



FIG WORKING WEEK 2019

22–26 April, Hanoi, Vietnam

"Geospatial Information for a Smarter Life
and Environmental Resilience"



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"The Application of the Laser Scanner in the Speleology"



21 April 2019
Matteo TARTAGLINI
3D Land Surveyor and Speleologist

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Speleology is the discipline that search, explore, map and study caves. It takes its name from Greek spēlaion (cave) and lògos (speech) and it's born in the eighteenth century.



Some Data:

- The largest cave in the world, is the “Mammoth Cave” (650 km), located in Kentucky (USA).
- The deepest cave in the world, is the “Veryovkina Cave” (-2212 m), located in The Caucasus mountains in Georgia.

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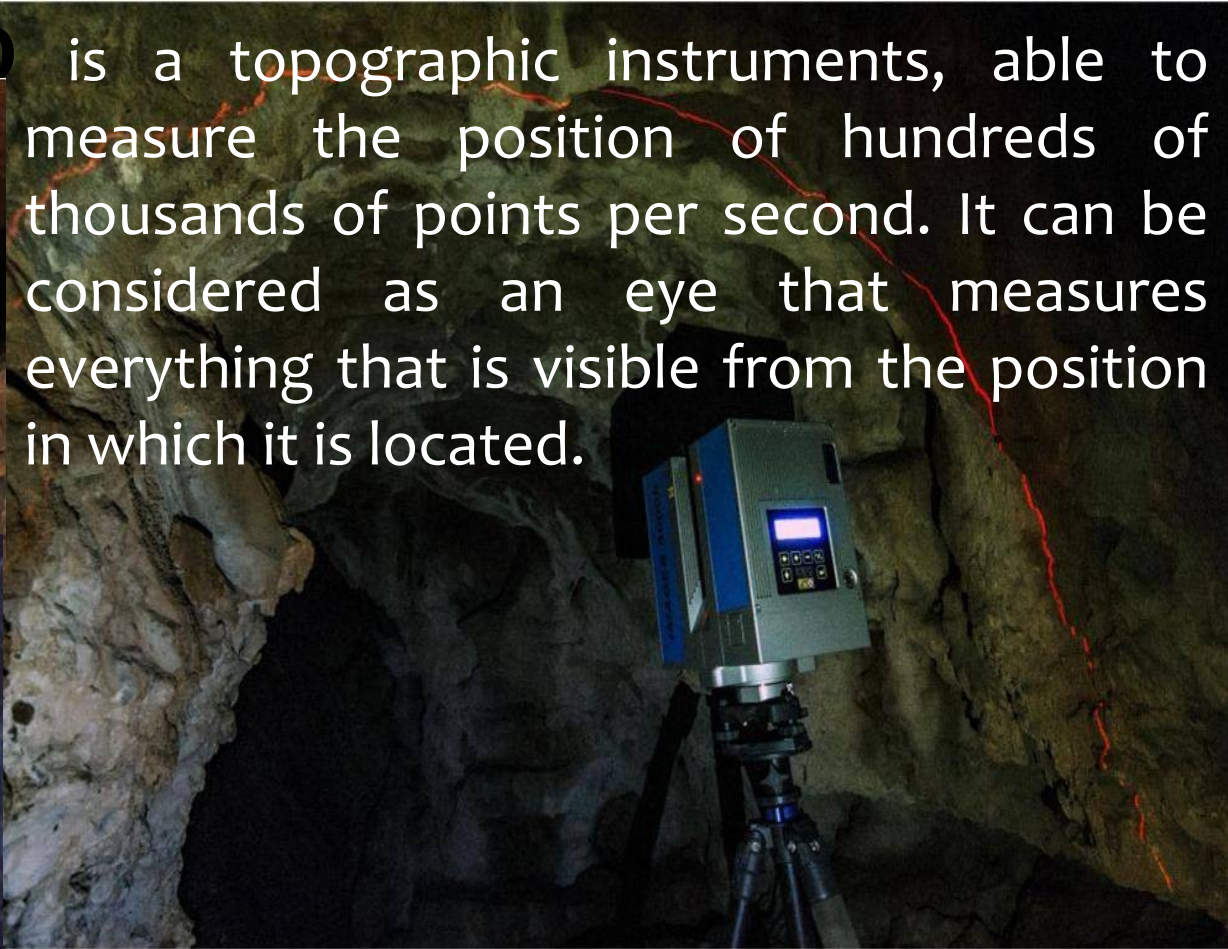
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Laser Scanner 3D

is a topographic instruments, able to measure the position of hundreds of thousands of points per second. It can be considered as an eye that measures everything that is visible from the position in which it is located.



