

REGIONE SICILIA
PROVINCE DI ENNA E CATANIA
COMUNI DI AIDONE, RADDUSA E RAMACCA



TITOLO BREVE

AGRIVOLTAICO "AIDONE"

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

REVISIONI	REV	DATA	DESCRIZIONE	REDATTO	VERIFICATO	APPROVATO
	00	10/10/2022	PRIMA EMISSIONE ELABORATO	D'Angelo Ruvolo	Claudio Rizzo	Claudio Rizzo

PROPONENTE

FRI-EL SOLAR

FRI-EL SOLAR S.r.l.
Piazza del Grano 3 - 39100 Bolzano (BZ)
P.IVA 02023090380
+39 0471324210 - fri-elsolar@legalmail.it

PROGETTAZIONE E SERVIZI



ENVLAB s.r.l.s. - C.F./P. IVA 02920050842
Via Smeraldo n. 39 - 92016 RIBERA (AG)
0925 096280 - envlab@pec.it - www.envlab.it

CODICE ELABORATO

FR-AIDONE-AFV-PD-R-1.1.2.0-r0A-R00

FOGLIO

1/20

FORMATO

A4

SCALA



IL DIRETTORE TECNICO DI ENVLAB



PROGETTO

IMPIANTO AGRIVOLTAICO "AIDONE" - PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO AGRIVOLTAICO DELLA POTENZA DI 44,95 MWp (40 MW IN IMMISSIONE) CON SISTEMA DI ACCUMULO DA 10,00 MW E RELATIVE OPERE DI CONNESSIONE ALLA RTN RICADENTE NEI COMUNI DI AIDONE, RADDUSA E RAMACCA

OGGETTO ELABORATO

PROGETTO DEFINITIVO
REPORT RILIEVO E RESTITUZIONE
ORTOFOTOGRAMMETRICA DELLE AREE DI PROGETTO

Progettazione e Consulenza Ambientale	ELABORATO	PROPONENTE
	<p align="center">REPORT RILIEVO E RESTITUZIONE ORTOFOTOGRAMMETRICA DELLE AREE DI PROGETTO</p>	<p>FRI-EL SOLAR Piazza del Grano 3 -39100 Bolzano (BZ) P.IVA 02023090380 +39 0471324210 - fri-elsolar@legalmail.it</p>
<p align="center"><i>IMPIANTO AGRIVOLTAICO "AIDONE"</i> PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO AGRIVOLTAICO DELLA POTENZA DI 44.95 MWp (40 MW IN IMMISSIONE) CON SISTEMA DI ACCUMULO DA 10,00 MW E RELATIVE OPERE DI CONNESSIONE ALLA RTN RICADENTE NEI COMUNI DI AIDONE, RADDUSA E RAMACCA</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 agrivoltaico "AIDONE" della potenza di 44.95 MWp (40 MW in immissione) con sistema di accumulo da 10 MW nominali e 20 MWh di capacità di accumulo e delle relative opere di connessione alla RTN che la società FRI-EL SOLAR S.r.l. intende realizzare nei Comuni di Aidone (EN), Raddusa (CT) e Ramacca (CT).

Il soggetto proponente dell'iniziativa è la Società FRI-EL SOLAR S.r.l. avente sede legale ed operativa in Bolzano, Piazza del Grano 3, iscritta nella Sezione Ordinaria della Camera di Commercio Industria Agricoltura ed Artigianato di Bolzano, C.F. e P.IVA N. 02023090380. La Fri-El Solar persegue lo sviluppo in Sicilia ed in altre parti d'Italia di progetti nel campo delle energie rinnovabili ed è parte del gruppo Fri-El Green Power SpA.

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;*

Progettazione e Consulenza Ambientale	ELABORATO	PROPONENTE
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<p align="center"><i>IMPIANTO AGRIVOLTAICO "AIDONE"</i> PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO AGRIVOLTAICO DELLA POTENZA DI 44.95 MWp (40 MW IN IMMISSIONE) CON SISTEMA DI ACCUMULO DA 10,00 MW E RELATIVE OPERE DI CONNESSIONE ALLA RTN RICADENTE NEI COMUNI DI AIDONE, RADDUSA E RAMACCA</p>		

5. *realizzazione di un modello tridimensionale in formato mesh;*
6. *produzione di un dettagliato Modello Digitale del Terreno (DTM);*
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 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.

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	aidone1
Processed	2022-03-29 16:11:54
Camera Model Name(s)	FC6310_8.8_5472x3648 (RGB)
Average Ground Sampling Distance (GSD)	3.03 cm / 1.19 in
Area Covered	1.264 km ² / 126.4285 ha / 0.49 sq. mi. / 312.5734 acres
Time for Initial Processing (without report)	06h:42m:36s

Quality Check



Images	median of 69932 keypoints per image	
Dataset	2296 out of 2296 images calibrated (100%), all images enabled	
Camera Optimization	1.6% relative difference between initial and optimized internal camera parameters	
Matching	median of 29783.3 matches per calibrated image	
Georeferencing	yes, no 3D GCP	

