

LOCALIZZAZIONE

**REGIONE SICILIA
PROVINCIA DI TRAPANI
COMUNI DI CALATAFIMI SEGESTA, SANTA NINFA E GIBELLINA**



TITOLO BREVE

AGRIVOLTAICO "GIBELLINA"

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

REVISIONI						
	00	16/05/2022	PRIMA EMISSIONE ELABORATO	Claudio Rizzo	Staff	Claudio Rizzo
	REV	DATA	DESCRIZIONE	REDATTO	VERIFICATO	APPROVATO

PROPONENTE

X-ELIO+

X-ELIO GIBELLINA S.r.l.
Corso Vittorio Emanuele II, 349 - 00186 - ROMA
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C.F./P.IVA 16234841001

PROGETTAZIONE E SERVIZI



ENVLAB s.r.l.s. - C.F./P. IVA 02920050842
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CODICE ELABORATO

XE-GIBELLINA-AFV-PD-R-1.1.2.0-r0A-R00

FOGLIO

1/28

FORMATO

A4

SCALA



IL DIRETTORE TECNICO DI ENVLAB



PROGETTO

IMPIANTO AGRIVOLTAICO "GIBELLINA" - PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO AGRIVOLTAICO DELLA POTENZA DI 86.95 MWp (80,00 MW IN IMMISSIONE) CON SISTEMA DI ACCUMULO DA 40,00 MW E RELATIVE OPERE DI CONNESSIONE ALLA RTN RICADENTE NEL COMUNI DI CALATAFIMI-SEGESTA, SANTA NINFA E GIBELLINA

OGGETTO ELABORATO

PROGETTO DEFINITIVO
**REPORT RILIEVO E RESTITUZIONE AERO-
FOTOGRAMMETRICA DELLE AREE DI PROGETTO**

Progettazione e Consulenza Ambientale	ELABORATO	PROPONENTE
	<p align="center">REPORT RILIEVO E RESTITUZIONE AEROFOTOGRAMMETRICA DELLE AREE DI PROGETTO</p>	<p align="center">X-ELIO X-ELIO GIBELLINA S.r.l. Corso Vittorio Emanuele II, 349 00186 ROMA – C.F./P.IVA 16234841001</p>
<p align="center">IMPIANTO AGRIVOLTAICO "GIBELLINA" PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO AGRIVOLTAICO DELLA POTENZA DI 86.95 MWp (80,00 MW IN IMMISSIONE) CON SISTEMA DI ACCUMULO DA 40,00 MW E RELATIVE OPERE DI CONNESSIONE ALLA RTN RICADENTE NEL COMUNI DI CALATAFIMI-SEGESTA, SANTA NINFA E GIBELLINA</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 dell'impianto agrovoltaco "GIBELLINA" della potenza di 86,95 MWp (80,00 MW in immissione) con sistema di accumulo da 40 MW e delle relative opere di connessione alla RTN che la società X-ELIO GIBELLINA S.r.l. intende realizzare nei Comuni di Calatafimi-Segesta, Santa Ninfa e Gibellina in provincia di Trapani.

Il soggetto proponente dell'iniziativa è la Società X-ELIO GIBELLINA S.r.l. avente sede legale ed operativa in ROMA, Corso Vittorio Emanuele II n. 349, iscritta nella Sezione Ordinaria della Camera di Commercio Industria Agricoltura ed Artigianato di Roma, C.F. e P.IVA N. 16234841001.

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/.

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">REPORT RILIEVO E RESTITUZIONE AEROFOTOGRAMMETRICA DELLE AREE DI PROGETTO</p>	<p align="center">X-ELIO X-ELIO GIBELLINA S.r.l. Corso Vittorio Emanuele II, 349 00186 ROMA – C.F./P.IVA 16234841001</p>
<p align="center">IMPIANTO AGRIVOLTAICO "GIBELLINA" PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO AGRIVOLTAICO DELLA POTENZA DI 86.95 MW_p (80,00 MW IN IMMISSIONE) CON SISTEMA DI ACCUMULO DA 40,00 MW E RELATIVE OPERE DI CONNESSIONE ALLA RTN RICADENTE NEL COMUNI DI CALATAFIMI-SEGESTA, SANTA NINFA E GIBELLINA</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



Additional information about the sections



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

Summary



Project	calatafimi
Processed	2021-11-23 19:01:27
Camera Model Name(s)	FC6310_8.8_5472x3648 (RGB)
Average Ground Sampling Distance (GSD)	3.66 cm / 1.44 in
Area Covered	2.182 km ² / 218.1636 ha / 0.84 sq. mi. / 539.3729 acres
Time for Initial Processing (without report)	02h:31m:30s

Quality Check



Images	median of 73158 keypoints per image	
Dataset	1622 out of 1622 images calibrated (100%), all images enabled	
Camera Optimization	2.14% relative difference between initial and optimized internal camera parameters	
Matching	median of 35959.4 matches per calibrated image	
Georeferencing	yes, no 3D GCP	

Preview

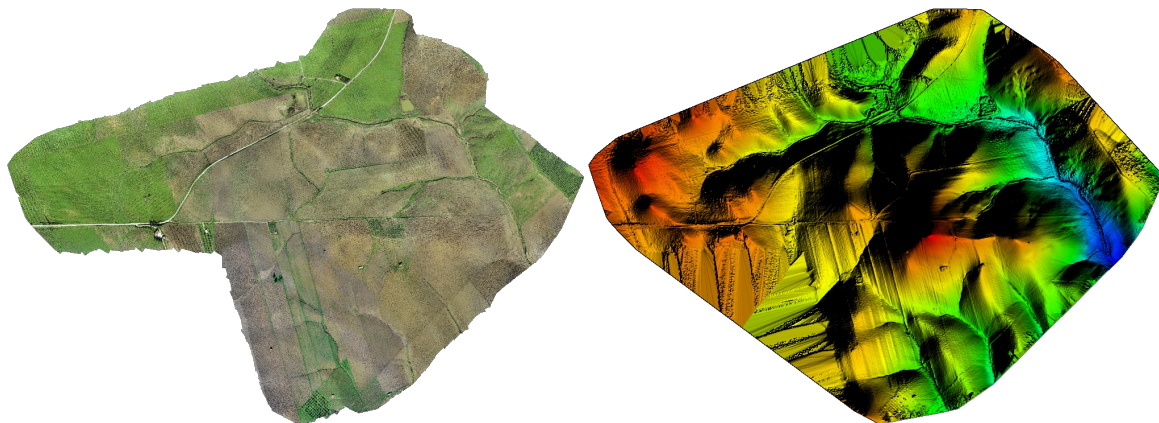


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details



Number of Calibrated Images	1622 out of 1622
Number of Geolocated Images	1622 out of 1622