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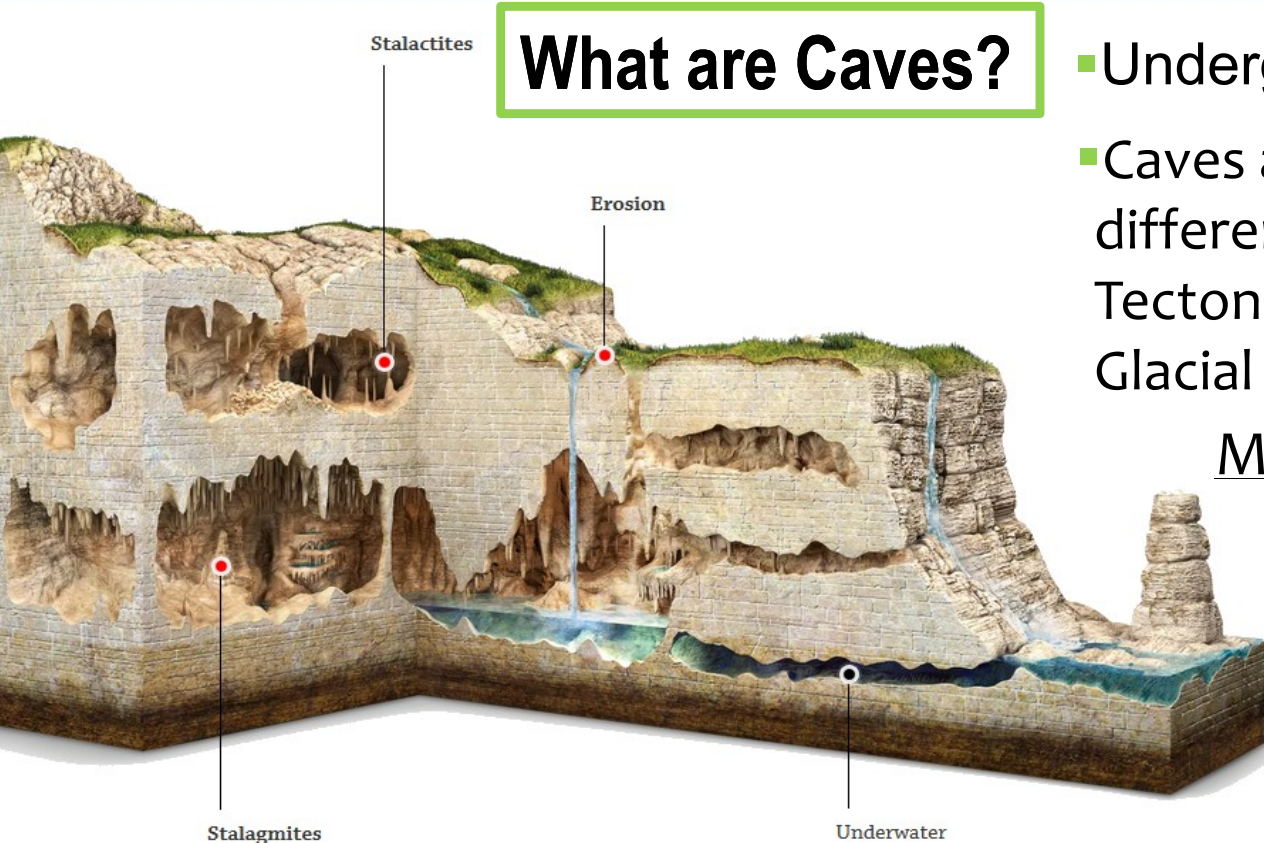
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What are Caves?

- Underground voids in darkness
- Caves are different, thanks to different formation processes: Tectonic, Volcanic, Marine, Wind; Glacial and Karst.

