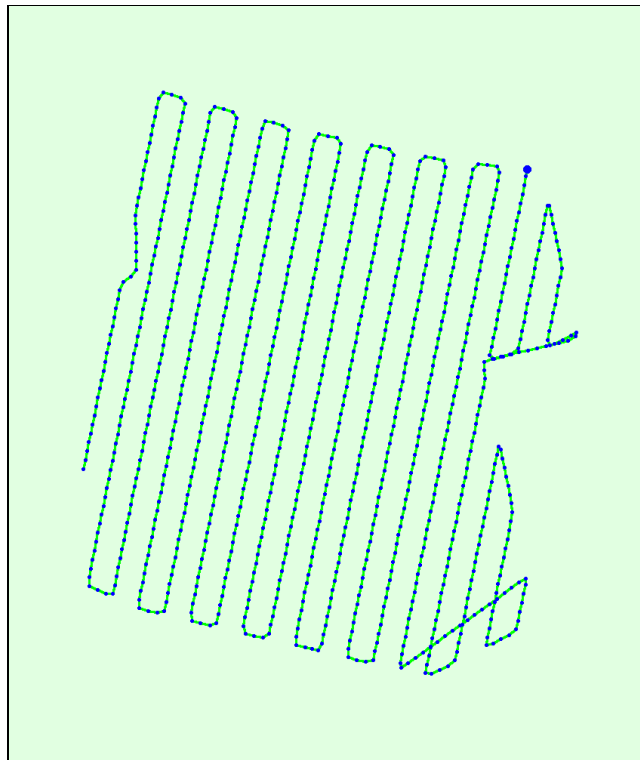
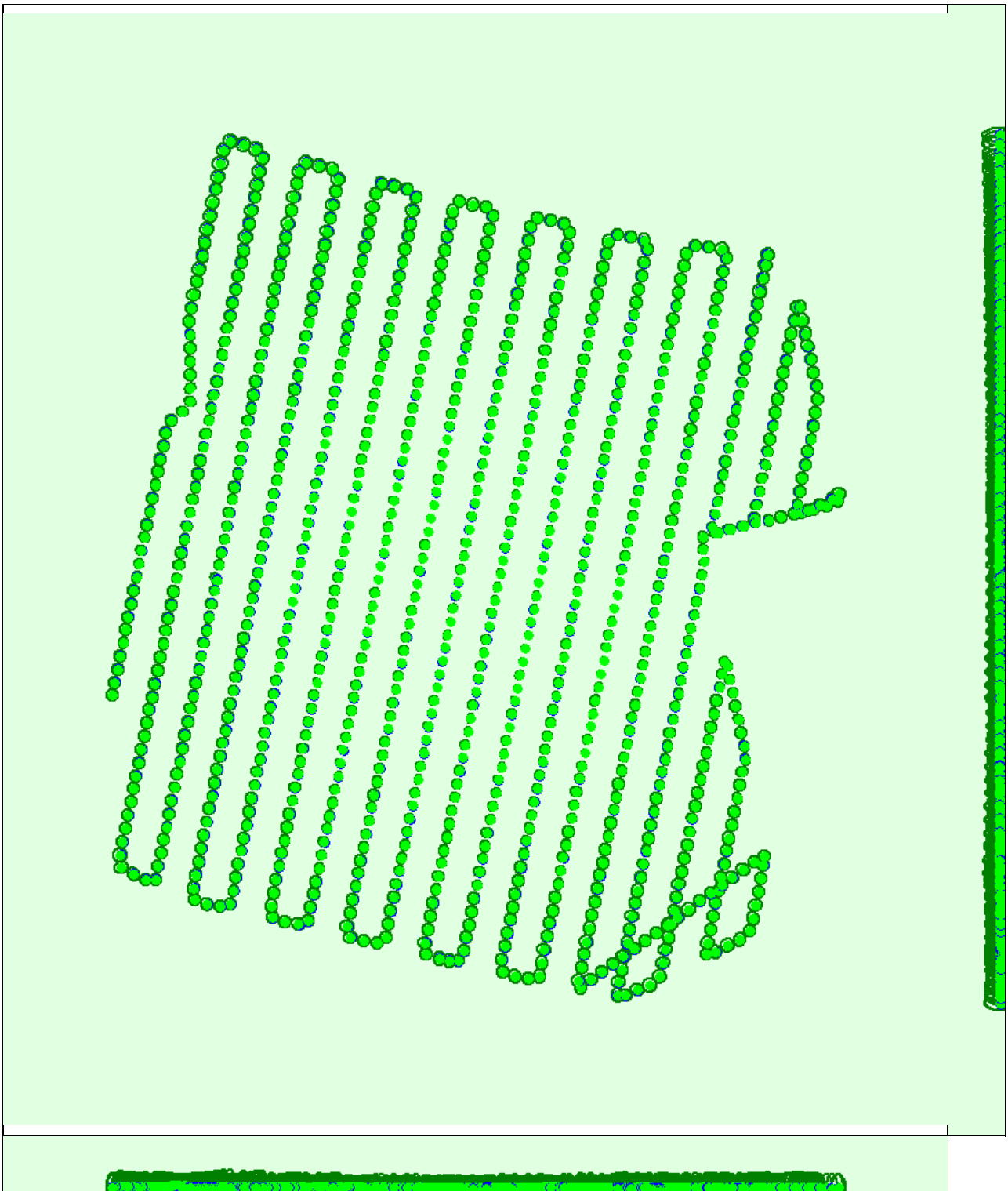


