

REPORT PROGETTO 1

Processing Report

24 January 2019



Survey Data

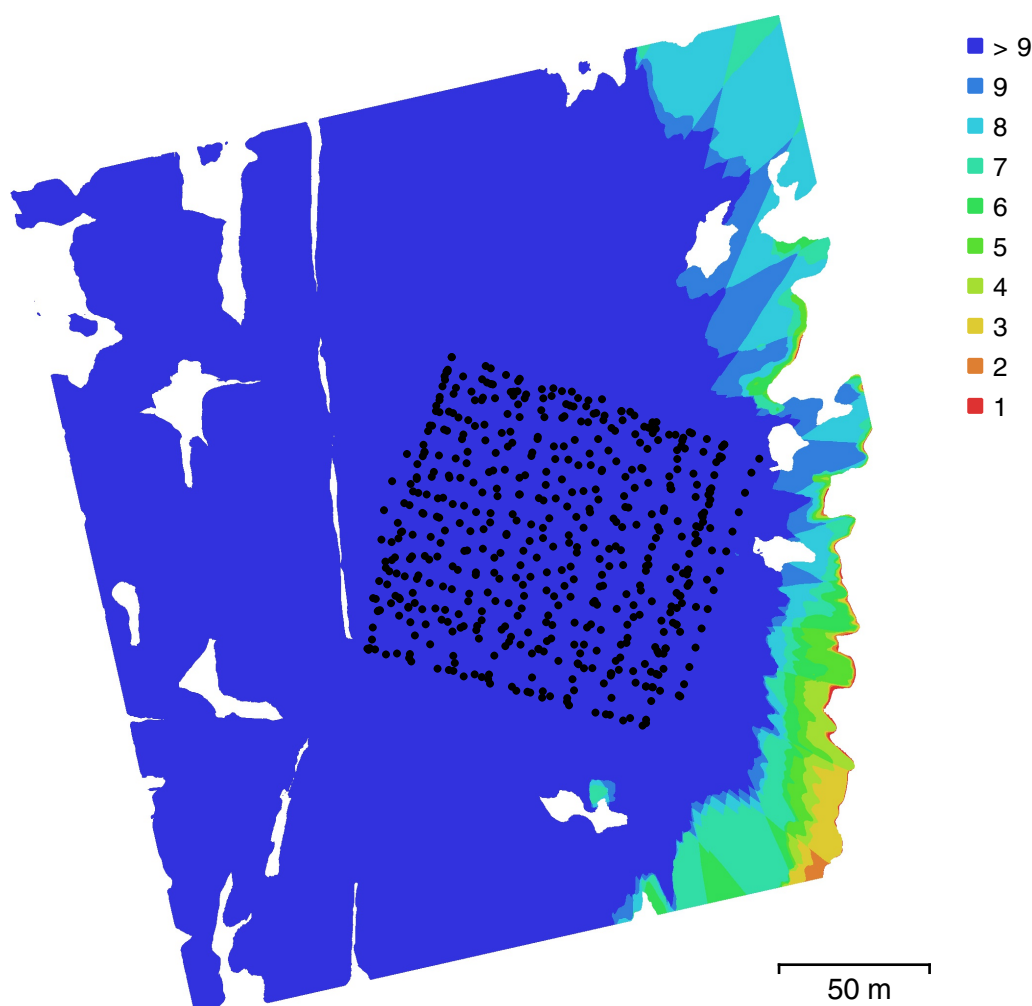


Fig. 1. Camera locations and image overlap.

Number of images:	529	Camera stations:	527
Flying altitude:	67.6 m	Tie points:	694,415
Ground resolution:	1.85 cm/pix	Projections:	3,168,092
Coverage area:	0.0651 km ²	Reprojection error:	1.19 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC220 (4.73mm)	4000 x 3000	4.73 mm	1.57 x 1.57 μm	No

Table 1. Cameras.

Camera Calibration

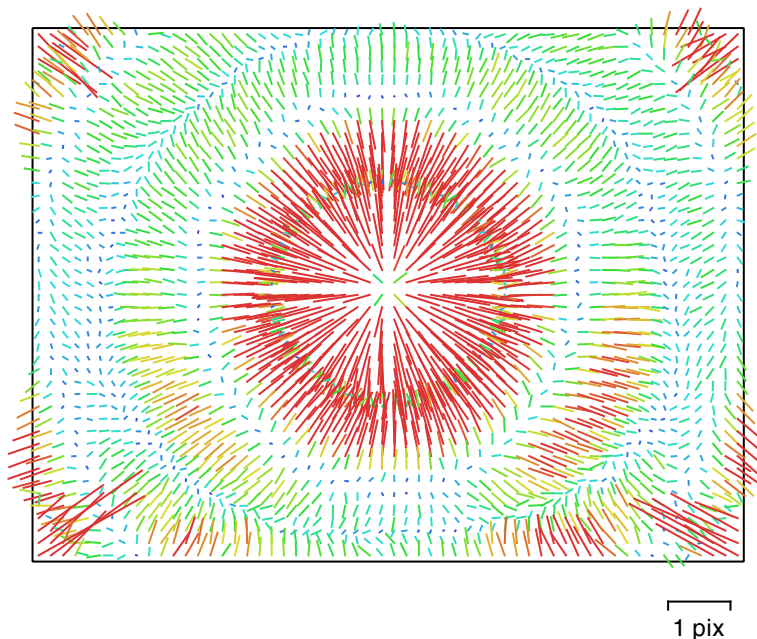


Fig. 2. Image residuals for FC220 (4.73mm).

FC220 (4.73mm)

529 images

Type
Frame

Resolution
4000 x 3000

Focal Length
4.73 mm

Pixel Size
1.57 x 1.57 μm

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	K4	P1	P2	P3	P4
F	3058.94	0.02	1.00	0.05	-0.23	-0.16	-0.01	-0.63	0.57	-0.52	0.47	0.04	-0.00	0.03	-0.00
Cx	-9.62778	0.019		1.00	-0.38	0.03	0.05	0.01	-0.00	-0.00	0.01	0.65	-0.21	0.40	-0.09
Cy	-14.6927	0.015			1.00	-0.18	0.04	-0.00	0.00	-0.01	0.01	-0.24	0.64	-0.19	0.03
B1	-7.10609	0.0045				1.00	0.02	0.01	-0.01	0.01	0.00	0.00	-0.01	-0.00	0.00
B2	0.00427556	0.0045					1.00	0.01	-0.01	0.00	-0.00	-0.02	0.01	-0.03	0.01
K1	0.119242	8.4e-05						1.00	-0.98	0.93	-0.89	0.01	-0.01	0.01	-0.01
K2	-0.651033	0.00051							1.00	-0.99	0.96	0.00	0.00	-0.01	0.02
K3	1.46835	0.0012								1.00	-0.99	-0.01	0.00	0.02	-0.02
K4	-1.13536	0.001									1.00	0.02	-0.00	-0.02	0.03
P1	0.00119414	4.9e-06										1.00	-0.27	-0.25	0.50
P2	-0.000487076	3.9e-06											1.00	0.11	-0.22
P3	-2.46489	0.0083												1.00	-0.93
P4	1.6036	0.015													1.00

Table 2. Calibration coefficients and correlation matrix.

Ground Control Points



Fig. 3. GCP locations and error estimates.

Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.

Estimated GCP locations are marked with a dot or crossing.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
12	0.647159	0.567707	1.19785	0.860875	1.47511

Table 3. Control points RMSE.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
D1	-0.571352	-1.27038	0.93302	1.67655	0.770 (48)
D2	0.190924	-0.0435389	-0.891843	0.913089	0.737 (26)
D3	-0.879561	-0.293727	-1.50433	1.76717	0.617 (22)
D4	-0.202841	-0.612776	-1.24183	1.39957	0.690 (46)
D5	-0.0012243	0.616401	2.4168	2.49417	0.802 (30)
D6	-0.263463	0.556225	-0.481295	0.781309	0.635 (23)
D7	-0.963924	0.240199	0.251722	1.0248	0.707 (37)
D8	0.332598	0.098309	0.824059	0.89407	0.692 (48)
D9	-0.242798	0.521254	1.06881	1.21368	0.697 (60)
D10	1.4013	0.737067	0.204259	1.59644	0.689 (57)
D100	0.494205	-0.458643	0.231341	0.712819	0.810 (19)
D200	0.687102	-0.0891045	-1.92212	2.04318	0.938 (26)
Total	0.647159	0.567707	1.19785	1.47511	0.728

Table 4. Control points.

