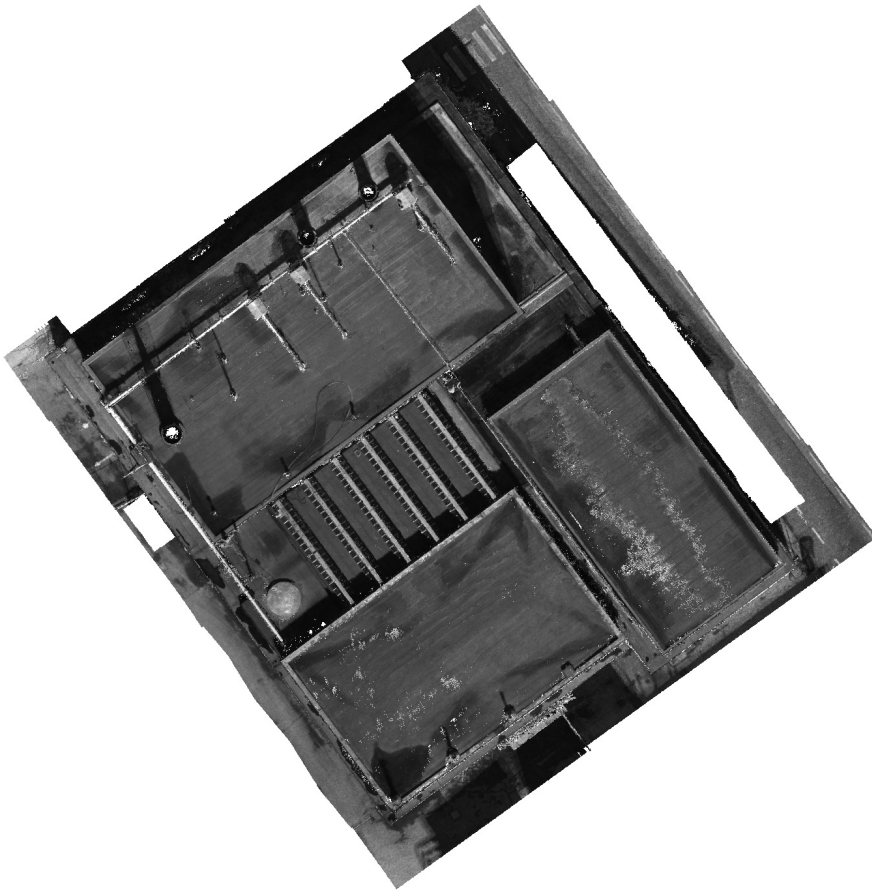


REPORT_UAV_RE

report drone re
14 March 2024



Survey Data

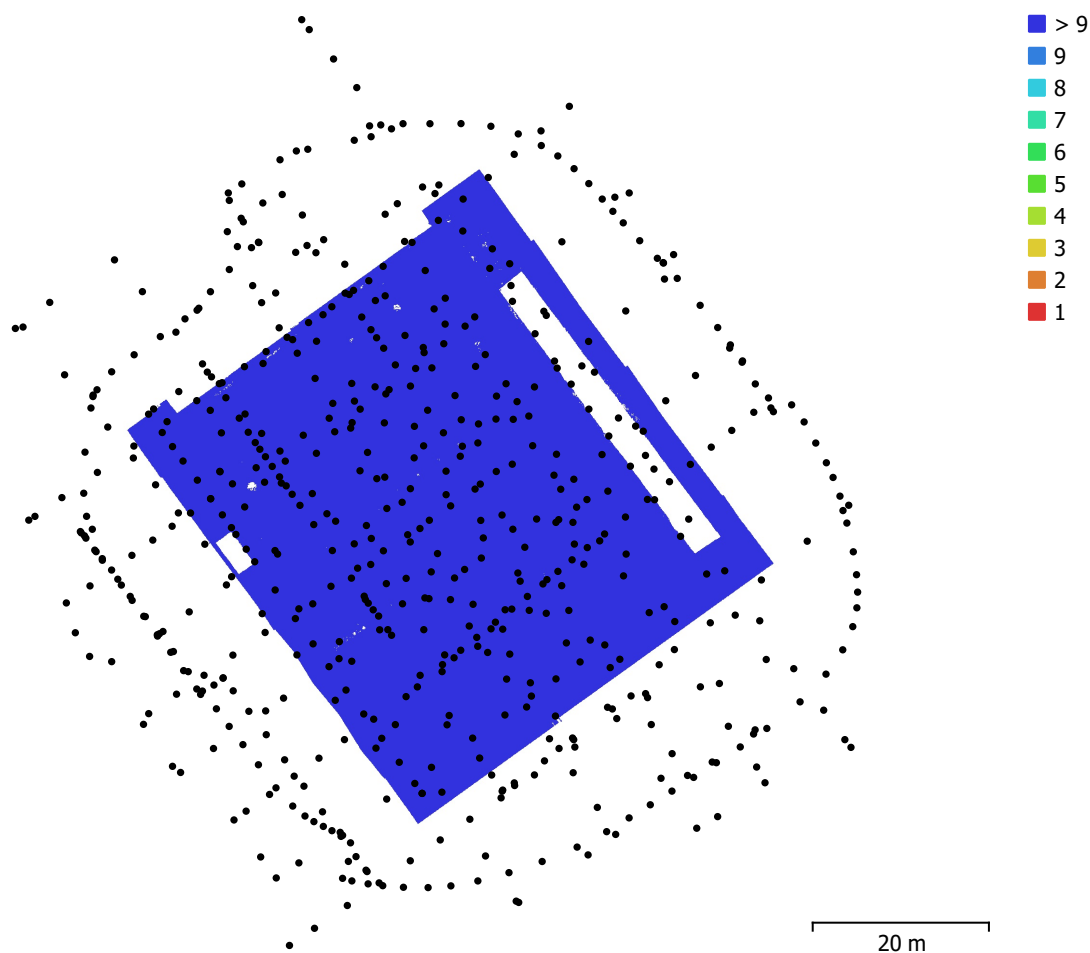


Fig. 1. Camera locations and image overlap.

Number of images:	598	Camera stations:	598
Flying altitude:	25.5 m	Tie points:	199,898
Ground resolution:	1.43 cm/pix	Projections:	1,308,303