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

## 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]
Mean	0.064	0.064	0.139	0.020	0.020	0.007
Sigma	0.010	0.010	0.024	0.003	0.002	0.000

**? Overlap**



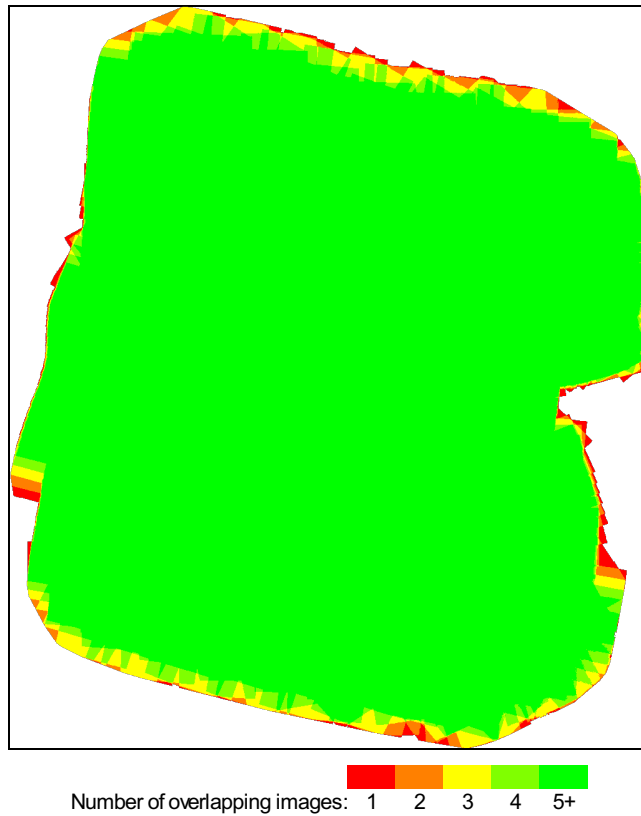


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint 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	37754975
Number of 3D Points for Bundle Block Adjustment	11620216
Mean Reprojection Error [pixels]	0.113

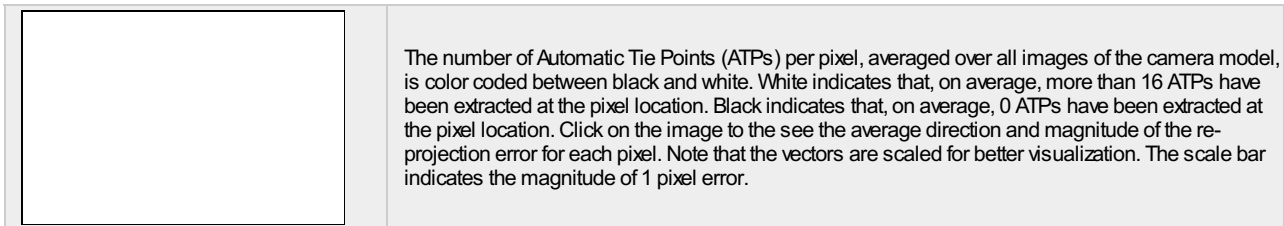
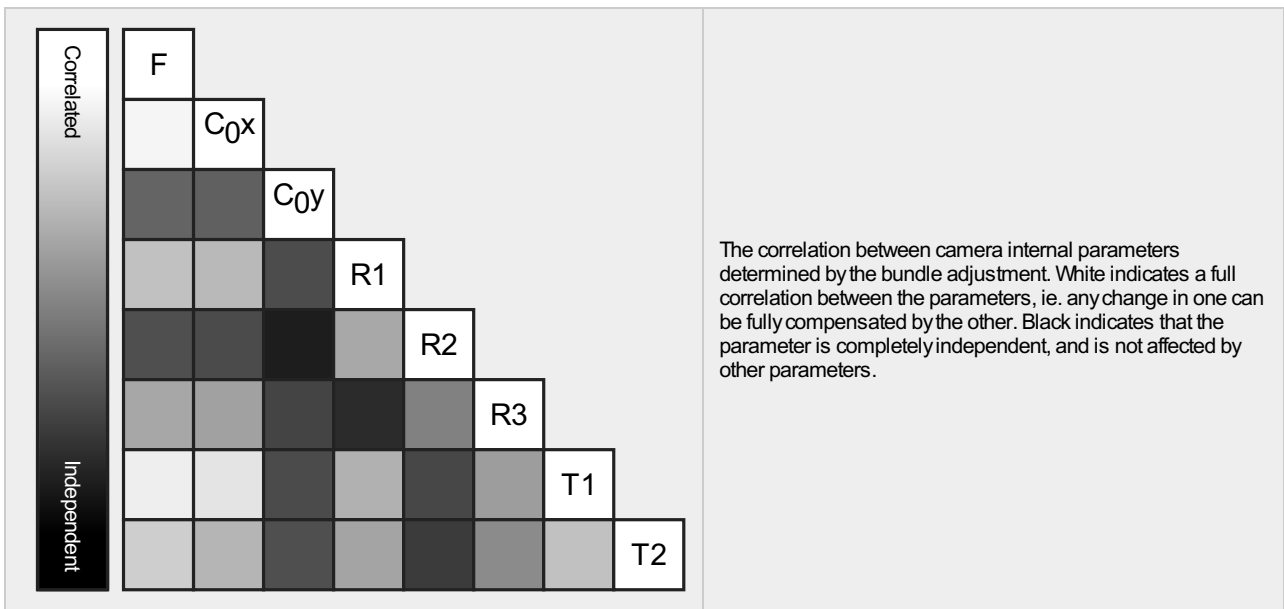
### Internal Camera Parameters

