MONTENEGRO

DRIVING THE TRANSITION
TO TOURISM INDUSTRY 4.0
POWERED BY DIGITAL
TECHNOLOGIES

TAKING YOU AND YOUR
INDUSTRY TO THE
NEXT LEVEL

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

PROJECT AT A GLANCE

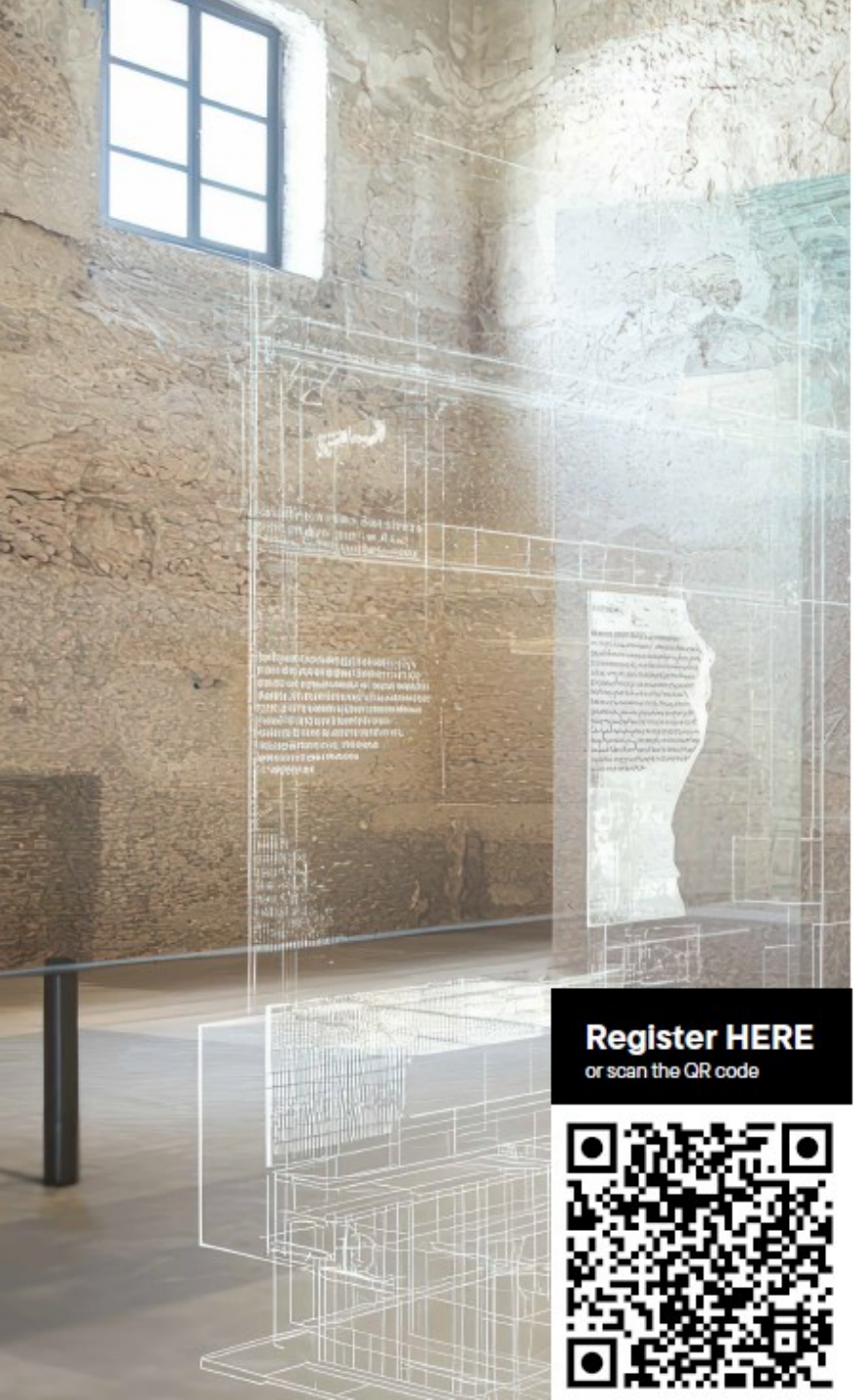
Supporting the transition to Tourism Industry 4.0. in Montenegro driven by digital technologies

Donor: Slovenia
Coordinating Agency: Ministry of Economic Development and Tourism of Montenegro

How to Receive Your Certificate

All participants will be able to receive a certificate of completion at the end of the program.

After the final lecture**, a short questionnaire** will be available and must be completed in order to receive the certificate.



Register HERE
or scan the QR code

Join the Training Programme

on Digital Innovation of Cultural Heritage!

As part of the project "Provision of Digital Technologies Fostering Tourism 4.0 and Technological Learning in Montenegro", we are pleased to invite you to participate in a **Training Programme** focused on digital storytelling and 3D technologies for cultural heritage and tourism. The programme consists of **five interactive workshops**, combining theory and practice:

- **Introduction to 3D and Digital Storytelling (online)**
  10 November 2025, 11:00–12:00 (Registration until 7 November)
- **3D Digital Capture and Data Processing (online)**
  17 November 2025, 11:00–12:00
- **Principles of Digital Storytelling with 3D Assets (hybrid)**
  27 November 2025, 11:00–12:00 TBC
- **3D Data Management (online)**
  1 December 2025, 11:00–12:00
- **Hands-on Workshop (on-site)**
  Planned for June 2026

Participants will gain both **conceptual understanding and practical experience** with digital tools and workflows that enable innovative storytelling and digital preservation of cultural heritage.
We warmly invite **professionals, students, researchers, and cultural heritage practitioners** to join us and enhance their skills in digital innovation for Tourism 4.0.

The project is coordinated by Arctur, a Slovenian high-tech company known for its award-winning initiatives in the field of digital cultural tourism, and is implemented under the mandate of the United Nations Industrial Development Organization (UNIDO) (UNIDO Project SAP ID 230074).

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UNIDO

Key Points

- Scanning methods to 3D model
- Pre-site preparation
- Camera setup
- Photo capture strategy (terrain-specific)
- Ground Control Points (markers)
- Survey measurements
- Processing overview in Agisoft Metashape
- Deliverables for mapping & game assets

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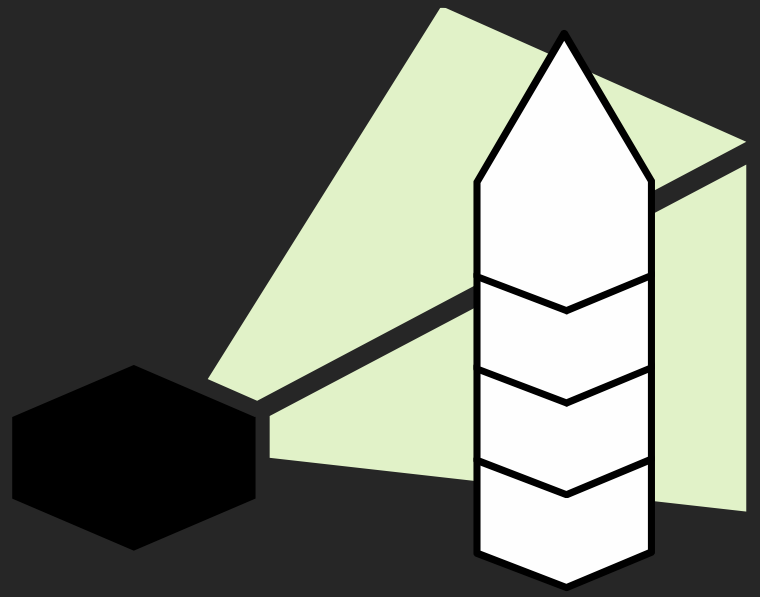
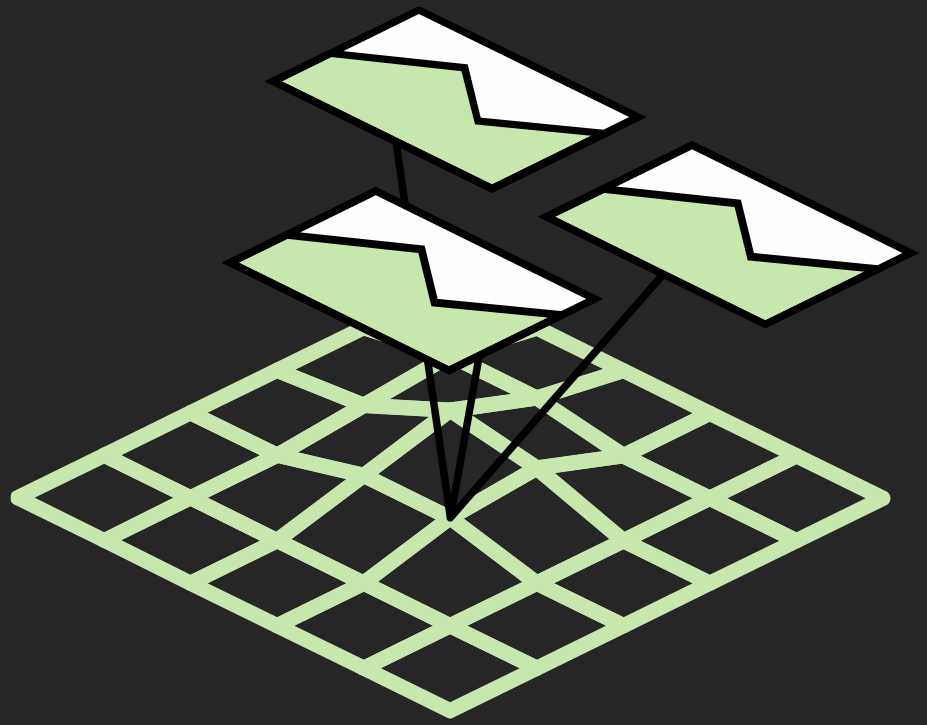


Laser scanning



Photogrammetry

Laser scanning

- **Laser scanner** captures 3D geometry of objects or environments without contact.
- **Infrared laser beam** is projected onto a rotating mirror to scan the surroundings.
- The rotating head **directs the beam** across the object or area.
- Reflected laser **light returns** to the scanner, providing data for 3D reconstruction.
- High accuracy in any environment, provide precise and fast measurements, even in challenging conditions such as low light, large spaces, or complex surfaces.