Initial Image Positions

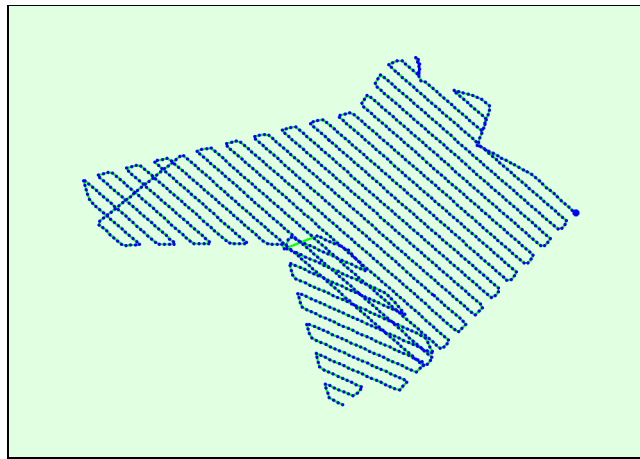
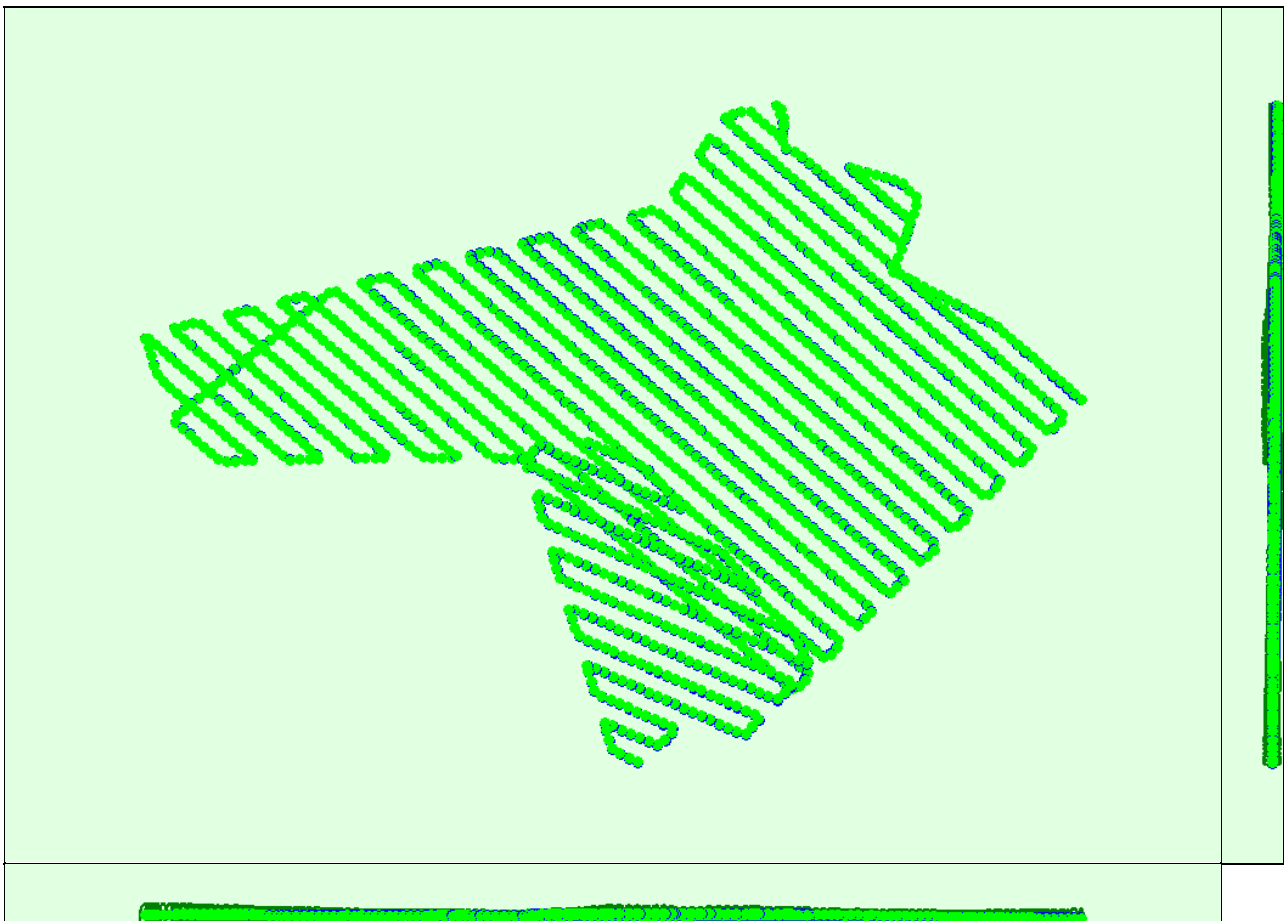


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

Computed Image/GCPs/Manual Tie Points Positions



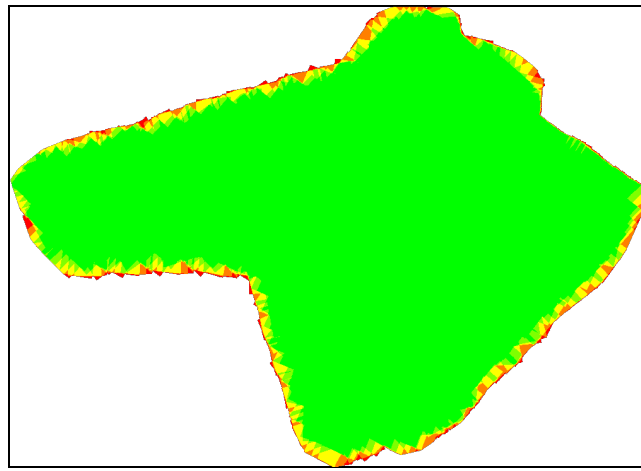
Uncertainty ellipses 100x magnified

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	0.055	0.054	0.130	0.014	0.014	0.004
Sigma	0.011	0.011	0.030	0.004	0.002	0.000



Number of overlapping images: 1 2 3 4 5+

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

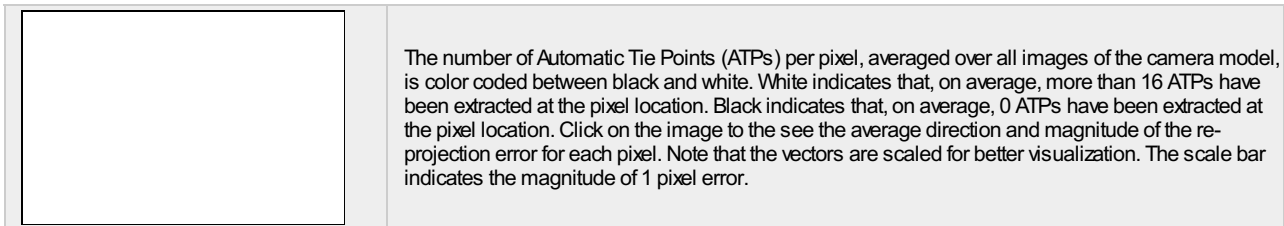
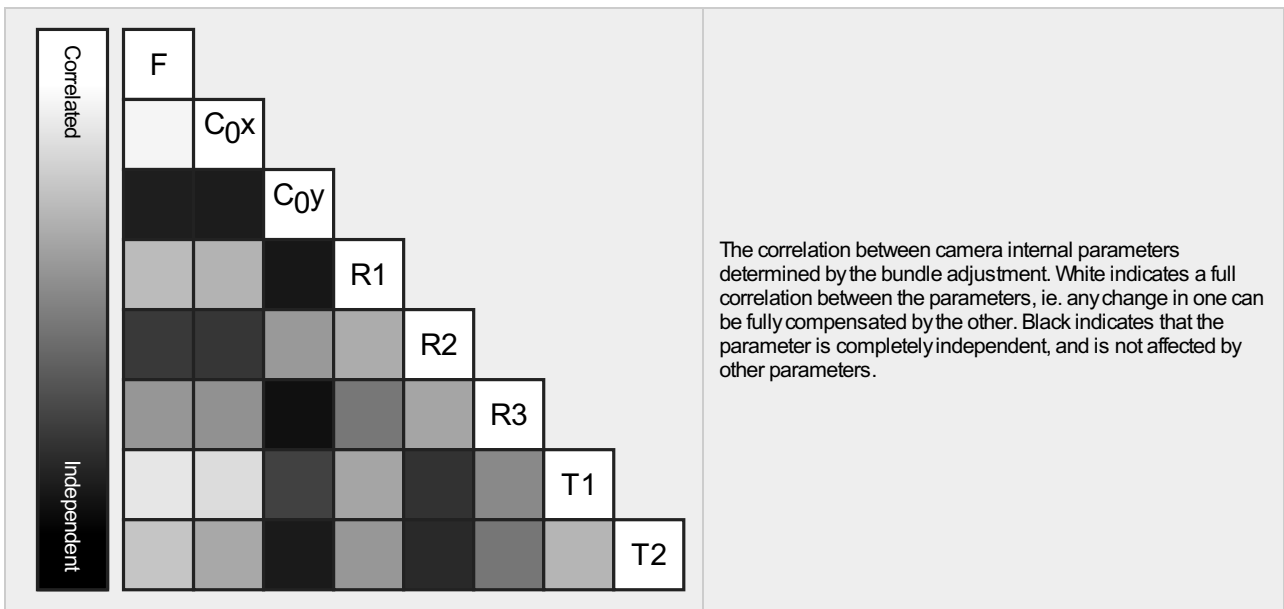
Number of 2D Keypoint Observations for Bundle Block Adjustment	53397557
Number of 3D Points for Bundle Block Adjustment	15365245
Mean Reprojection Error [pixels]	0.120