FC6310\_8.8\_5472x3648 (RGB). Sensor Dimensions: 12.833 [mm] x 8.556 [mm]



EXIF ID: FC6310S\_8.8\_5472x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3668.759 [pixel] 8.604 [mm]	2736.001 [pixel] 6.417 [mm]	1823.999 [pixel] 4.278 [mm]	0.003	-0.008	0.008	-0.000	0.000
Optimized Values	3771.860 [pixel] 8.846 [mm]	2714.988 [pixel] 6.367 [mm]	1806.325 [pixel] 4.236 [mm]	-0.014	0.004	0.006	-0.002	-0.001
Uncertainties (Sigma)	9.149 [pixel] 0.021 [mm]	0.201 [pixel] 0.000 [mm]	0.055 [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	84134	38005
Mn	67662	17715
Max	93215	51917
Mean	83299	38252

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



	Number of 3D Points Observed
In 2 Images	6487994
In 3 Images	2312856
In 4 Images	1064848
In 5 Images	576891
In 6 Images	350294
In 7 Images	220534
In 8 Images	144152
In 9 Images	102866
In 10 Images	76724
In 11 Images	59402
In 12 Images	46597
In 13 Images	36362
In 14 Images	28470
In 15 Images	22417
In 16 Images	17665
In 17 Images	14600
In 18 Images	11939
In 19 Images	9297
In 20 Images	7345
In 21 Images	5959
In 22 Images	4637
In 23 Images	3714

In 24 Images	3035
In 25 Images	2421
In 26 Images	1985
In 27 Images	1510
In 28 Images	1272
In 29 Images	1025
In 30 Images	812
In 31 Images	660
In 32 Images	492
In 33 Images	373
In 34 Images	279
In 35 Images	206
In 36 Images	169
In 37 Images	117
In 38 Images	88
In 39 Images	77
In 40 Images	57
In 41 Images	35
In 42 Images	22
In 43 Images	13
In 44 Images	5