Setup 047


/SUS


YellowScan


Perspective 30°
points: 145,990,714

Photogrammetry

- 3D reconstruction using overlapping photos
- Especially useful for environments, terrain patches, cliffs, quarries, and outdoor scans
- Requires careful:
  - Lighting control
  - Camera stability
  - Coverage & angles
  - Accurately measured scale

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HERITAGE+
by
ARCTUR


11
Jack Bar

PointCloud with 18.050 000 points

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Photogrammetry Softwares

- **Autodesk ReCap Pro**
- **Agisoft Metashape**
- **Meshroom**
- **Pix4D**
- **RealityCapture**
- **…**

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Terms in Photogrammetry

- Markers
- Key points
- Tie points
- Align
- Terestrial photo /Aerial photo
- Laser
- Origin
- Point cloud
- Spare cloud
- Dense cloud
- Mesh
- Texture
- Chunk
- Control points

Pre-Capture Preparation

Environment & conditions

- Overcast sky preferred
- Avoid shadows + changing light
- Little/no wind for marker stability

Terrain readiness

- Remove vegetation if possible
- Ensure you can walk the whole capture area…


UAS geografska območja (geographical zones)
CAA Slovenia
Find address or place
Layer List
Layers
Airfields - vzletisca
Aerodromes - letalisca
Nuclear power plant - NEK
VFR aerodromes - VFR letalisca
national park - nacionalni park
CTR - Kontrolirana cona
Danger area
Heliport
Restricted areas
Built - pozidano
FIR
grad Brežice
cona letališča (r=5km)
meja

Aerial data capture

- European regulation for drone flight authorization
- Drone registration
- Flight notification to the aviation authority (https://caa.me)
- Site check / NOTAM review
- Proper certification for the required category
- Permission from the landowner


EASA
European Union Aviation Safety Agency
AGENCIJA ZA CIVILNO LETALSTVO CIVIL AVIATION AGENCY, SLOVENIA CAA
SLO
A1/A3 OPEN SUB CATEGORY
Certifikat o uspešno opravljenem spletnem usposabljanju
PROOF OF COMPLETION OF THE ONLINE TRAINING
Ime in priimek (First and last name)
Luka Vodopivec
Številka zadeve (Case number)
60414-2792/2021
Registracijska številka (Registration number)
[redacted]
Veljavno do (Expiration date)
25. 12. 2026


EASA
European Union Aviation Safety Agency
SLOVENIJA
AGENCIJA ZA CIVILNO LETALSTVO CIVIL AVIATION AGENCY, SLOVENIA CAA
Registracija operatorja sistemov brezpilotnih zrakoplovov
UAS OPERATOR REGISTRATION
Operator (Operator)
ARCTUR Računalniški inženiring d.o.o.
Datum izdaje (Issuing date)
24.10.2025
Številka zadeve (Case number)
37248-1934/2025
Naslov (Address)
Industrijska cesta 001A, 5000 Nova Gorica, SI
Veljavno do (Expiration date)
24. 04. 2028
Registracijska številka (Registration number)
[redacted]

AGENCIJA ZA CIVILNO LETALSTVO
CIVIL AVIATION AGENCY, SLOVENIA CAA

NAJAVA LETA BREZPILOTNEGA ZRAKOPLOVA

Podatki o napravi in operatorju

Naziv operatorja:	Arctur d.o.o.
Telefonska številka upravljavca:	041 400 971
Tip naprave:	DJI Mavic 2 Pro
Serijska številka naprave:	163CGCA R0A6FMU
Kategorija dejavnosti:	A
Konfiguracija opreme:	
1.	samo serijsko nameščena oprema
2.	
3.	
4.	

Podatki o letu

Namen leta:	fotogrametrija
Datum leta:	Thu, 20. Feb. 2020
Čas leta (LOC):	od: 09:00 do: 12:00
Lokacija:	Volčji Grad (Komen), Debela Griža
Področje letenja:	I.

Koordinate letenja/območje:

T1	**N**	45.802011	**E**	13.745860
T2	**N**	45.805227	**E**	13.744407
T3	**N**	45.805649	**E**	13.747556
T4	**N**	45.802609	**E**	13.750130
T5	**N**		**E**	
T6	**N**		**E**	

Datoteka .kmz: PRIPNI DATOTEKO .kmz | IZBRIŠI DATOTEKO

debelagriza.kmz

Načrtovana višina letenja: 80m

Največja načrtovana oddaljenost: 400m

POŠLJI NAJAVO LETA

* Za delovanje vseh fukcij obrazca uporabite različico Adobe Reader XI ali novejšo. Pri drugačni programski opremi priložite datoteko .klm kot priponko elektronskemu sporočilu.

* V primeru nedelovanja samodejnega izpolnjevanja elektronskega sporočila, pošljite najavo na elektronski naslov: uav@caa.si

JAVNA AGENCIJA ZA CIVILNO LETALSTVO REPUBLIKE SLOVENIJE
KOTNIKOVA ULICA 19 A SI-1000 LJUBLJANA SLOVENIJA
T: +386 1 244 66 00
F: +386 1 244 66 99
info@caa.si
www.caa.si

Arctur d.o.o.
Industrijska Cesta 1A
5000 Nova Gorica

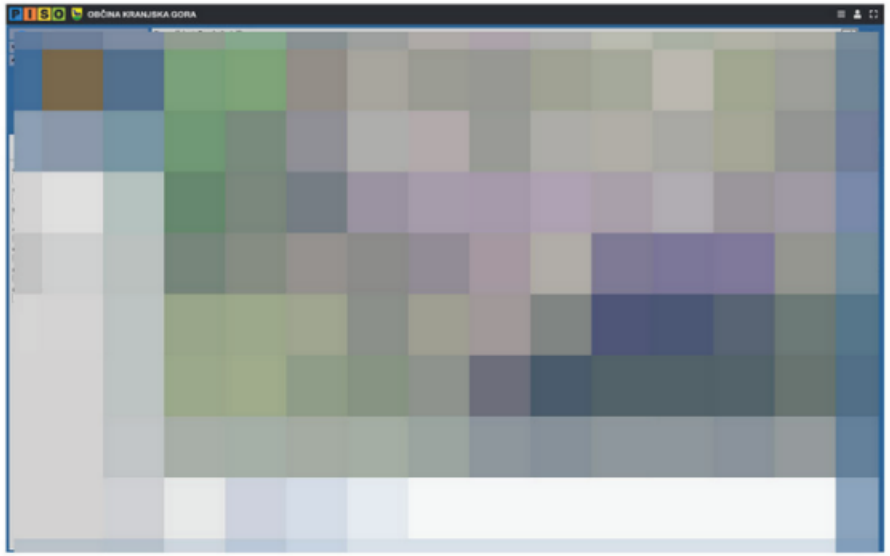
ARCTUR

Dovoljenje za prelet z dronom.

Podjetje _____ dovoljuje prelet navednih parcel z dronom, za potrebe izdelave multimedijskih oglaševalskih materialov.

Parcela št.: _____
Parcela št.: _____
Parcela št.: _____

Na sliki so označene z _____ naslov je _____



Nova Gorica, dne _____

Managing Director


POZOR!
BREZPILOTNI
ZRAKOPLOV
GALERIJA
MUZEJ
V PILOT
edrone

Equipment Checklist

- Mirrorless/DSLR or high-end phone
- 24–50 mm equivalent lens
- Extra batteries + storage
- Survey gear: GNSS RTK / Total Station (optional)
- GCP markers: checkerboards, coded targets, or X-marks
- Measuring tape or scale bars

Capture Strategy

- Aerial photos
  - Ortofoto (avtomatsko letenje)
  - Ring (avtomatsko letenje, kroženje)
  - Vertikalni ortofoto (ročno letenje)
  - Detalji – vertical Ring (ročno letenje)

- Terrain
  - Interier
  - Zunanji / eksterier
  - Detalji
  - Streha / napušč

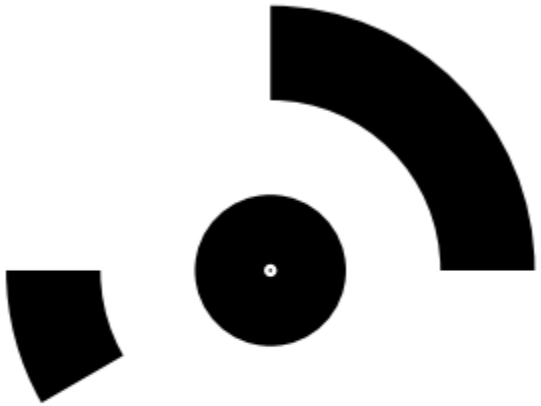
Preparation

- What will be scanned
- Site inspection / cleaning
- Planning marker placement
- Planning marker placement for orthophotos
- Flight planning
- Scheduling scan time
- Laser requirements

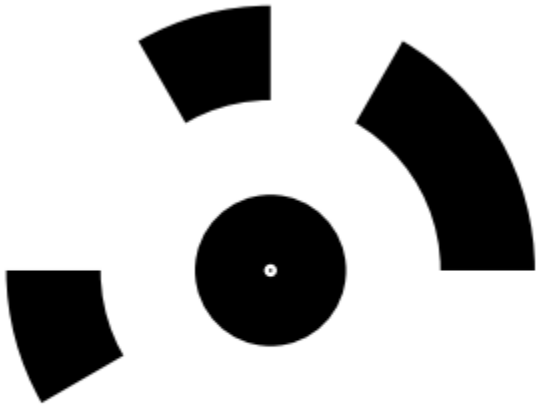

allowed
selected04
selected
restricted
drog
home03
selected02
home01
home02
Z
X
Y

Markers

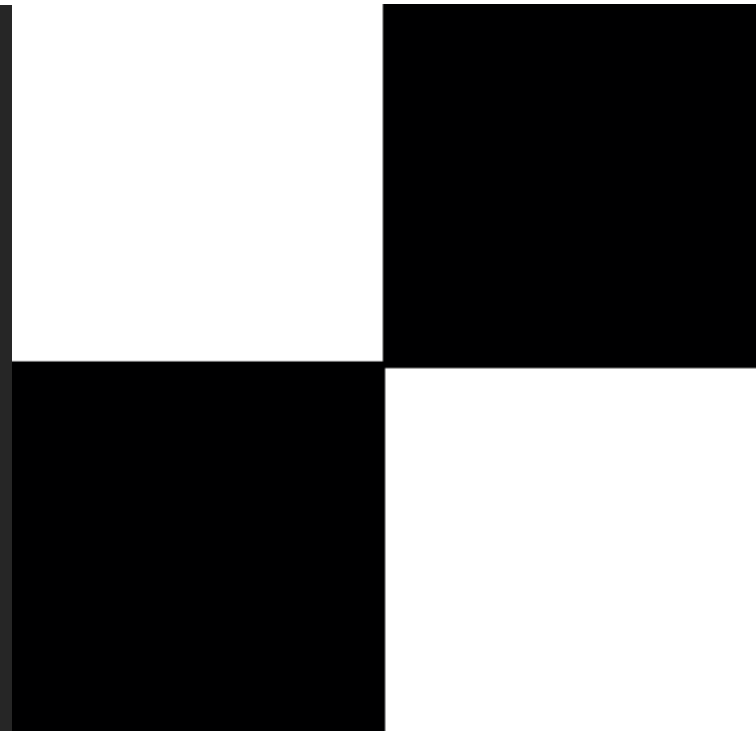
- 12 bitni
- 16 bit
- Cross
- Painted X marks
- Scale bars



1

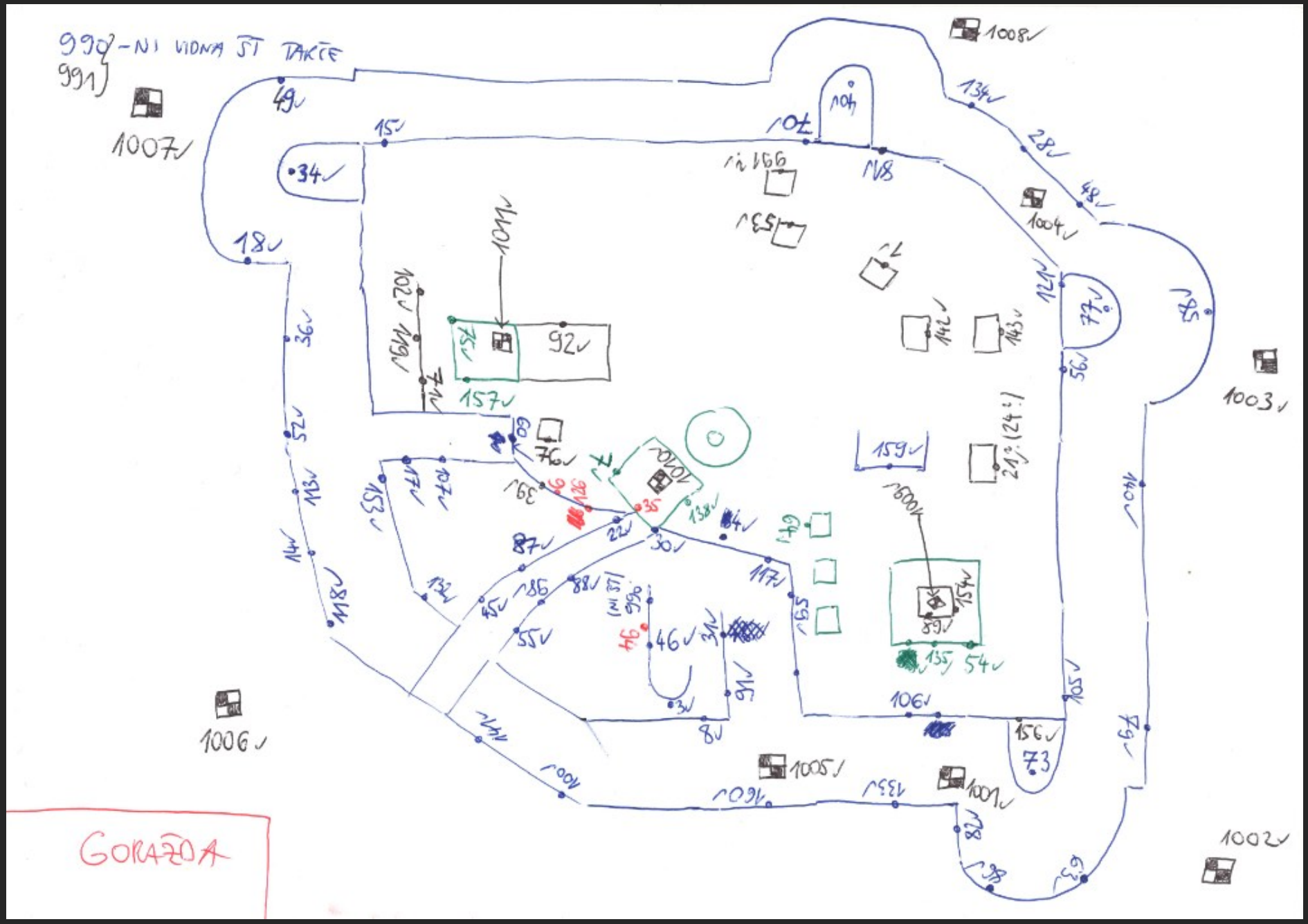


2



Why Use Markers?