Coverage area:	2.56e+03 m ²	Reprojection error:	1.12 pix

Camera Model	Resolution	Focal Length	Pixel Size	Precalibrated
M3M (4.34mm)	2592 x 1944	4.34 mm	2 x 2 μm	Yes

Table 1. Cameras.

Camera Calibration

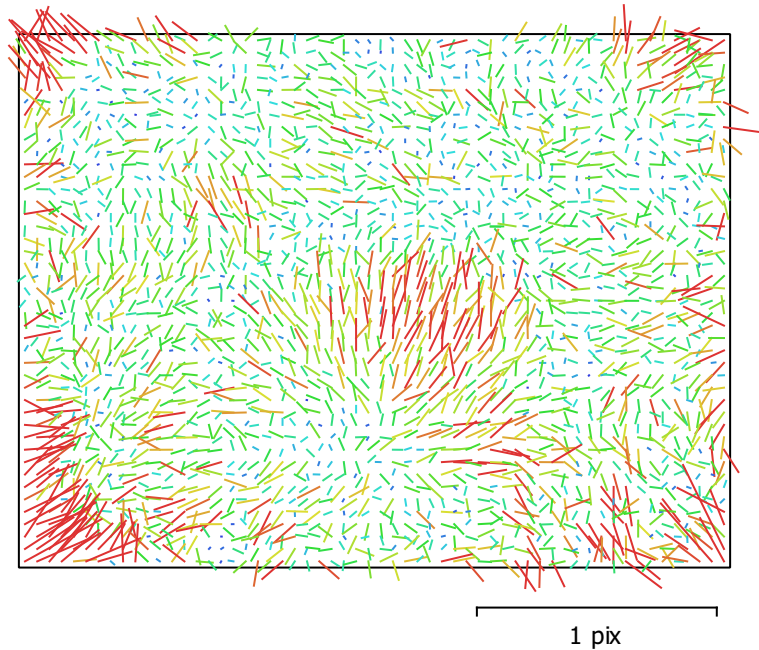


Fig. 2. Image residuals for M3M (4.34mm).