Most studied are “karstic origin”, created by the chemical dissolution of the limestone due to the action of water



It's estimated human discovered about 30,000 km of caves, about 15%. We are only at the beginning of the research.

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The Project: "Explore, discover, research and conserve natural heritage in the North Macedonian territory."

Main Focus: "Multidisciplinary research, aim on touristic development and virtual visualization."

Sponsored: "United Nations Development Programme"
"European Union Projects"



Teams:

Performed by: "Studio Tecnico MT"



Thanks to: "Persephone Esplorazioni" (Italian Speleological Association)



Thanks to: "Speleo Korabi" (Republic of North Macedonia Speleological Association)



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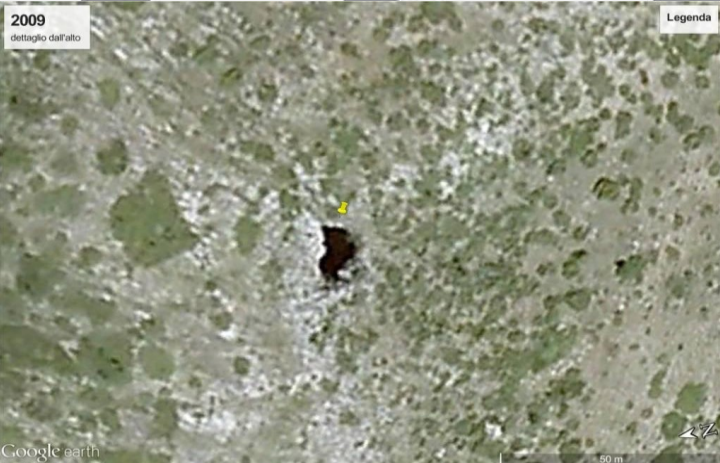
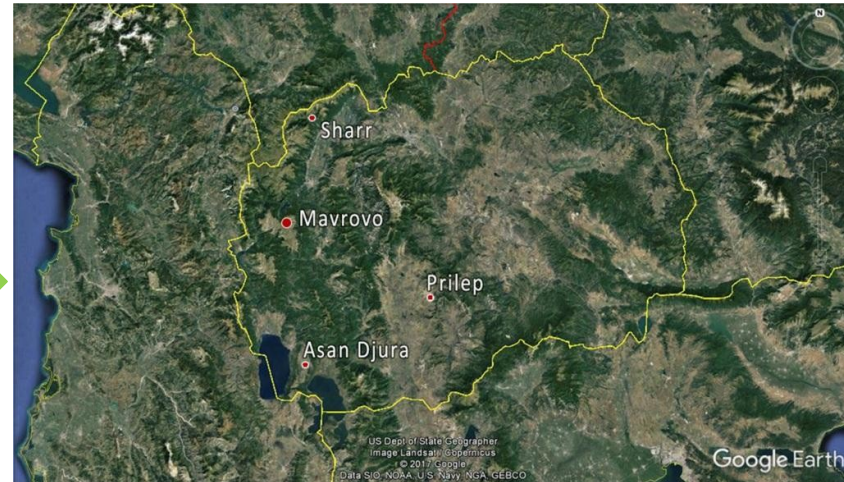
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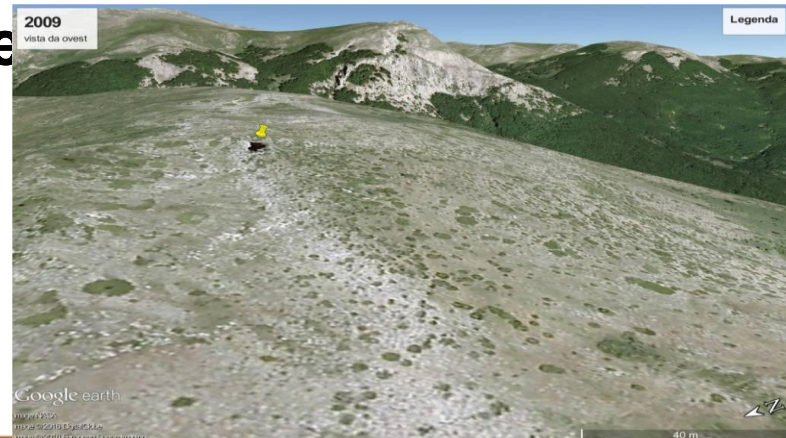
The Project Area:



Caves Positions



"Belul" Cave Satellite Identification



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3D Survey Project Parameters:

Multidisciplinary international project, that purpose to test new topographic instruments in hard condition, to provide new and better results compared with oldest methods.