- Provides true scale
- Greatly improves accuracy
- Reduces model drift
- Essential for GIS or when merging multiple scans
- Helps Software optimize camera parameters


990 - NI VIDNA ŠT TAKŠE
991
1007
1008
1004
1003
1002
1006
1005
1001
GORAZDA

Marker Placement

- Minimum 5 markers
- Best: 8–12 markers
- Spread evenly around perimeter
- 2–3 inside the capture zone
- Place on stable ground, not vegetation
- Ensure each is visible in 6+ photos

Survey Measurements

- Correcting GPS data
- Geo-referencing (matching data with coordinate system)
- Using local coordinate systems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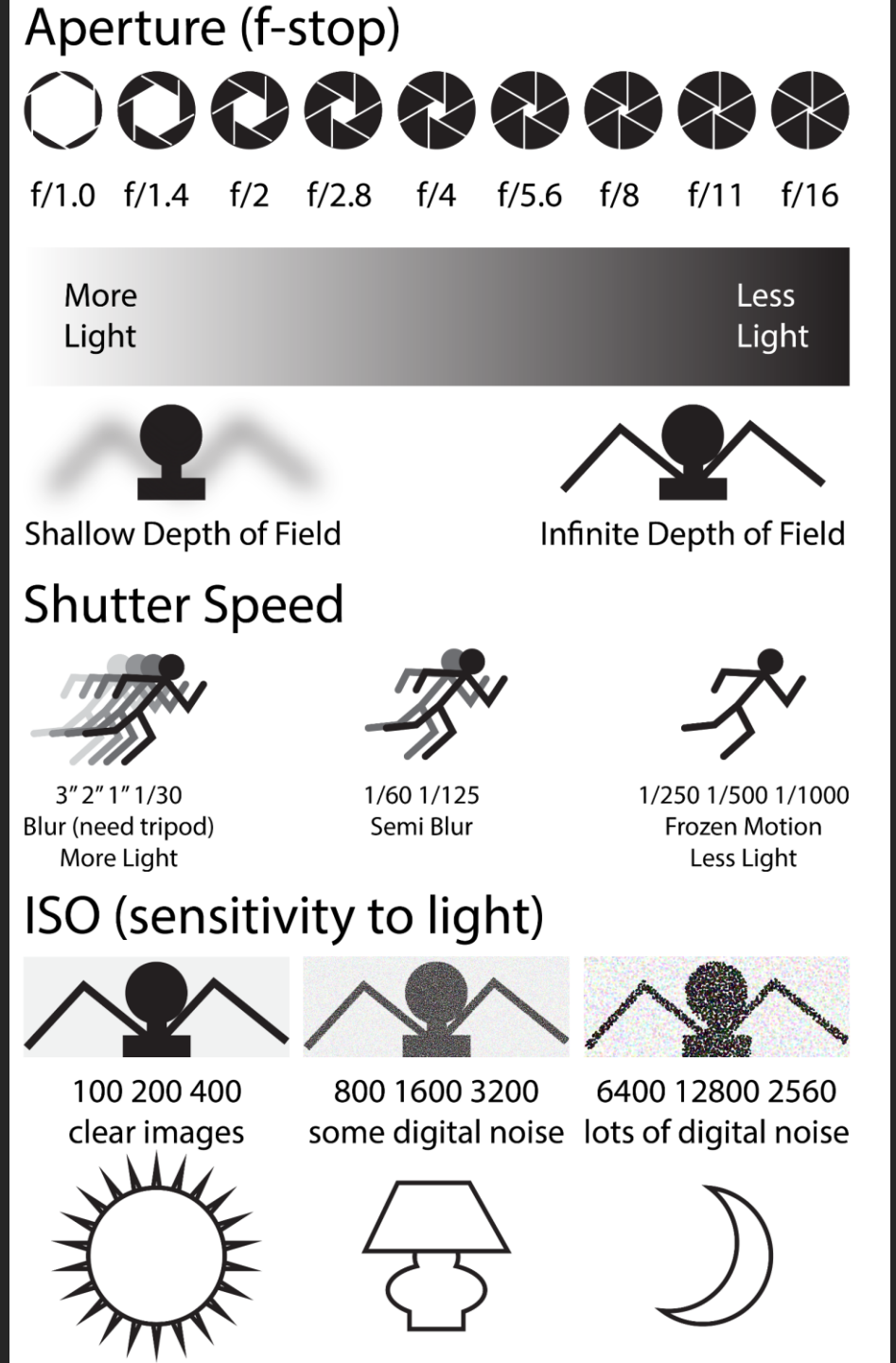
Camera Settings



Use Manual Mode / Advance

- **Shutter: ≥ 1/125**
- **Aperture: f/8 – f/11**
- **ISO: 100–400**
- **Focus: Automatic**
- **White balance: Locked**
- **Image format: RAW**

Drone Settings

Use Manual Mode / Advance

- **Shutter: ≥ 1/700**
- **Aperture: f/6 – f/11**
- **ISO: 100–400**
- **Focus: Automatic**
- **White balance: Locked**
- **Image format: RAW**

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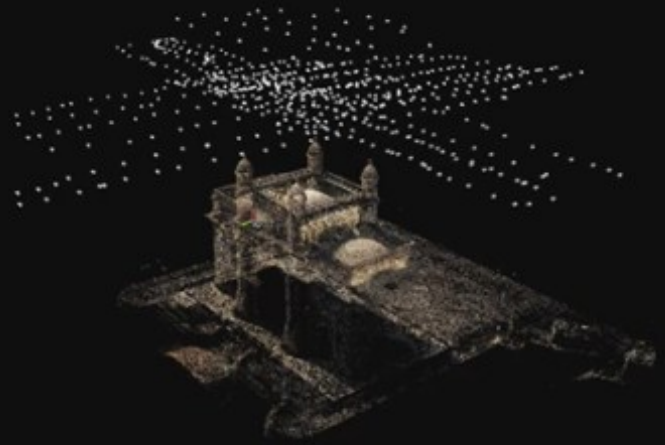
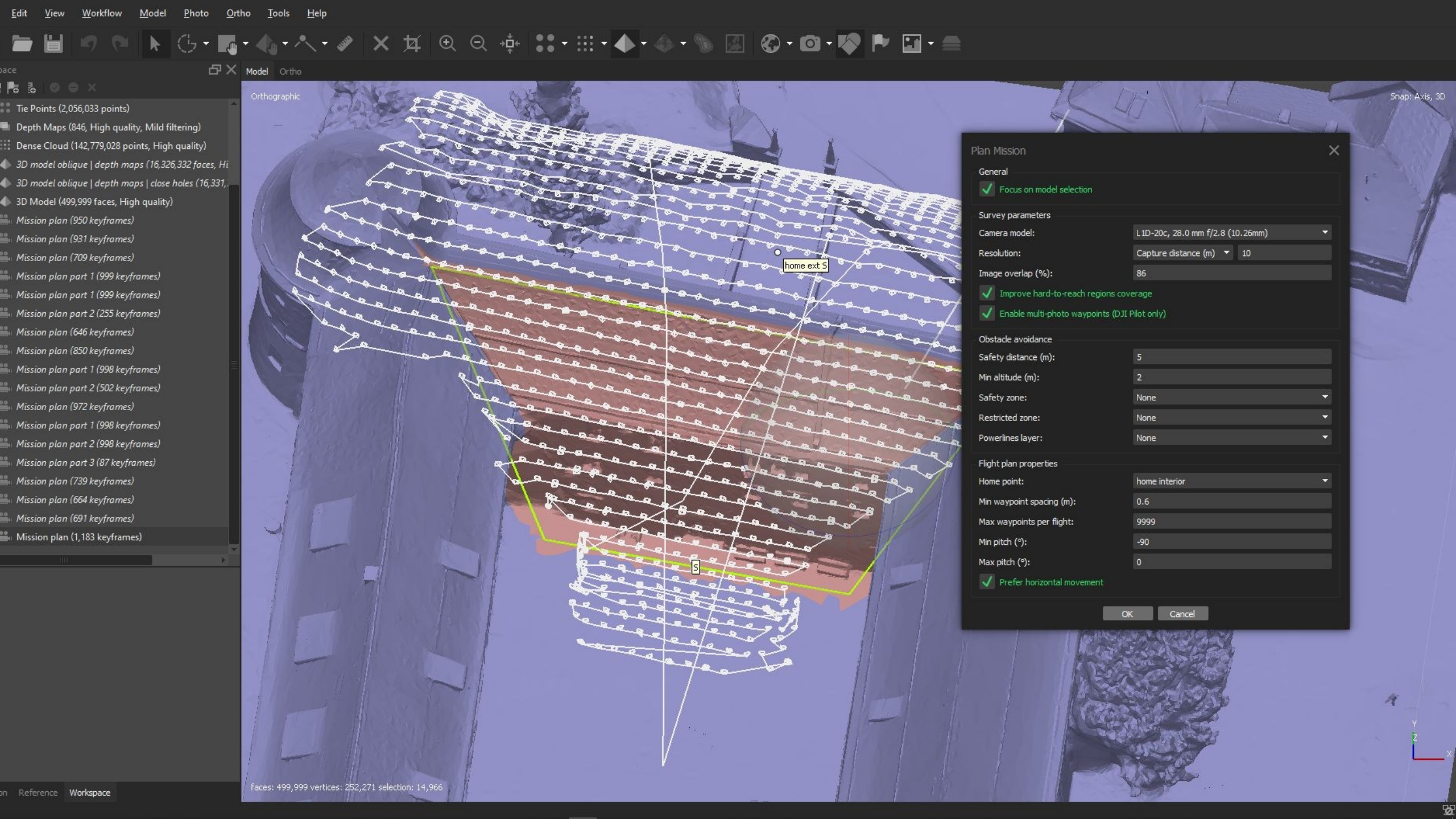
Grid Flights