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	3747.415 [pixel] 8.789 [mm]	2714.725 [pixel] 6.367 [mm]	1806.091 [pixel] 4.236 [mm]	-0.014	0.004	0.006	-0.002	-0.001
Uncertainties (Sigma)	5.657 [pixel] 0.013 [mm]	0.127 [pixel] 0.000 [mm]	0.031 [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	73158	35959
Mn	50486	2908
Max	93221	57579
Mean	72339	32921

? 3D Points from 2D Keypoint Matches



	Number of 3D Points Observed
In 2 Images	8054306
In 3 Images	3014172
In 4 Images	1481962
In 5 Images	852610
In 6 Images	537577
In 7 Images	353751
In 8 Images	248853
In 9 Images	184141
In 10 Images	139266
In 11 Images	106106
In 12 Images	83140
In 13 Images	64919
In 14 Images	51269
In 15 Images	40718
In 16 Images	32130
In 17 Images	25587
In 18 Images	20531
In 19 Images	16129
In 20 Images	13010
In 21 Images	10418
In 22 Images	8311
In 23 Images	6281

In 24 Images	4885
In 25 Images	3766
In 26 Images	2811
In 27 Images	2080
In 28 Images	1515
In 29 Images	1168
In 30 Images	870
In 31 Images	676
In 32 Images	559
In 33 Images	389
In 34 Images	322
In 35 Images	231
In 36 Images	193
In 37 Images	132
In 38 Images	118
In 39 Images	89
In 40 Images	59
In 41 Images	44
In 42 Images	42
In 43 Images	32
In 44 Images	21
In 45 Images	20
In 46 Images	9
In 47 Images	11
In 48 Images	5
In 49 Images	6
In 50 Images	2
In 51 Images	1
In 52 Images	1
In 54 Images	1

2D Keypoint Matches

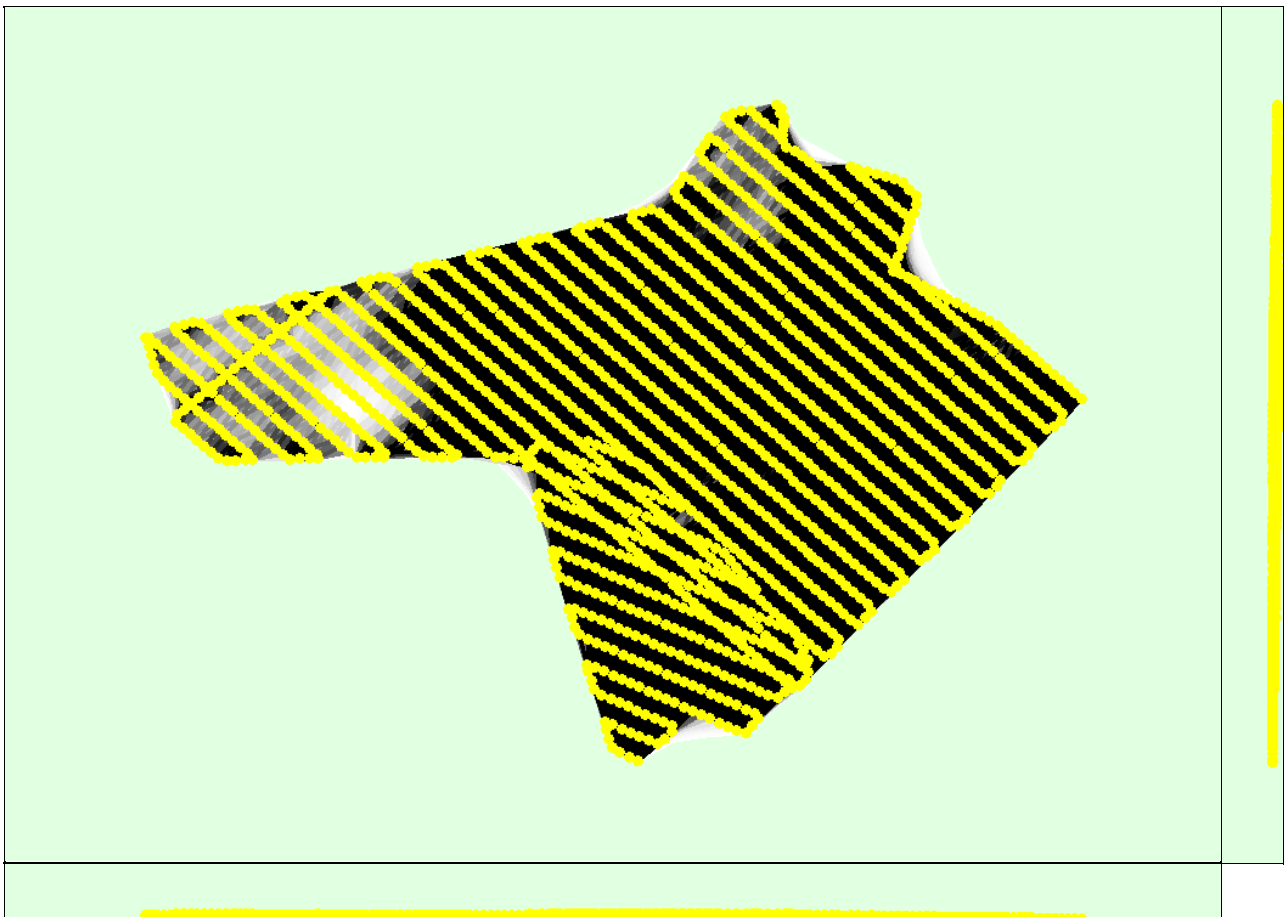




Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

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	0.06	5.92	0.00
-3.00	0.00	52.40	38.96	52.03
0.00	3.00	47.53	55.06	46.55
3.00	6.00	0.00	0.06	1.42
6.00	9.00	0.00	0.00	0.00
9.00	12.00	0.00	0.00	0.00
12.00	15.00	0.00	0.00	0.00
15.00	-	0.00	0.00	0.00
Mean [m]		-0.000000	-0.000000	0.000000
Sigma [m]		0.978225	1.647113	1.491444
RMS Error [m]		0.978225	1.647113	1.491444

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
Mean of Geolocation Accuracy [m]	5.000000	5.000000	10.000000
Sigma of Geolocation Accuracy [m]	0.000000	0.000000	0.000000

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

Geolocation Orientational Variance	RMS [degree]
Omega	0.619
Phi	0.533
Kappa	2.709

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: 27.21.14.5148), Intel(R) UHD Graphics 630 (Driver: 27.20.100.8190)
Operating System	Windows 10 Pro, 64-bit

Coordinate Systems



Image Coordinate System	WGS 84 (EGM96 Geoid)
Output Coordinate System	WGS 84 / UTM zone 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:12m:13s
Time for Point Cloud Classification	15m:42s
Time for 3D Textured Mesh Generation	22m:49s

Results



Number of Processed Clusters	74
Number of Generated Tiles	6
Number of 3D Densified Points	136638871
Average Density (per m ³)	83.05

DSM, Orthomosaic and Index Details



Processing Options



DSM and Orthomosaic Resolution	1 x GSD (3.66 [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
DTMResolution	5 x GSD (3.66 [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	58m:12s
Time for Orthomosaic Generation	04h:49m:47s
Time for DTM Generation	01h:19m:54s
Time for Contour Lines Generation	15s
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 i

Project	gibbellina est
Processed	2021-11-24 19:49:11
Camera Model Name(s)	FC6310_8.8_5472x3648 (RGB)
Average Ground Sampling Distance (GSD)	2.81 cm / 1.11 in
Area Covered	0.474 km ² / 47.4071 ha / 0.18 sq. mi. / 117.2060 acres
Time for Initial Processing (without report)	42m:16s

Quality Check i

? Images	median of 83018 keypoints per image	✓
? Dataset	338 out of 338 images calibrated (100%), all images enabled	✓
? Camera Optimization	1.35% relative difference between initial and optimized internal camera parameters	✓
? Matching	median of 51867.3 matches per calibrated image	✓
? Georeferencing	yes, no 3D GCP	⚠