Parameter	Number
Project Caves	3
Person necessary	5/7
Average Length/Width	From 200 to 400 mt/from 0 to -100 mt
Project Duration	1 week per year
Accuracy Results	Subcentimetric
Aspected Results	(2D/3D design)-(Virtual Tour)-(3D Video) 3D Models
Hardware to carry	(GPS)-(Laser Scanner)-(Camera)-(Drone)

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The equipment and instruments:

- 1: Caver equipment
- 2: Gas Detector
- 3: GPS
- 4: Laser Scanner
- 5: Camera+Nodal Ninja
- 6: UAV System (Drone)

2



1



3



4



5



6



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3D Survey Expected Results:

GPS Survey → Geolocalize "Trail" and "Entrance" of the caves

Laser Scanner → Accurate data: 3D model of the caves

→ Accurate Drawing: Plants, Sections, Particular

Photogrammetry → Digital Database: for studies and catalog

→ 3D print of particular objects

Virtual Tour → Interactive tour for smartphone and PC:
Aim is the tourist who want to try a virtual visit
and then encourage the real tourism

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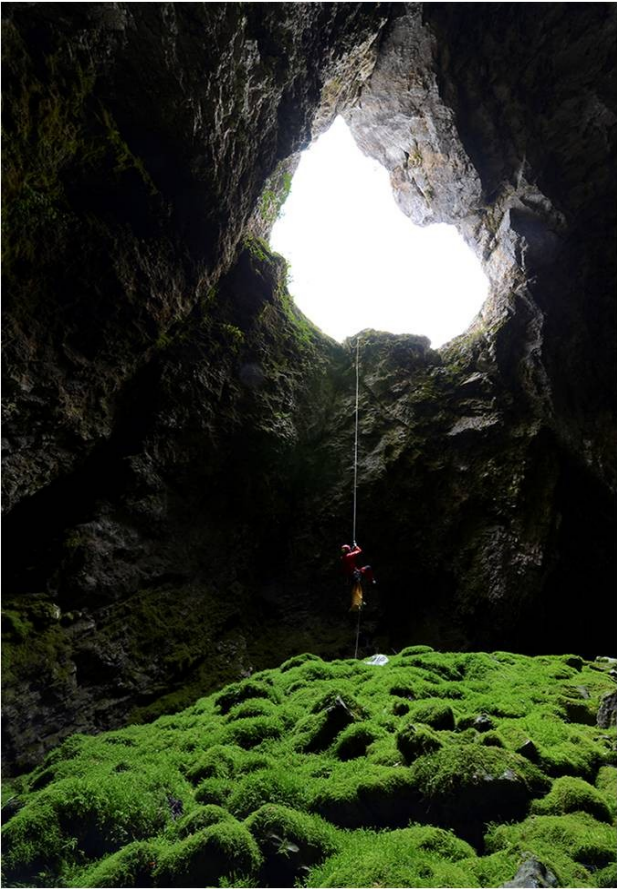
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Projects Caves



BELUL (*Shepherd's name)