Digital Elevation Model

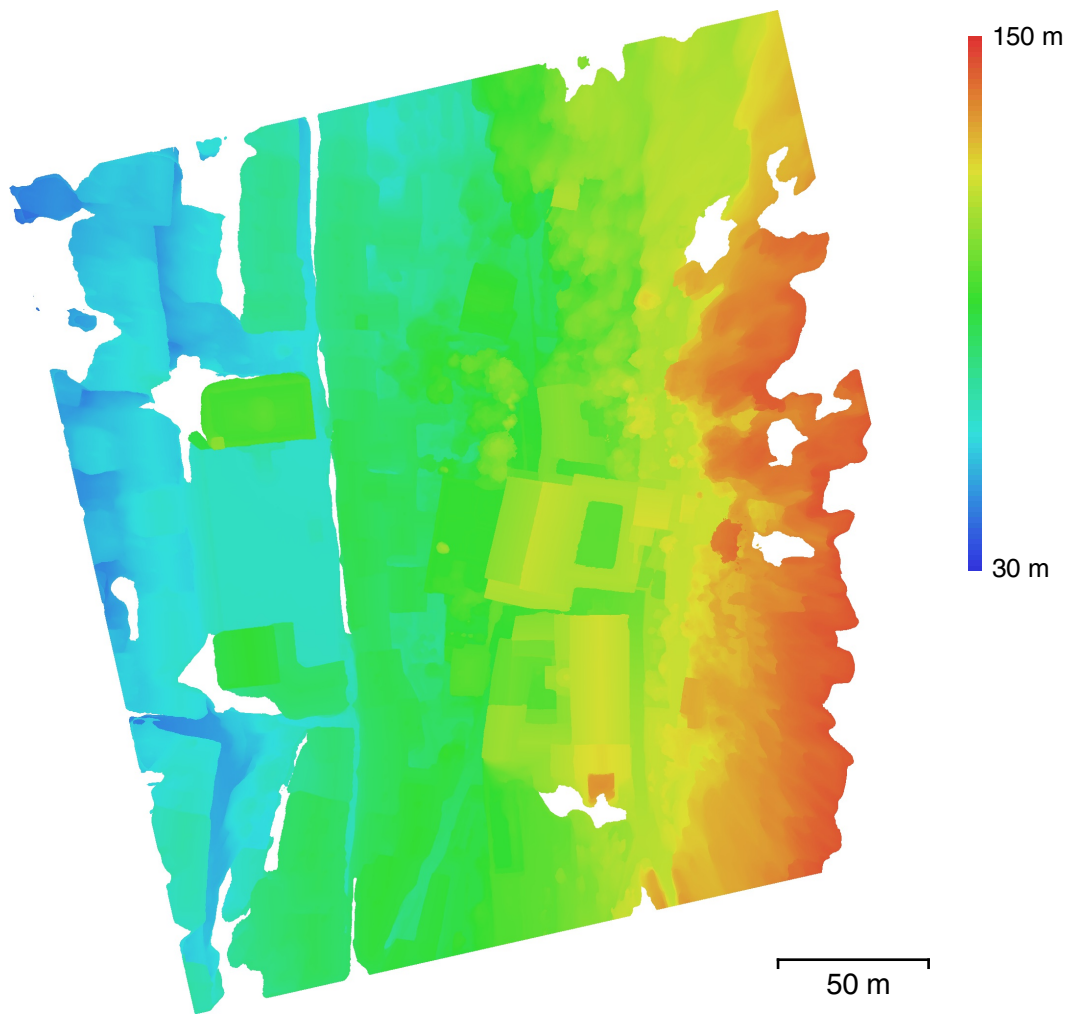


Fig. 4. Reconstructed digital elevation model.

Resolution: 7.41 cm/pix
Point density: 182 points/m²

Processing Parameters

General

Cameras	529
Aligned cameras	527
Markers	12
Coordinate system	Local Coordinates (m)
Rotation angles	Yaw, Pitch, Roll

Point Cloud

Points	694,415 of 812,638
RMS reprojection error	0.343114 (1.19033 pix)
Max reprojection error	2.91173 (77.2156 pix)
Mean key point size	3.42611 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	6.17408

Alignment parameters

Accuracy	High
Generic preselection	No
Key point limit	40,000
Tie point limit	10,000
Adaptive camera model fitting	No
Matching time	15 hours 35 minutes
Alignment time	20 minutes 51 seconds

Optimization parameters

Parameters	f, b1, b2, cx, cy, k1-k4, p1-p4
Adaptive camera model fitting	No
Optimization time	2 minutes 6 seconds

Model

Faces	3,297,242
Vertices	1,656,084
Vertex colors	3 bands, uint8
Texture	8,172 x 8,172 x 4, 4 bands, uint8

Reconstruction parameters

Surface type	Arbitrary
Source data	Dense
Interpolation	Enabled
Quality	Medium
Depth filtering	Moderate
Face count	3,297,243
Processing time	15 minutes 6 seconds

Texturing parameters

Mapping mode	Generic
Blending mode	Average
Texture size	8,172 x 8,172
Enable hole filling	Yes
Enable ghosting filter	No
UV mapping time	1 minutes 45 seconds
Blending time	9 minutes 58 seconds

Orthomosaic

Size	15,447 x 17,974
Coordinate system	Local Coordinates (m)
Colors	3 bands, uint8

Reconstruction parameters

Blending mode	Mosaic
Surface	Mesh
Enable hole filling	Yes

Processing time	3 minutes 44 seconds
Software	
Version	1.4.2 build 6205
Platform	Windows 64

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Survey Data

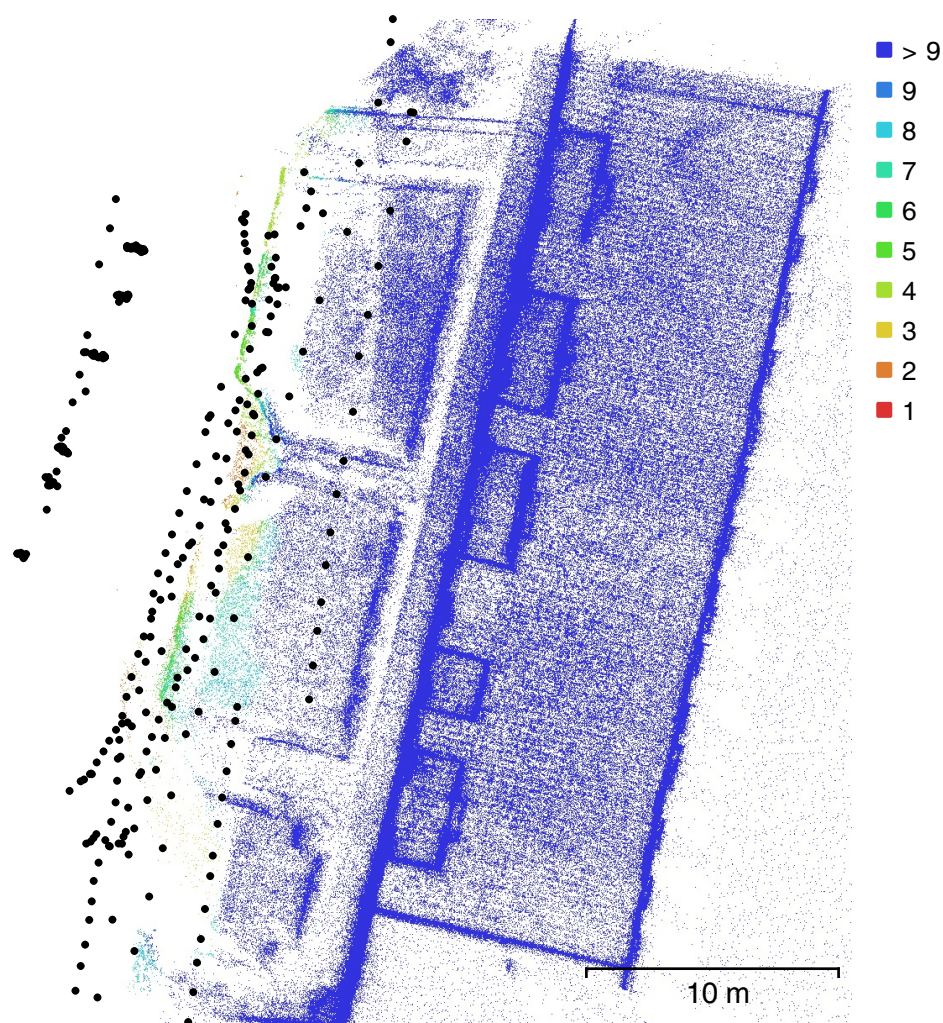


Fig. 1. Camera locations and image overlap.

Number of images:	366	Camera stations:	366
Flying altitude:	16.3 m	Tie points:	1,429,302
Ground resolution:	5.34 mm/pix	Projections:	6,352,648
Coverage area:	325 m²	Reprojection error:	1.16 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC220 (4.73mm)	4000 x 3000	4.73 mm	1.57 x 1.57 µm	No

Table 1. Cameras.

