COGEAR

MODULE 1:

Integration of remote sensing data for the Visp area and Matter Valley

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COGEAR Report

Description of the available data and the database structure

Task 1b.2: Integration of remote sensing data for the Visp area and Matter Valley
Deliverable 1b.1.1 and 1b.1.2: Digital Imaga Data and derived Products

March 2010

Content

Description of available datasets

PRS (ETHZ) is providing a large number of datasets for the project. The following photogrammetric data are available for the Matter valley:

- LiDAR data (aerial based)
  - DTM-AV, DOM-AV from swisstopo
  - Available for areas up to 2000 m above sea level
  - With point spacing of less than 2m and vertical point accuracy better than 0.3m
- LiDAR data (helicopter based)
  - DTM generated using the Helimap system
  - Data acquisition was November 2007
  - 1-3 pt/m^2 and vertical point accuracy better than 0.2 m
  - high-resolution oblique photographs
- Aerial images
  - 62 images with a scale ~1:25'000
  - Image acquisition date was August 17th 2005
  - With orientation data (Bundle adjustment with GPS measured control points, accuracy of coordinates of the projection centre 0.5 -1 m)
- UAV images
  - Test data set of the lower part of the rock fall in Randa
  - Image acquisition date was May 24th 2007
  - Image resolution 3-5 cm in object space
- Additional data accessible for ETH
  - Swissimage, DHM 25, PK 25 etc.

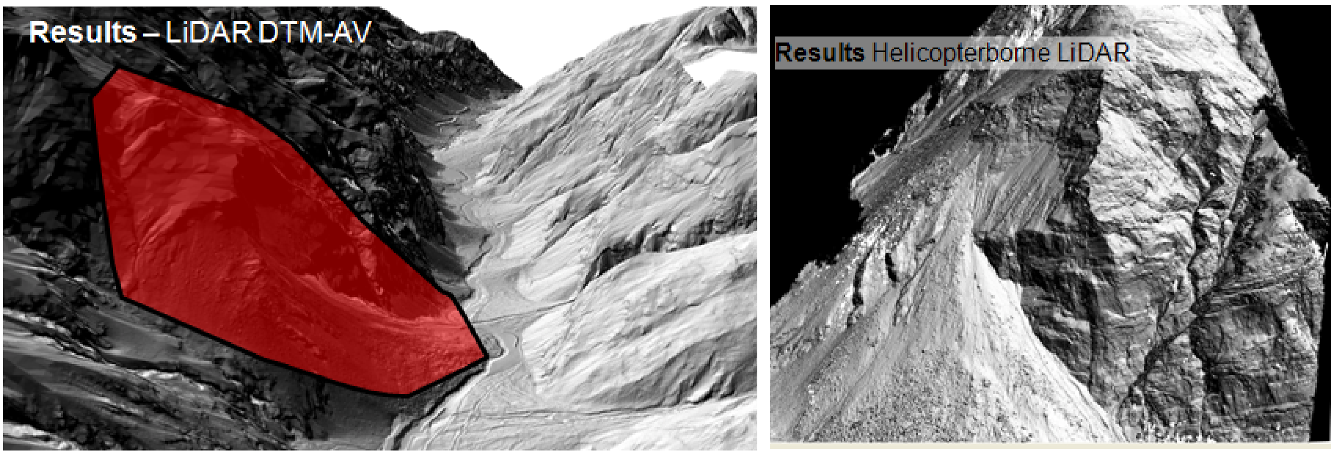

Figure 4: Example of the existing data showing on the left: Airborne LiDAR, and on the right: Helicopterborne LiDAR.

In COGEAR, PRS mainly dealt with the dissemination of spatial data produced in the Matter valley, with focus on the Randa rockslide. These data are Digital Surface Models (DSM), Digital Terrain

Models (DTM) and orthoimages. Furthermore, the original aerial images acquired by means of a helicopter and an Unmanned Aerial Vehicle (UAV) and the corresponding attribute data such as image orientation parameters, camera parameters derived from calibration (focal length, principal point coordinates and lens distortion parameters) can be provided. We realized that the original aerial images, in this case the Helimap, UAV and Swisstopo images, cannot be integrated into the WMS in a meaningful way due to their geometric properties, especially the central perspective, therefore we will integrate georeferenced orthoimages derived from these images into the Web Map Service (WMS).

Field works

UAV 2007

Given that the accessibility to the Randa rockslide is quite complicated, the start and landing point of the UAV was defined close to a road at the bottom of the debris zone. The field work itself *could be accomplished* in few minutes, where the longest part of the flight was the section from the starting point to the first image acquisition point and the way back. Since the UAV system used for the field work does not work above 2000m a.s.l., only few images were acquired at the bottom of the rockslide and the whole part of the rockslide was acquired using a manned helicopter. Currently, in March 2010 we tested a new UAV system at Jungfraujoch with an absolute height of 3800m a.s.l. The test was quite successful. Thus for upcoming tasks in the Alps, we now have a platform for fast autonomous data acquisition.