MELNICHKA

UBAVICA

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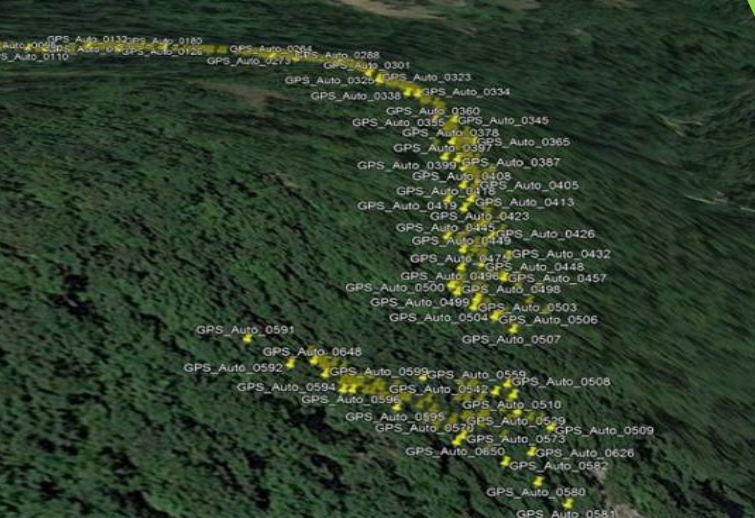
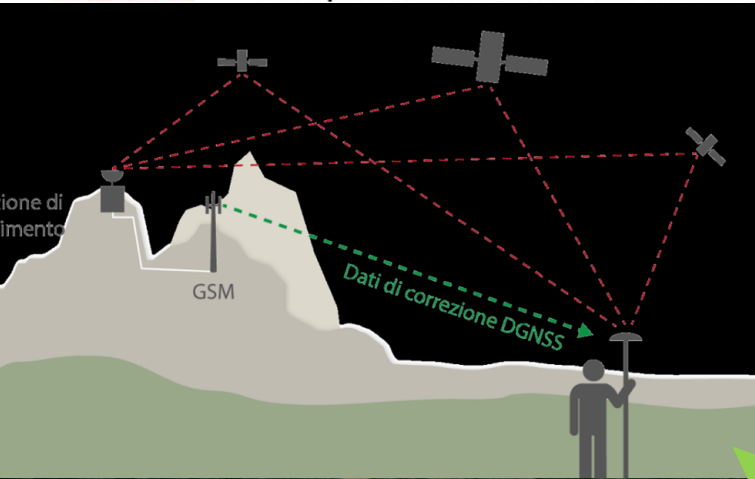




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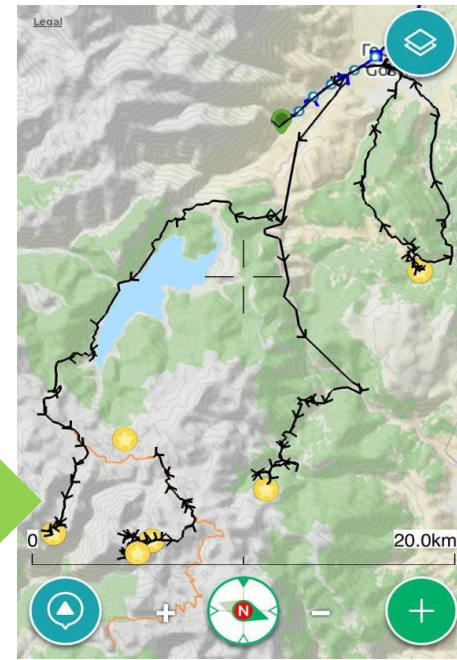


The Survey phases

- GPS survey of the Trail and entrance with Leica Viva GS15



OR



- GPS survey of the Trail and entrance with Smartphone using "View Range App"

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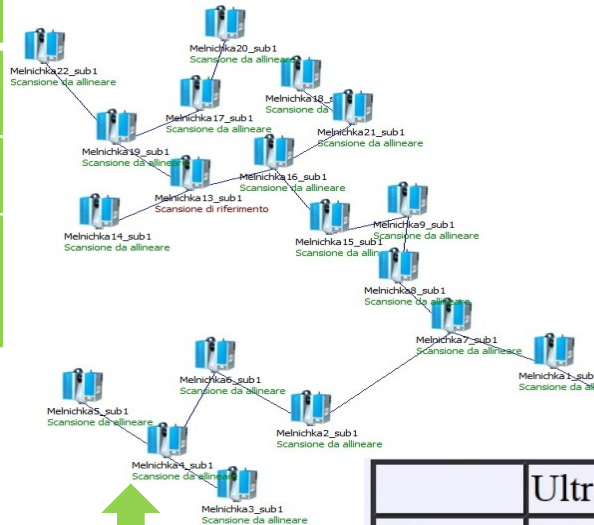
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"Geospatial Information for a Smarter Life and Environmental Resilience"