Ring Flights

Ortho Flights


Edit
View
Workflow
Model
Photo
Ortho
Tools
Help
Model
Ortho
Orthographic
Snap: Axis, 3D
Tie Points (2,056,033 points)
Depth Maps (846, High quality, Mild filtering)
Dense Cloud (142,779,028 points, High quality)
3D model oblique | depth maps (16,326,332 faces, Hi
3D model oblique | depth maps | close holes (16,331,
3D Model (499,999 faces, High quality)
Mission plan (950 keyframes)
Mission plan (931 keyframes)
Mission plan (709 keyframes)
Mission plan part 1 (999 keyframes)
Mission plan part 1 (999 keyframes)
Mission plan part 2 (255 keyframes)
Mission plan (646 keyframes)
Mission plan (850 keyframes)
Mission plan part 1 (998 keyframes)
Mission plan part 2 (502 keyframes)
Mission plan (972 keyframes)
Mission plan part 1 (998 keyframes)
Mission plan part 2 (998 keyframes)
Mission plan part 3 (87 keyframes)
Mission plan (739 keyframes)
Mission plan (664 keyframes)
Mission plan (691 keyframes)
Mission plan (1,183 keyframes)
home ext 5
5
Plan Mission
General
Focus on model selection
Survey parameters
Camera model:
L1D-20c, 28.0 mm f/2.8 (10.26mm)
Resolution:
Capture distance (m)
10
Image overlap (%):
86
Improve hard-to-reach regions coverage
Enable multi-photo waypoints (DJI Pilot only)
Obstacle avoidance
Safety distance (m):
5
Min altitude (m):
2
Safety zone:
None
Restricted zone:
None
Powerlines layer:
None
Flight plan properties
Home point:
home interior
Min waypoint spacing (m):
0.6
Max waypoints per flight:
9999
Min pitch (°):
-90
Max pitch (°):
0
Prefer horizontal movement
OK
Cancel
Faces: 499,999 vertices: 252,271 selection: 14,966
Reference
Workspace


F9
F10
F11
F12
HOME
END
DELETE


Snap: Axis, 3D
Z
X
Y

Field Checklist (errors)

- Stable lighting (Overcast weather)
- High overlap
- Overlap between aerial and terrain photos
- Multi-height coverage
- Markers clearly visible
- No motion blur
- Even exposure across all images
- Weather stability
- RAW data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HASSELBLAD
F/2.8 EQV 28mm


ALIENWARE


www.rctur.si


ALIENWARE
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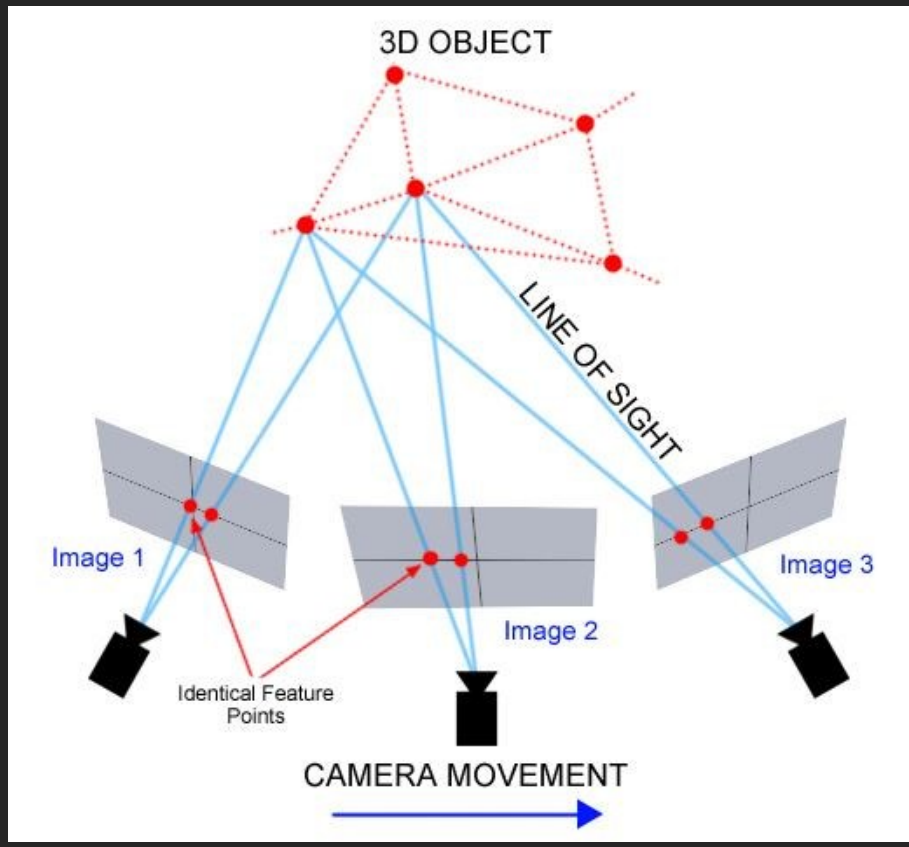
Leica


HERITAGE+
by
ARCTUR

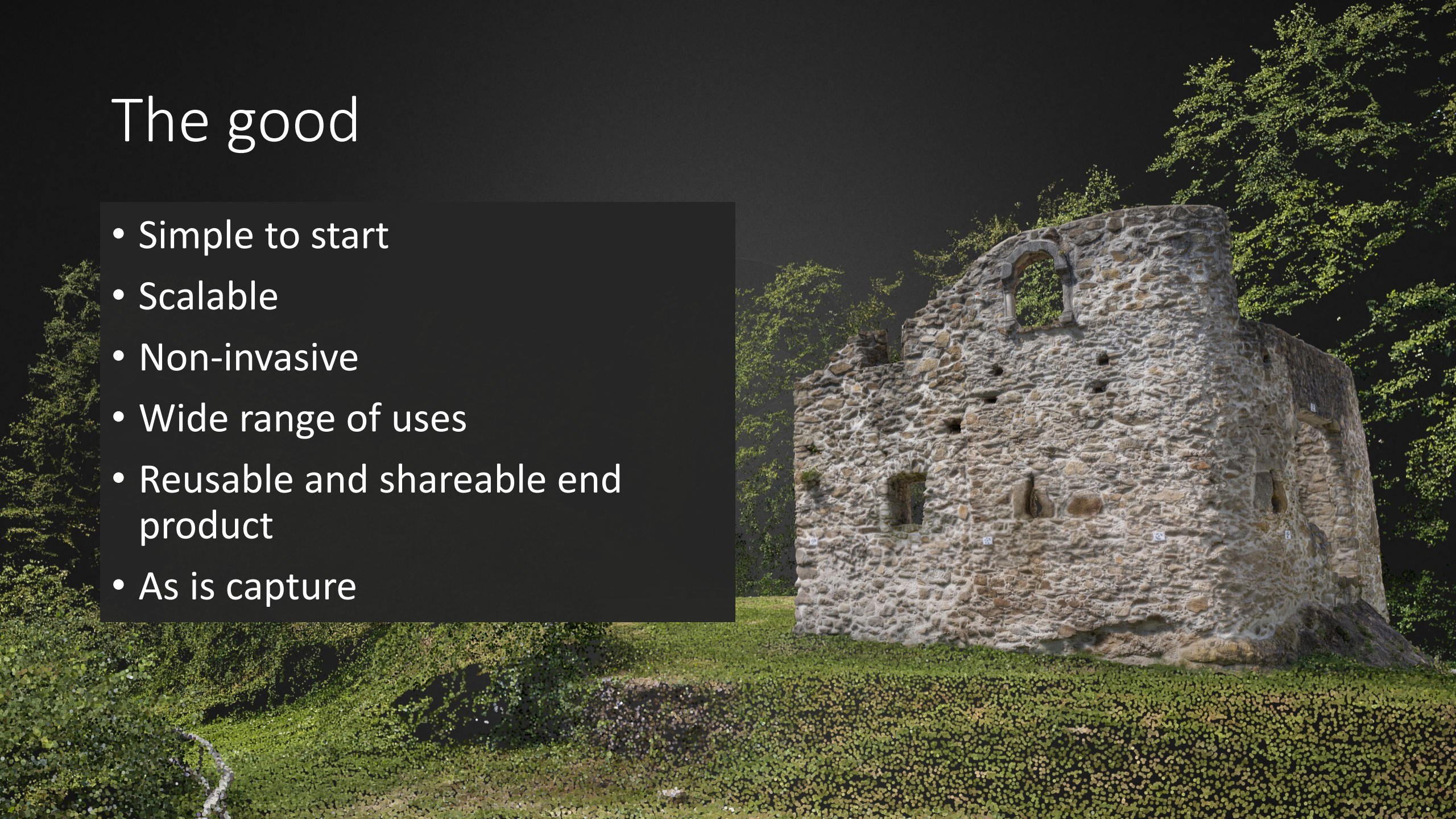
What is photogrammetry

- Getting information about physical object dimensions by examining and interpreting images.
  - Feature matching
- Reverse photography process
  - Photography compresses 3D object into a 2D image
  - Taking 2D images and turning them into a 3D model
- Difference in perspective



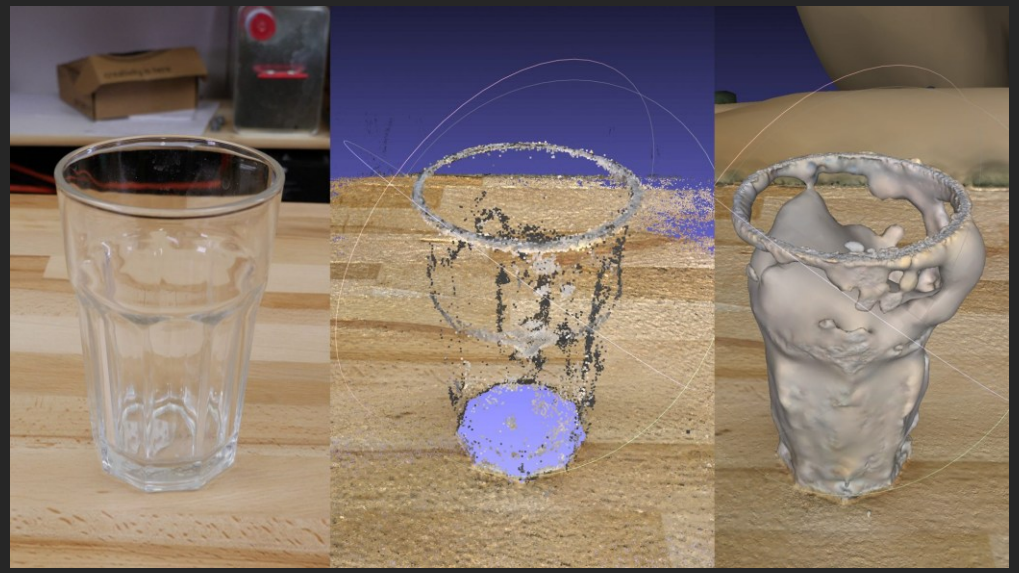
The good

- Simple to start
- Scalable
- Non-invasive
- Wide range of uses
- Reusable and shareable end product
- As is capture



The bad

- As is capture
- Not suited for every type of material*
- Data dependant



Getting started

BASIC

- Camera
  - In our case a phone camera
- Software

Advanced

- Basic
- Lights
- Softboxes
- Filters
- Drones
- Georeferencing equipment
- Measuring equipment
- A lot of data storage space
- Powerfull computers

Photogrammetry Softwares

- **Autodesk ReCap Pro**
- **Agisoft Metashape**
- **Meshroom**
- **Pix4D**
- **RealityCapture**
- **…**

