3D tree canopy reconstruction from Structure-from-Motion

Anton Kuzmin

Victor Molina

Daria Polmanska

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ABEL "UAVs and biogeochemical cycling" training school

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- Research area
- Materials & Methods
- Results
- Discussion

Aims

- UAV image acquisition
- Orthophoto extraction from global mapping flight
- Angular change effect on 3D reconstruction of single tree
- Merging UAV-based and ground-based point clouds
- Analysis of the results

Research area

Majadas de Tiétar, Spain (39°56'47.27"N, 5°46'26.39"W)

- Site 1

1 target tree

- Site 2

2 target trees

Materials & Methods

- UAV

AIBOTIX X6 (Kassel, Germany)

Specifications:

Length / Width / Height - 1,05 x 1,05 x 0,45 m

Weight – 3.4 kg

Payload – 2 kg

Max. speed – 50 km/h

Climb rate – 8 m/s

Flight height – 1000 m (3000 m)

Flight time – 30 min

Control – Remote control, waypoints

Materials & Methods

OPTIMISE
Innovative Optical Tools for Proximal Sensing of Ecophysiological Processes

- Sensors

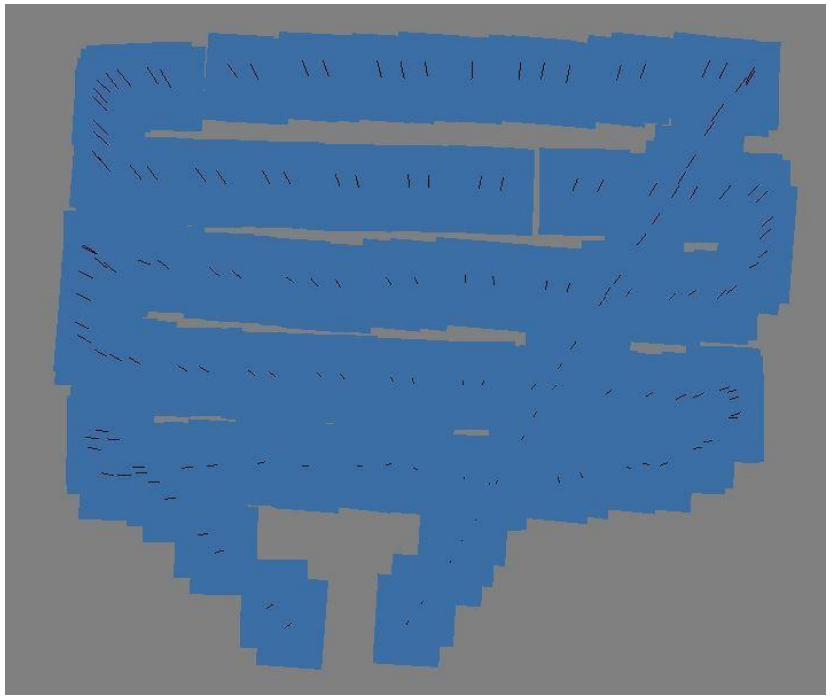
Parameter	Panasonic Lumix DMC-GX1	Ricoh GR
Measurement mode	UAV, Ground	Ground
Weight	367 g	245 g
Resolution	16 Mpix	16 Mpix
Pixel size	4592x3448	4928x3264
Focal length	14 mm	18 mm

Materials & Methods

Flight planning

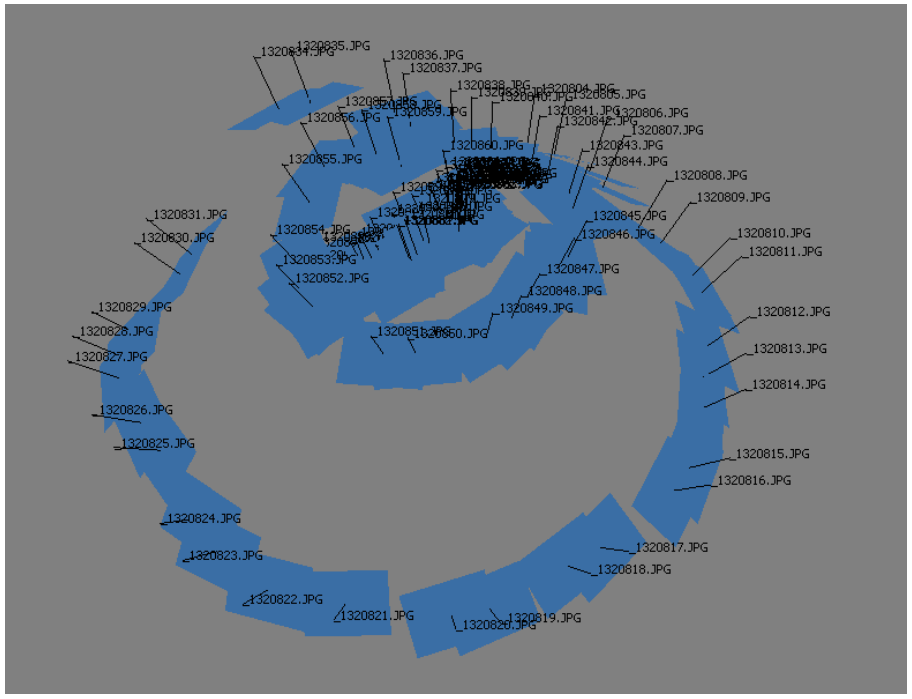
Flight 1 – Global mapping (RGB, Nadir)