Camera Calibration

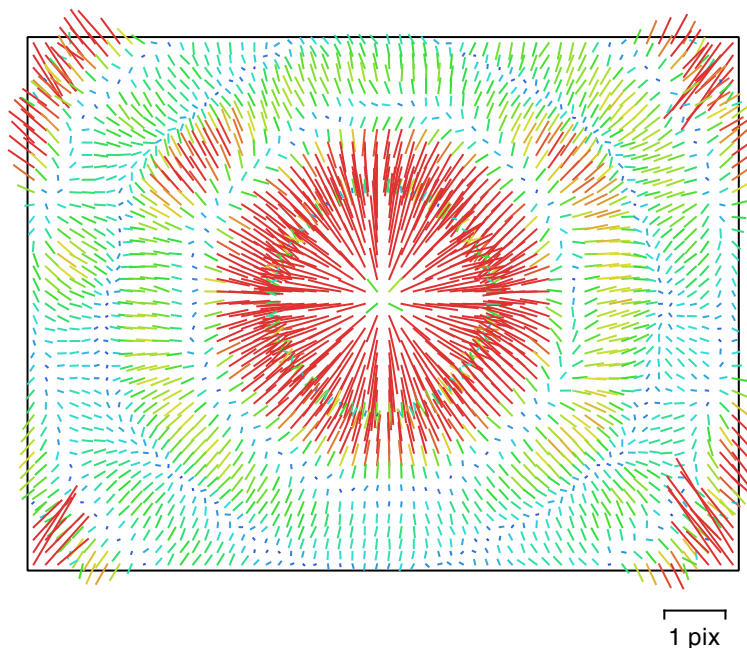


Fig. 2. Image residuals for FC220 (4.73mm).

FC220 (4.73mm)

366 images

Type
Frame

Resolution
4000 x 3000

Focal Length
4.73 mm

Pixel Size
1.57 x 1.57 μm

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	K4	P1	P2	P3	P4
F	3043.28	0.056	1.00	-0.09	0.25	-0.59	0.10	-0.02	0.04	0.00	-0.04	-0.08	0.08	-0.11	0.08
Cx	-12.4657	0.058		1.00	-0.49	-0.03	0.15	-0.01	-0.01	0.01	-0.01	0.76	-0.27	0.78	-0.60
Cy	-8.89939	0.04			1.00	-0.18	0.06	0.04	-0.03	0.02	-0.02	-0.39	0.67	-0.48	0.36
B1	2.32251	0.055				1.00	-0.04	-0.01	0.01	-0.00	-0.01	-0.02	-0.02	-0.03	0.02
B2	-6.91761	0.05					1.00	0.01	-0.01	0.01	-0.01	0.04	0.01	0.04	-0.04
K1	0.132395	6.5e-05						1.00	-0.97	0.93	-0.89	0.00	0.04	-0.02	0.02
K2	-0.733105	0.0004							1.00	-0.99	0.96	-0.02	-0.03	-0.00	-0.00
K3	1.66746	0.00099								1.00	-0.99	0.02	0.02	-0.00	0.01
K4	-1.29918	0.00083									1.00	-0.02	-0.02	0.01	-0.01
P1	0.00127505	5.4e-06										1.00	-0.26	0.45	-0.21
P2	-0.000508383	4.8e-06											1.00	-0.19	0.08
P3	-2.2754	0.011												1.00	-0.95
P4	1.88199	0.015													1.00

Table 2. Calibration coefficients and correlation matrix.

Ground Control Points

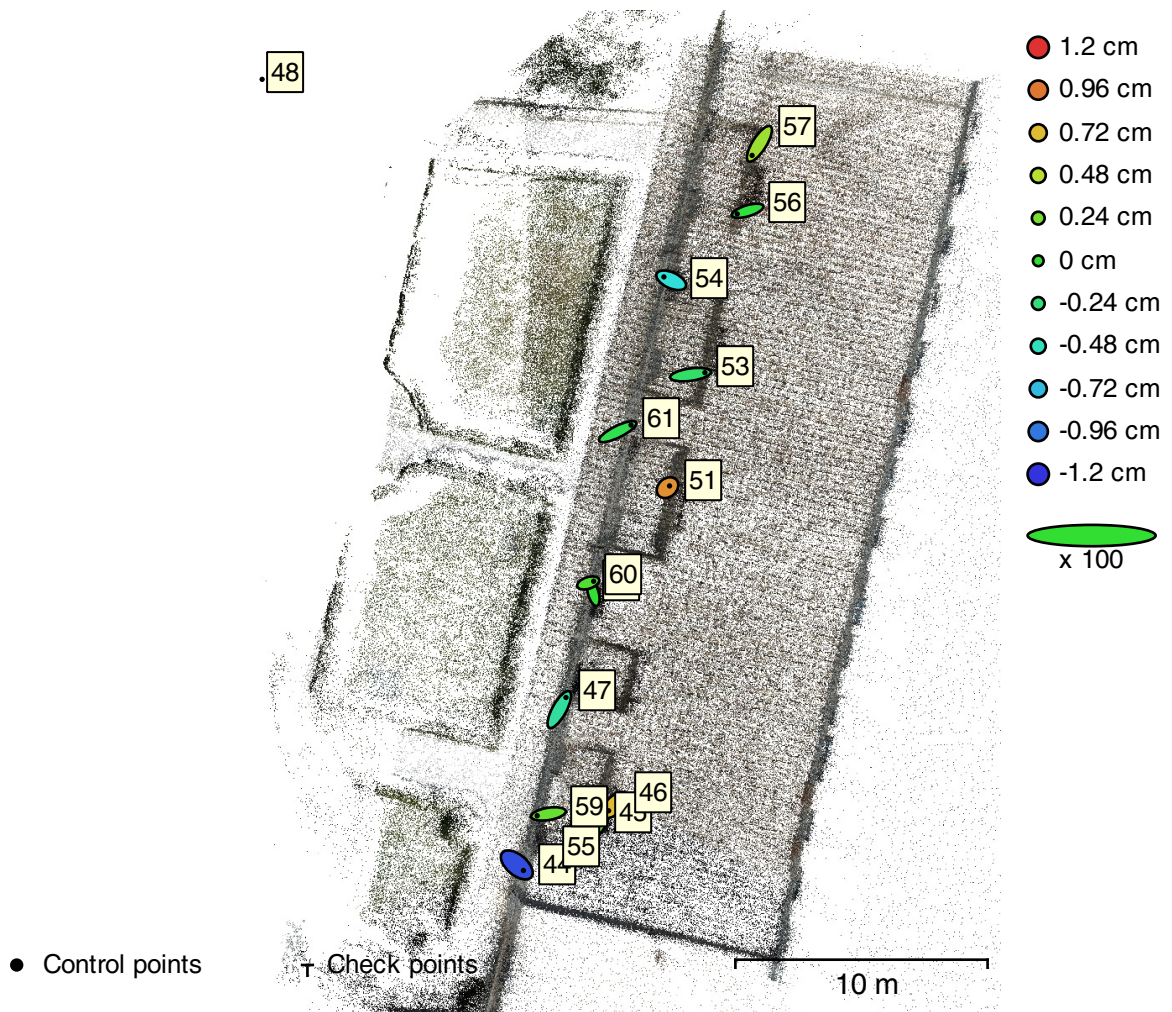


Fig. 3. GCP locations and error estimates.

Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.

Estimated GCP locations are marked with a dot or crossing.

Count	X error (mm)	Y error (mm)	Z error (mm)	XY error (mm)	Total (mm)
13	6.62144	5.05923	5.00149	8.33302	9.71875

Table 3. Control points RMSE.

Label	X error (mm)	Y error (mm)	Z error (mm)	Total (mm)	Image (pix)
44	5.26087	-4.42343	-11.1034	13.0586	1.283 (46)
45	-3.52756	-5.69781	1.57497	6.88399	1.296 (52)
46	-4.61732	-4.51356	7.26425	9.71912	0.907 (68)
47	5.30901	9.59187	-3.74508	11.5851	2.011 (56)
48					
49	-1.63878	5.88784	-0.0632708	6.11197	2.021 (88)
51	1.60401	1.38306	8.71349	8.96719	1.944 (96)
53	11.3685	1.58068	-1.88797	11.6321	1.659 (78)
54	-5.80037	2.66144	-5.79499	8.6203	2.748 (67)
55					
56	-8.26405	-2.48544	-0.436749	8.64075	1.063 (41)
57	-5.81287	-9.19698	3.7335	11.5027	2.070 (34)
59	-8.93627	-1.45233	1.81609	9.23387	1.342 (85)
60	4.28461	1.3708	1.02082	4.61292	1.696 (103)
61	10.5781	5.23701	-1.04292	11.8494	1.675 (87)
Total	6.62144	5.05923	5.00149	9.71875	1.755

Table 4. Control points.