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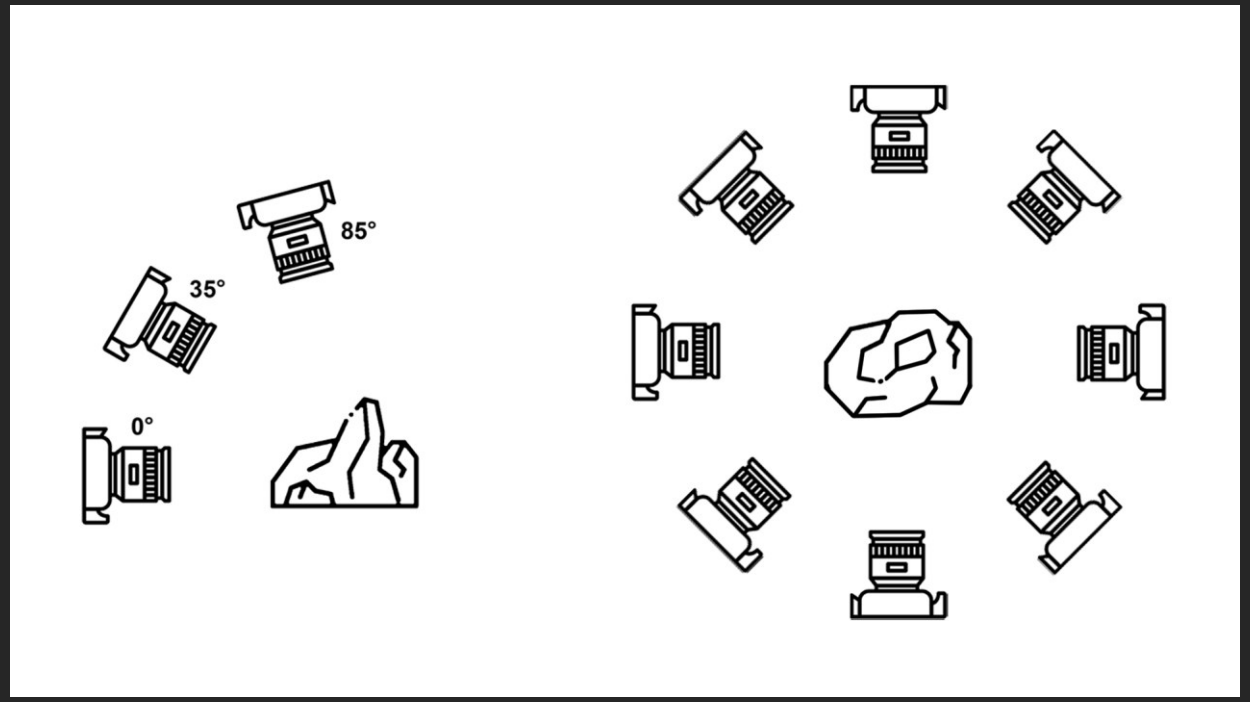
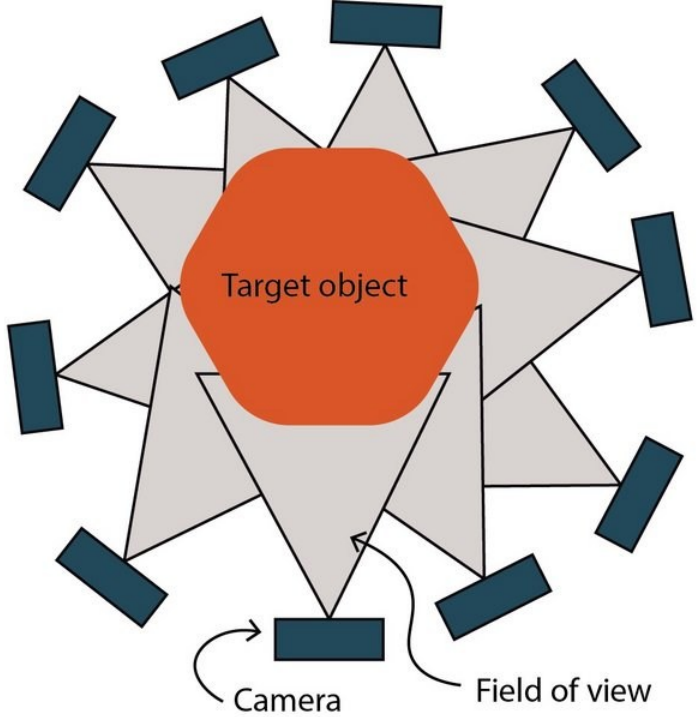
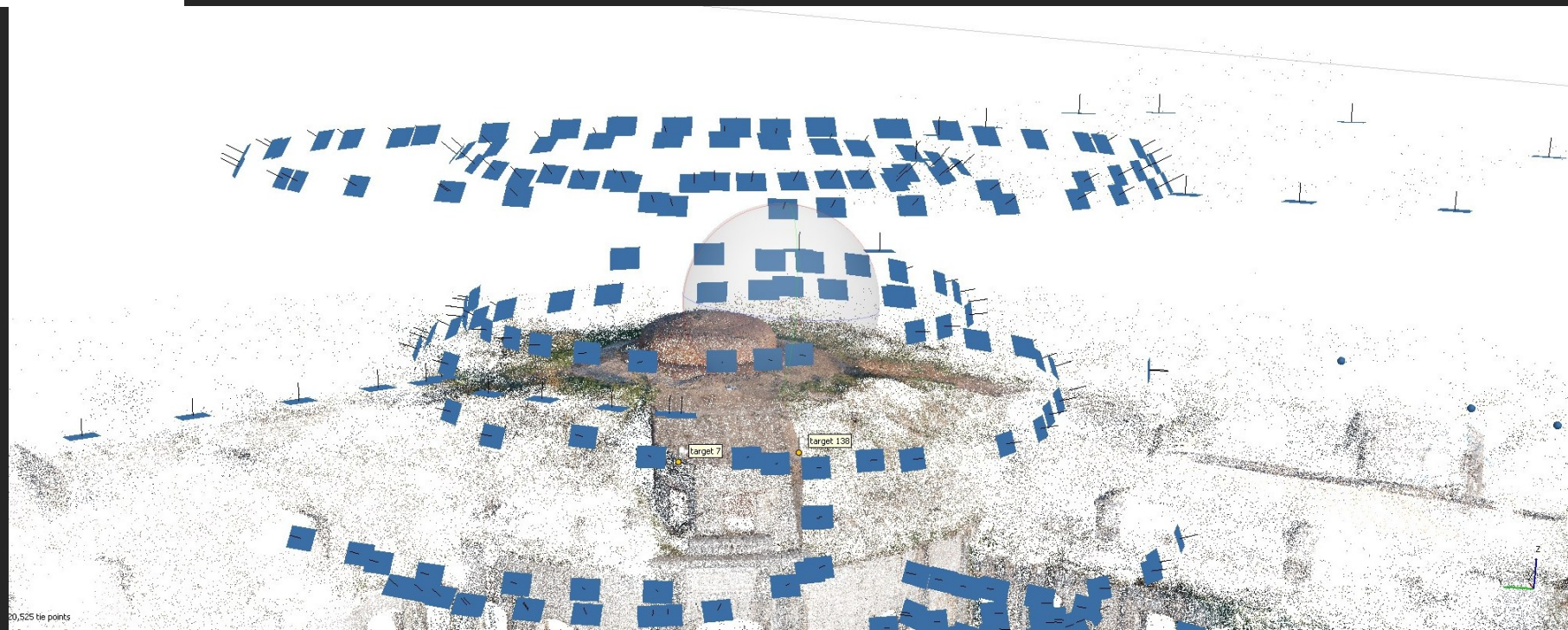
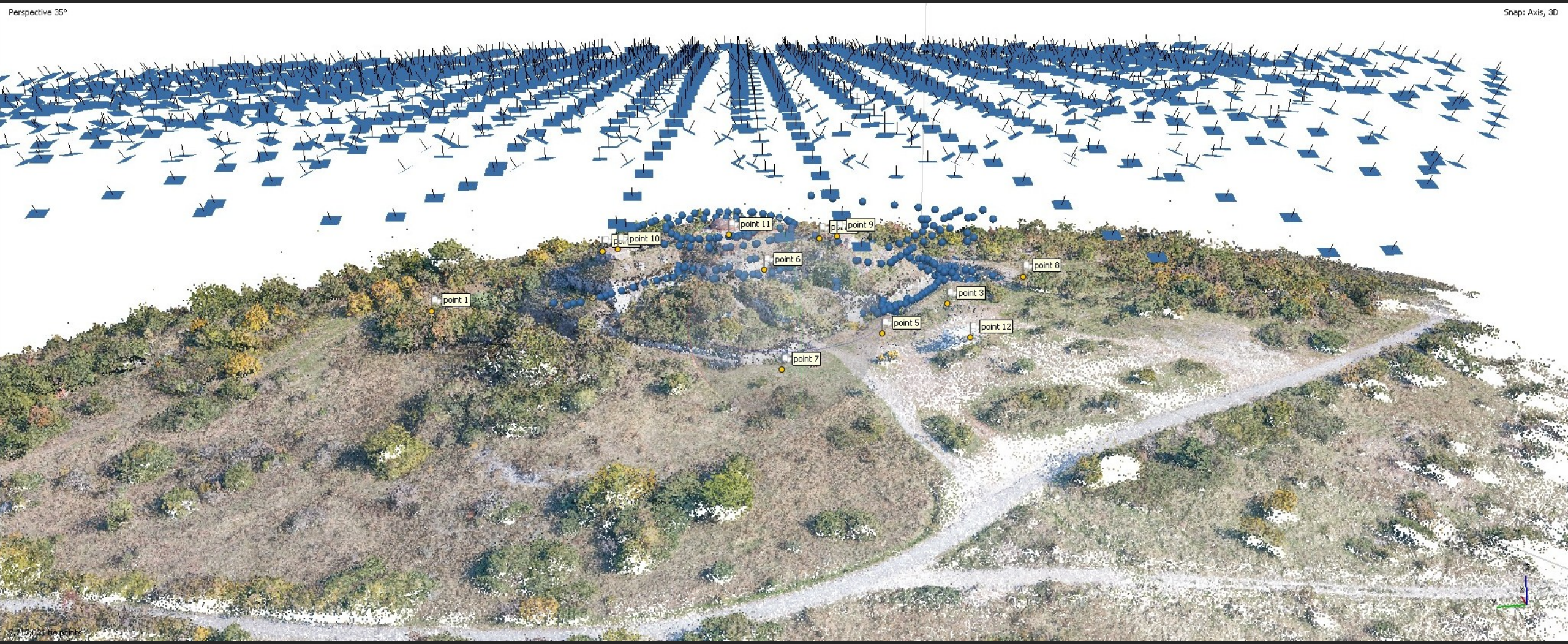
Capturing data




Target object
Camera
Field of view


target 7
target 138


Perspective 35°
Snap: Axis, 3D
point 11
point 9
point 10
point 6
point 8
point 1
point 3
point 5
point 12
point 7