? Preview i

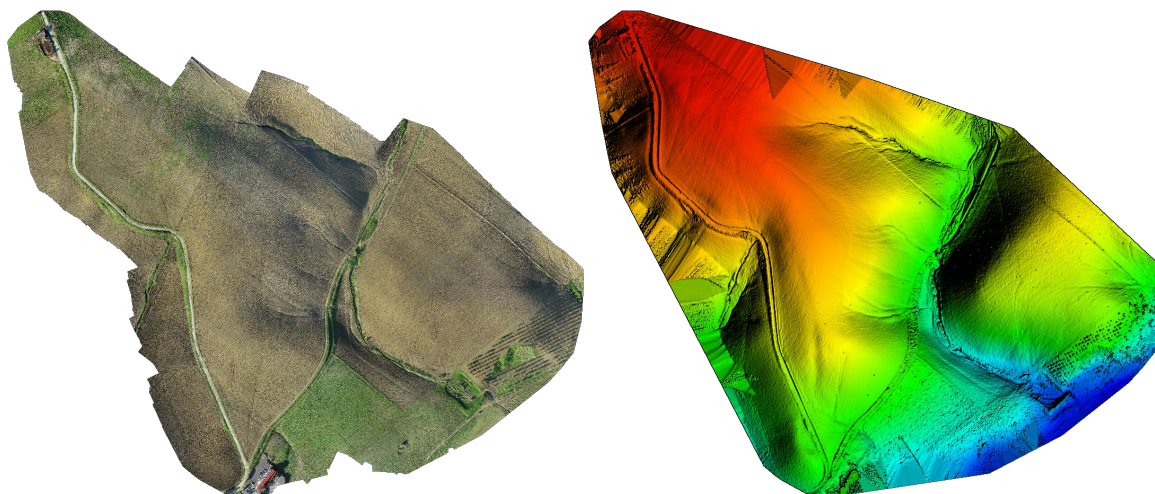


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details i

Number of Calibrated Images	338 out of 338
Number of Geolocated Images	338 out of 338

Initial Image Positions

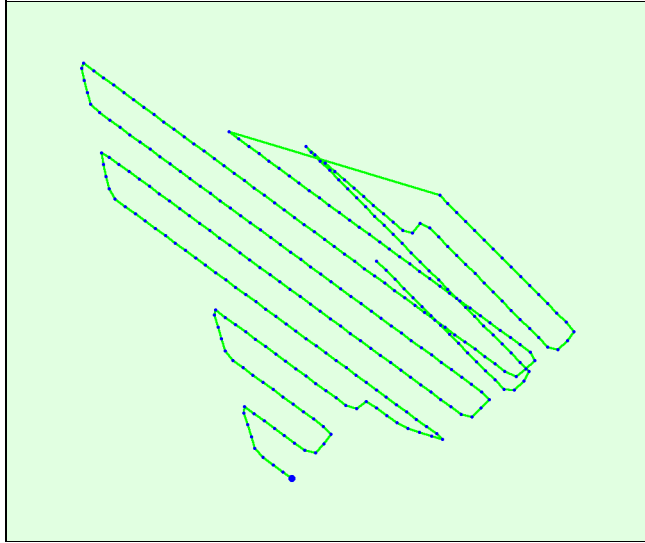
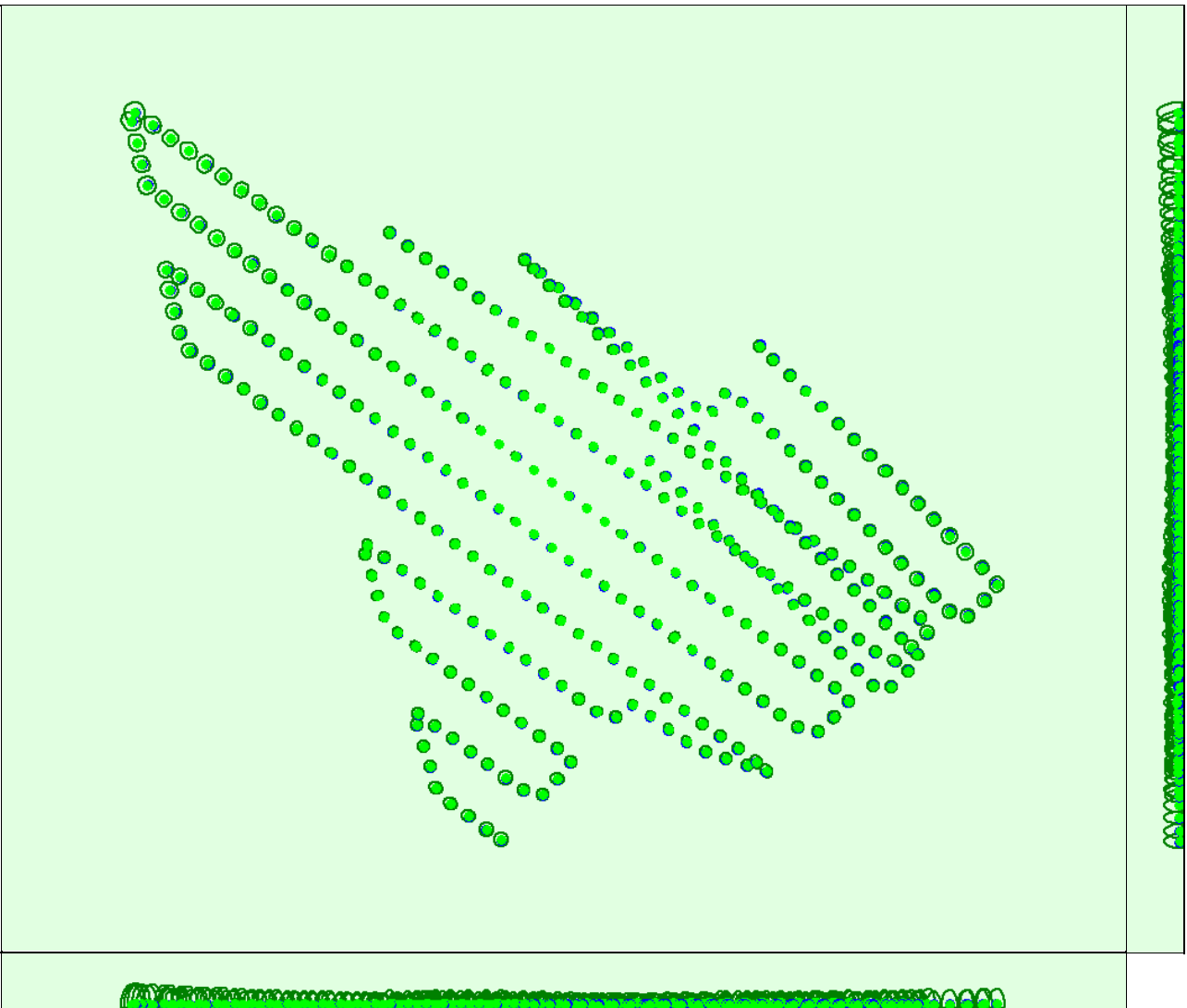


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

Computed Image/GCPs/Manual Tie Points Positions



Uncertainty ellipses 50x 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	0.116	0.116	0.234	0.041	0.041	0.018
Sigma	0.024	0.024	0.045	0.003	0.003	0.000

Overlap

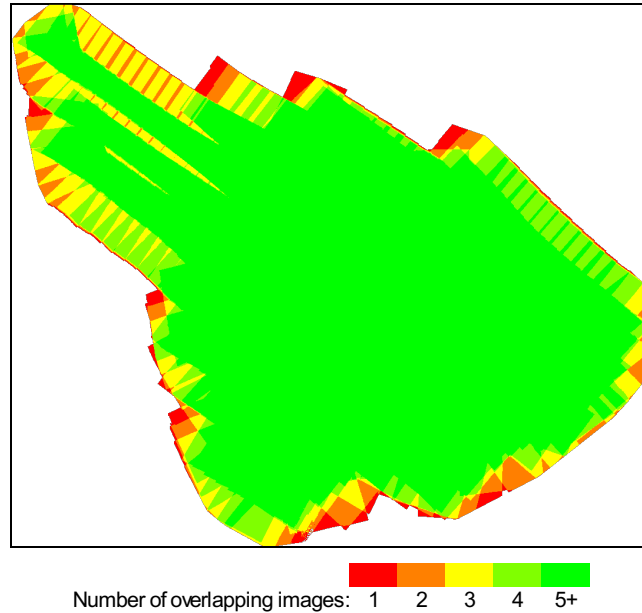


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint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