Digital Elevation Model

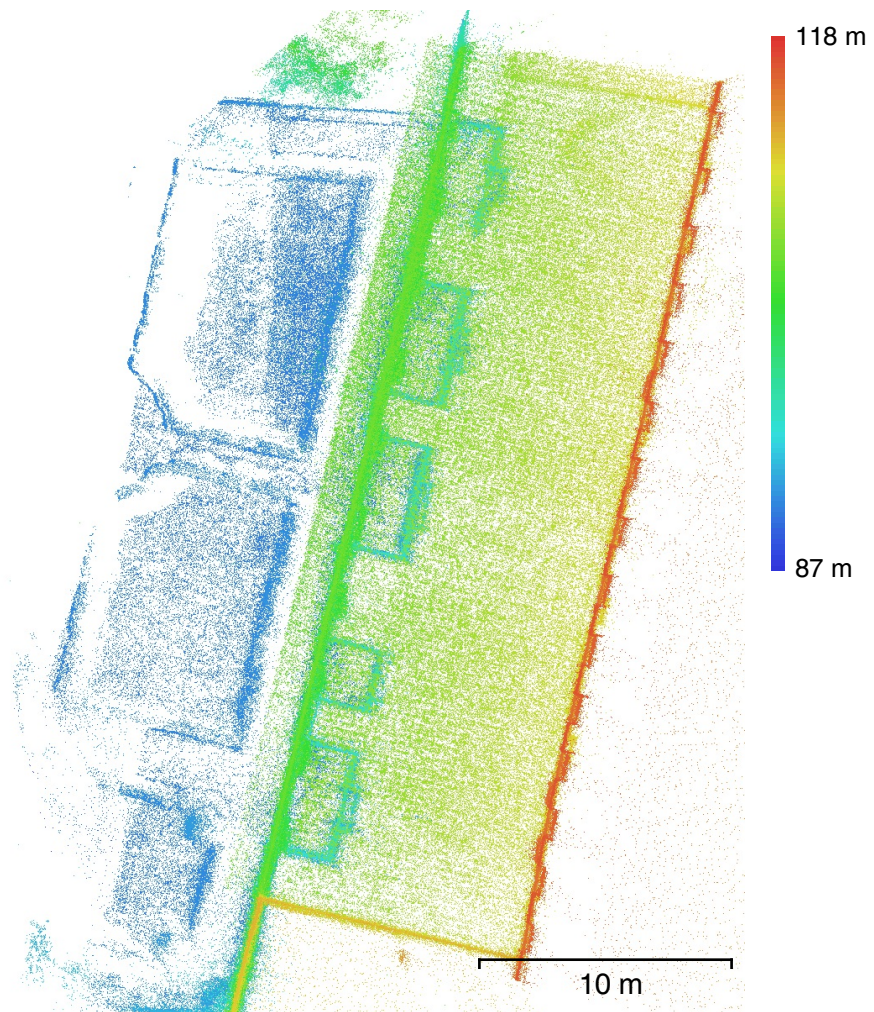


Fig. 4. Reconstructed digital elevation model.

Resolution: unknown
Point density: unknown

Processing Parameters

General

Cameras	366
Aligned cameras	366
Markers	15
Coordinate system	Local Coordinates (m)
Rotation angles	Yaw, Pitch, Roll

Point Cloud

Points	1,429,302 of 2,008,730
RMS reprojection error	0.344105 (1.15811 pix)
Max reprojection error	6.28058 (52.044 pix)
Mean key point size	3.5452 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	6.6568

Alignment parameters

Accuracy	High
Generic preselection	Yes
Reference preselection	Yes
Key point limit	0
Tie point limit	0
Matching time	1 hours 9 minutes

Optimization parameters

Parameters	f, b1, b2, cx, cy, k1-k4, p1-p4
Adaptive camera model fitting	No
Optimization time	5 minutes 30 seconds