Altitude 60m, Overlap 80/80, 152 images



Flight 2 – Single tree (RGB, Oblique + nadir)

Altitude 30-40m, 96 images



Materials & Methods

- Single tree radial imagery from the ground

Target tree 1 (S1T1)

135 images (every ~2.7°)

Target tree 2 (S2T1)

171 images (several images from every position)

Target tree 3 (S2T2)

157 images (several images from every position)

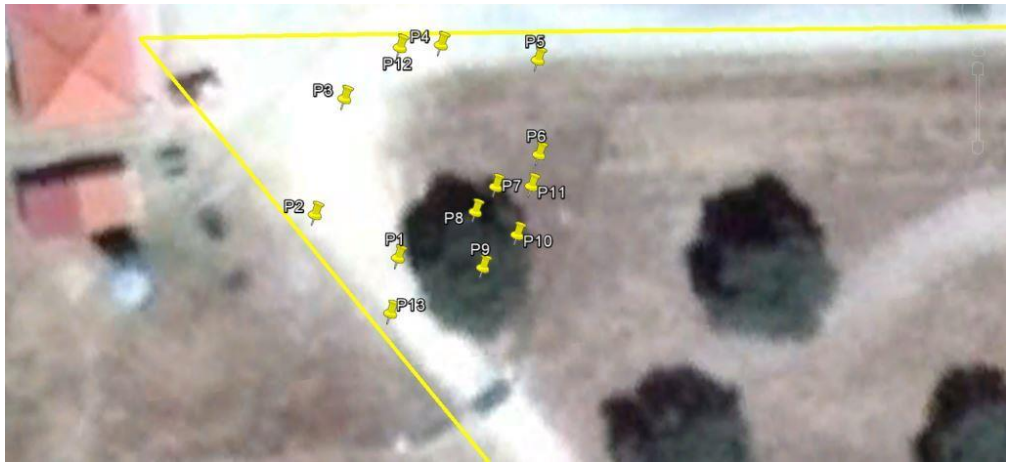
Materials & Methods

- Geo-referencing

GPS-tracker eTrex Vista HCx

Flight 1 – 9 GCPs

Flight 2 – 13 GCPs



Materials & Methods

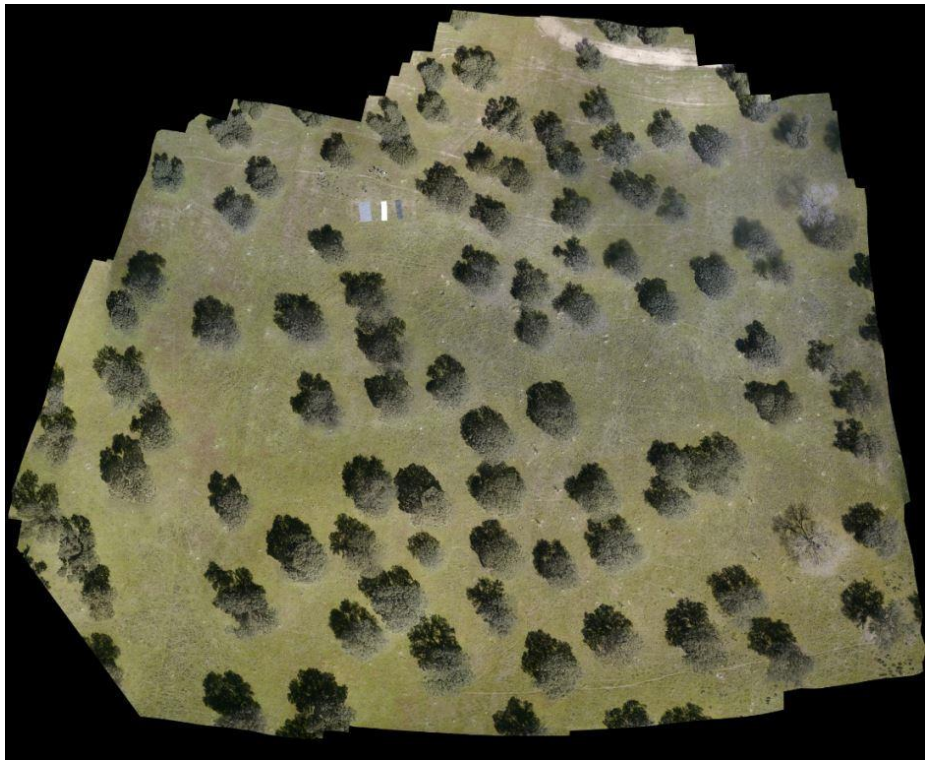
Image processing

- Agisoft Photoscan ver. 1.1.4 (Global mapping, single tree)
- Pix4D (Global mapping)

Results

- Global mapping Agisoft (left) Vs Pix4D (right)