Bundle Block Adjustment Details

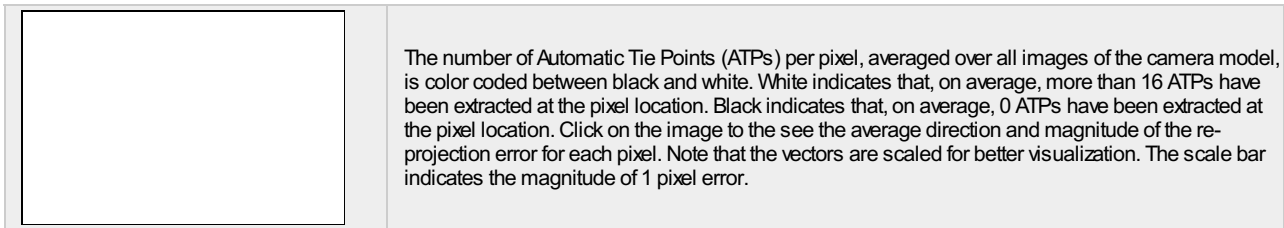
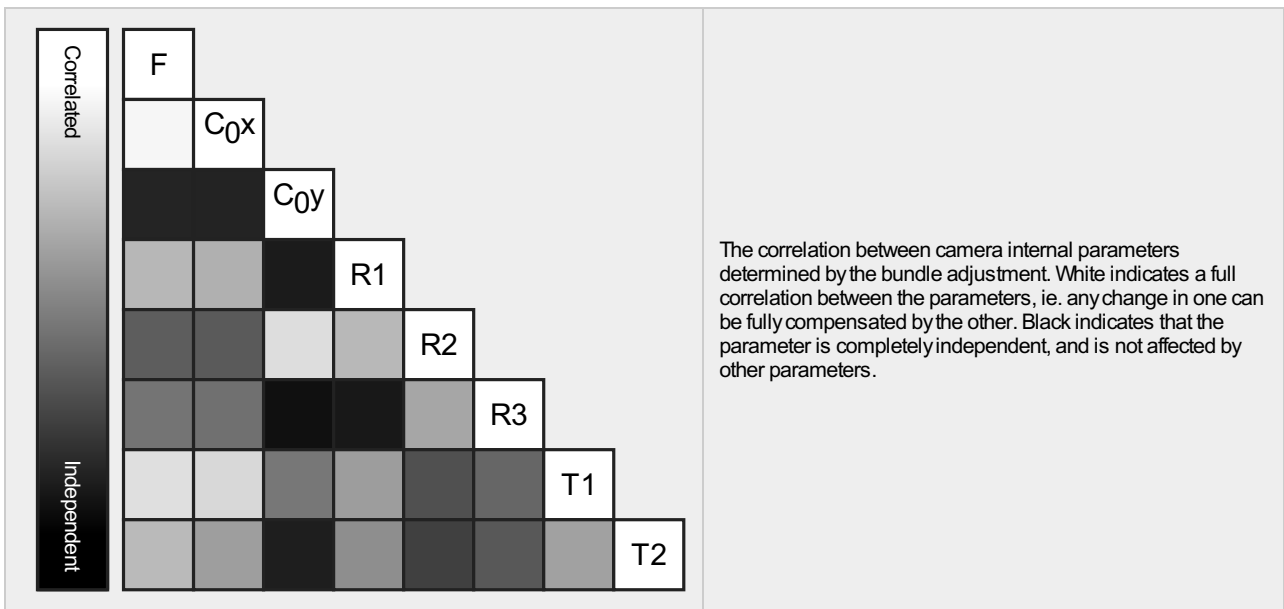
Number of 2D Keypoint Observations for Bundle Block Adjustment	17194731
Number of 3D Points for Bundle Block Adjustment	5647335
Mean Reprojection Error [pixels]	0.132

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	3718.319 [pixel] 8.720 [mm]	2714.160 [pixel] 6.365 [mm]	1805.990 [pixel] 4.236 [mm]	-0.015	0.006	0.004	-0.002	-0.001
Uncertainties (Sigma)	11.107 [pixel] 0.026 [mm]	0.272 [pixel] 0.001 [mm]	0.062 [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	83018	51867
Mn	65327	27300
Max	99747	70477
Mean	83574	50872

3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	3223014
In 3 Images	1136616
In 4 Images	535097
In 5 Images	275990
In 6 Images	161379
In 7 Images	106137
In 8 Images	71038
In 9 Images	46137
In 10 Images	28982
In 11 Images	19643
In 12 Images	13008
In 13 Images	9247
In 14 Images	6482
In 15 Images	4583
In 16 Images	3063
In 17 Images	2065
In 18 Images	1432
In 19 Images	1031
In 20 Images	735
In 21 Images	524
In 22 Images	386
In 23 Images	266

In 24 Images	178
In 25 Images	115
In 26 Images	70
In 27 Images	53
In 28 Images	28
In 29 Images	13
In 30 Images	15
In 31 Images	4
In 32 Images	3
In 33 Images	1