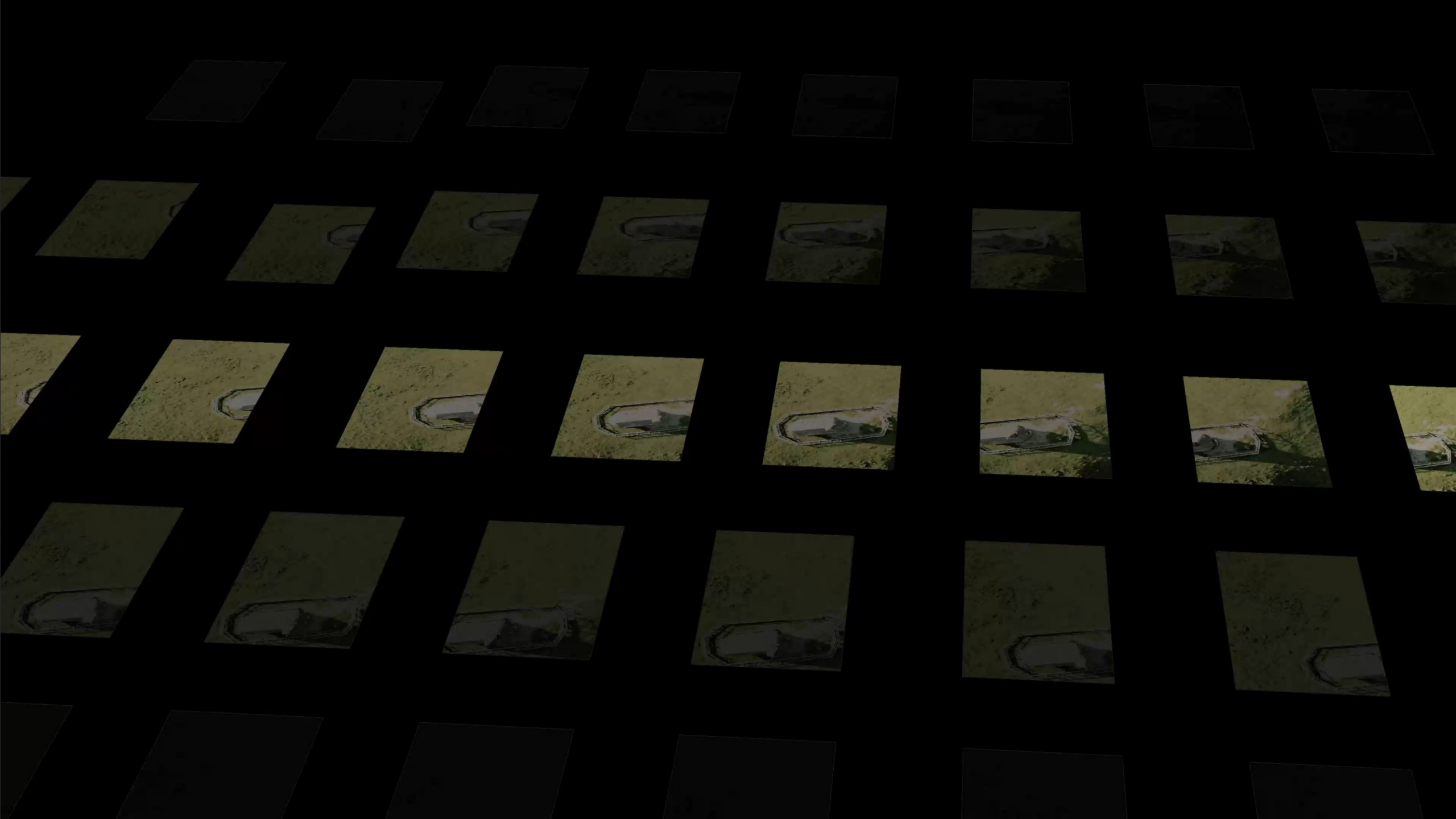
Direct Sunlight - Hard Shadows

Diffused Sunlight - Soft Shadows

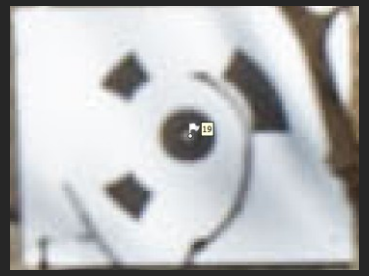
Data processing

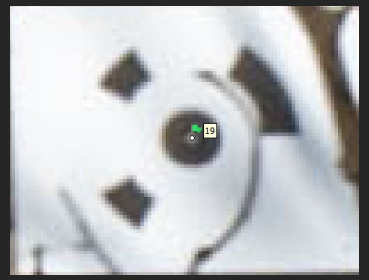
- **We are not looking for a pretty picture!**
- Background doesn’t matter
- **Don’t trust your eyes**
- As much data as possible
- Uniformity across the dataset