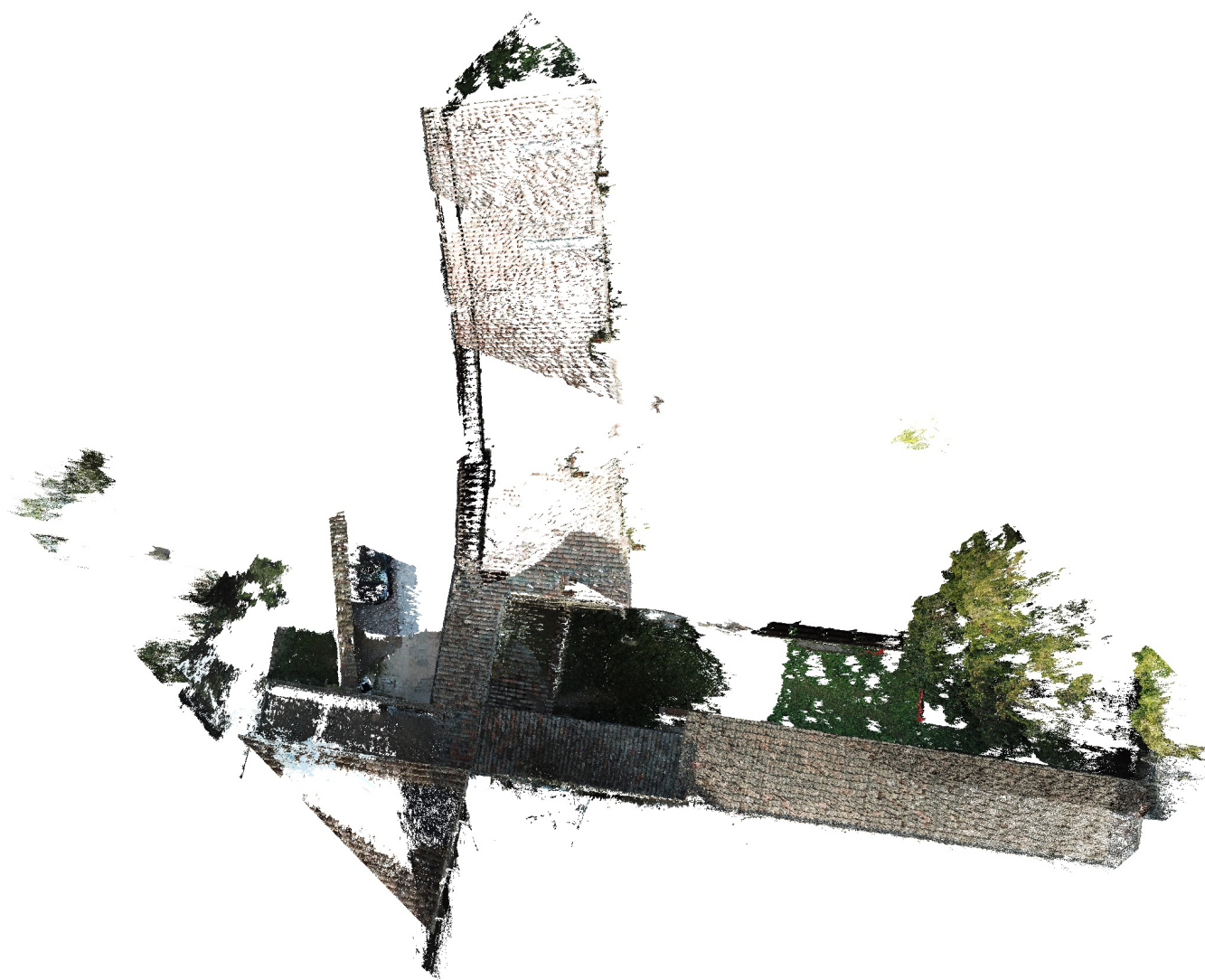
Software

Version	1.4.2 build 6205
Platform	Windows 64

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Survey Data

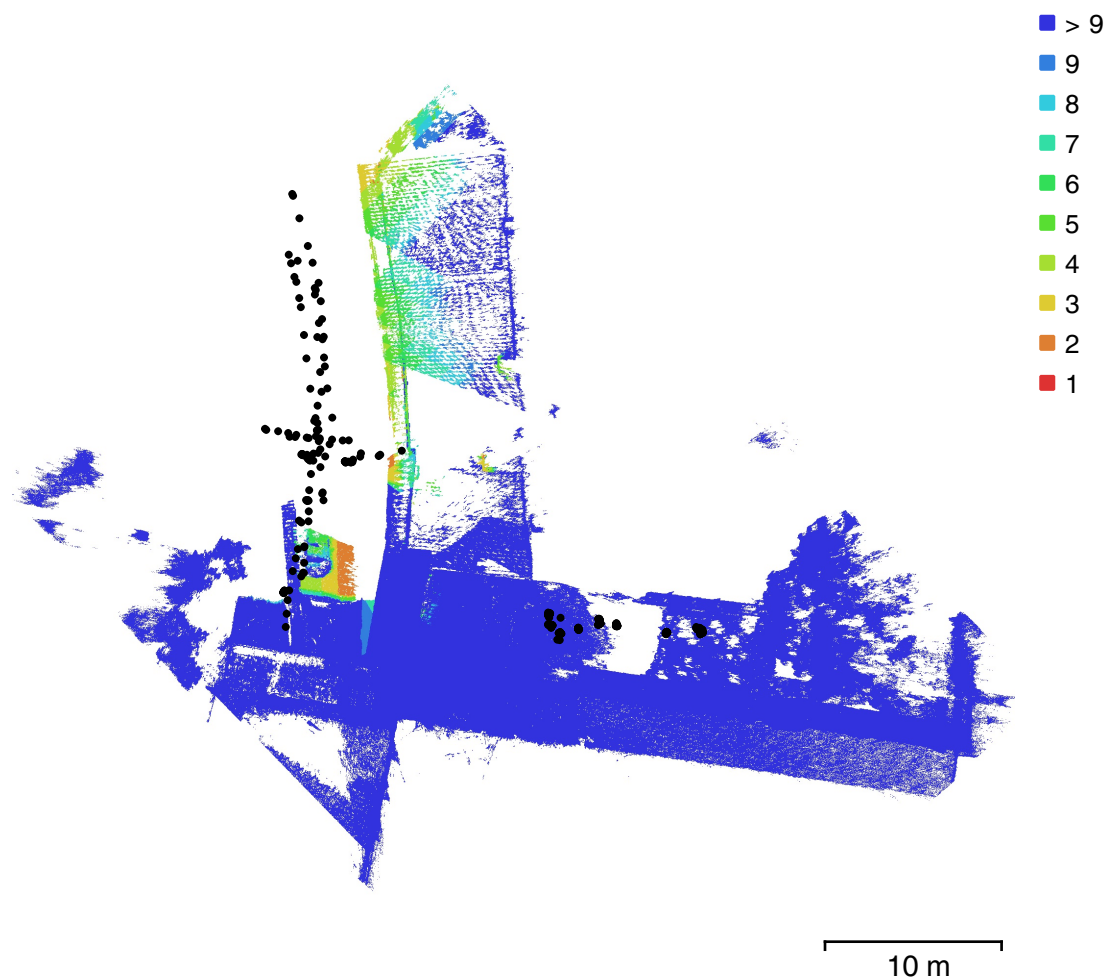


Fig. 1. Camera locations and image overlap.

Number of images:	316	Camera stations:	316
Flying altitude:	7.78 m	Tie points:	1,848,737
Ground resolution:	2.32 mm/pix	Projections:	6,925,956
Coverage area:	494 m²	Reprojection error:	1.2 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC220 (4.73mm)	4000 x 3000	4.73 mm	1.57 x 1.57 µm	No

Table 1. Cameras.

Camera Calibration

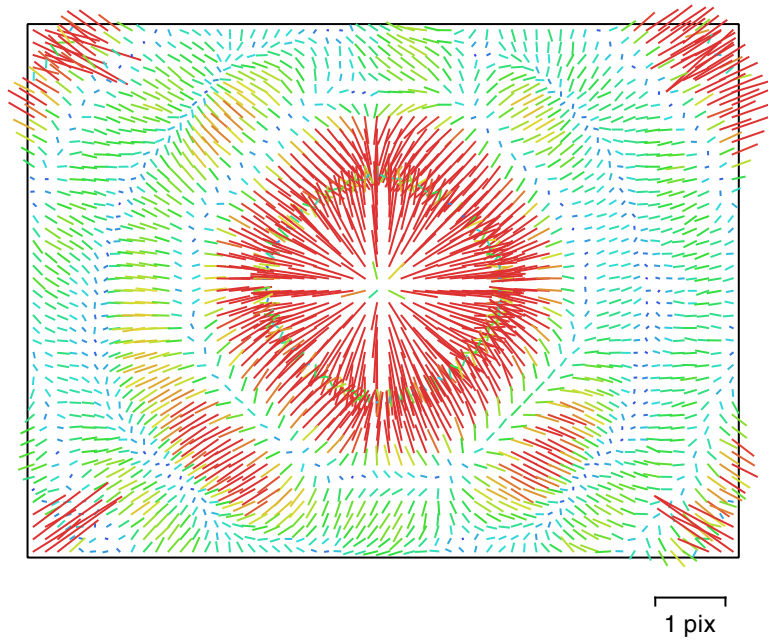


Fig. 2. Image residuals for FC220 (4.73mm).

FC220 (4.73mm)

316 images

Type	Resolution	Focal Length	Pixel Size
Frame	4000 x 3000	4.73 mm	1.57 x 1.57 μm

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	K4	P1	P2
F	3043.16	0.082	1.00	-0.05	0.05	-0.83	-0.01	-0.02	0.01	0.04	-0.08	-0.03	0.07
Cx	-5.14891	0.06		1.00	0.05	-0.01	0.08	0.01	-0.01	0.01	-0.00	0.90	0.06
Cy	0.120872	0.064			1.00	-0.01	-0.01	0.00	0.01	-0.01	0.01	0.07	0.93
B1	-3.03413	0.08				1.00	0.03	-0.05	0.06	-0.07	0.08	-0.01	-0.03
B2	0.520993	0.048					1.00	-0.01	0.01	-0.01	0.01	0.04	-0.01
K1	0.124789	6.5e-05						1.00	-0.97	0.92	-0.87	0.02	0.00
K2	-0.671751	0.00039							1.00	-0.99	0.95	-0.02	0.01
K3	1.50916	0.00093								1.00	-0.99	0.02	-0.01
K4	-1.16403	0.00077									1.00	-0.01	0.01
P1	-0.000386283	4.7e-06										1.00	0.08
P2	0.000567026	5.1e-06											1.00

Table 2. Calibration coefficients and correlation matrix.

Ground Control Points

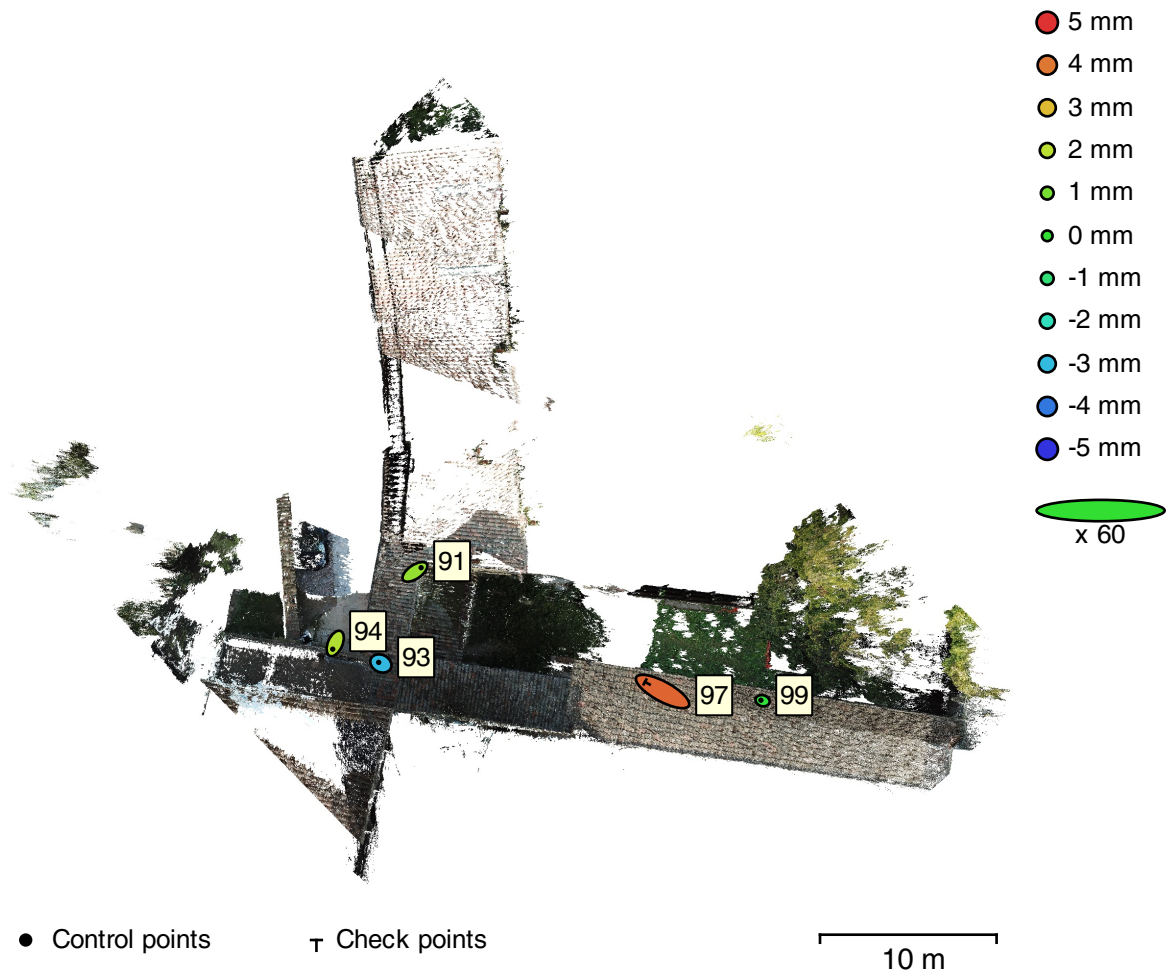


Fig. 3. GCP locations and error estimates.

Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.

Estimated GCP locations are marked with a dot or crossing.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
4	0.679869	0.680395	0.191966	0.961852	0.980821

Table 3. Control points RMSE.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
1	3.31809	1.80524	0.425645	3.77738	3.80129

Table 4. Check points RMSE.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
91	1.16639	0.792078	0.14186	1.41703	0.044 (23)
93	-0.411088	0.206277	-0.306045	0.552456	0.057 (7)
94	-0.469373	-1.08347	0.182693	1.19482	0.039 (11)
99	-0.314826	0.0889311	-0.0154651	0.32751	0.645 (12)
Total	0.679869	0.680395	0.191966	0.980821	0.309

Table 5. Control points.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
97	-3.31809	1.80524	0.425645	3.80129	0.509 (3)
Total	3.31809	1.80524	0.425645	3.80129	0.509

Table 6. Check points.

Digital Elevation Model

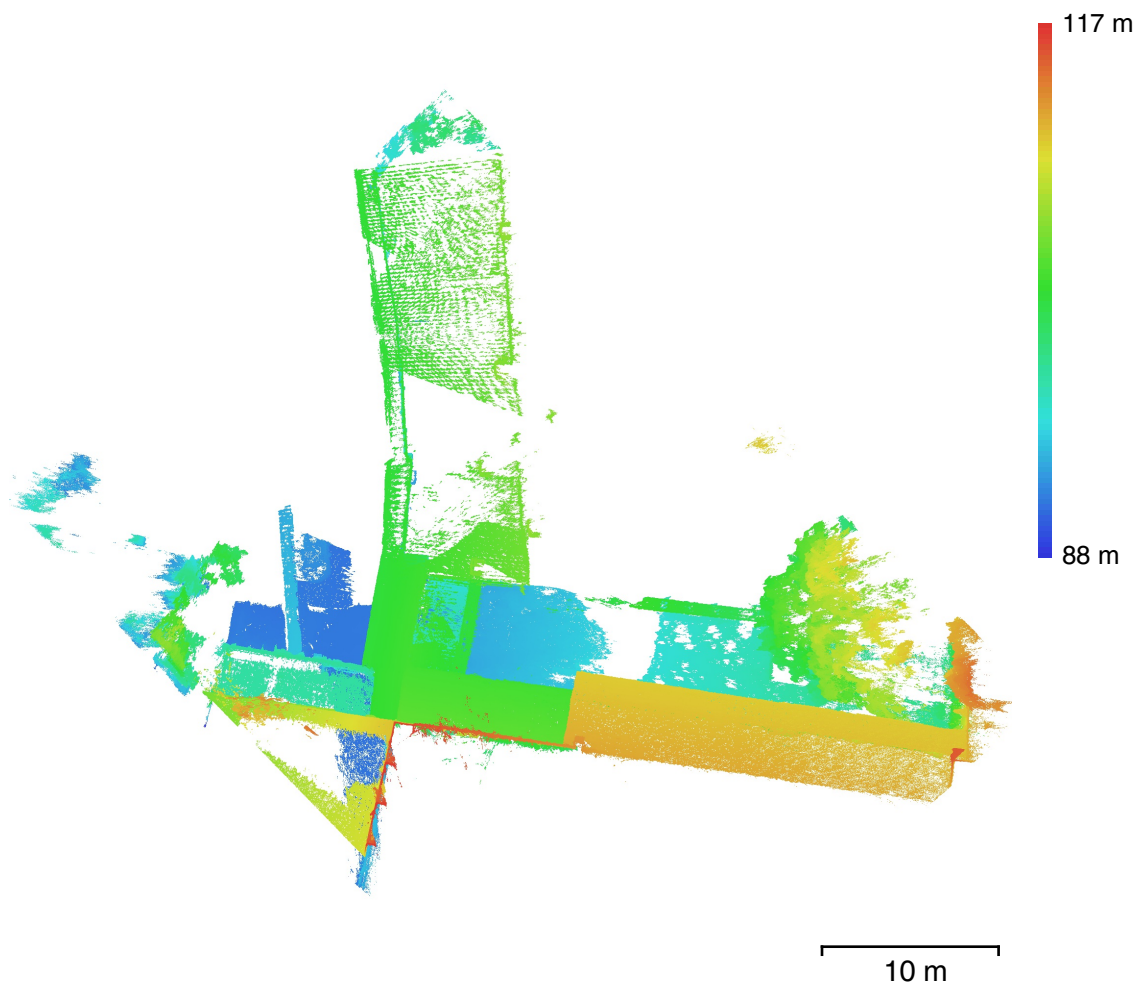


Fig. 4. Reconstructed digital elevation model.

Resolution: unknown
Point density: unknown

Processing Parameters

General

Cameras	316
Aligned cameras	316
Markers	5
Coordinate system	Local Coordinates (m)
Rotation angles	Yaw, Pitch, Roll

Point Cloud

Points	1,848,737 of 2,238,398
RMS reprojection error	0.333689 (1.19605 pix)
Max reprojection error	1.7183 (56.7221 pix)
Mean key point size	3.89 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	4.23177

Alignment parameters

Accuracy	High
Generic preselection	Yes
Key point limit	0
Tie point limit	0
Adaptive camera model fitting	Yes
Matching time	41 minutes 38 seconds
Alignment time	56 minutes 4 seconds

Optimization parameters

Parameters	f, b1, b2, cx, cy, k1-k4, p1, p2
Adaptive camera model fitting	No
Optimization time	26 seconds

Dense Point Cloud

Points	83,045,090
Point colors	3 bands, uint8

Reconstruction parameters

Quality	High
Depth filtering	Moderate
Depth maps generation time	1 hours 7 minutes
Dense cloud generation time	3 hours 20 minutes