Super-High Resolution	3
High Resolution	18
Color Data	Reflectance
Number of points surveyed	156'264'204 points

Laser Scanner



Sketch Alignment

Scans Settings

	Ultrahigh	Superhigh	High	Middle	Preview
10m	1.6mm	3.1mm	6.3mm	12.6mm	50.3mm
25m	3.9mm	7.9mm	15.7mm	31.4mm	125.7mm
50m	7.9mm	15.7mm	31.4mm	62.8mm	251.3mm
80m	12.6mm	25.1mm	50.3mm	100.5mm	402.1mm
Scantime	13.3 min	6.6 min	3.3 min	1.6 min	24 sec
Filesize	4.5 GB	1.1 GB	289 MB	72 MB	4 MB

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N° Photos	120
Photos Processed	88
Time of Fly	12 min.
Data Link Distance	55mt x 135 mt

Drone

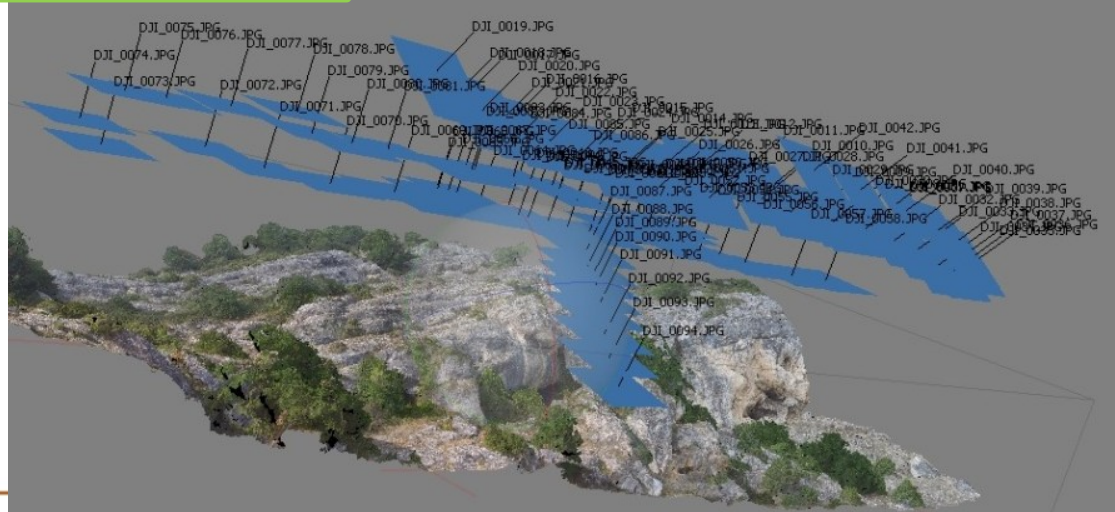
Adobe **Photoshop**
Agisoft **Photoscan**



Post Processing:

- 1) Filter raw data in Camera Raw
- 2) Aerial Triangulation;
- 3) Point Cloud Generation;
- 4) Scale Point Cloud;
- 5) DTM (Digital Terrain Model);
- 6) Colored True Orthophoto;

DJI Phantom 3 Professional



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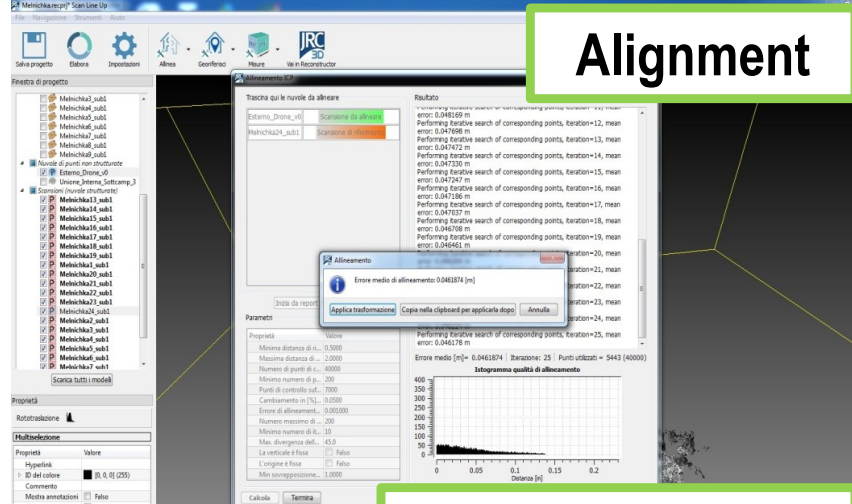
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Pre-Alignment