 2D Keypoint Matches



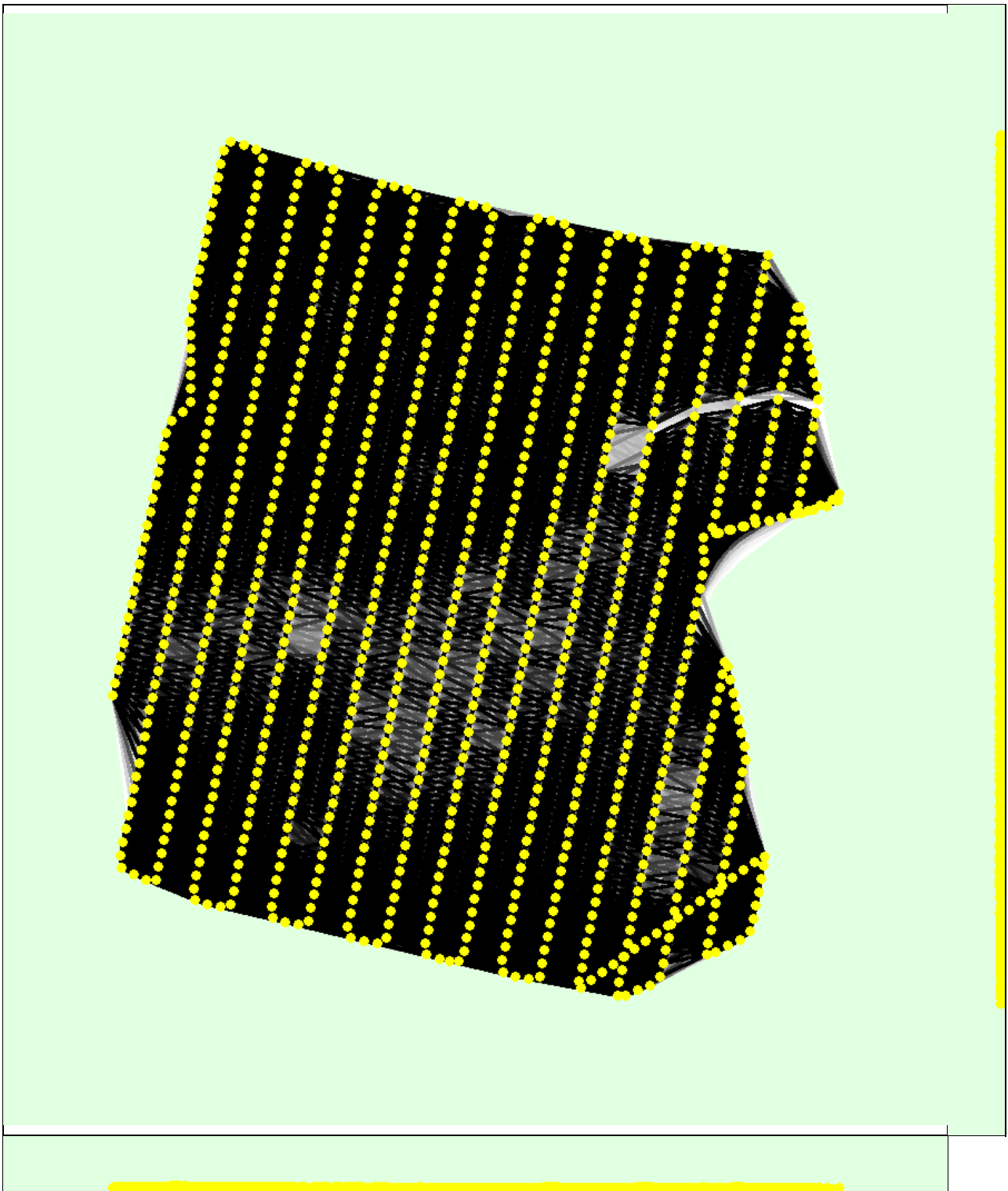


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

## Geolocation Details

### 🔍 Absolute Geolocation Variance

Mn 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	54.81	56.84	51.57
0.00	3.00	45.19	43.16	48.43
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
<b>Mean [m]</b>		0.000000	-0.000000	0.000185
<b>Sigma [m]</b>		0.501264	0.559017	0.508675
<b>RMS Error [m]</b>		0.501264	0.559017	0.508675

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]	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
<b>Mean of Geolocation Accuracy [m]</b>	5.000000	5.000000	10.000000
<b>Sigma of Geolocation Accuracy [m]</b>	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	0.327
Phi	0.583
Kappa	7.063

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) Core(TM) i7-10700 CPU @2.90GHz RAM: 16GB GPU: NVIDIA Quadro P1000 (Driver: 31.0.15.1740), Intel(R) UHD Graphics 630 (Driver: 27.20.100.8190), Virtual MonitorX (Driver: 17.10.42.834)
Operating System	Windows 10 Pro, 64-bit

### Coordinate Systems

Image Coordinate System	WGS 84 (EGM96 Geoid)
Output Coordinate System	WGS 84 / UTMzone 33N (EGM96 Geoid)

### Processing Options

Detected Template	 CUDDIA CURVE OK*
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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, no

## 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	53m:01s
Time for Point Cloud Classification	10m:36s
Time for 3D Textured Mesh Generation	25m:04s

### Results



Number of Processed Clusters	47
Number of Generated Tiles	4
Number of 3D Densified Points	91207627
Average Density (per m <sup>3</sup> )	121.73

## DSM, Orthomosaic and Index Details



### Processing Options



DSM and Orthomosaic Resolution	1 x GSD (3.29 [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: yes
Grid DSM	Generated: yes, Spacing [cm]: 100
Raster DTM	Generated: yes Merge Tiles: yes
DTM Resolution	5 x GSD (3.29 [cm/pixel])
Contour Lines Generation	Generated: yes Contour Base [m]: 0 Elevation Interval [m]: 0.5 Resolution [cm]: 300 Minimum Line Size [vertices]: 10
Time for DSM Generation	36m:31s

Time for Orthomosaic Generation	01h:49m:56s
Time for DTM Generation	36m:02s
Time for Contour Lines Generation	07s
Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s

- !** **Important:** Click on the different icons for:
  - ?** Help to analyze the results in the Quality Report
  - i** Additional information about the sections

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

## Summary



Project	gncr sottostazione
Processed	2023-02-22 13:19:11
Camera Model Name(s)	FC6310_8.8_5472x3648 (RGB)
Average Ground Sampling Distance (GSD)	2.76 cm / 1.09 in
Area Covered	0.133 km <sup>2</sup> / 13.2990 ha / 0.05 sq. mi. / 32.8796 acres
Time for Initial Processing (without report)	14m:15s

## Quality Check



<b>?</b> Images	median of 86920 keypoints per image	
<b>?</b> Dataset	104 out of 104 images calibrated (100%), all images enabled	
<b>?</b> Camera Optimization	7.36% relative difference between initial and optimized internal camera parameters	
<b>?</b> Matching	median of 52893.5 matches per calibrated image	
<b>?</b> Georeferencing	yes, no 3D GCP	