Area – 2.9 ha
Avg GSD – 1.5 cm
CS – WGS84



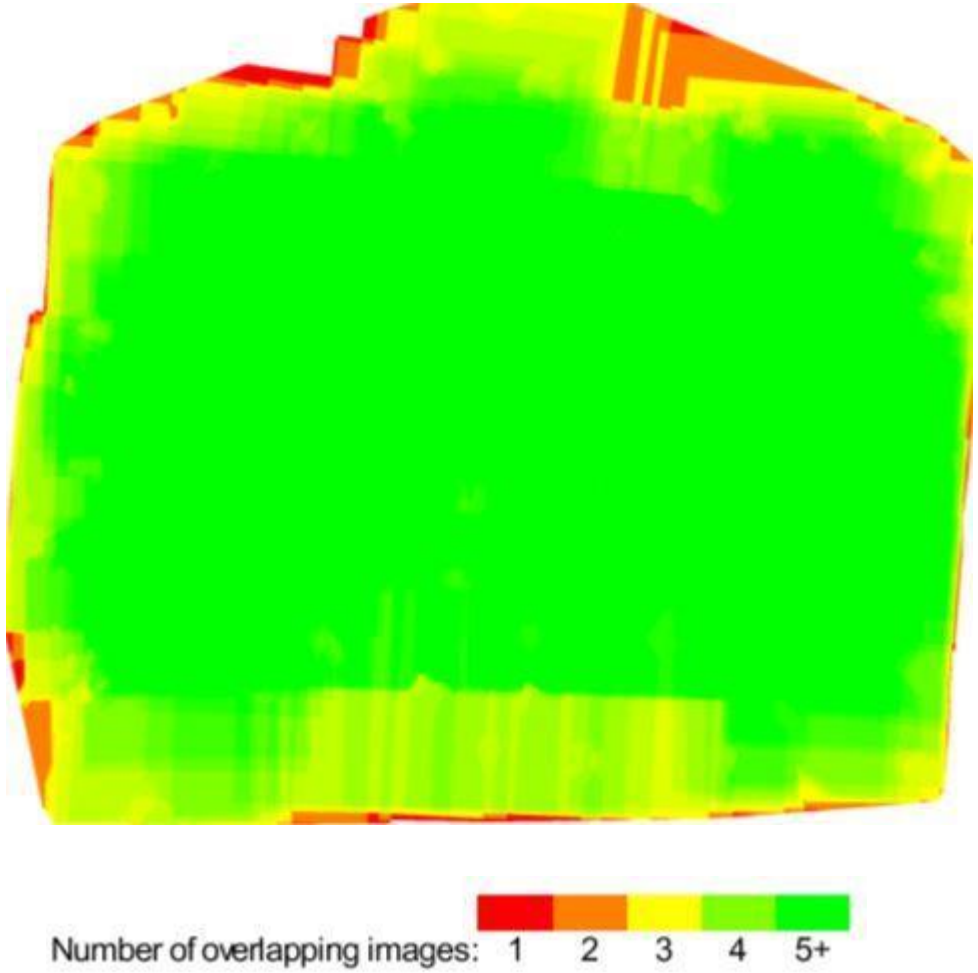
Number of 3D points – 13 705 891

Number of 3D points – 14 171 458

Results

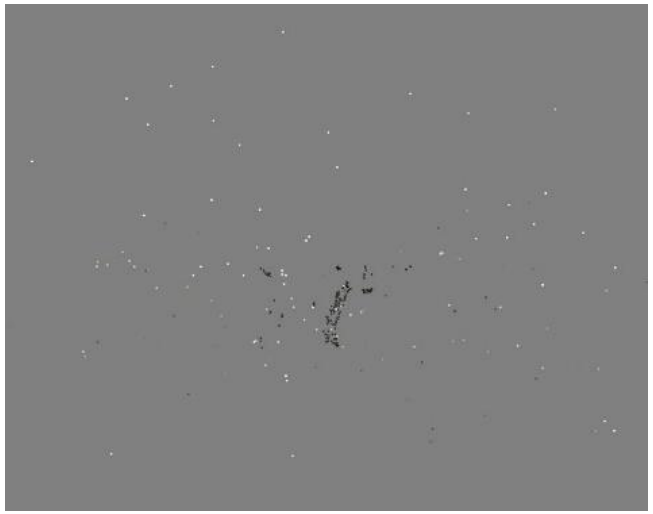
- Global mapping Pix4D

Covered Area – 2.9 ha
Average GSD – 1.5 cm
CS – WGS84
Time processing – 4 h
Average density – 769 per m3
RMSE:
X – 0.8 m
Y – 0.6 m
Z – 1.9 m

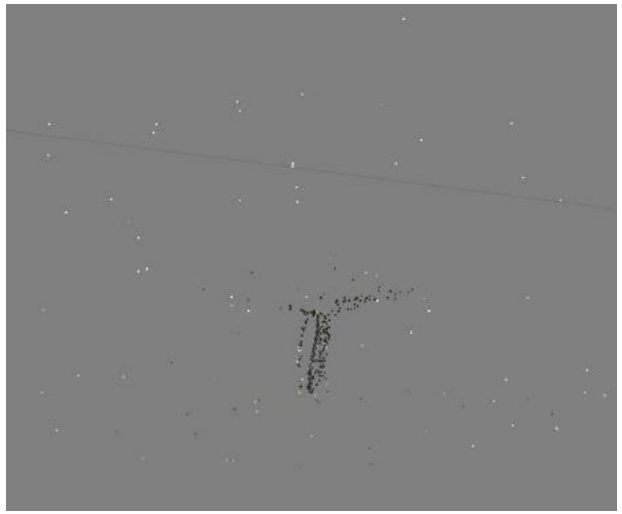


Results

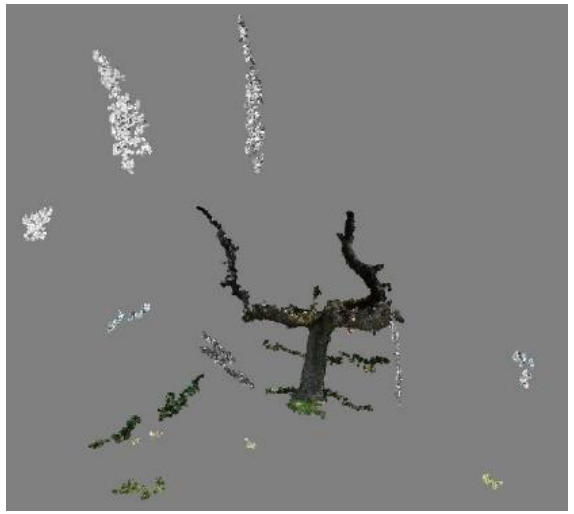
- Angular change effect on 3D tree canopy reconstruction