"Melniccka Cave"



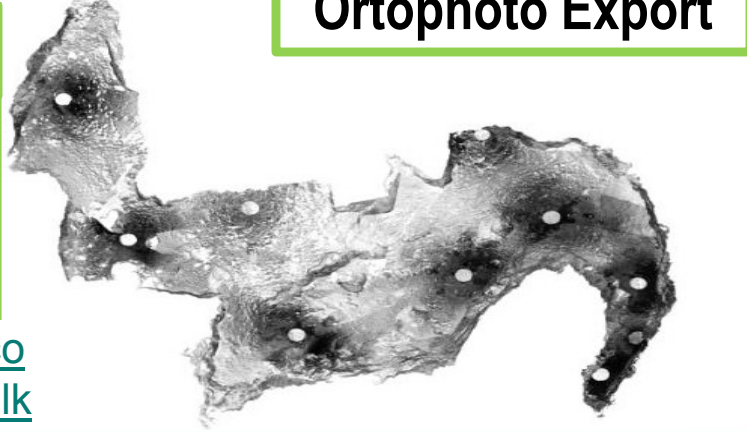
Alignment

G.Earth Export



<https://www.youtube.com/watch?v=eEmj9ajlsIk>

Ortophoto Export



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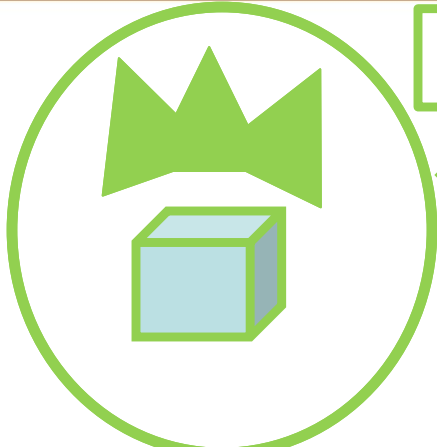




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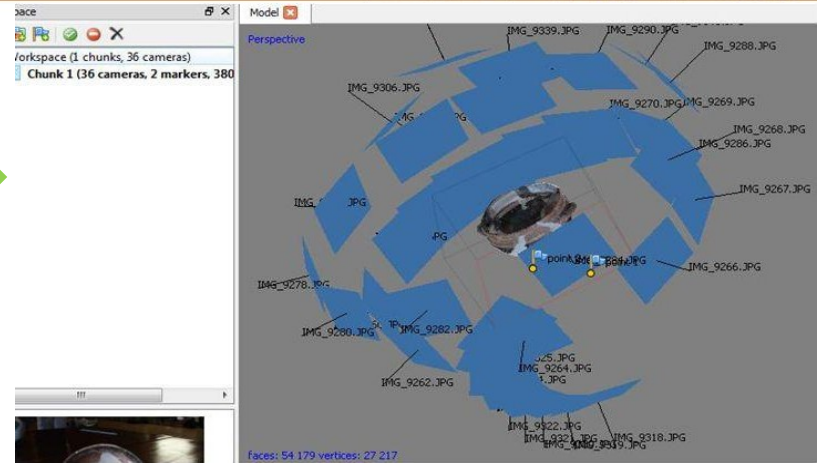
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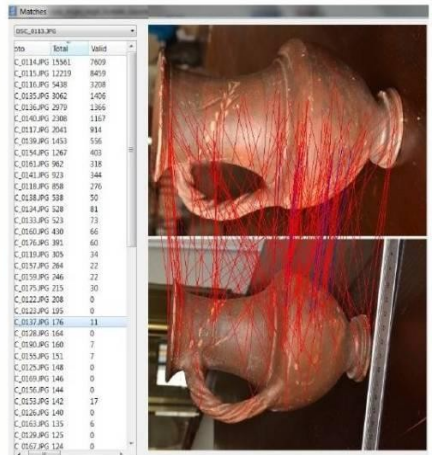
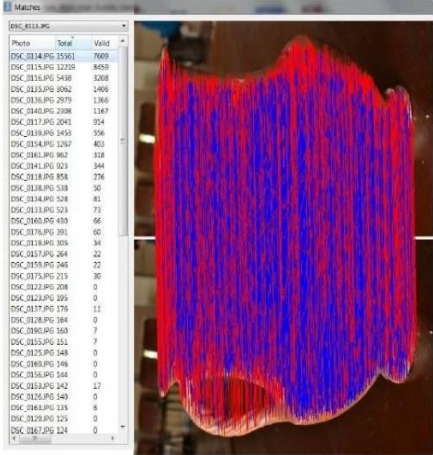
Photogrammetry