## **?** Preview

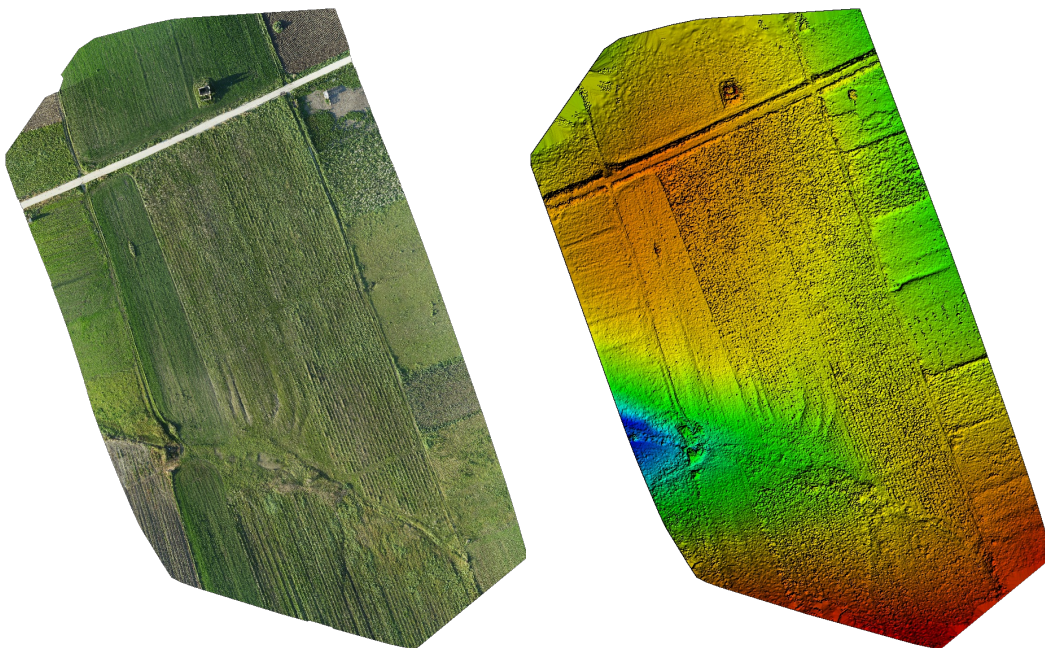


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

# Calibration Details



Number of Calibrated Images	104 out of 104
Number of Geolocated Images	104 out of 104

## ? Initial Image Positions

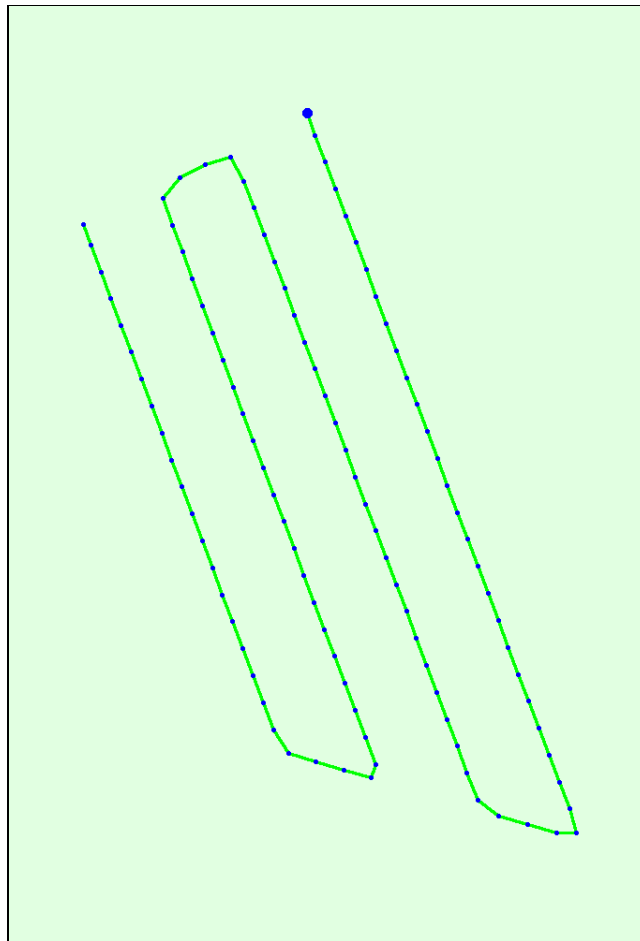
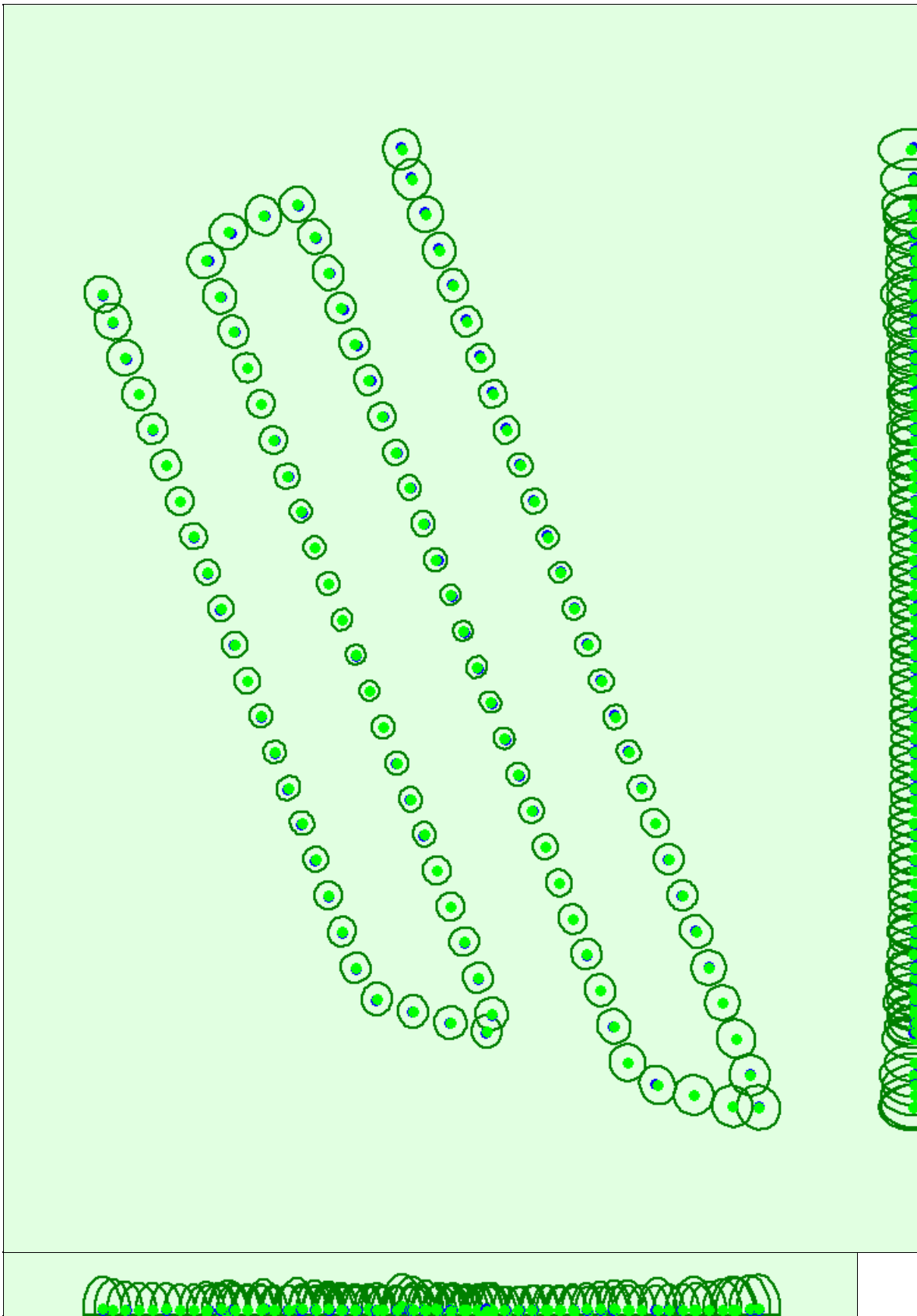