Preview

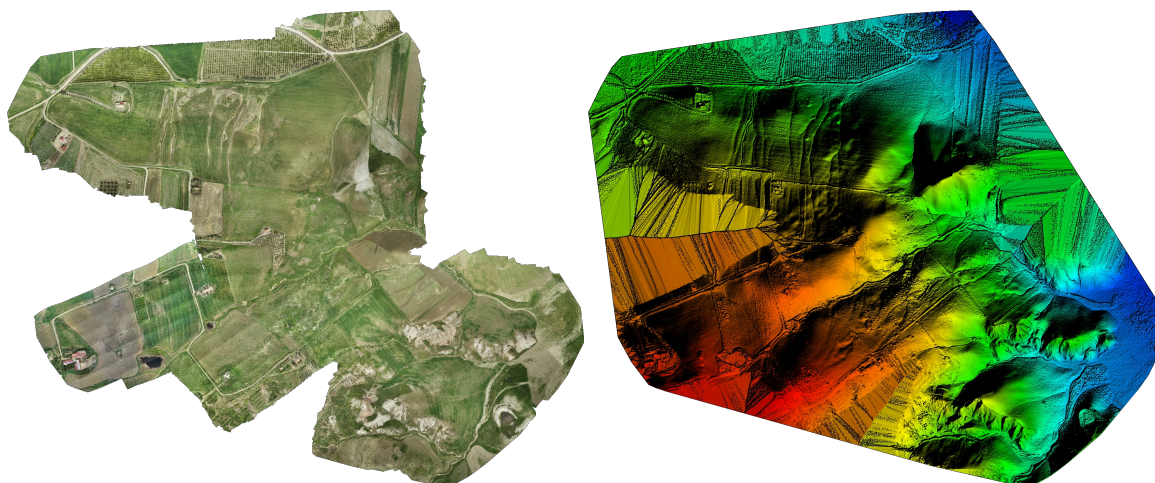


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details



Number of Calibrated Images	2296 out of 2296
Number of Geolocated Images	2296 out of 2296

Initial Image Positions

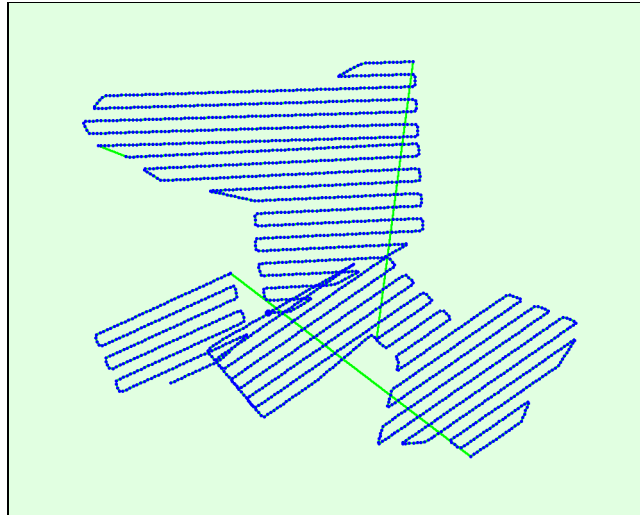
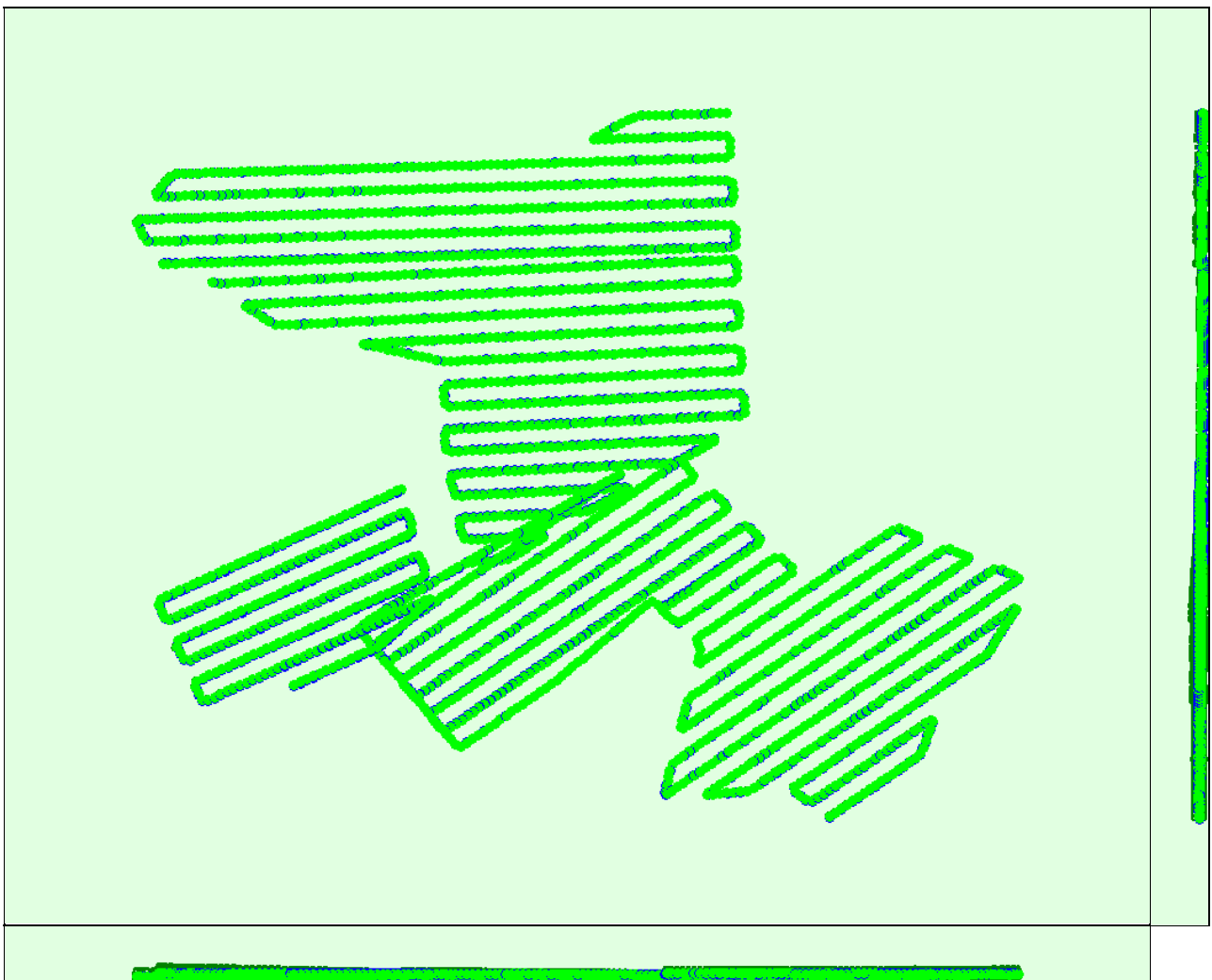