How it work

Minimum Overlap 60%
Optimal Overlap 80%



Cow Skull from Belu Cave



<https://sketchfab.com/models/8a80e83ce690411b84bc5794db2bbf20>

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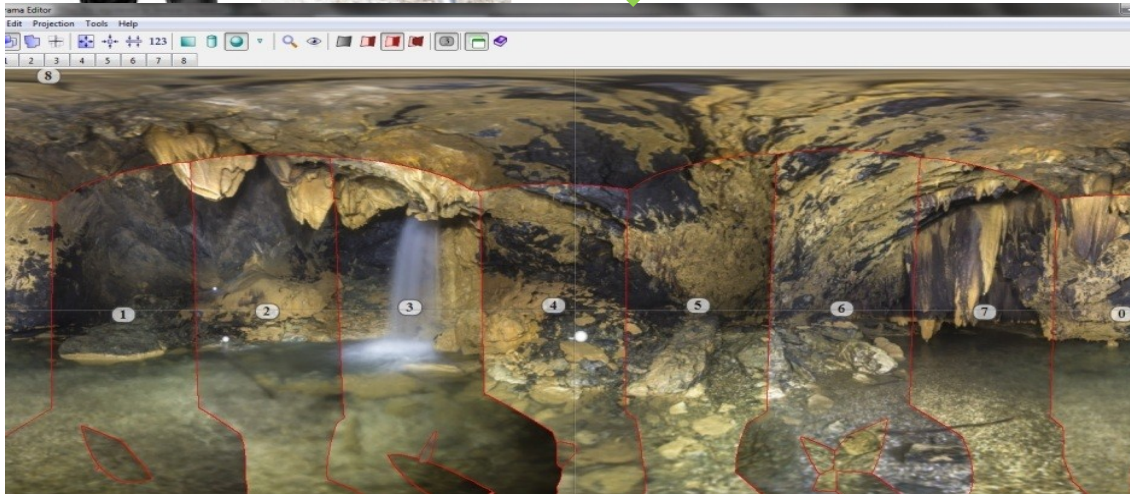
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Virtual Tour

Necessary Photos for
a good Panorama:
8 orizontals (45°)
1 Vertical

Camera	Canon D700
Lens	Fish Eye 8mm F3.5
Technical	Nodal Ninja
Technical	Photo – Tripod
Shooting Technique	Light Painting



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Virtual Tour

File Edit View Help

Home | Tour | Style | Build

Properties - Panorama_88a

UBAVICA-Cave2018 > Panorama_88a > Selected spots

Name: Panorama_88a

Geolocalisation

Description

Projection

Input field of view

Horizontal: 360,00°

Vertical: 180,00°

Vertical offset: 0,00°

Output projection

View

Preview

Fov: 90,00°

Yaw: -38,70°

Pitch: 32,85°

Quality: Med

Default view

Fov: 90,00°

Yaw: -38,70°

Pitch: 32,85°

Zoom limits

Max: [Slider]

Min: 100,00%

Limit to image resolution

http://www.studiotecnicomt.it/Virtual_tour/Ubavica_Cave/05-Tour/Ubavica_2018.html

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CONCLUSION:

- New method to survey the caves;
- New visualization for tourist;
- More data to study and research;
- New accurate data;

SUGGESTION FOR FUTURE PROJECTS:

- 3D Mapping Mobile System
- Video Virtual Tour

THANK YOU!!

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"Let's Come to Explore with us"
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