2D Keypoint Matches

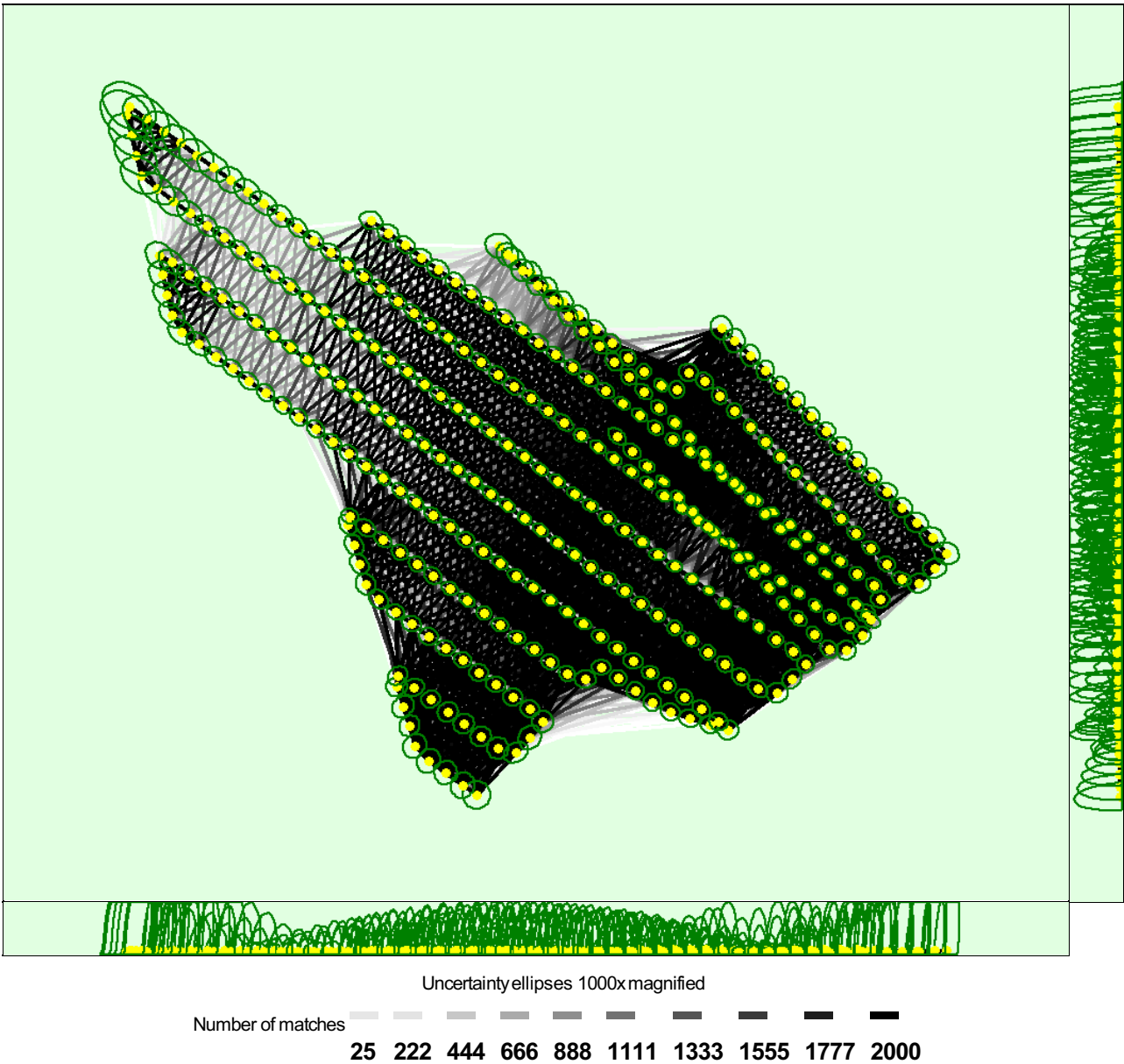


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images. Dark green ellipses indicate the relative camera position uncertainty 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	0.010	0.009	0.036	0.014	0.014	0.002
Sigma	0.003	0.003	0.026	0.009	0.008	0.001

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	49.70	61.83	42.01
0.00	3.00	50.30	38.17	57.99
3.00	6.00	0.00	0.00	0.00
6.00	9.00	0.00	0.00	0.00
9.00	12.00	0.00	0.00	0.00
12.00	15.00	0.00	0.00	0.00
15.00	-	0.00	0.00	0.00
Mean [m]		-0.000000	-0.000000	0.000001
Sigma [m]		0.525829	0.798657	0.955686
RMS Error [m]		0.525829	0.798657	0.955686

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
Mean of Geolocation Accuracy [m]	5.000000	5.000000	10.000000
Sigma of Geolocation Accuracy [m]	0.000000	0.000000	0.000000

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

Geolocation Orientational Variance	RMS [degree]
Omega	0.535
Phi	0.575
Kappa	3.361

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: 27.21.14.5148), Intel(R) UHD Graphics 630 (Driver: 27.20.100.8190)
Operating System	Windows 10 Pro, 64-bit

Coordinate Systems



Image Coordinate System	WGS 84 (EGM96 Geoid)
Output Coordinate System	WGS 84 / UTM zone 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	19m:36s
Time for Point Cloud Classification	03m:45s
Time for 3D Textured Mesh Generation	10m:01s

Results



Number of Processed Clusters	3
Number of Generated Tiles	3
Number of 3D Densified Points	46813973
Average Density (per m ³)	214.79

DSM, Orthomosaic and Index Details



Processing Options



DSM and Orthomosaic Resolution	1 x GSD (2.81 [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
DTMResolution	5 x GSD (2.81 [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	17m:39s
Time for Orthomosaic Generation	48m:32s
Time for DTM Generation	29m:12s
Time for Contour Lines Generation	05s
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	gibellina sud
Processed	2021-11-23 13:42:05
Camera Model Name(s)	FC6310_8.8_4864x3648 (RGB)
Average Ground Sampling Distance (GSD)	3.60 cm / 1.42 in
Area Covered	0.478 km ² / 47.7598 ha / 0.18 sq. mi. / 118.0781 acres
Time for Initial Processing (without report)	24m:11s

Quality Check



? Images	median of 73335 keypoints per image	✓
? Dataset	319 out of 322 images calibrated (99%), all images enabled	✓
? Camera Optimization	4.32% relative difference between initial and optimized internal camera parameters	✓
? Matching	median of 45488.1 matches per calibrated image	✓
? Georeferencing	yes, no 3D GCP	⚠

? Preview

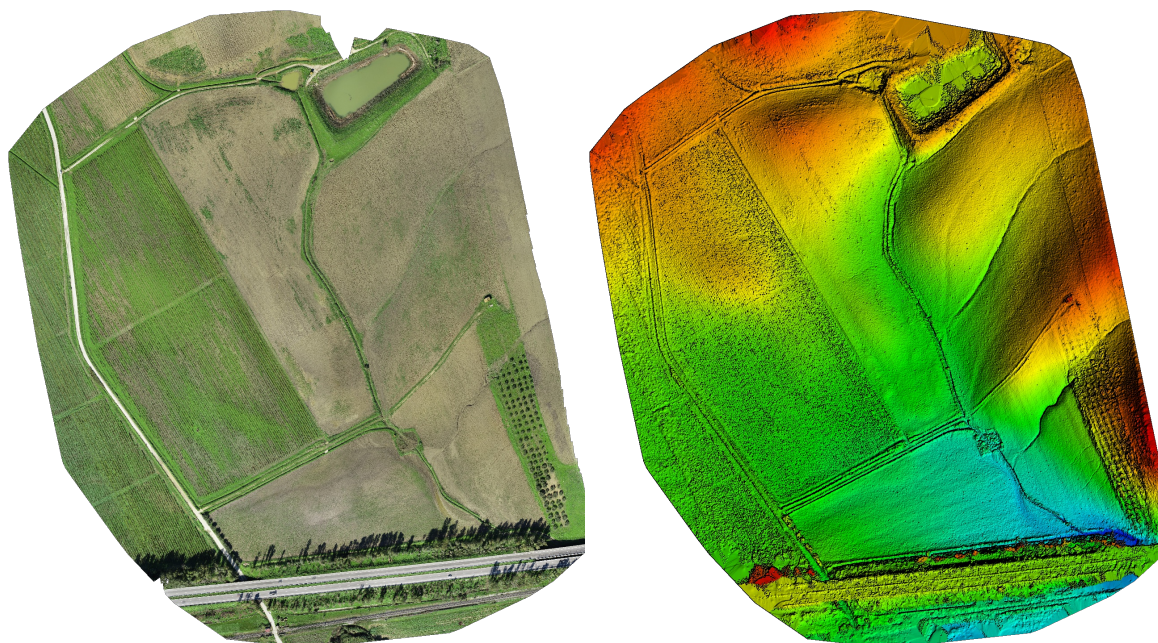


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details



Number of Calibrated Images	319 out of 322
Number of Geolocated Images	322 out of 322