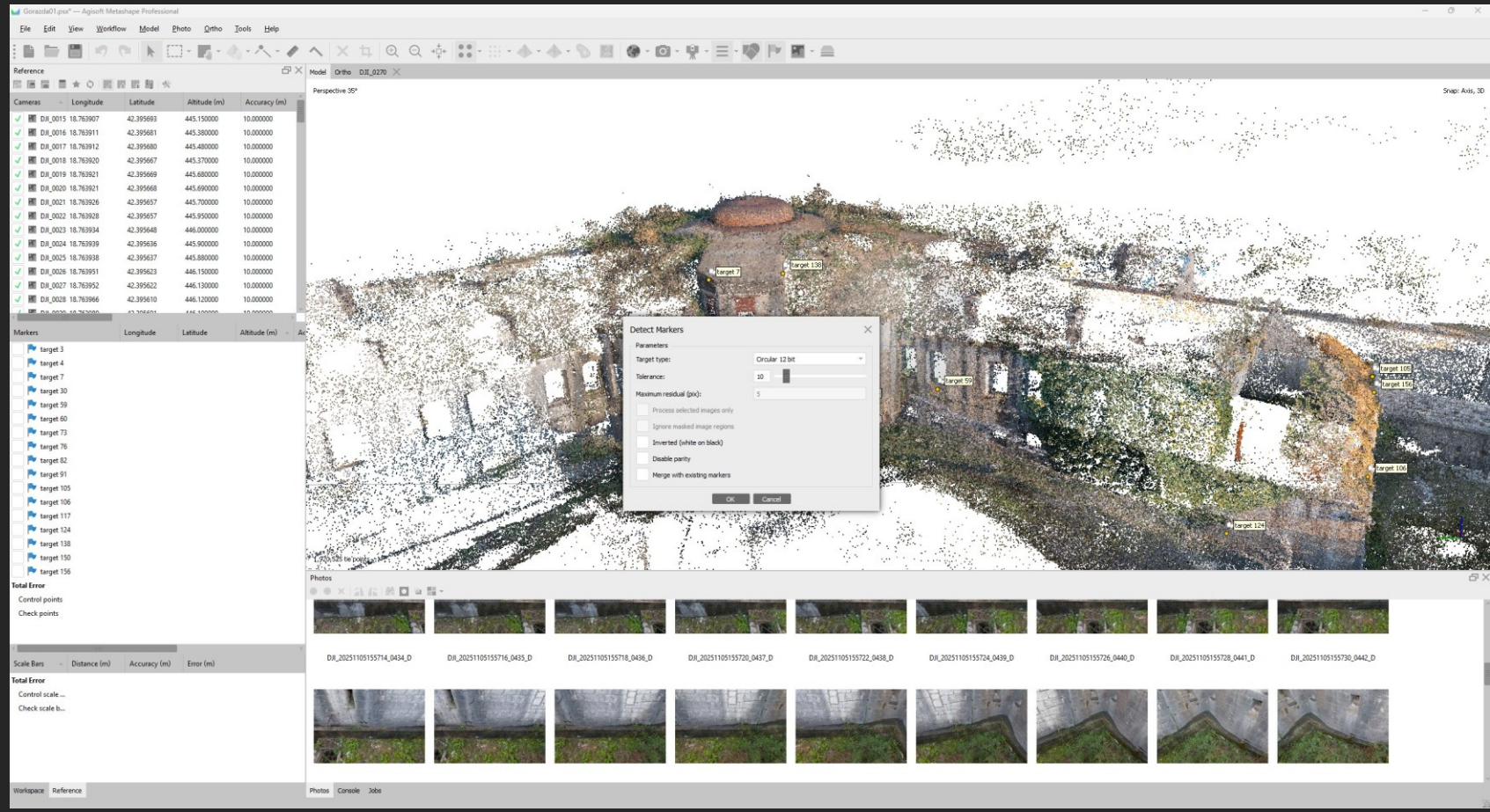
AS SHOT

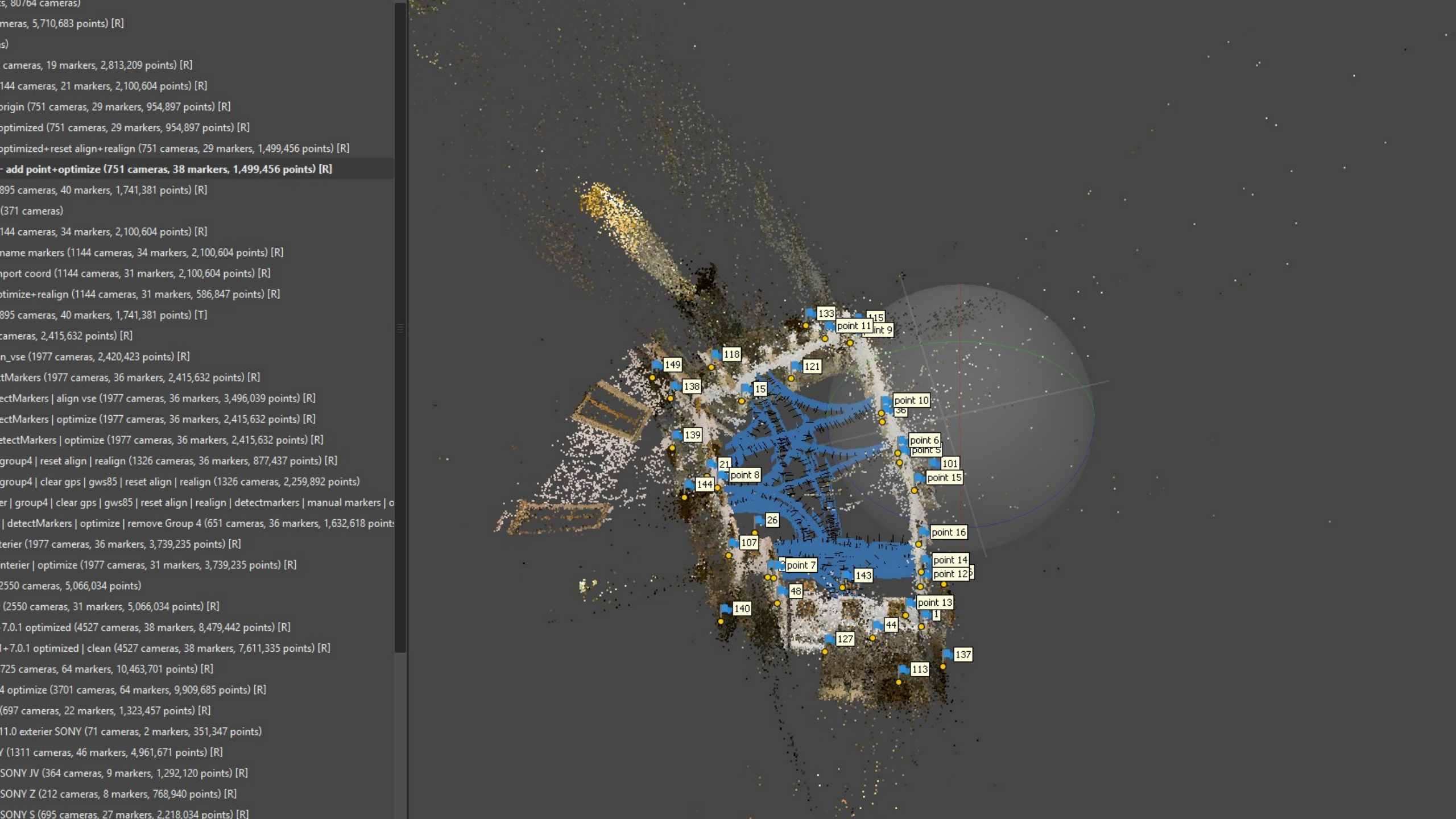


Markers

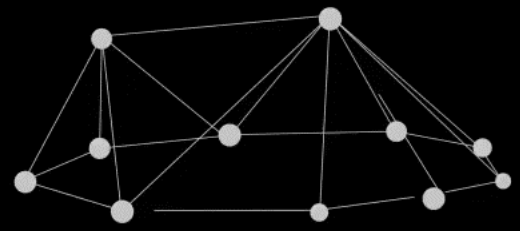


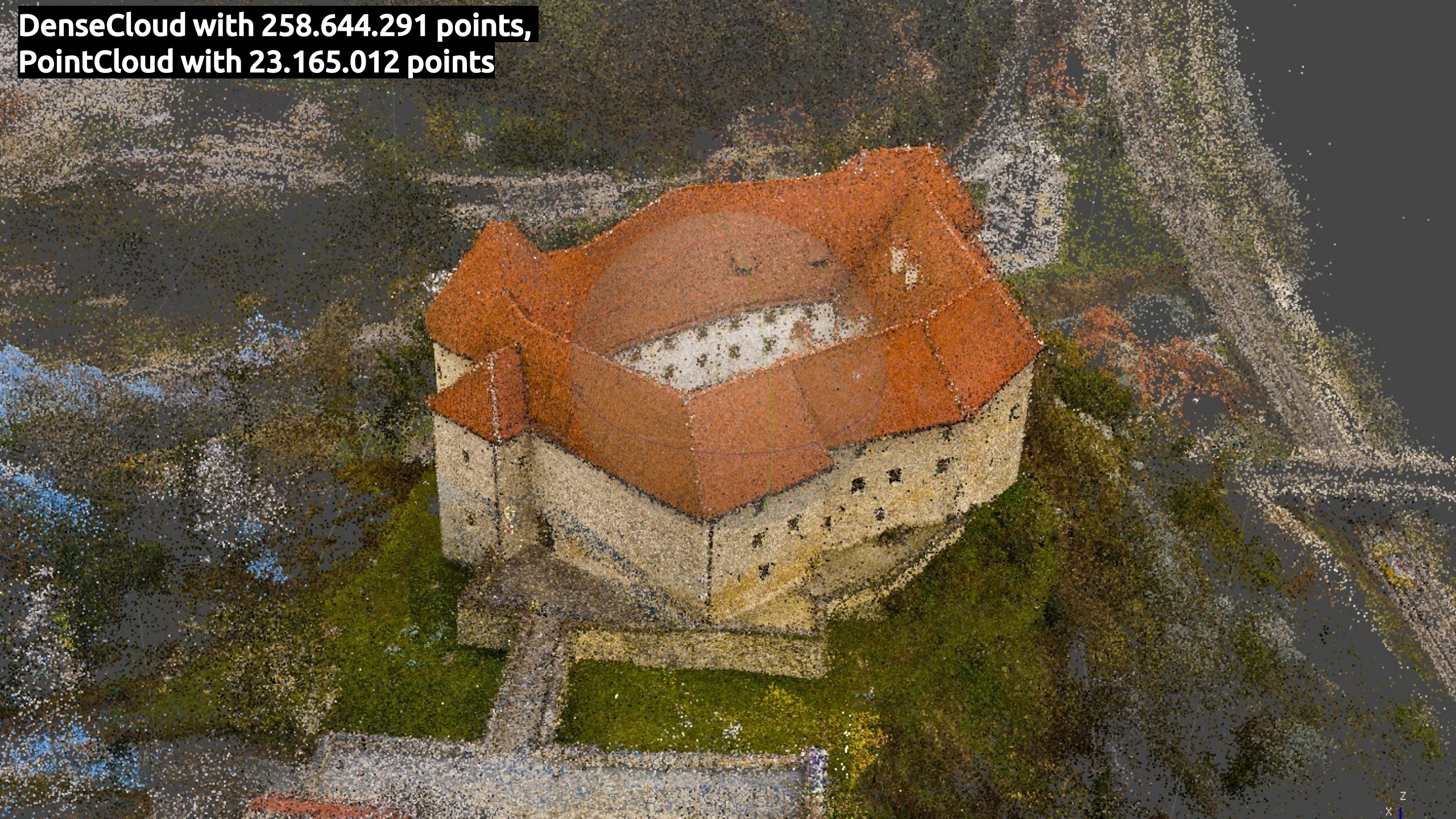



Detect Markers
Parameters
Target type:
Circular 12 bit
Tolerance:
Maximum residual (pix):
Process selected images only
Ignore masked image regions
Inverted (white on black)
Disable parity
Merge with existing markers
OK
Cancel

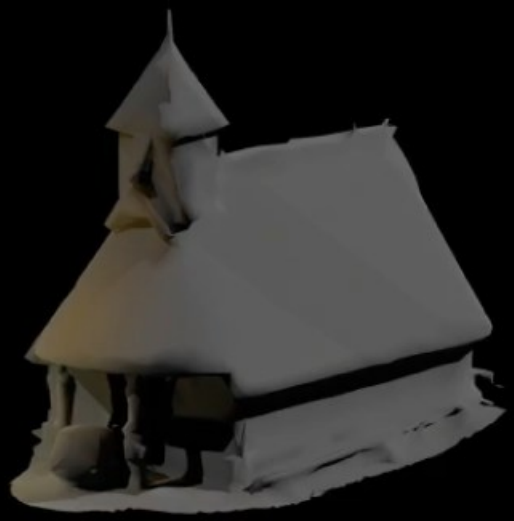


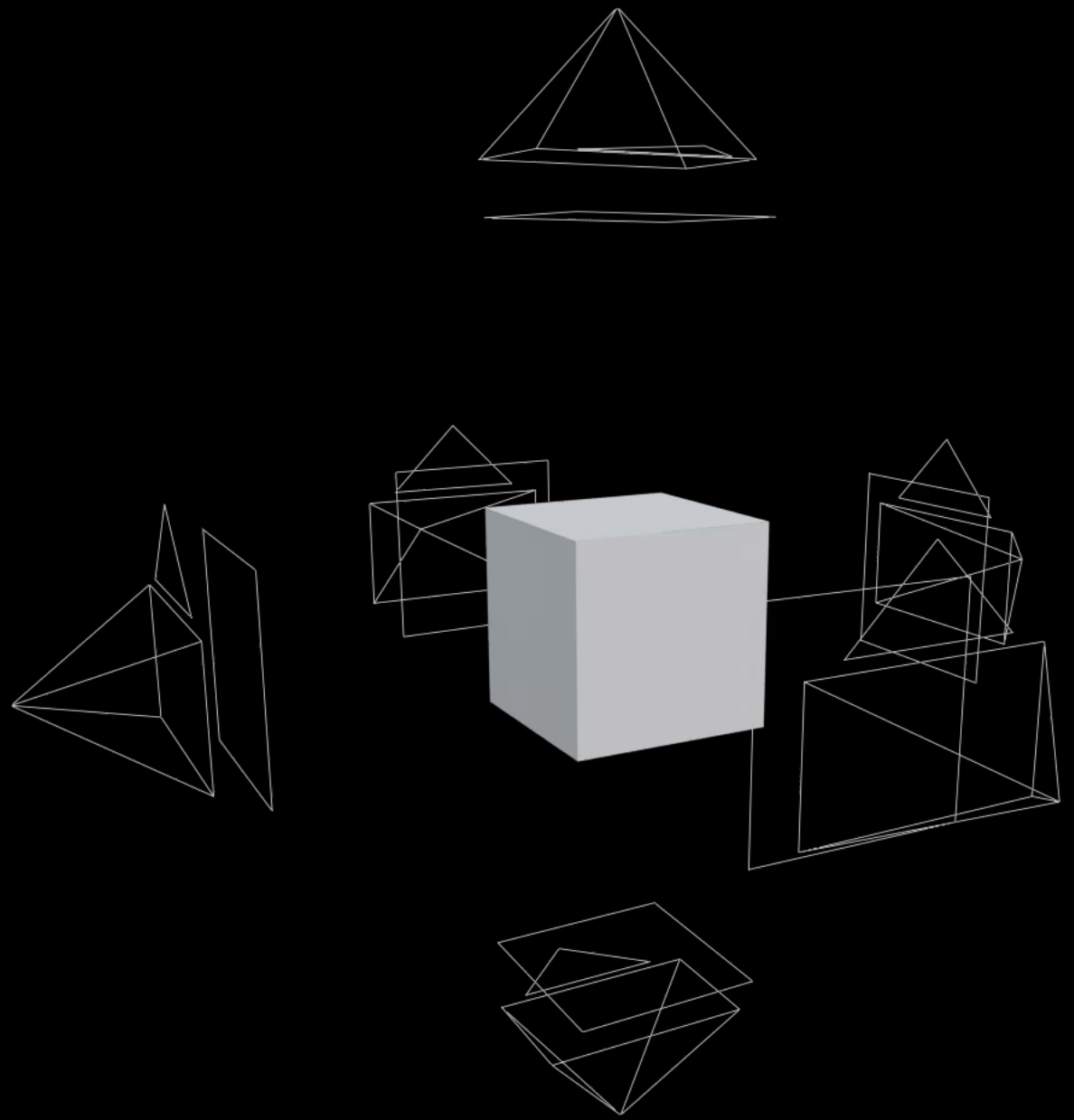
cameras)
meras, 5,710,683 points) [R]
s)
cameras, 19 markers, 2,813,209 points) [R]
144 cameras, 21 markers, 2,100,604 points) [R]
origin (751 cameras, 29 markers, 954,897 points) [R]
optimized (751 cameras, 29 markers, 954,897 points) [R]
optimized+reset align+realign (751 cameras, 29 markers, 1,499,456 points) [R]
- add point+optimize (751 cameras, 38 markers, 1,499,456 points) [R]
895 cameras, 40 markers, 1,741,381 points) [R]
(371 cameras)
144 cameras, 34 markers, 2,100,604 points) [R]
name markers (1144 cameras, 34 markers, 2,100,604 points) [R]
nport coord (1144 cameras, 31 markers, 2,100,604 points) [R]
timize+realign (1144 cameras, 31 markers, 586,847 points) [R]
895 cameras, 40 markers, 1,741,381 points) [T]
cameras, 2,415,632 points) [R]
n_vse (1977 cameras, 2,420,423 points) [R]
tMarkers (1977 cameras, 36 markers, 2,415,632 points) [R]
ectMarkers | align vse (1977 cameras, 36 markers, 3,496,039 points) [R]
ectMarkers | optimize (1977 cameras, 36 markers, 2,415,632 points) [R]
etectMarkers | optimize (1977 cameras, 36 markers, 2,415,632 points) [R]
group4 | reset align | realign (1326 cameras, 36 markers, 877,437 points) [R]
group4 | clear gps | gws85 | reset align | realign (1326 cameras, 2,259,892 points)
er | group4 | clear gps | gws85 | reset align | realign | detectmarkers | manual markers | o
| detectMarkers | optimize | remove Group 4 (651 cameras, 36 markers, 1,632,618 points
terier (1977 cameras, 36 markers, 3,739,235 points) [R]
nterier | optimize (1977 cameras, 31 markers, 3,739,235 points) [R]
2550 cameras, 5,066,034 points)
(2550 cameras, 31 markers, 5,066,034 points) [R]
7.0.1 optimized (4527 cameras, 38 markers, 8,479,442 points) [R]
l+7.0.1 optimized | clean (4527 cameras, 38 markers, 7,611,335 points) [R]
725 cameras, 64 markers, 10,463,701 points) [R]
4 optimize (3701 cameras, 64 markers, 9,909,685 points) [R]
(697 cameras, 22 markers, 1,323,457 points) [R]
11.0 exterior SONY (71 cameras, 2 markers, 351,347 points)
Y (1311 cameras, 46 markers, 4,961,671 points) [R]
SONY JV (364 cameras, 9 markers, 1,292,120 points) [R]
SONY Z (212 cameras, 8 markers, 768,940 points) [R]
SONY S (695 cameras, 27 markers, 2,218,034 points) [R]




DenseCloud with 258.644.291 points,
PointCloud with 23.165.012 points

Connecting points to create a mesh
and a solid model





Where it gets complicated

- Accuracy
- Large objects
- Difficult terrain
- Weather conditions
- Flight automation
- Manual flying
- Limited spaces
- Large (and I do mean large) datasets