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

Computed Image/GCPs/Manual Tie Points Positions



Uncertainty ellipses 100xmagnified

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	0.036	0.036	0.080	0.011	0.012	0.004
Sigma	0.007	0.007	0.018	0.002	0.003	0.001

🔍 Overlap

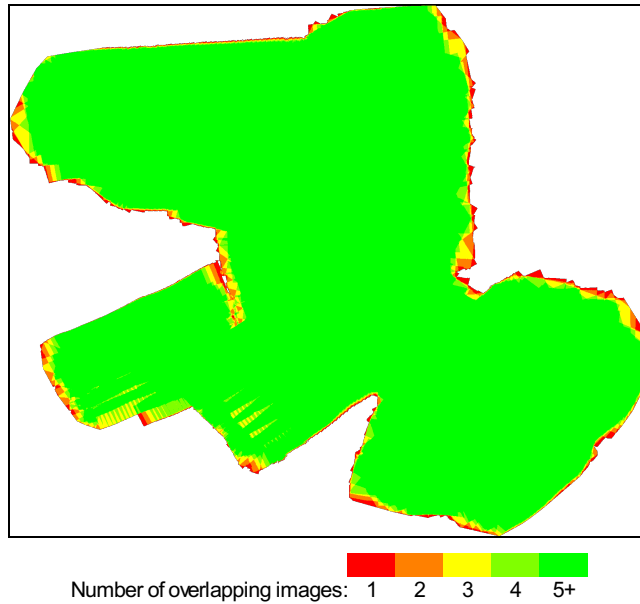


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint 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	64117166
Number of 3D Points for Bundle Block Adjustment	17649383
Mean Reprojection Error [pixels]	0.118

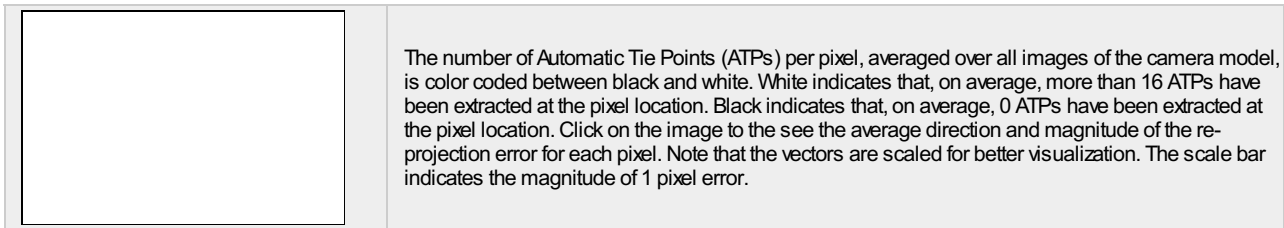
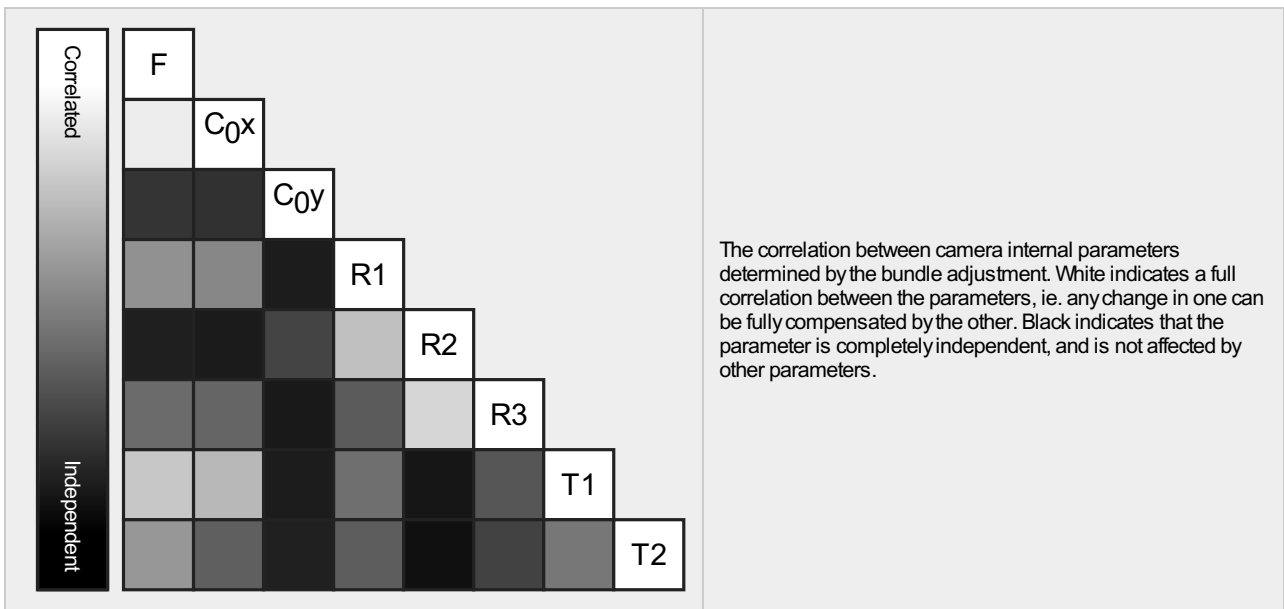
🔍 Internal Camera Parameters