Initial Image Positions

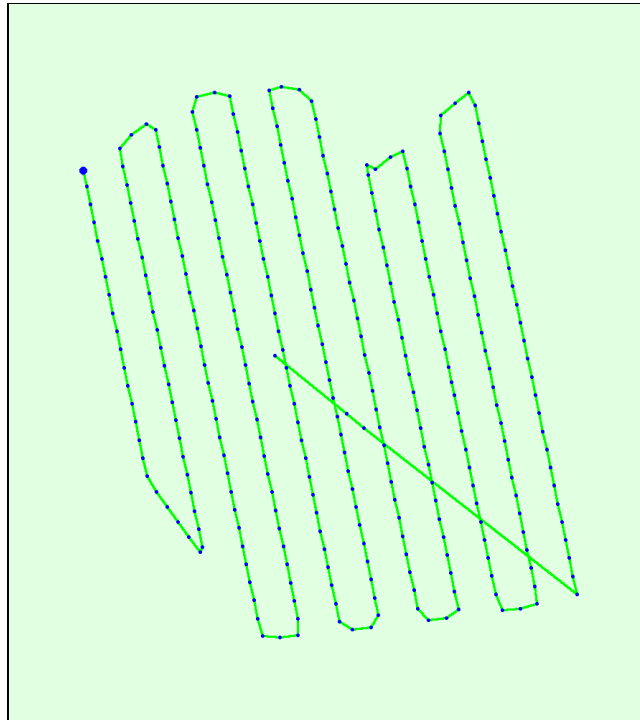
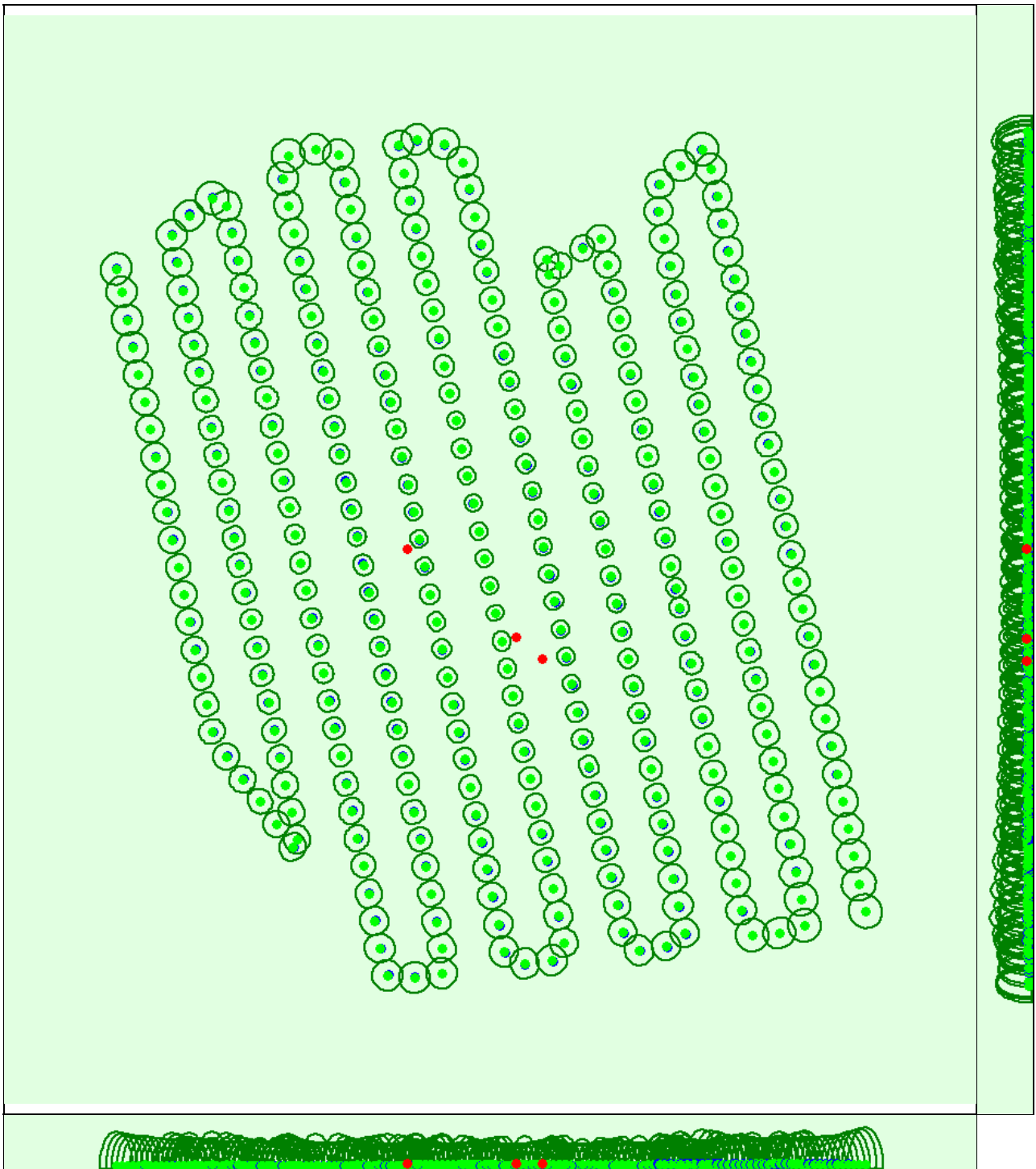


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

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). 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	0.100	0.100	0.200	0.040	0.041	0.017
Sigma	0.016	0.016	0.030	0.008	0.005	0.000

🔍 Overlap



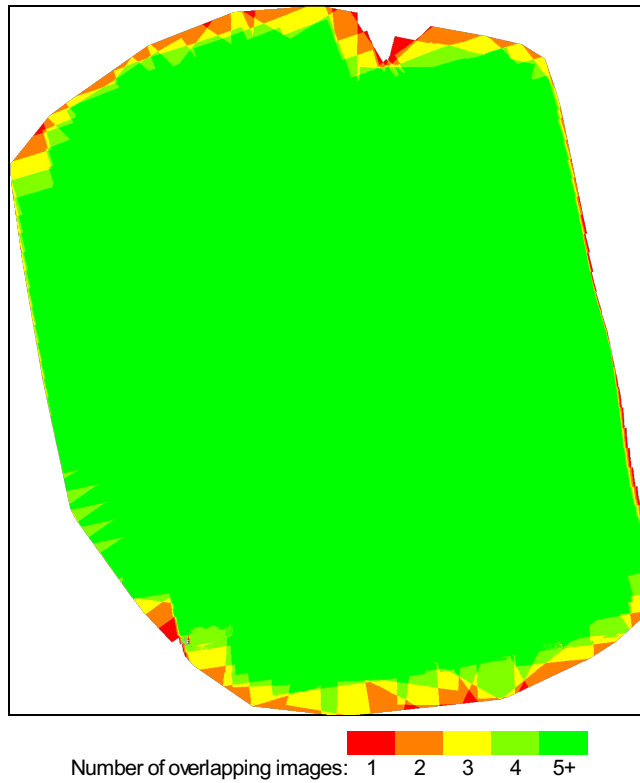


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint 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	14544777
Number of 3D Points for Bundle Block Adjustment	3973010
Mean Reprojection Error [pixels]	0.145

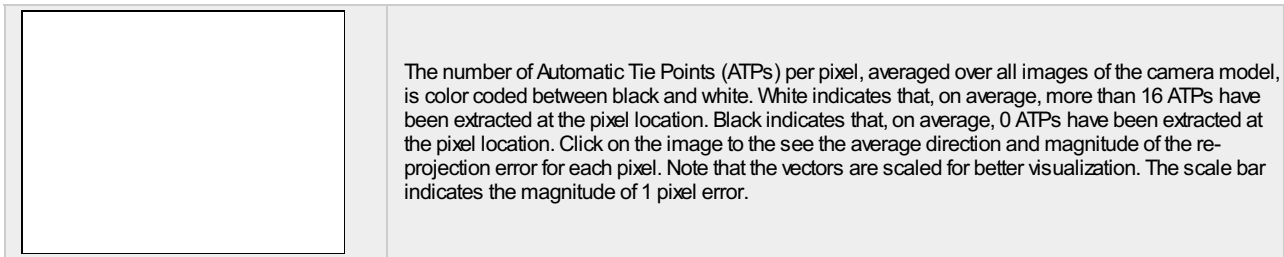
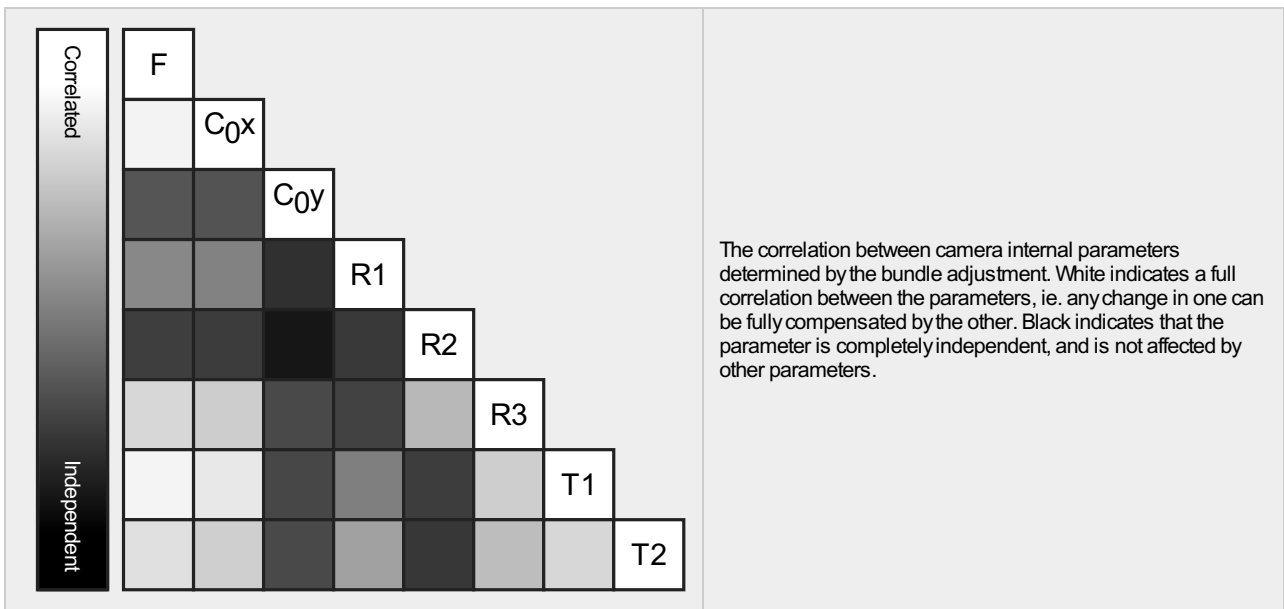
Internal Camera Parameters