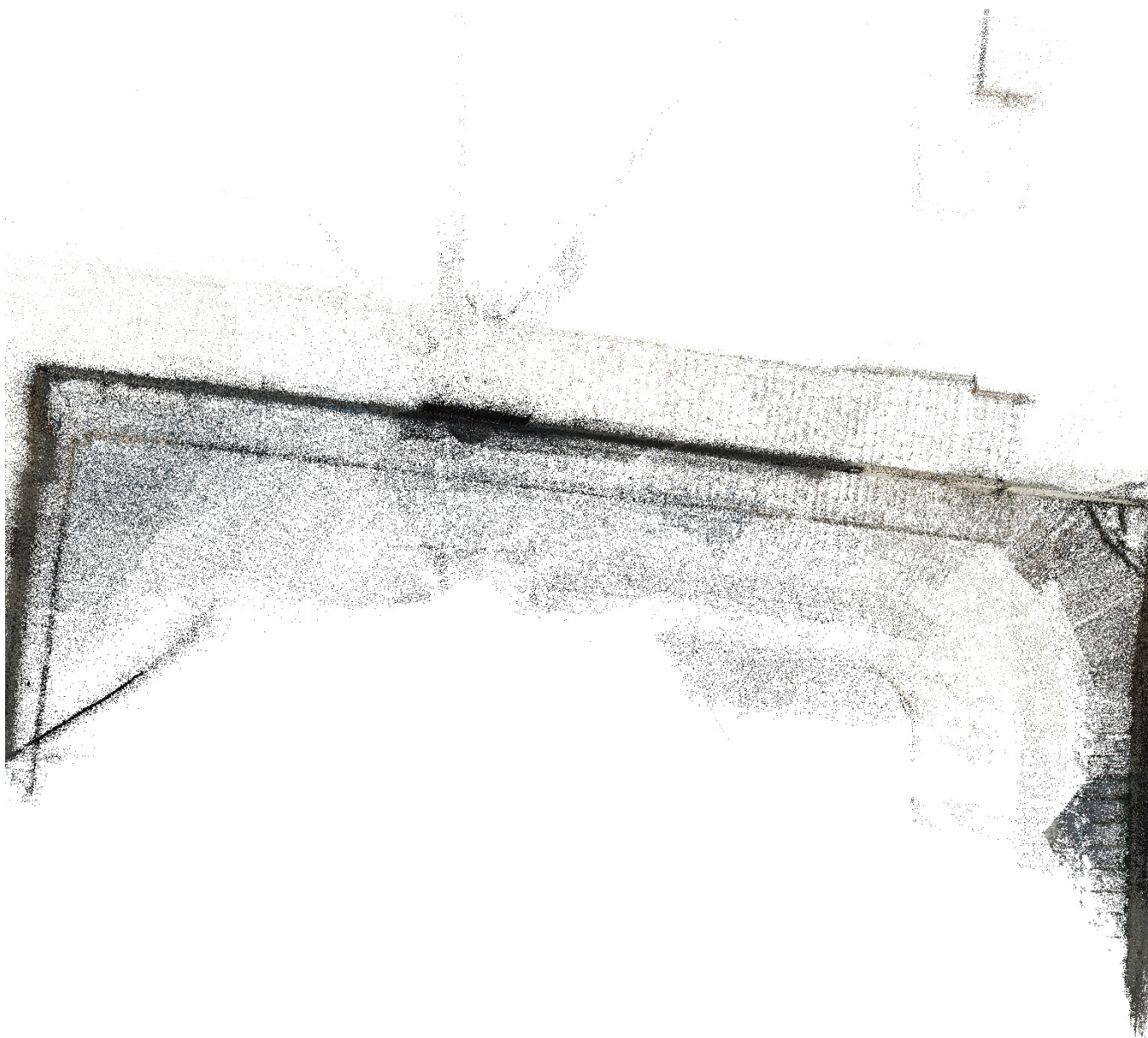
Software

Version	1.4.2 build 6205
Platform	Windows 64

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Survey Data

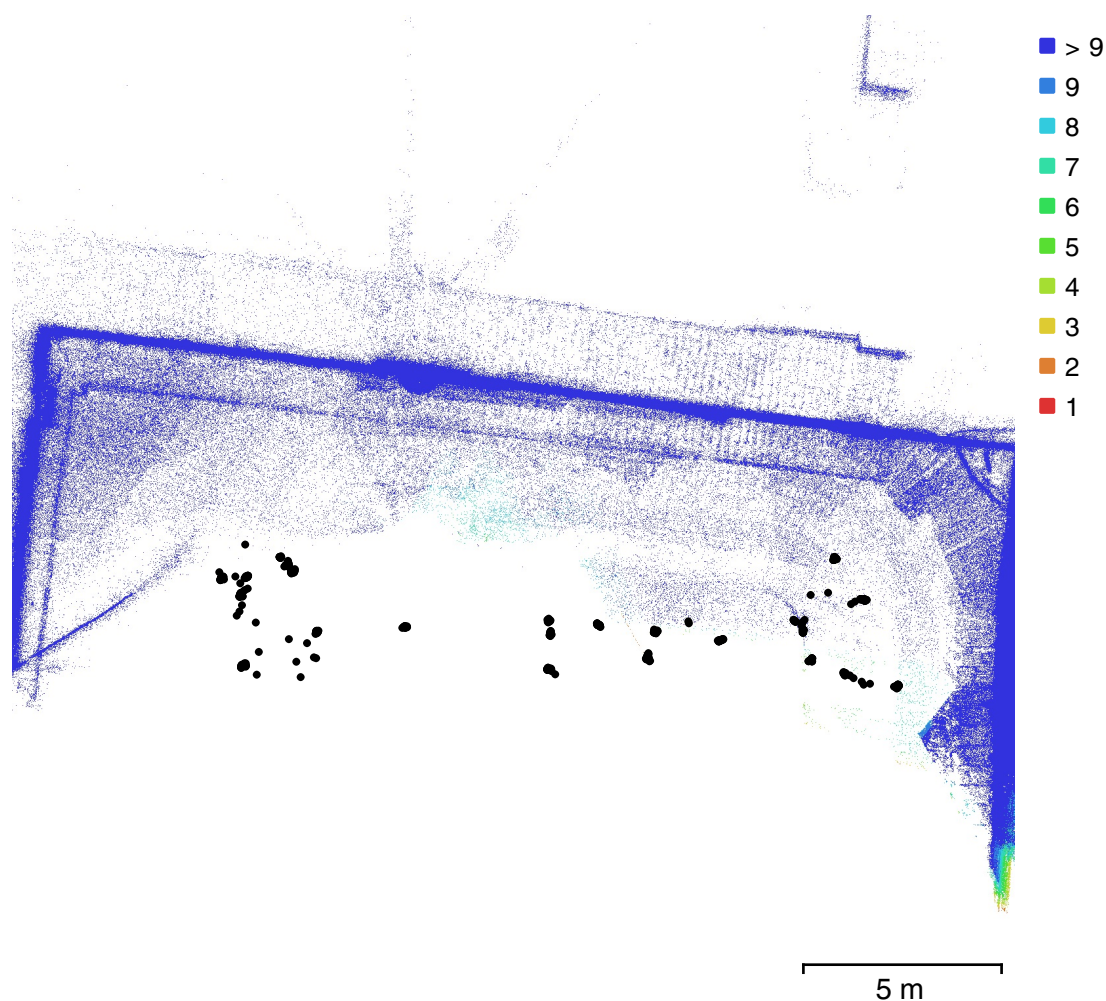


Fig. 1. Camera locations and image overlap.

Number of images:	449	Camera stations:	449
Flying altitude:	7.52 m	Tie points:	2,339,366
Ground resolution:	2.48 mm/pix	Projections:	9,796,655
Coverage area:	56.4 m ²	Reprojection error:	1.39 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
FC220 (4.73mm)	4000 x 3000	4.73 mm	1.57 x 1.57 μm	No

Table 1. Cameras.

Camera Calibration

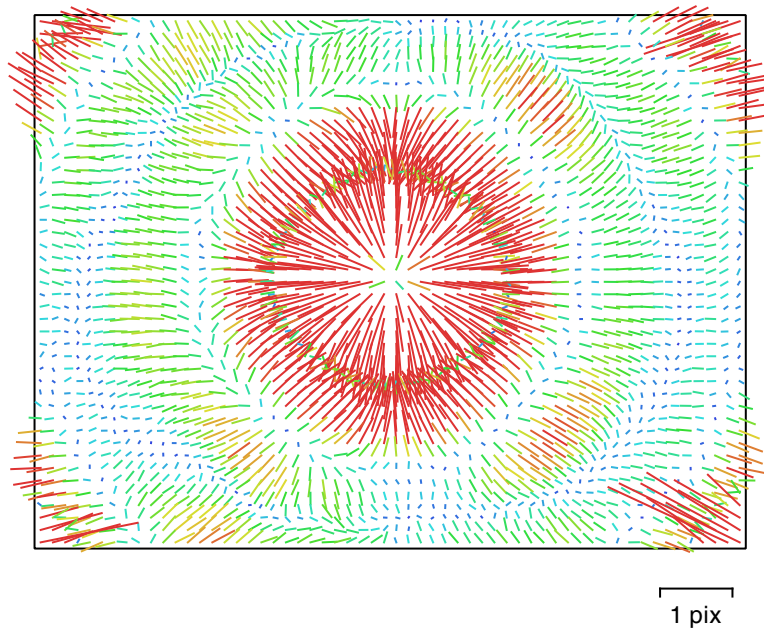


Fig. 2. Image residuals for FC220 (4.73mm).

FC220 (4.73mm)

449 images

Type	Resolution	Focal Length	Pixel Size
Frame	4000 x 3000	4.73 mm	1.57 x 1.57 μm

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	K4	P1	P2	P3	P4
F	3035.51	0.1	1.00	0.03	0.10	-0.95	-0.21	-0.01	-0.03	0.08	-0.12	0.05	-0.10	0.09	-0.07
Cx	-28.0194	0.039		1.00	-0.67	-0.00	0.10	0.03	-0.07	0.10	-0.12	0.63	-0.43	0.71	-0.58
Cy	-11.3245	0.045			1.00	-0.18	-0.10	-0.04	0.06	-0.08	0.10	-0.42	0.68	-0.75	0.59
B1	9.17181	0.099				1.00	0.24	-0.05	0.08	-0.11	0.14	-0.04	0.05	-0.04	0.04
B2	-2.87262	0.037					1.00	-0.00	0.01	-0.01	0.01	-0.06	0.01	-0.08	0.04
K1	0.123227	5.9e-05						1.00	-0.97	0.92	-0.87	0.00	-0.04	0.05	-0.03
K2	-0.667027	0.00035							1.00	-0.98	0.95	-0.03	0.06	-0.08	0.06
K3	1.50184	0.00085								1.00	-0.99	0.07	-0.08	0.10	-0.07
K4	-1.15665	0.0007									1.00	-0.10	0.10	-0.10	0.07
P1	0.000969381	4.5e-06										1.00	-0.36	0.36	-0.20
P2	-0.00111798	5.2e-06											1.00	-0.40	0.24
P3	-2.79754	0.0099												1.00	-0.95
P4	2.61331	0.013													1.00

Table 2. Calibration coefficients and correlation matrix.