M3M (4.34mm)

598 images, precalibrated

Type	Resolution	Focal Length	Pixel Size
Frame	2592 x 1944	4.34 mm	2 x 2 μm

	Value	Error	F	Cx	Cy	B1	B2	K1	K2	K3	K4	P1	P2
F	2177.77	0.031	1.00	-0.08	-0.48	-0.25	-0.02	-0.52	0.49	-0.45	0.41	-0.04	-0.36
Cx	4.57851	0.034		1.00	0.07	-0.01	0.10	-0.01	0.00	-0.00	0.00	0.88	0.04
Cy	44.8783	0.039			1.00	-0.14	0.07	-0.02	-0.00	0.01	-0.00	0.03	0.72
B1	-0.534831	0.012				1.00	-0.06	0.01	-0.03	0.02	-0.02	-0.01	0.20
B2	0.340888	0.0097					1.00	0.00	0.00	-0.00	0.00	-0.12	-0.03
K1	0.00186288	0.00017						1.00	-0.97	0.93	-0.88	-0.01	-0.04
K2	-0.0455497	0.0012							1.00	-0.99	0.96	0.00	0.02
K3	0.0126119	0.0031								1.00	-0.99	-0.00	-0.01
K4	-0.0290869	0.0029									1.00	0.00	0.02
P1	-0.00082134	5e-06										1.00	0.03
P2	-0.00110497	4.7e-06											1.00

Table 2. Calibration coefficients and correlation matrix.