FC6310_8.8_4864x3648 (RGB). Sensor Dimensions: 11.407 [mm] x 8.556 [mm]



EXIF ID: FC6310S_8.8_4864x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3666.955 [pixel] 8.600 [mm]	2432.001 [pixel] 5.704 [mm]	1823.999 [pixel] 4.278 [mm]	0.004	-0.017	0.019	-0.000	0.000
Optimized Values	3825.429 [pixel] 8.972 [mm]	2413.418 [pixel] 5.660 [mm]	1806.450 [pixel] 4.237 [mm]	-0.013	-0.003	0.015	-0.002	-0.001
Uncertainties (Sigma)	17.395 [pixel] 0.041 [mm]	0.454 [pixel] 0.001 [mm]	0.136 [pixel] 0.000 [mm]	0.000	0.000	0.000	0.000	0.000



2D Keypoints Table

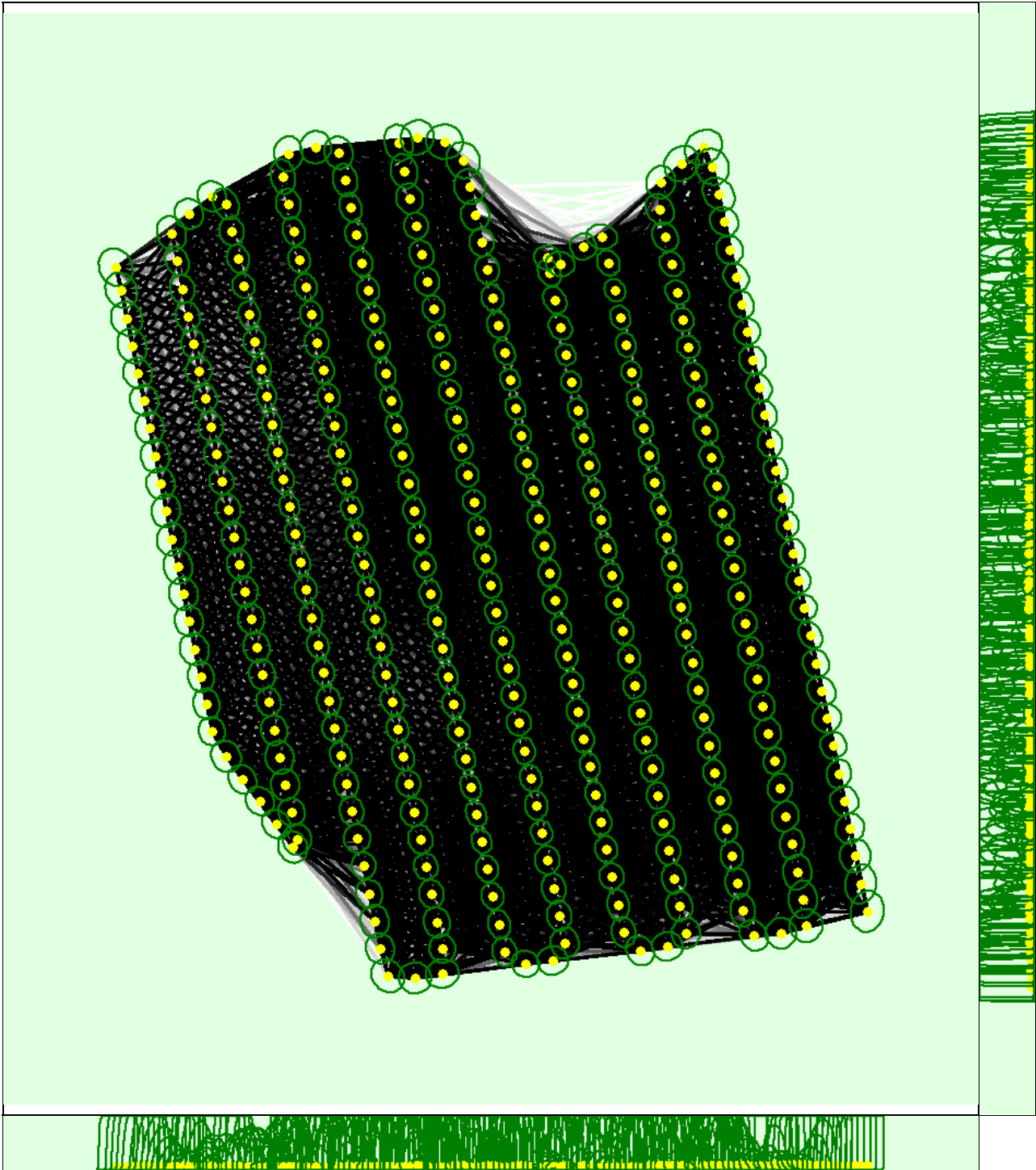
	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	73335	45488
Mn	58621	22306
Max	79945	56958
Mean	72771	45595

3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	2036281
In 3 Images	723805
In 4 Images	369393
In 5 Images	226330
In 6 Images	151502
In 7 Images	103303
In 8 Images	79085
In 9 Images	62938
In 10 Images	50447
In 11 Images	40359
In 12 Images	31541
In 13 Images	22970
In 14 Images	18315
In 15 Images	15044
In 16 Images	11985
In 17 Images	9304
In 18 Images	6886
In 19 Images	4451
In 20 Images	3116
In 21 Images	2287
In 22 Images	1691

In 23 Images	1082
In 24 Images	624
In 25 Images	199
In 26 Images	48
In 27 Images	20
In 28 Images	3
In 29 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	0.010	0.011	0.057	0.034	0.027	0.001
Sigma	0.001	0.001	0.038	0.021	0.017	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	49.22	51.72	47.96
0.00	3.00	50.78	48.28	52.04
3.00	6.00	0.00	0.00	0.00
6.00	9.00	0.00	0.00	0.00
9.00	12.00	0.00	0.00	0.00
12.00	15.00	0.00	0.00	0.00
15.00	-	0.00	0.00	0.00
Mean [m]		0.000000	-0.000000	-0.000000
Sigma [m]		0.361123	0.473183	0.423787
RMS Error [m]		0.361123	0.473183	0.423787

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
Mean of Geolocation Accuracy [m]	5.000000	5.000000	10.000000
Sigma of Geolocation Accuracy [m]	0.000000	0.000000	0.000000

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

Geolocation Orientational Variance	RMS [degree]
Omega	0.256
Phi	0.794
Kappa	4.593

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: 27.21.14.5148), Intel(R) UHD Graphics 630 (Driver: 27.20.100.8190)
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	20m:16s
Time for Point Cloud Classification	03m:00s
Time for 3D Textured Mesh Generation	08m:17s

Results



Number of Processed Clusters	3
Number of Generated Tiles	1
Number of 3D Densified Points	29359121
Average Density (per m ³)	79.76

DSM, Orthomosaic and Index Details



Processing Options



DSM and Orthomosaic Resolution	1 x GSD (3.6 [cm/pixel])
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DSMFilters	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
DTMResolution	5 x GSD (3.6 [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	10m:43s
Time for Orthomosaic Generation	28m:09s
Time for DTM Generation	09m:59s
Time for Contour Lines Generation	03s
Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s