Case 1 – 15.7°



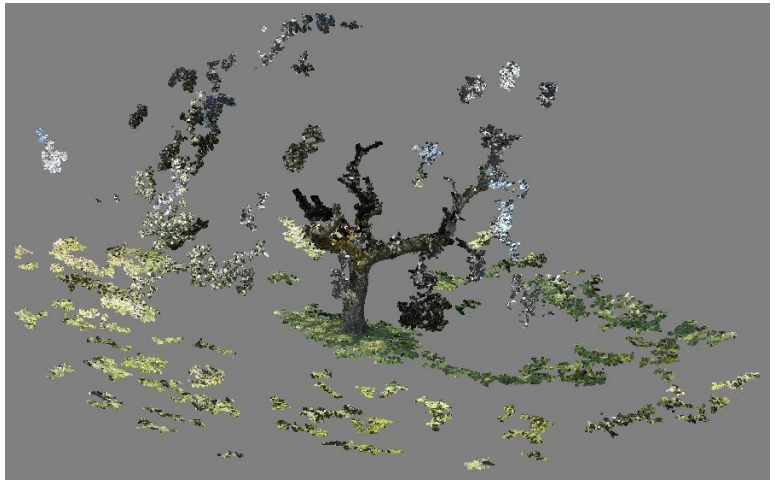
Case 2 – 13.3°



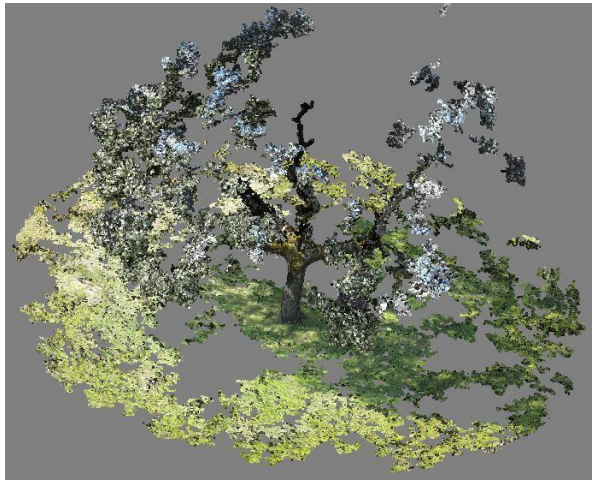
Case 3 – 10.6°

Results