📷 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	3727.661 [pixel] 8.742 [mm]	2713.943 [pixel] 6.365 [mm]	1806.201 [pixel] 4.236 [mm]	-0.014	0.003	0.006	-0.002	-0.001
Uncertainties (Sigma)	2.806 [pixel] 0.007 [mm]	0.066 [pixel] 0.000 [mm]	0.022 [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	69932	29783
Mn	52661	1407
Max	79993	45740
Mean	69770	27926

? 3D Points from 2D Keypoint Matches



	Number of 3D Points Observed
In 2 Images	9594511
In 3 Images	3392429
In 4 Images	1603521
In 5 Images	884616
In 6 Images	541186
In 7 Images	357265
In 8 Images	251486
In 9 Images	184305
In 10 Images	139114
In 11 Images	107375
In 12 Images	84493
In 13 Images	67869
In 14 Images	55700
In 15 Images	46468
In 16 Images	39225
In 17 Images	33517
In 18 Images	28558
In 19 Images	24815
In 20 Images	21489
In 21 Images	18713
In 22 Images	16324
In 23 Images	14561

In 24 Images	13123
In 25 Images	11312
In 26 Images	10281
In 27 Images	9018
In 28 Images	8296
In 29 Images	7698
In 30 Images	6780
In 31 Images	6442
In 32 Images	5887
In 33 Images	5528
In 34 Images	4961
In 35 Images	4517
In 36 Images	4186
In 37 Images	3746
In 38 Images	3489
In 39 Images	3253
In 40 Images	2959
In 41 Images	2736
In 42 Images	2472
In 43 Images	2380
In 44 Images	2230
In 45 Images	2068
In 46 Images	1823
In 47 Images	1730
In 48 Images	1437
In 49 Images	1338
In 50 Images	1244
In 51 Images	972
In 52 Images	941
In 53 Images	879
In 54 Images	744
In 55 Images	728
In 56 Images	676
In 57 Images	631
In 58 Images	590
In 59 Images	492
In 60 Images	476
In 61 Images	413
In 62 Images	344
In 63 Images	318
In 64 Images	318
In 65 Images	247
In 66 Images	237
In 67 Images	252
In 68 Images	203
In 69 Images	176
In 70 Images	174
In 71 Images	173
In 72 Images	142
In 73 Images	134
In 74 Images	151
In 75 Images	95
In 76 Images	85
In 77 Images	85
In 78 Images	67
In 79 Images	46
In 80 Images	40
In 81 Images	33
In 82 Images	18

In 83 Images	12
In 84 Images	6
In 85 Images	6
In 86 Images	3
In 88 Images	1
In 91 Images	1