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

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





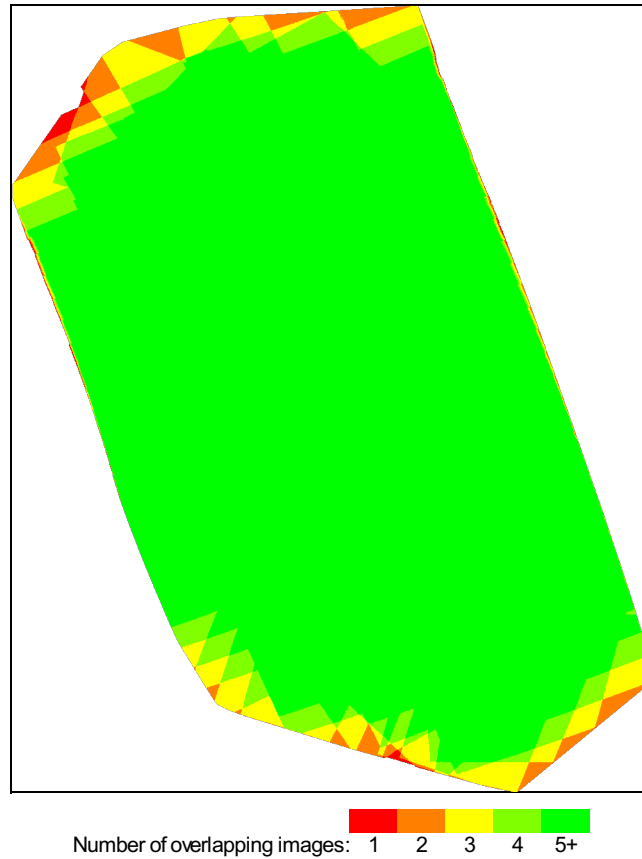
Uncertainty ellipses 100x magnified

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]
Mean	0.059	0.060	0.103	0.030	0.029	0.018
Sigma	0.011	0.011	0.011	0.005	0.004	0.000