- Angular change effect on 3D tree canopy reconstruction



Case 4 – 8°

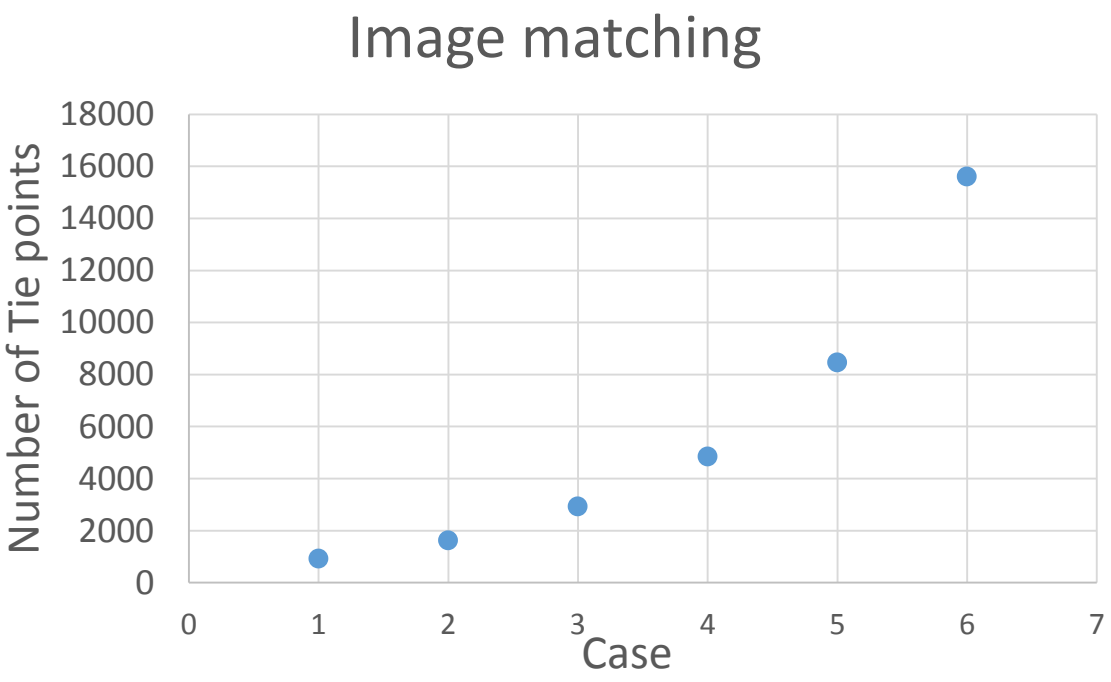


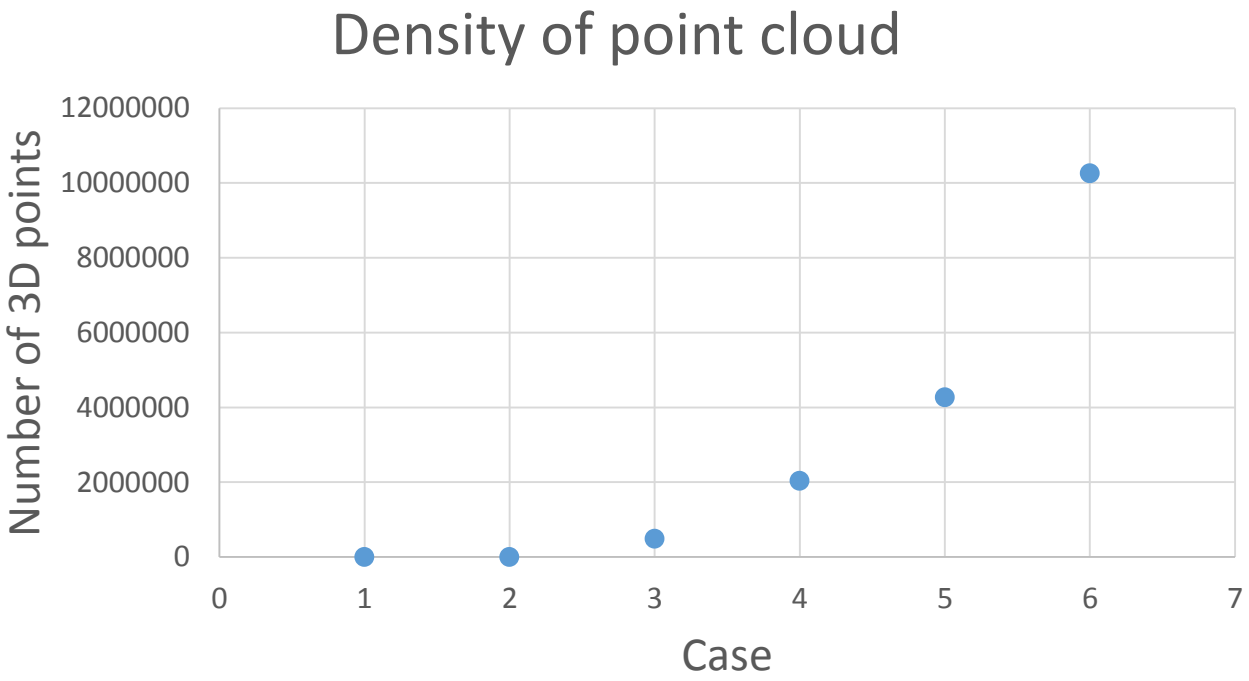