Ground Control Points

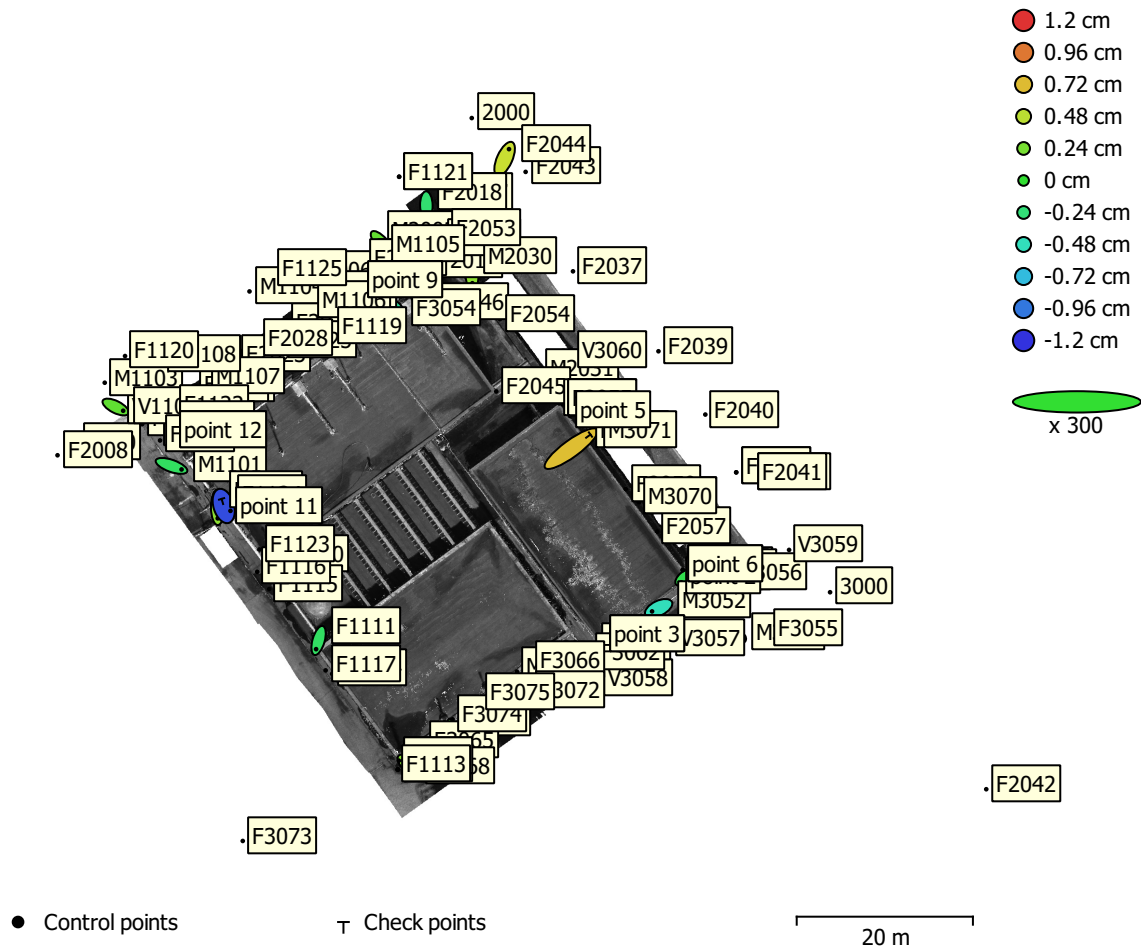


Fig. 3. GCP locations and error estimates.

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)
22	0.372788	0.505299	0.2766	0.627932	0.686153

Table 3. Control points RMSE.

X - Easting, Y - Northing, Z - Altitude.

Count	X error (cm)	Y error (cm)	Z error (cm)	XY error (cm)	Total (cm)
6	0.93079	0.890553	0.728797	1.2882	1.48007

Table 4. Check points RMSE.

X - Easting, Y - Northing, Z - Altitude.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
1000					
3000					
2000					
M2001					
M2002	0.458803	-0.519174	0.17325	0.714183	0.559 (4)
M2003					
M2004					
V2005					
V2006					
F2007					
F2008					
F2015					
F2016					
F2017	0.15664	-0.0288584	0.161066	0.22652	0.362 (10)
F2018	0.0108228	-0.592517	-0.214476	0.630233	0.590 (16)
F2019	-0.894361	0.294891	-0.237048	0.9711	0.596 (14)
F2020	0.00992629	0.182007	-0.458196	0.493121	0.721 (10)
F2021					
F2022	0.218977	0.789108	-0.162755	0.834944	0.235 (11)
F2023					
F2024	-0.24533	0.898239	0.151336	0.943357	0.363 (7)
F2025					
F2026					
F2027					
F2028					
M2029					
M2030	0.0368556	-0.789412	0.317102	0.851519	0.151 (11)
M2031					
M2032					
M2033					
C2034					

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
C2035					
F2035					
F2036					
F2037					
M2038					
F2039					
F2040					
F2041					
F2042					
F2043					
F2044	0.331605	0.738644	0.52904	0.967181	1.782 (7)
F2045					
F2046					
F2047					
F2048					
F2049	0.313511	0.253676	-0.097005	0.41479	0.545 (10)
F2050					
F2051					
F2054					
F2055					
F2057					
F2058					
M3050	0.120539	-0.0326534	-0.177876	0.217338	0.272 (7)
M3051					
M3052	-0.497724	-0.237619	-0.476629	0.728949	0.458 (15)
F3053	0.099668	0.0862938	-0.154967	0.203458	0.545 (12)
F3054	-0.487294	0.435455	-0.364297	0.748191	0.634 (10)
F3055					
V3057					
V3059					
V3060	-0.263903	0.611353	0.333251	0.744616	0.439 (15)
F3061	0.0033345	-0.372278	0.300107	0.478191	3.091 (20)