**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

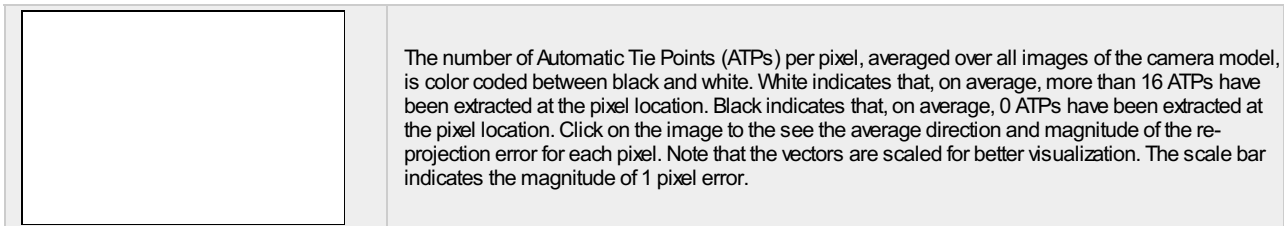
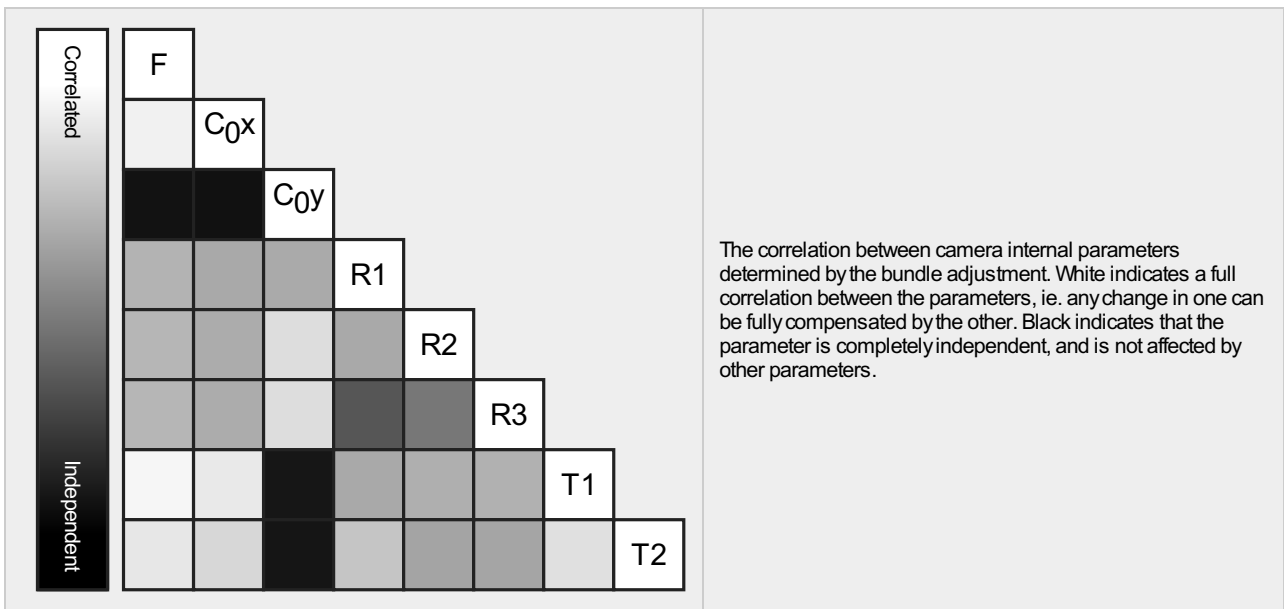
Number of 2D Keypoint Observations for Bundle Block Adjustment	5407933
Number of 3D Points for Bundle Block Adjustment	1796053
Mean Reprojection Error [pixels]	0.135

### **?** Internal Camera Parameters

**FC6310\_8.8\_5472x3648 (RGB). Sensor Dimensions: 12.833 [mm] x 8.556 [mm]**

EXIF ID: FC6310S\_8.8\_5472x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3668.759 [pixel] 8.604 [mm]	2736.001 [pixel] 6.417 [mm]	1823.999 [pixel] 4.278 [mm]	0.003	-0.008	0.008	-0.000	0.000
Optimized Values	3938.990 [pixel] 9.238 [mm]	2719.245 [pixel] 6.377 [mm]	1806.333 [pixel] 4.236 [mm]	-0.017	0.008	0.005	-0.002	-0.002
Uncertainties (Sigma)	19.986 [pixel] 0.047 [mm]	0.477 [pixel] 0.001 [mm]	0.147 [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	86920	52894
Mn	82134	40410
Max	91262	60623
Mean	86917	51999