2D Keypoint Matches

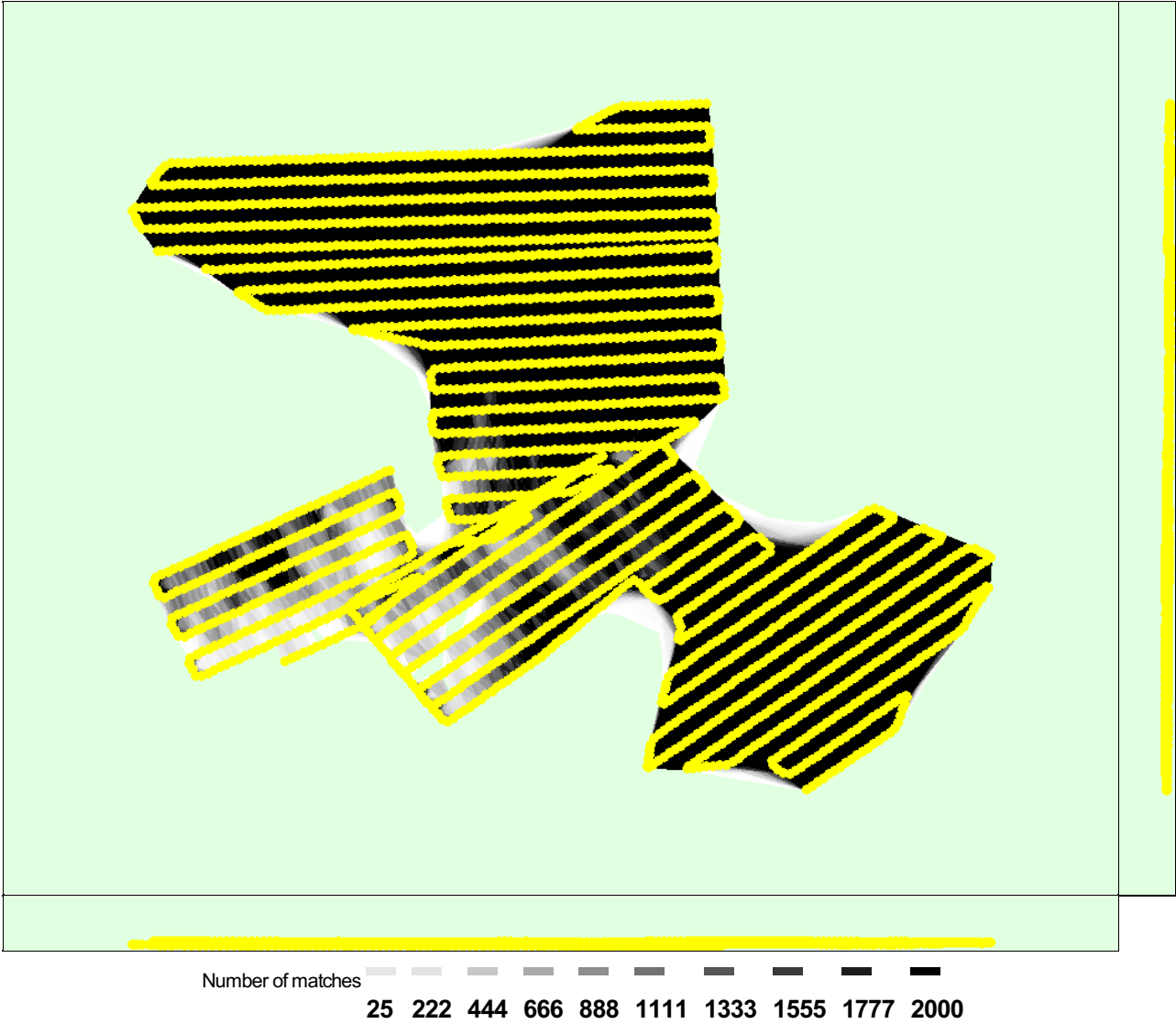


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

Geolocation Details

Absolute Geolocation Variance

Mn Error [m]	MaxError [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	0.04	3.44
-3.00	0.00	52.31	40.94	41.20

0.00	3.00	47.69	59.02	55.31
3.00	6.00	0.00	0.00	0.04
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]		0.564980	1.097549	1.419934
RMS Error [m]		0.564980	1.097549	1.419934

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	0.673
Phi	0.301
Kappa	7.196

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: NMDIA 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, 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:44m:22s
Time for Point Cloud Classification	18m:55s
Time for 3D Textured Mesh Generation	28m:42s

Results



Number of Processed Clusters	164
Number of Generated Tiles	8
Number of 3D Densified Points	183894356
Average Density (per m ³)	174.74

DSM, Orthomosaic and Index Details



Processing Options



DSM and Orthomosaic Resolution	1 x GSD (3.03 [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 (3.03 [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	01h:19m:20s
Time for Orthomosaic Generation	04h:38m:01s
Time for DTM Generation	01h:03m:13s
Time for Contour Lines Generation	13s
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	AIDONE3
Processed	2022-03-31 14:02:50
Camera Model Name(s)	FC6310_8.8_5472x3648 (RGB)
Average Ground Sampling Distance (GSD)	4.10 cm / 1.61 in
Area Covered	1.087 km ² / 108.6644 ha / 0.42 sq. mi. / 268.6547 acres
Time for Initial Processing (without report)	04h:13m:42s

Quality Check



? Images	median of 61826 keypoints per image	✓
? Dataset	1566 out of 1568 images calibrated (99%), all images enabled	✓
? Camera Optimization	0.76% relative difference between initial and optimized internal camera parameters	✓
? Matching	median of 27174.9 matches per calibrated image	✓
? Georeferencing	yes, no 3D GCP	⚠

? Preview

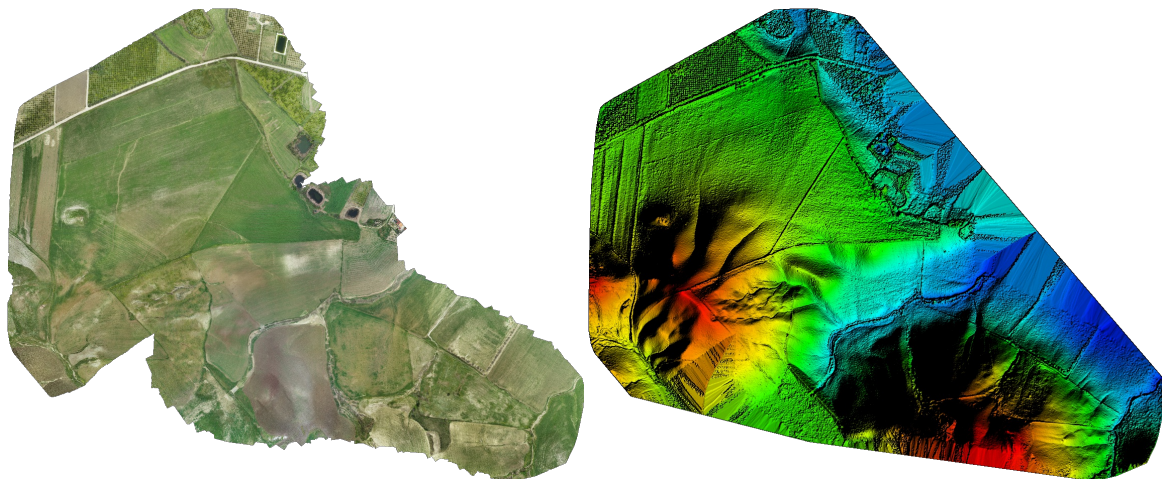


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details



Number of Calibrated Images	1566 out of 1568
Number of Geolocated Images	1568 out of 1568