Case 5 – 5.3°

Case 6 – 2.7°

Results

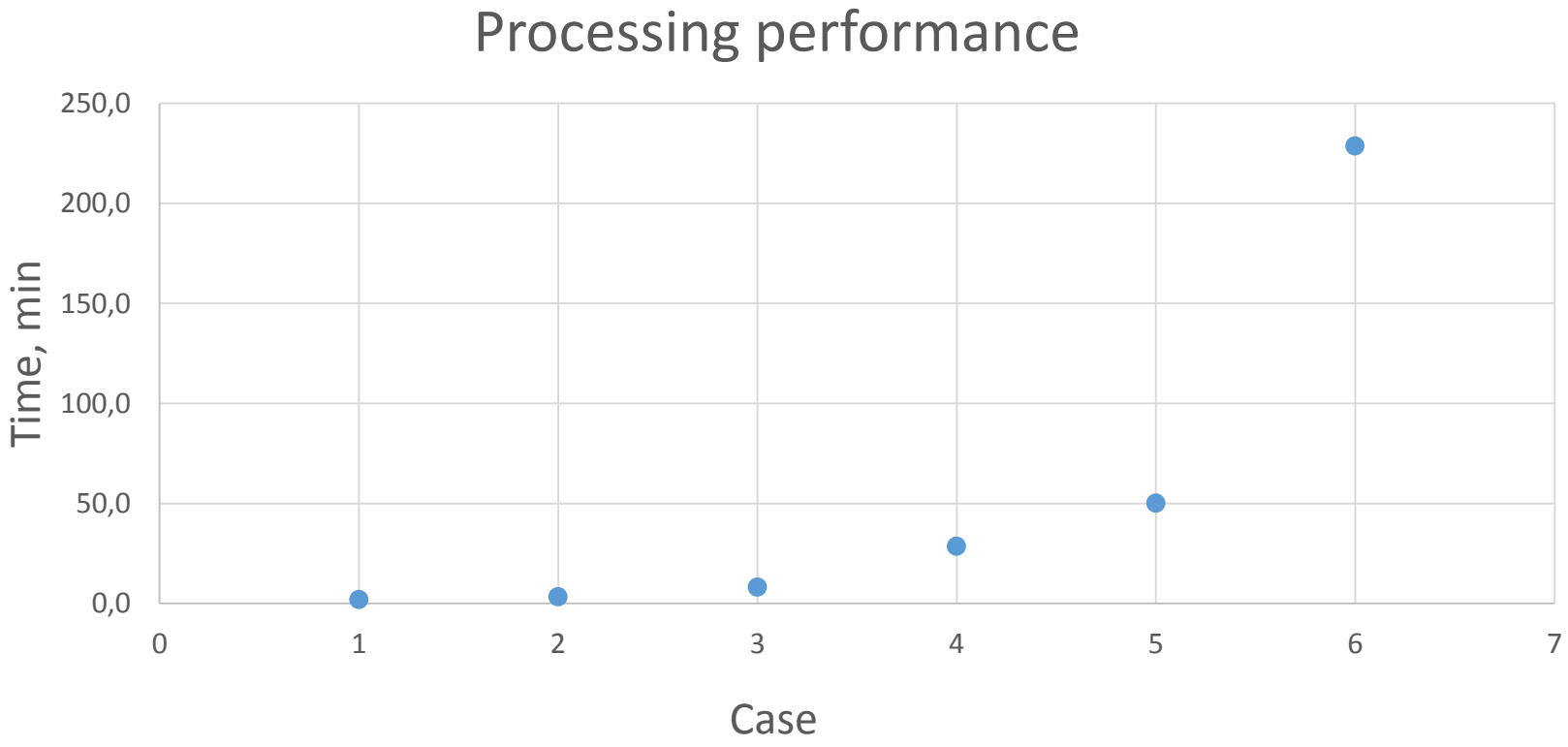
- Angular change effect on 3D tree canopy reconstruction





