3D tree canopy reconstruction from Structure-from-Motion

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ABEL "UAVs and biogeochemical cycling" training school
Content

• Aims
• 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

• Sensors

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Panasonic Lumix DMC-GX1</th>
<th>Ricoh GR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement mode</td>
<td>UAV, Ground</td>
<td>Ground</td>
</tr>
<tr>
<td>Weight</td>
<td>367 g</td>
<td>245 g</td>
</tr>
<tr>
<td>Resolution</td>
<td>16 Mpix</td>
<td>16 Mpix</td>
</tr>
<tr>
<td>Pixel size</td>
<td>4592x3448</td>
<td>4928x3264</td>
</tr>
<tr>
<td>Focal length</td>
<td>14 mm</td>
<td>18 mm</td>
</tr>
</tbody>
</table>
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!