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
F3062					
F3063					
F3065					
F3066					
F3067					
F3068	-0.430029	0.409712	0.285094	0.658838	0.525 (9)
F3069					
M3070					
F3072					
F3073					
F3074					
F3075					
M1100					
M1101	0.759269	-0.267391	-0.16062	0.820844	0.372 (10)
M1102	0.00564607	-0.83007	0.309681	0.885974	0.752 (10)
M1103					
M1104					
M1105					
M1106					
M1107					
M1108					
V1109	0.566515	-0.282242	0.160889	0.653059	0.278 (10)
F1110	-0.0847561	-0.0917044	-0.050271	0.134612	0.243 (12)
F1111	-0.188713	-0.655461	-0.166674	0.702155	0.300 (15)
F1112					
F1113					
F1114					
F1115					
F1116					
F1117					
F1118					
F1119					

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
F1120					
F1121					
F1122					
F1123					
F1125					
point 1					
point 2					
point 3					
point 4					
point 5					
point 6					
point 7					
point 8					
point 9					
point 10					
point 11					
point 12					
Total	0.372788	0.505299	0.2766	0.686153	1.036

Table 5. Control points.
X - Easting, Y - Northing, Z - Altitude.

Label	X error (cm)	Y error (cm)	Z error (cm)	Total (cm)	Image (pix)
F2053	0.912619	-0.563615	-0.899805	1.40007	0.387 (7)
V3056	1.23228	0.584649	0.580539	1.48235	0.564 (13)
V3058	-0.807827	0.266646	0.542468	1.00894	0.454 (13)
F3064	-0.2005	1.6129	0.0929563	1.62797	0.721 (15)
M3071	1.4588	1.06728	0.711221	1.94243	0.084 (11)
F1124	-0.161079	0.536107	-1.10971	1.2429	0.265 (10)
Total	0.93079	0.890553	0.728797	1.48007	0.488

Table 6. Check points.
X - Easting, Y - Northing, Z - Altitude.