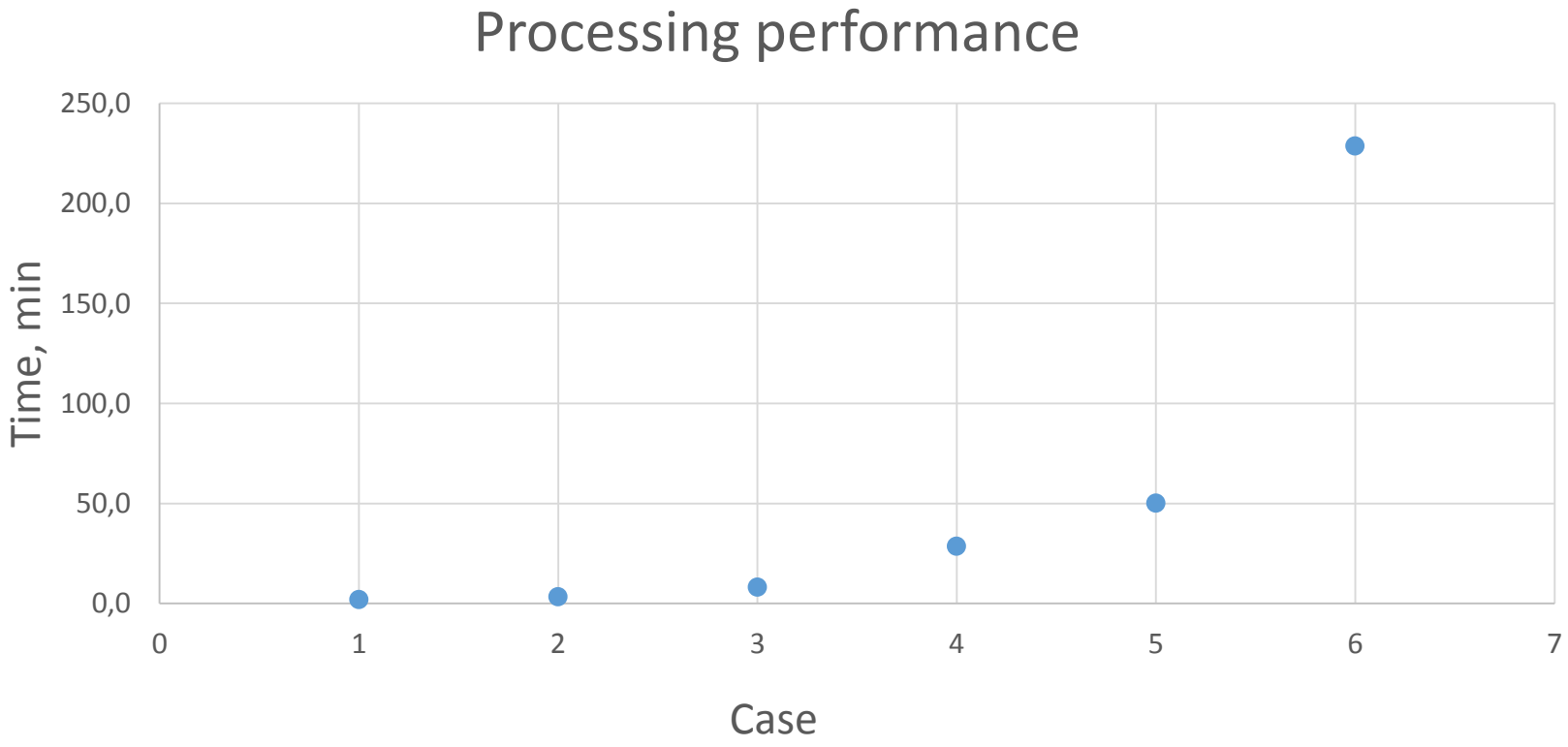
Results

- Angular change effect on 3D tree canopy reconstruction



Results

- Angular change effect on 3D tree canopy reconstruction

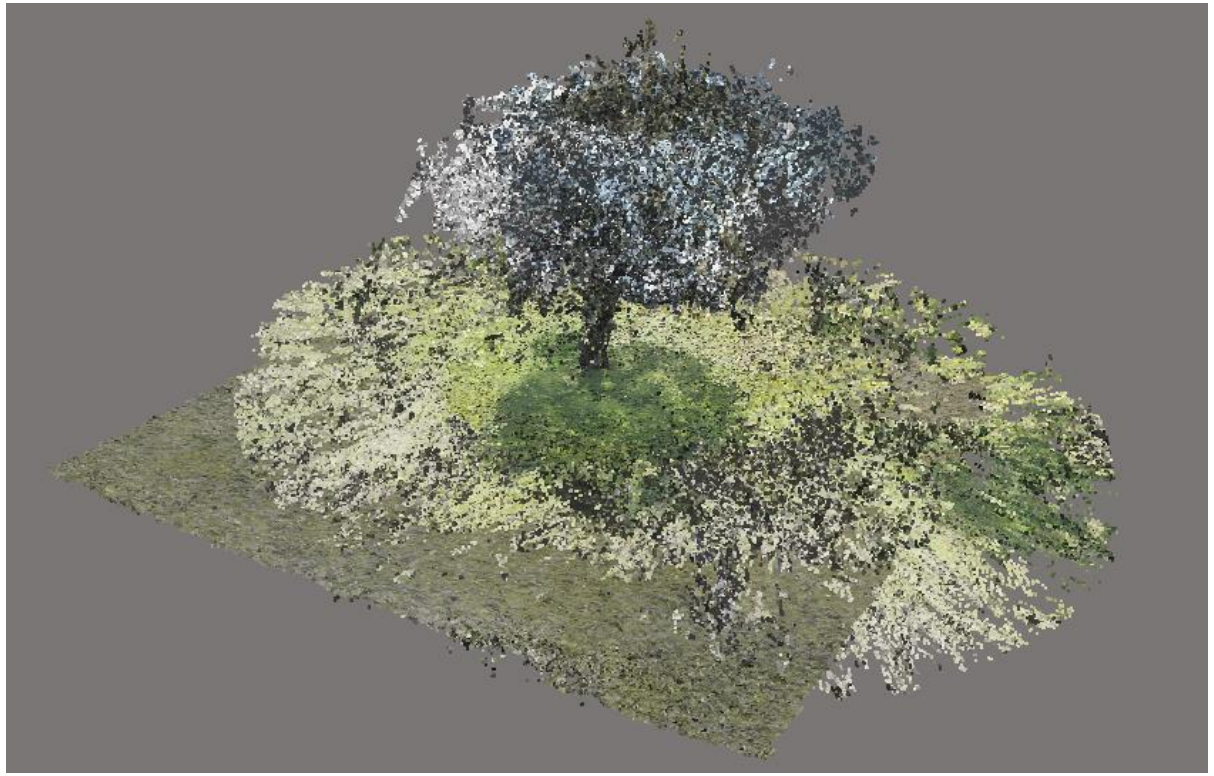


Results

- 3D reconstruction of single tree (UAV nadir + oblique)

Results

- Merging of 3D point clouds was not successful



Discussion

- It is essential to plan the tasks in advance
- Accurate geo-referencing is very important
- Time consuming processes
- Field of application
- Reliable tools for low cost 3D reconstruction
- More investigation is required

Thank you for your attention!