Initial Image Positions

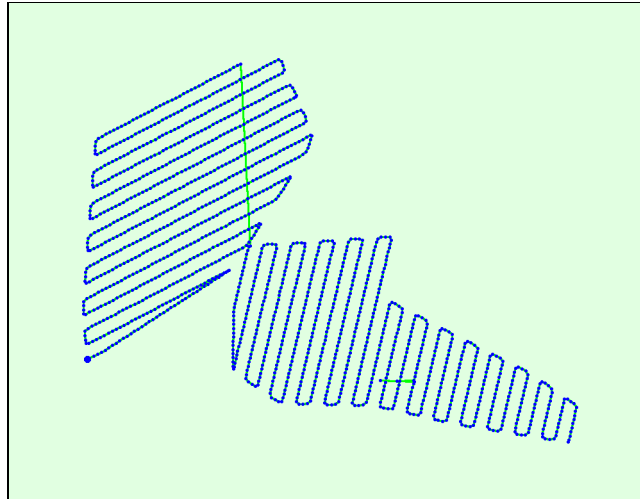
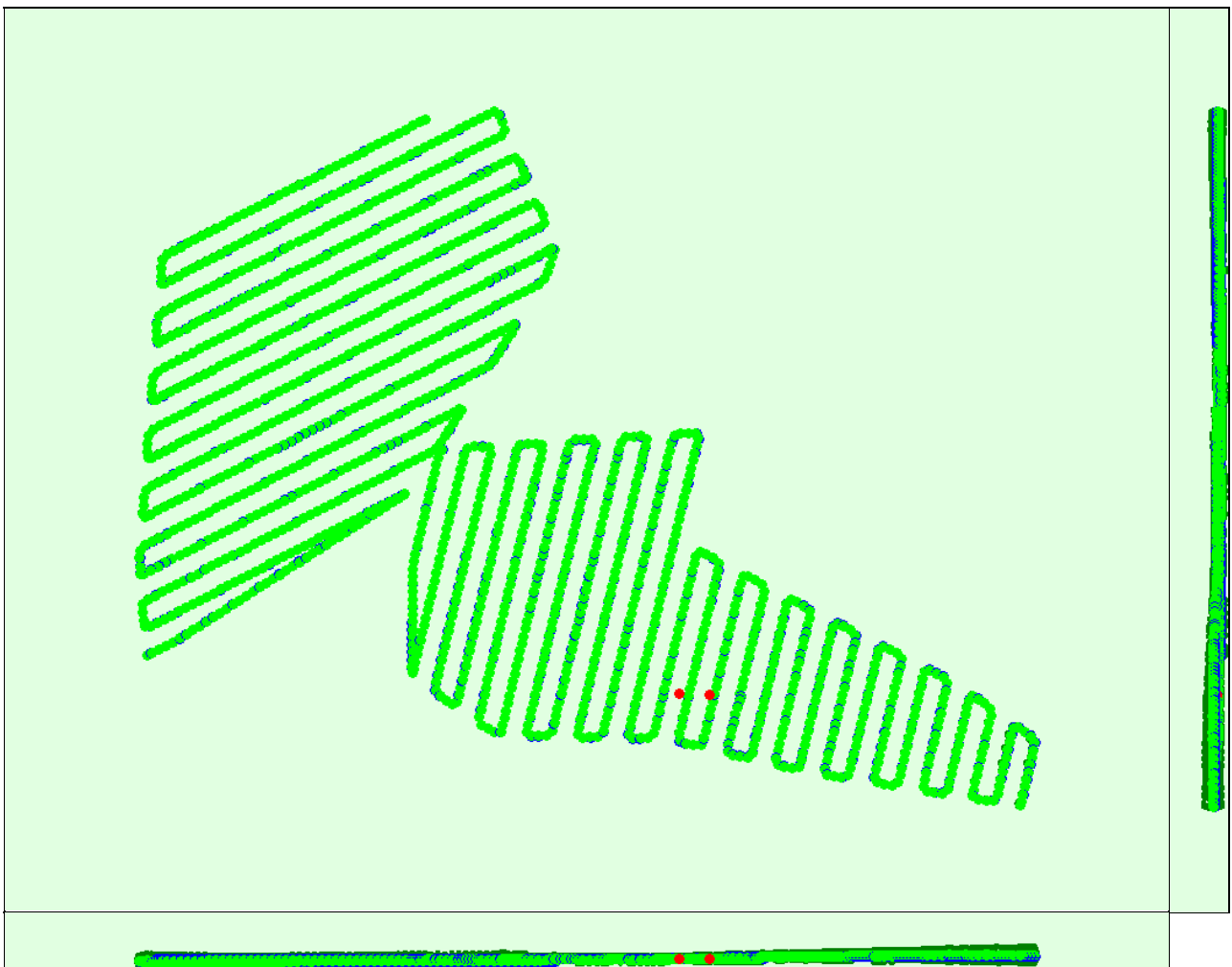


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

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	0.037	0.037	0.079	0.011	0.012	0.004
Sigma	0.007	0.007	0.017	0.001	0.002	0.000

🔍 Overlap

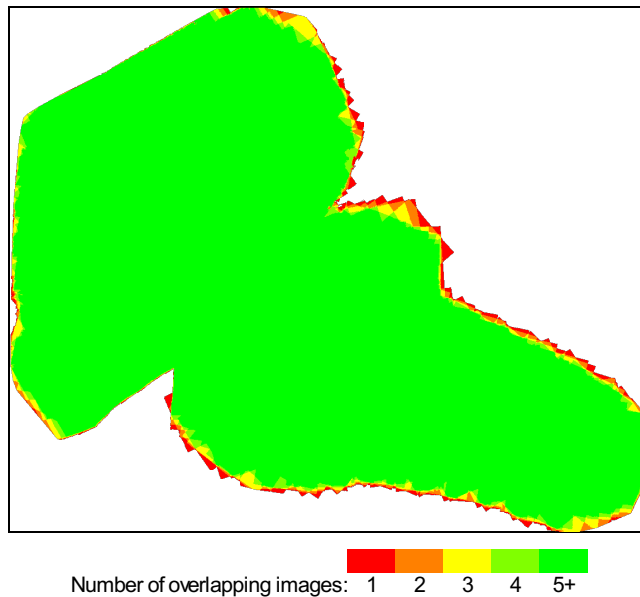


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic. Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint 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	41844958
Number of 3D Points for Bundle Block Adjustment	10056218
Mean Reprojection Error [pixels]	0.126