HERITAGE+
by
ARCTUR


HASSELBLAD
F/2.8 EQV 28mm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ALIENWARE
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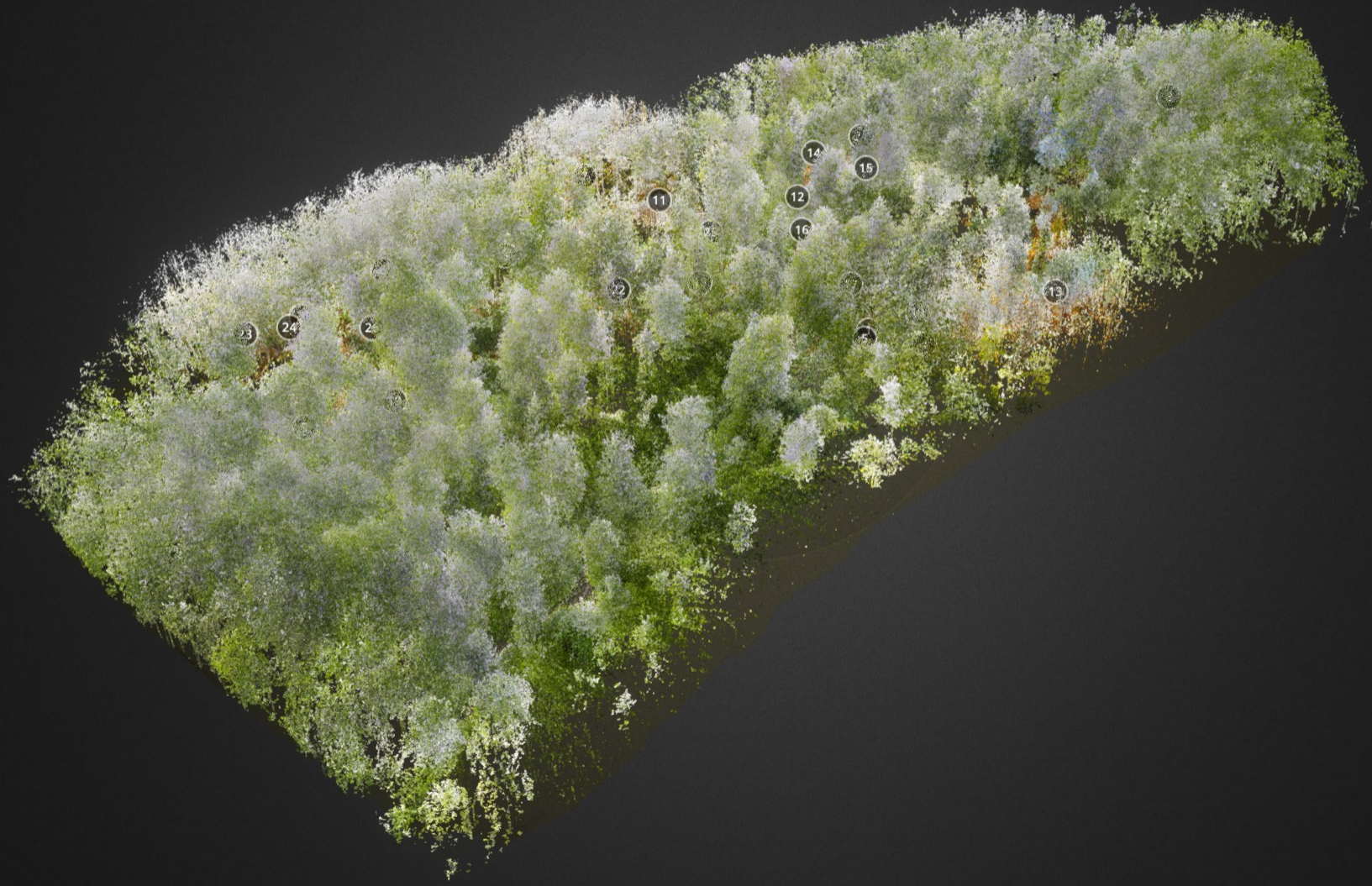
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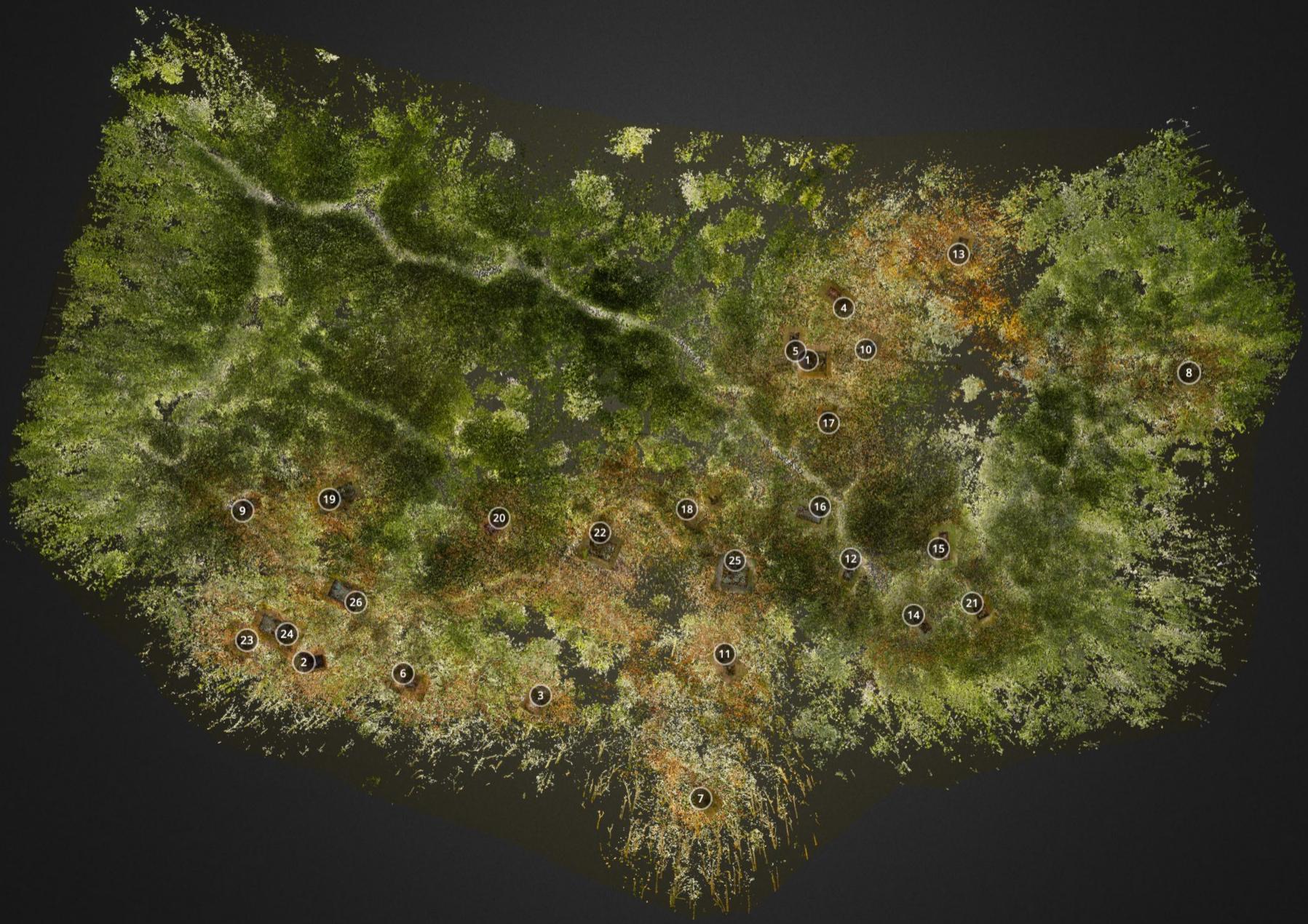
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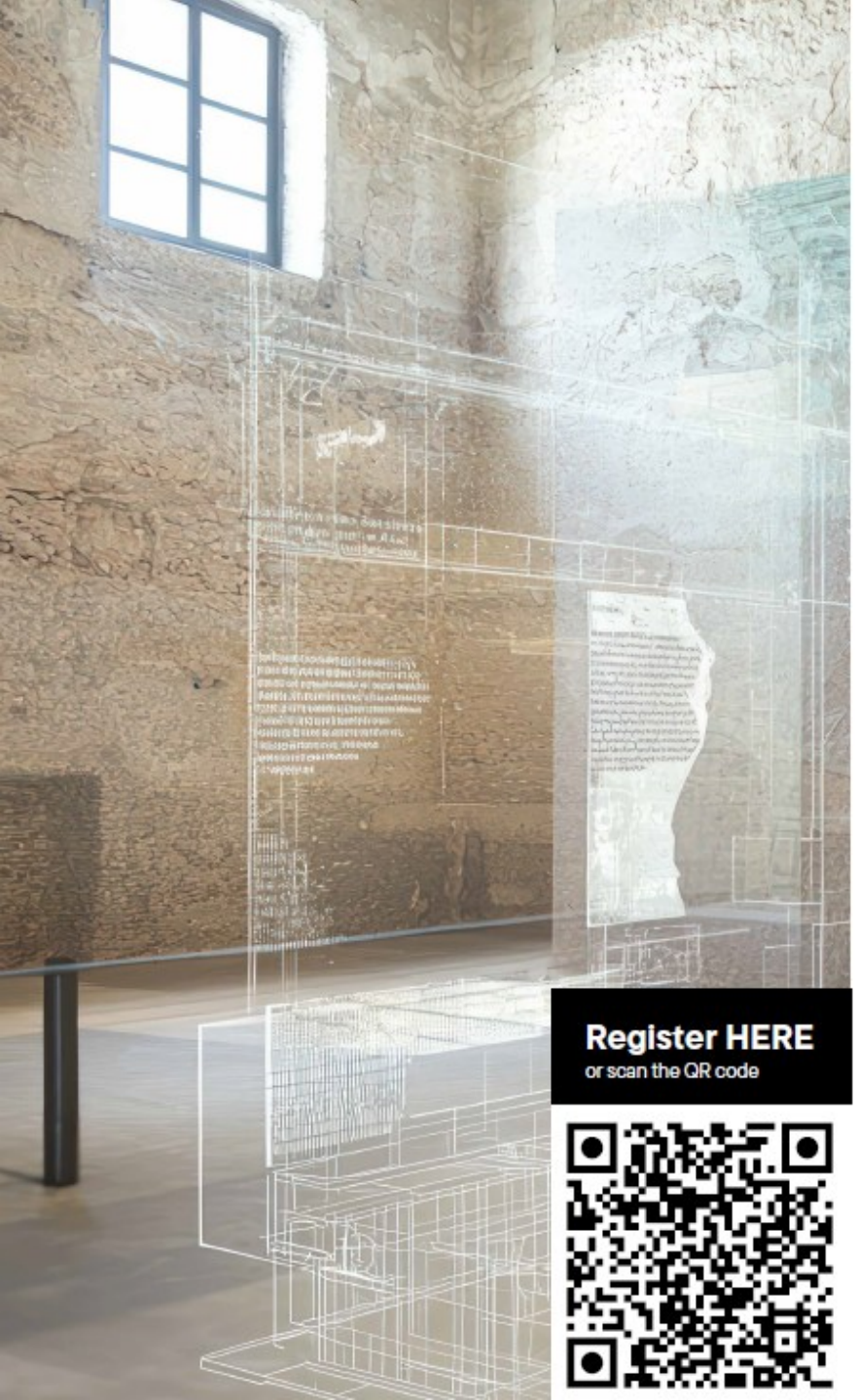

Register HERE
or scan the QR code

Join the Training Programme

on Digital Innovation of Cultural Heritage!

As part of the project "Provision of Digital Technologies Fostering Tourism 4.0 and Technological Learning in Montenegro", we are pleased to invite you to participate in a **Training Programme** focused on digital storytelling and 3D technologies for cultural heritage and tourism. The programme consists of **five interactive workshops**, combining theory and practice:

- **Introduction to 3D and Digital Storytelling (online)**
  10 November 2025, 11:00–12:00 (Registration until 7 November)
- **3D Digital Capture and Data Processing (online)**
  17 November 2025, 11:00–12:00
- **Principles of Digital Storytelling with 3D Assets (hybrid)**
  27 November 2025, 11:00–12:00 TBC
- **3D Data Management (online)**
  1 December 2025, 11:00–12:00
- **Hands-on Workshop (on-site)**
  Planned for June 2026

Participants will gain both **conceptual understanding and practical experience** with digital tools and workflows that enable innovative storytelling and digital preservation of cultural heritage.
We warmly invite **professionals, students, researchers, and cultural heritage practitioners** to join us and enhance their skills in digital innovation for Tourism 4.0.

The project is coordinated by Arctur, a Slovenian high-tech company known for its award-winning initiatives in the field of digital cultural tourism, and is implemented under the mandate of the United Nations Industrial Development Organization (UNIDO) (UNIDO Project SAP ID 230074).

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