Modeling of the “Plan da Mattun” Archaeological Site

using a combination of different sensors

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Situation
• finds derive from early alpine dwellers (time of Ötzi)
• overhanging boulders where used as shelter
Plan da Mattun
• The archaeological site “Plan da Mattun” belongs to the project «Silvretta historica» and is part of the „Alpine Archäologie in der Silvretta“

• This is a project of the department of Pre- and Protohistory of the Institute of History, University Zurich under the leadership of Dr. Thomas Reitmaier

• Geodetic Project Course of the Institute of Geodesy and Photogrammetry, ETH Zurich
  – Participation of 19 students
  – Duration of 3 weeks
Surveying Work

Goal
Digital terrain model of
• rock stream (located at the end of the valley)
• four larger boulders (2 to 15 meters high)

Challenge
Rough terrain (400m x 200m) at 2400m a.s.l.
– Difficult to access certain areas
– Requires multiple measuring techniques to cover all the objects of interest

Solution
Rock stream
– Combination of laser scanning and unmanned aerial vehicle (UAV) photogrammetry.
Boulders
– Laser scanner, terrestrial and UAV photogrammetry.
Georeferencing

- Geodetic reference system within the Swiss coordinate system LV95

- Swipos service could not be used (lack of mobile phone reception)

- Reference points were measured by static GNSS and corrected with a virtual reference station (VRS) in advance. Points used for a GNSS reference station.

- Measure the ground control points for the photogrammetry in real time. (horizontal accuracy of 2 cm and 5 cm in height)

- The georeferencing of the scans was done by
  - Measuring the scanner position
  - Using several sphere targets with known coordinates
Measuring Equipment
Data Processing

- Digital terrain model (DTM) created with UAV photogrammetry and with terrestrial laser scanner
- Boulders with close range photogrammetry and laser scanner
- Terrestrial laser scanner as base with a resolution of 10 cm
- UAV images with a resolution of 2 cm
- Combination to create a final DTM of 10 cm
- Combined in Geomagic
Processing Chain

1. Flight planning
2. Camera calibration
3. Flight
4. Measurements
5. DTM extraction & orthophoto generation
UAV-Flight Planning

Latitude: 46°38′58″ N
Longitude: 10°20′02″ E
Height: 10 m
UAV-Camera Calibration
Results – Model from TLS
Results – Model from UAV
Results – Combined Model (TLS & UAV)
# Results – Required Time Frame

## Pure photogrammetric time frame

<table>
<thead>
<tr>
<th>Type</th>
<th>Time (for experts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight planning</td>
<td>2 h</td>
</tr>
<tr>
<td>Flight</td>
<td>3 h</td>
</tr>
<tr>
<td>Camera calibration</td>
<td>0.5 h</td>
</tr>
<tr>
<td>Image sorting &amp; clean up</td>
<td>2 h</td>
</tr>
<tr>
<td>Ground control point measurements in images</td>
<td>2 h</td>
</tr>
<tr>
<td>Exterior orientation assignment</td>
<td>2 h</td>
</tr>
</tbody>
</table>

## Automated

<table>
<thead>
<tr>
<th>Type</th>
<th>Time (for experts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated tie point measurement &amp; bundle adjustment</td>
<td>2 h</td>
</tr>
<tr>
<td>DTM extraction</td>
<td>7 h</td>
</tr>
<tr>
<td>Orthophoto generation</td>
<td>3 h</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>~24 h</td>
</tr>
</tbody>
</table>

![Pie chart showing time distribution between manual and automated tasks]
Conclusion

- UAV photogrammetry time consuming
- Laser scanner not so mobile
- Combination of laser scanner and photogrammetry is a major improvement over either technique alone
- Dataset for the archaeologists
Thank You