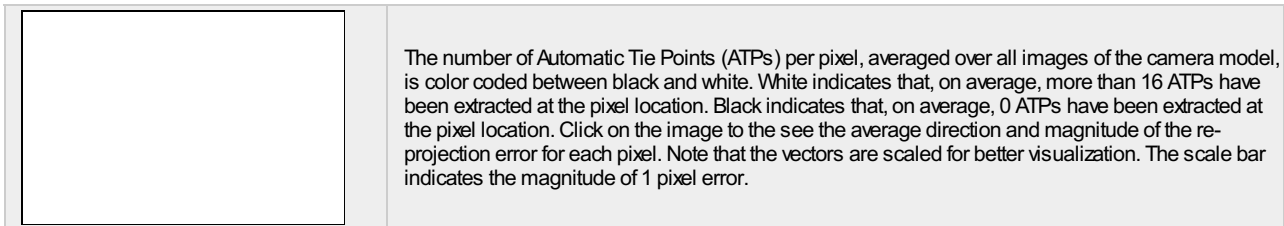
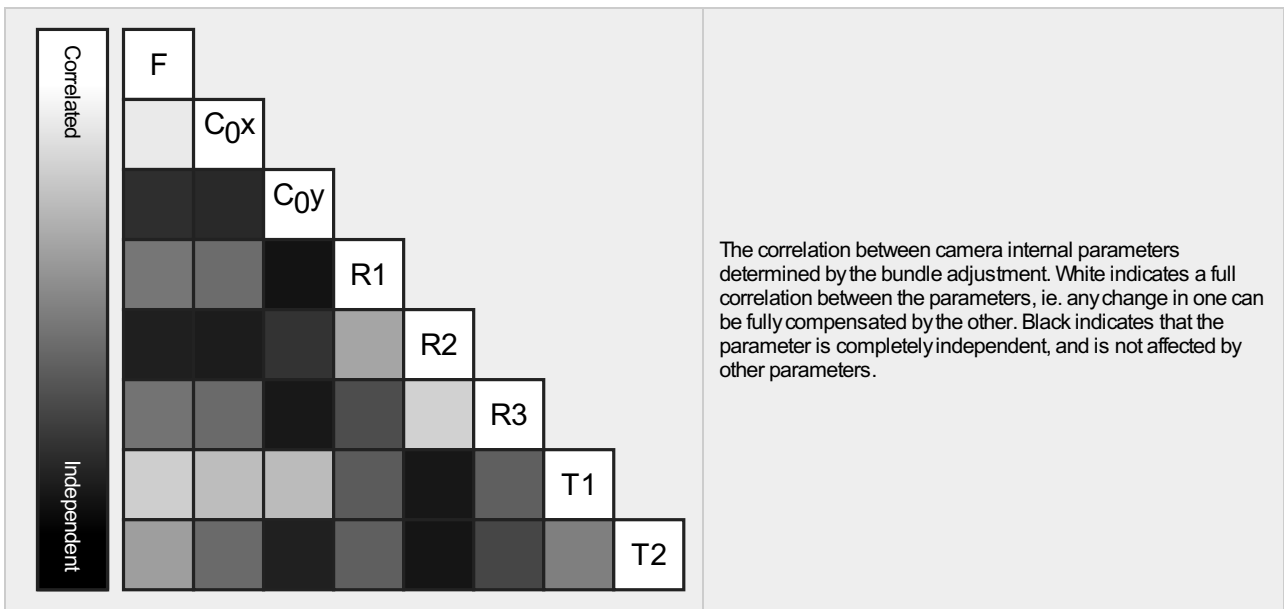
🔍 Internal Camera Parameters

📷 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	3696.713 [pixel] 8.670 [mm]	2713.252 [pixel] 6.363 [mm]	1805.757 [pixel] 4.235 [mm]	-0.013	0.003	0.007	-0.002	-0.001
Uncertainties (Sigma)	2.815 [pixel] 0.007 [mm]	0.066 [pixel] 0.000 [mm]	0.024 [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	61826	27175
Mn	28679	10265
Max	79931	40127
Mean	60565	26721

? 3D Points from 2D Keypoint Matches



	Number of 3D Points Observed
In 2 Images	5098972
In 3 Images	1923423
In 4 Images	942401
In 5 Images	543214
In 6 Images	346156
In 7 Images	235123
In 8 Images	168966
In 9 Images	125765
In 10 Images	96841
In 11 Images	76684
In 12 Images	61206
In 13 Images	50294
In 14 Images	41571
In 15 Images	35312
In 16 Images	29678
In 17 Images	25953
In 18 Images	22610
In 19 Images	19830
In 20 Images	17358
In 21 Images	15356
In 22 Images	13664
In 23 Images	12198

In 24 Images	11266
In 25 Images	10133
In 26 Images	9079
In 27 Images	8297
In 28 Images	7464
In 29 Images	6780
In 30 Images	6481
In 31 Images	5851
In 32 Images	5423
In 33 Images	5037
In 34 Images	4638
In 35 Images	4392
In 36 Images	4053
In 37 Images	3725
In 38 Images	3515
In 39 Images	3322
In 40 Images	3031
In 41 Images	2847
In 42 Images	2768
In 43 Images	2532
In 44 Images	2342
In 45 Images	2309
In 46 Images	2165
In 47 Images	2034
In 48 Images	1934
In 49 Images	1840
In 50 Images	1821
In 51 Images	1723
In 52 Images	1586
In 53 Images	1572
In 54 Images	1517
In 55 Images	1421
In 56 Images	1253
In 57 Images	1195
In 58 Images	1127
In 59 Images	1104
In 60 Images	1089
In 61 Images	1021
In 62 Images	1042
In 63 Images	915
In 64 Images	891
In 65 Images	837
In 66 Images	838
In 67 Images	736
In 68 Images	742
In 69 Images	621
In 70 Images	609
In 71 Images	626
In 72 Images	553
In 73 Images	545
In 74 Images	458
In 75 Images	468
In 76 Images	432
In 77 Images	404
In 78 Images	334
In 79 Images	297
In 80 Images	266
In 81 Images	235
In 82 Images	224