Digital Elevation Model

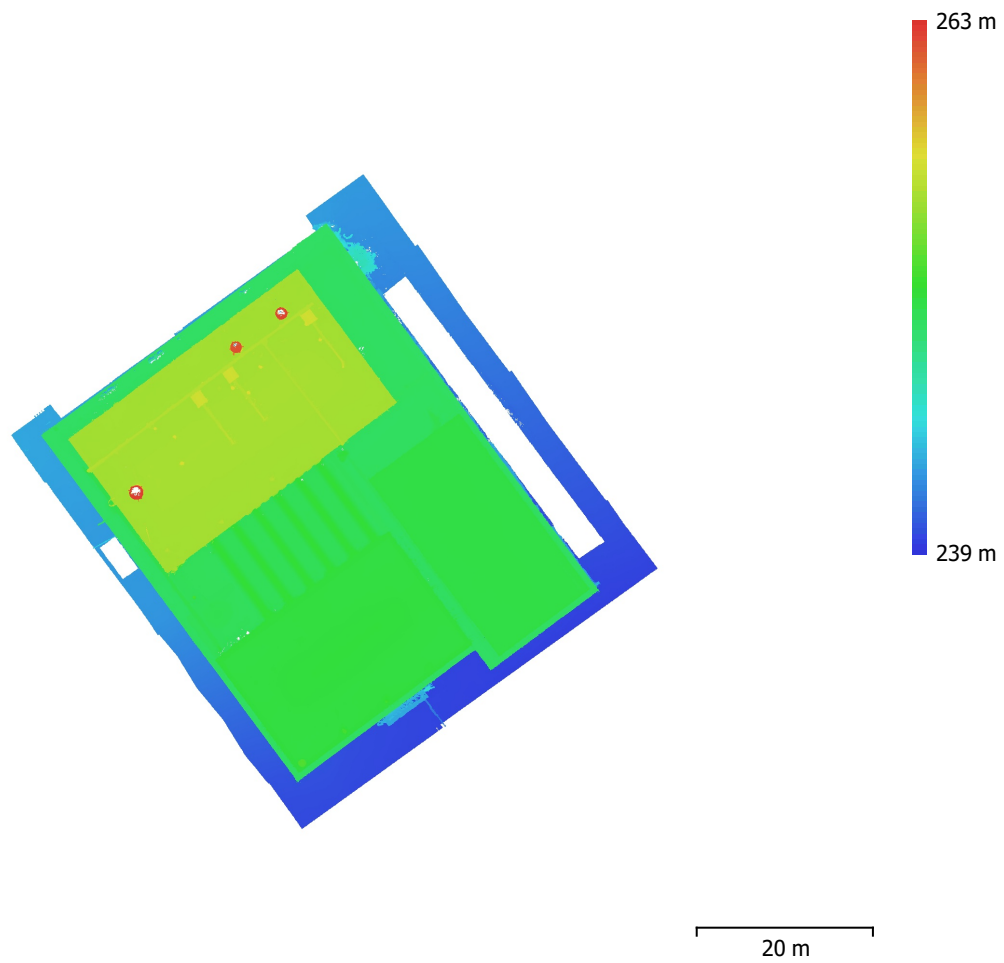


Fig. 4. Reconstructed digital elevation model.

Resolution: 2.86 cm/pix
Point density: 0.122 points/cm²

Processing Parameters

General

Cameras	598
Aligned cameras	598
Markers	120
Coordinate system	WGS 84 / UTM zone 32N (EPSG::32632)
Rotation angles	Omega, Phi, Kappa

Tie Points

Points	199,898 of 325,714
RMS reprojection error	0.310657 (1.11834 pix)
Max reprojection error	1.18074 (48.4508 pix)
Mean key point size	3.35494 pix
Point colors	1 bands, uint16
Key points	1.17 GB
Average tie point multiplicity	8.07444

Alignment parameters

Accuracy	High
Generic preselection	No
Reference preselection	Source
Key point limit	40,000
Key point limit per Mpx	1,000
Tie point limit	4,000
Exclude stationary tie points	Yes
Guided image matching	No
Adaptive camera model fitting	No
Matching time	38 minutes 9 seconds
Matching memory usage	615.22 MB
Alignment time	5 minutes 27 seconds
Alignment memory usage	610.59 MB

Optimization parameters

Parameters	f, b1, b2, cx, cy, k1-k4, p1, p2
Adaptive camera model fitting	No
Optimization time	10 seconds
Date created	2024:01:11 17:14:12
Software version	2.0.3.16960
File size	55.45 MB

Point Cloud

Points	7,188,766
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Point attributes

Color	1 bands, uint16
Normal	

Point classes

Created (never classified)	7,188,766
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Depth maps generation parameters

Quality	High
Filtering mode	Mild
Max neighbors	16
Processing time	44 minutes 44 seconds
Memory usage	3.31 GB

Point cloud generation parameters

Processing time	56 minutes 37 seconds
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Memory usage	7.37 GB
Date created	2024:01:16 22:39:01
Software version	2.0.3.16960
File size	411.92 MB
DEM	
Size	1,960 x 813
Coordinate system	WGS 84 (EPSG::4978)
Reconstruction parameters	
Source data	Point cloud
Interpolation	Disabled
Processing time	2 seconds
Memory usage	190.02 MB
Date created	2024:01:19 16:06:40
Software version	2.0.3.16960
File size	3.44 MB
Orthomosaic	
Size	1,867 x 774
Coordinate system	WGS 84 (EPSG::4978)
Colors	1 bands, uint16
Reconstruction parameters	
Blending mode	Mosaic
Surface	DEM
Enable hole filling	No
Enable ghosting filter	No
Processing time	2 minutes 7 seconds
Memory usage	92.50 MB
Date created	2024:01:19 16:16:49
Software version	2.0.3.16960
File size	270.21 MB
System	
Software name	Agisoft Metashape Professional
Software version	2.0.3 build 16960
OS	Windows 64 bit
RAM	127.91 GB
CPU	Intel(R) Core(TM) i7-6850K CPU @ 3.60GHz
GPU(s)	Quadro M2000