Ground Control Points

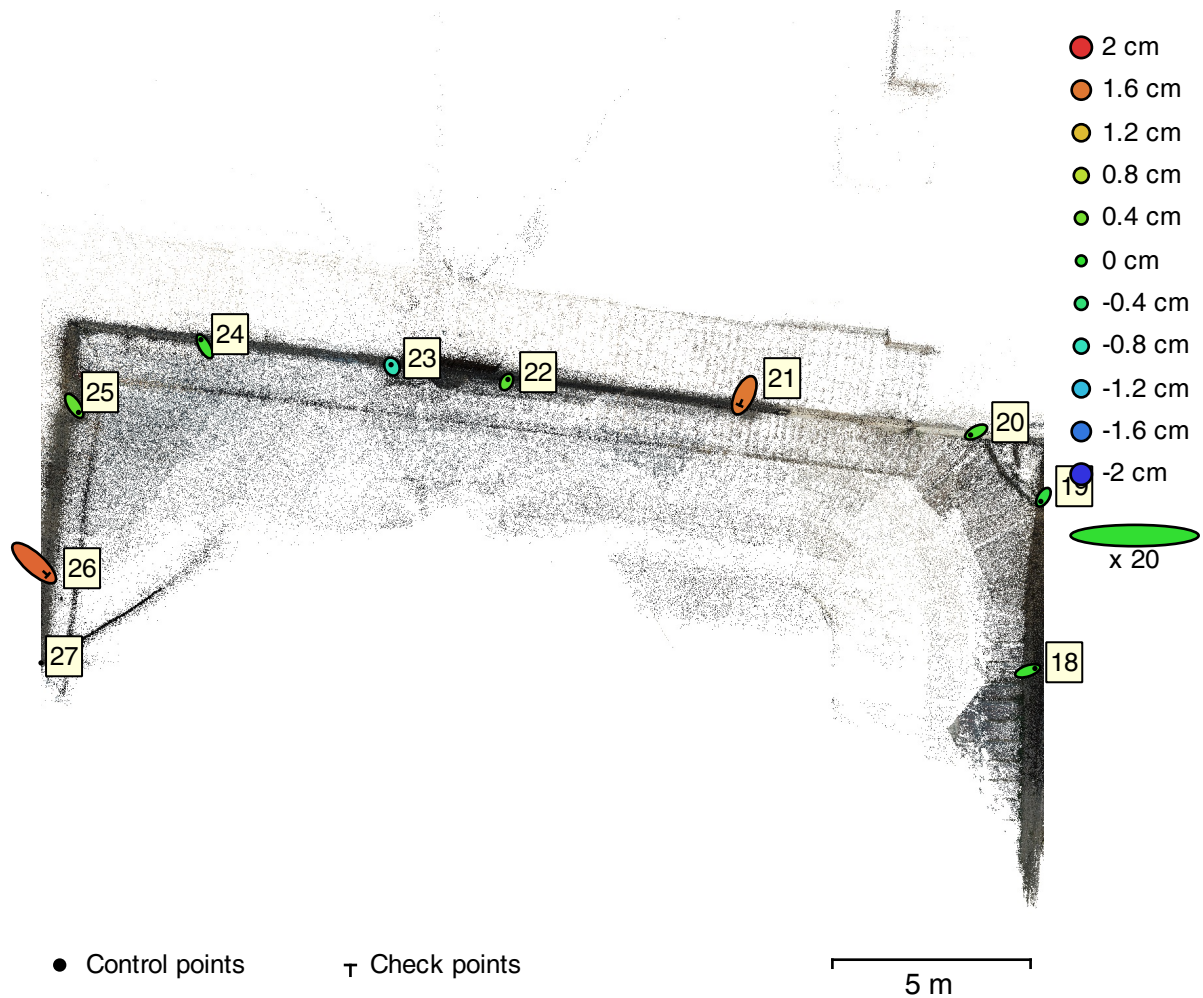


Fig. 3. GCP locations and error estimates.

Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.

Estimated GCP locations are marked with a dot or crossing.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
7	1.06815	1.08766	0.328348	1.52445	1.55941

Table 3. Control points RMSE.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
2	2.55656	2.81772	1.64856	3.80468	4.14648

Table 4. Check points RMSE.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
18	1.8245	0.614154	0.0674845	1.92628	1.380 (28)
19	-0.656863	-1.04842	-0.0924292	1.24064	1.012 (37)
20	-1.40512	-0.736121	0.152528	1.59358	1.551 (34)
22	0.342723	0.638582	0.239106	0.763163	1.619 (52)
23	-0.22327	0.47502	-0.752277	0.917286	0.907 (19)
24	-0.958838	1.70492	0.0926178	1.95824	1.132 (35)
25	1.07947	-1.65005	0.29437	1.99363	1.377 (52)
27					
Total	1.06815	1.08766	0.328348	1.55941	1.350

Table 5. Control points.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
21	-1.17831	-2.53321	1.59088	3.21504	1.209 (14)
26	3.41813	-3.07603	1.70429	4.90409	1.036 (42)
Total	2.55656	2.81772	1.64856	4.14648	1.082

Table 6. Check points.

Digital Elevation Model

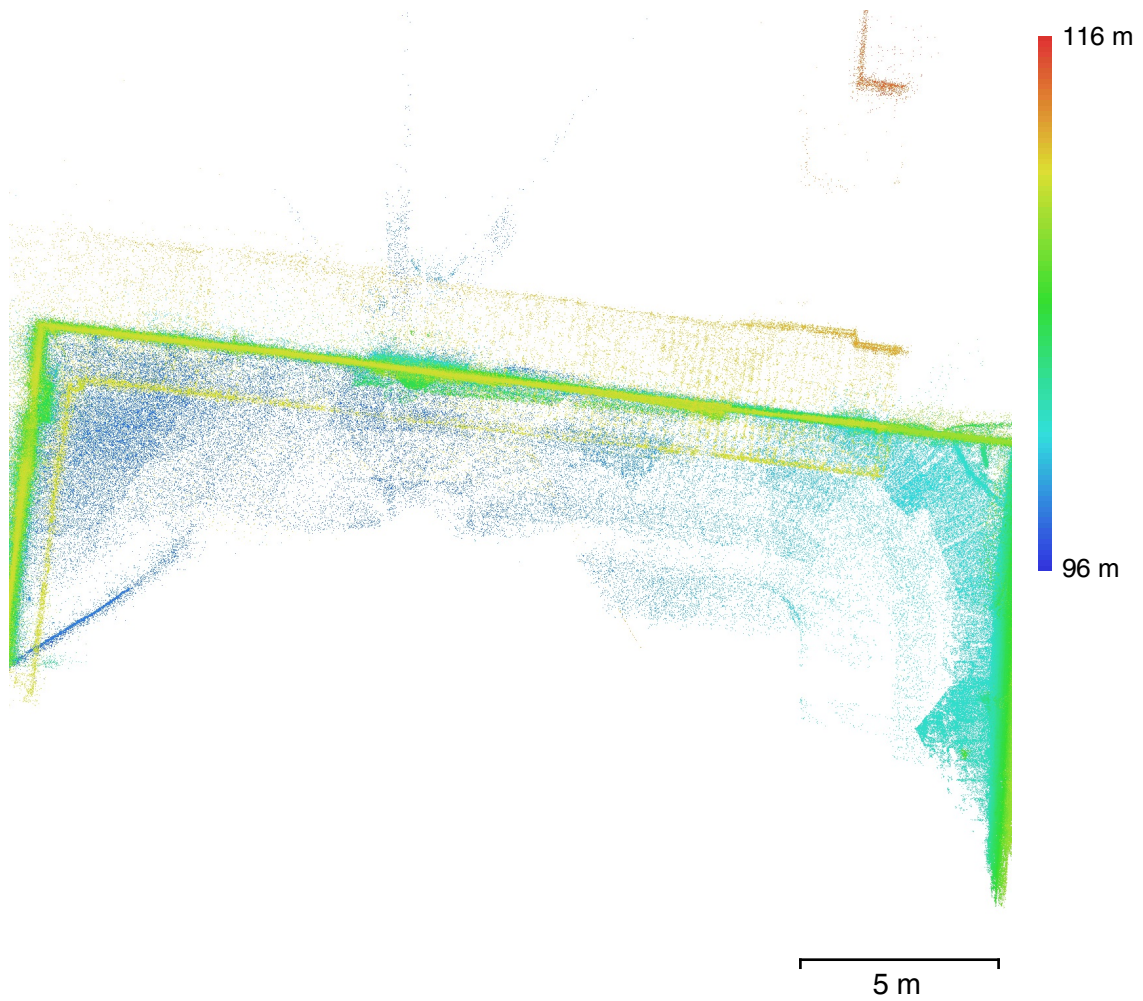


Fig. 4. Reconstructed digital elevation model.

Resolution: unknown

Point density: unknown

Processing Parameters

General

Cameras	449
Aligned cameras	449
Markers	10
Coordinate system	Local Coordinates (m)
Rotation angles	Yaw, Pitch, Roll

Point Cloud

Points	2,339,366 of 2,904,018
RMS reprojection error	0.36203 (1.39101 pix)
Max reprojection error	3.22789 (47.8948 pix)
Mean key point size	4.04976 pix
Point colors	3 bands, uint8
Key points	No
Average tie point multiplicity	5.0807

Alignment parameters

Accuracy	High
Generic preselection	Yes
Reference preselection	Yes
Key point limit	0
Tie point limit	0
Matching time	37 minutes 5 seconds

Optimization parameters

Parameters	f, b1, b2, cx, cy, k1-k4, p1-p4
Adaptive camera model fitting	No
Optimization time	1 minutes 26 seconds

Software

Version	1.4.2 build 6205
Platform	Windows 64