In 83 Images	196
In 84 Images	162
In 85 Images	138
In 86 Images	144
In 87 Images	128
In 88 Images	123
In 89 Images	125
In 90 Images	94
In 91 Images	91
In 92 Images	87
In 93 Images	83
In 94 Images	71
In 95 Images	62
In 96 Images	44
In 97 Images	42
In 98 Images	52
In 99 Images	44
In 100 Images	38
In 101 Images	40
In 102 Images	32
In 103 Images	22
In 104 Images	27
In 105 Images	13
In 106 Images	9
In 107 Images	4
In 108 Images	2
In 109 Images	3
In 110 Images	4
In 111 Images	2
In 112 Images	1

 **2D Keypoint Matches**



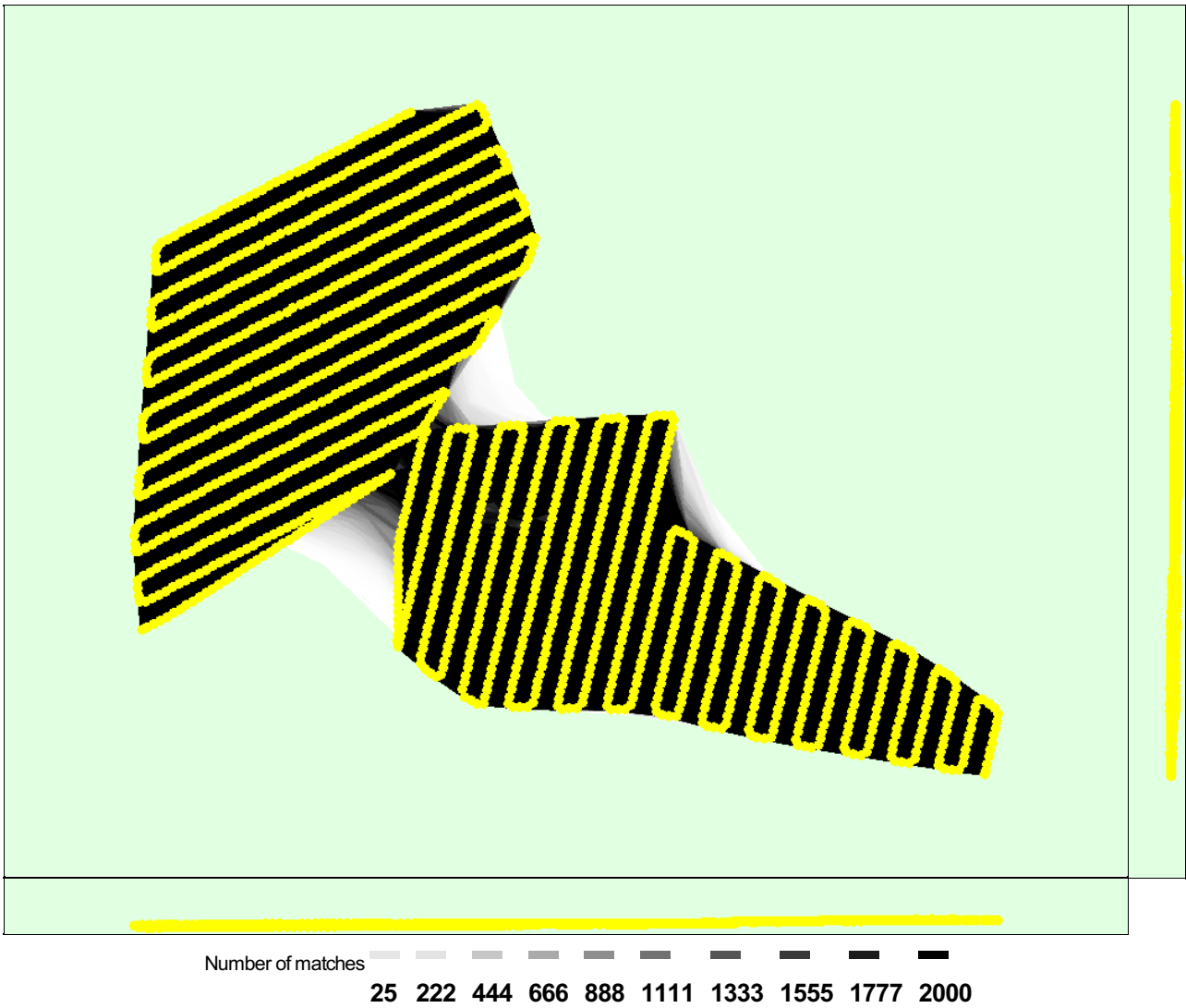


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

Geolocation Details



? Absolute Geolocation Variance



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	5.75
-3.00	0.00	45.34	46.68	37.04
0.00	3.00	54.66	53.32	55.11
3.00	6.00	0.00	0.00	2.11
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]		0.282277	0.515737	1.711765
RMS Error [m]		0.282277	0.515737	1.711765

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	0.504
Phi	0.582
Kappa	5.729

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	 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:32s
Time for Point Cloud Classification	08m:16s
Time for 3D Textured Mesh Generation	20m:40s

Results



Number of Processed Clusters	42
Number of Generated Tiles	4
Number of 3D Densified Points	76032193
Average Density (per m ³)	63.29

DSM, Orthomosaic and Index Details



Processing Options



DSM and Orthomosaic Resolution	1 x GSD (4.1 [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 (4.1 [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	34m:02s
Time for Orthomosaic Generation	02h:22m:58s
Time for DTM Generation	30m:01s
Time for Contour Lines Generation	07s
Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s