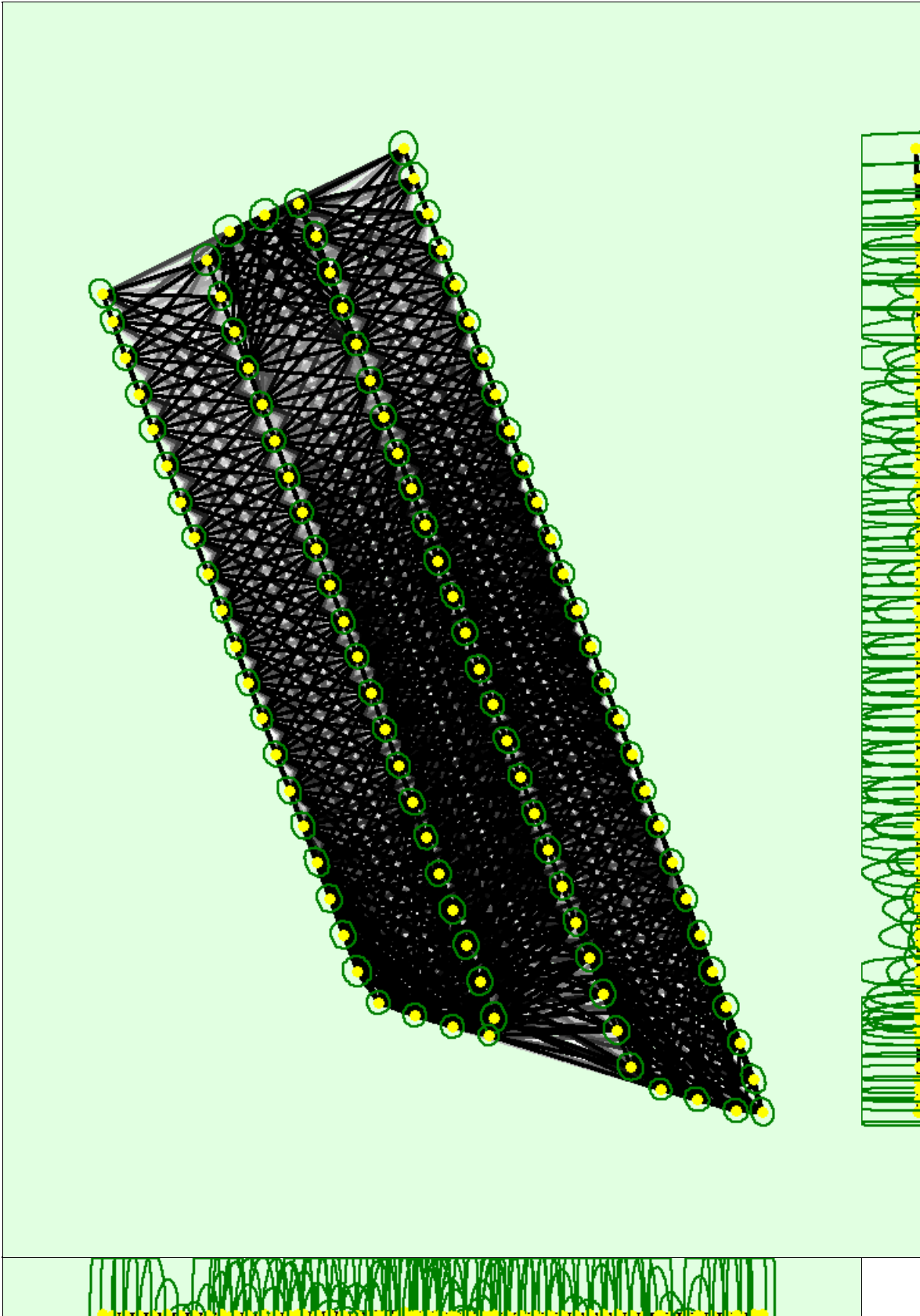
### 3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	1079046
In 3 Images	341784
In 4 Images	149327
In 5 Images	79587
In 6 Images	51358
In 7 Images	29243
In 8 Images	16040
In 9 Images	11986
In 10 Images	9339
In 11 Images	7305
In 12 Images	5837
In 13 Images	4509
In 14 Images	2741
In 15 Images	1976
In 16 Images	1501
In 17 Images	1222
In 18 Images	1002
In 19 Images	815
In 20 Images	433
In 21 Images	308
In 22 Images	243
In 23 Images	171



In 24 Images	103
In 25 Images	83
In 26 Images	50
In 27 Images	21
In 28 Images	17
In 29 Images	5
In 30 Images	1

2D Keypoint Matches



Uncertainty ellipses 1000x magnified



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	0.005	0.005	0.034	0.033	0.022	0.001
Sigma	0.000	0.000	0.021	0.020	0.016	0.000

## Geolocation Details

### Absolute Geolocation Variance

Mn 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	59.62	62.50	49.04
0.00	3.00	40.38	37.50	50.96
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
<b>Mean [m]</b>		-0.000372	0.000143	-0.014144
<b>Sigma [m]</b>		0.356747	0.469939	0.276105
<b>RMS Error [m]</b>		0.356748	0.469939	0.276467

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]	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
<b>Mean of Geolocation Accuracy [m]</b>	5.000000	5.000000	10.000000
<b>Sigma of Geolocation Accuracy [m]</b>	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	0.253
Phi	0.707
Kappa	3.524

# Initial Processing Details



## System Information



Hardware	CPU: Intel(R) Core(TM) i7-10700 CPU @ 2.90GHz RAM: 16GB GPU: NVIDIA Quadro P1000 (Driver: 31.0.15.1740), Intel(R) UHD Graphics 630 (Driver: 27.20.100.8190), Virtual MonitorX (Driver: 17.10.42.834)
Operating System	Windows 10 Pro, 64-bit

## Coordinate Systems



Image Coordinate System	WGS 84 (EGM96 Geoid)
Output Coordinate System	WGS 84 / UTMzone 33N (EGM96 Geoid)

## Processing Options



Detected Template	CUDDIACURVE OK*
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	07m:10s
Time for Point Cloud Classification	01m:19s
Time for 3D Textured Mesh Generation	03m:27s

## Results



Number of Generated Tiles	1
Number of 3D Densified Points	13074568
Average Density (per m <sup>3</sup> )	163.77

# DSM, Orthomosaic and Index Details



## Processing Options



DSM and Orthomosaic Resolution	1 x GSD (2.76 [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: yes
Grid DSM	Generated: yes, Spacing [cm]: 100
Raster DTM	Generated: yes Merge Tiles: yes
DTM Resolution	5 x GSD (2.76 [cm/pixel])
Contour Lines Generation	Generated: yes Contour Base [m]: 0 Elevation Interval [m]: 0.5 Resolution [cm]: 300 Minimum Line Size [vertices]: 10
Time for DSM Generation	05m:08s
Time for Orthomosaic Generation	15m:45s
Time for DTM Generation	05m:48s
Time for Contour Lines Generation	01s
Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s