Manned Helicopter 2007

Due to the mentioned problems with our UAV, we decided to document the Randa site completely using the Helimap system. Thus, in November 2007, both LiDAR data and high-resolution oblique images were acquired using a manned system. About 143 oblique aerial images were acquired, together with the helicopter-based LiDAR data, using the Hasselblad H1 camera. These photographs show a very high level of detail and cover an extent of about 300x250m^2 each. For normal use, the system relies on a Riegl LMS-Q240i-60 Laserscanner for point cloud generation. Data acquisition was done along 19 horizontal flight lines that were arranged parallel to each other on different heights to cover the whole flank. The point cloud of this LiDAR data consists of $5.6 \cdot 10^6$ points and covers a total area of 3km^2 with a point density of 1-3pt/m^2 at a vertical point accuracy better than 0.2m ((Skaloud J., Vallet et al. 2005)).

Processing of image and LiDAR data

UAV images

The orientation of the images, which were acquired in the UAV field campaign 2007, was done with a digital photogrammetric workstation. These results were used for the processing of a DSM of the covered area. Figure 5 shows matching results of SAT-PP. In particular, the software matches features such as interest points, grid points and edges in order to achieve a highly dense and geomorphologically correct DSM. For the complete covered area it was possible to extract grid, feature points and edges even in the shadow areas. This was possible since the images were acquired in the early morning to avoid strong shadows.

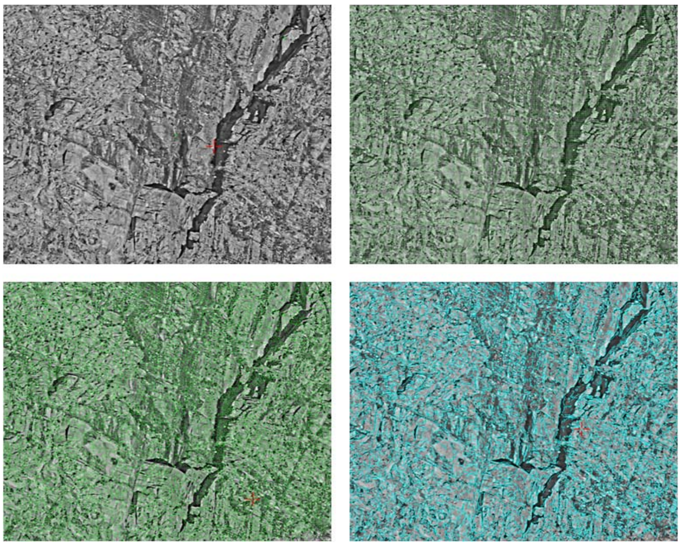

Figure 5: Matching results from SAT-PP of part of an image. Top: Preprocessed image (left) and matched grid points (right); Bottom: Extracted feature points (left) and edges (right).

LiDAR data

Since all measurements of the geologists are done in the local Swiss coordinate system LV03 and are further analyzed in ArcGIS, the 3D LiDAR data are transformed into 2.5D data. Thus, in the steep areas the data would be interpolated to a raster, which would result in a loss of information in the steep parts. Therefore, the DSM was visualized in Geomagic and an optimal view, perpendicular to the area of interest, was defined visually (see Figure 4). The rotation parameters around a defined point (e.g. center of gravity) were selected. Using an in-house developed tool, the point cloud was rotated around the defined point. Since the aspect of the site has two major orientations, the point cloud was turned two times using separate rotation angles. The rotation parameters and the point of rotation are given in (Eisenbeiss 2009).

Comparison and data analysis

Using the acquired UAV images (4-5cm GSD), a DSM of the lower part of the Randa rockslide with 15cm resolution was generated (see Figure 6). The complete site was documented with the Helimap system, with a pixel size of 6cm to 8cm. In comparison to the flight defined for the mini UAV-system, the Helimap flight was controlled by a pilot, who followed the flight lines with an accuracy of 30m. For the whole area the scale varied depending on the complexity of the terrain. It was also found that the Helimap system captured the cliff with an oblique field of view, which resulted in gaps in the data set. For the laser scan, the final point density was approximately 3pt/m^2 (see Figure 6).

The visual comparison of the extracted UAV-DSM and the LiDAR-DSM shows clearly that the fine structure of the cliff could be modeled from the UAV-DSM, while the LiDAR-DSM had large holes and less resolution (see Figure 6).

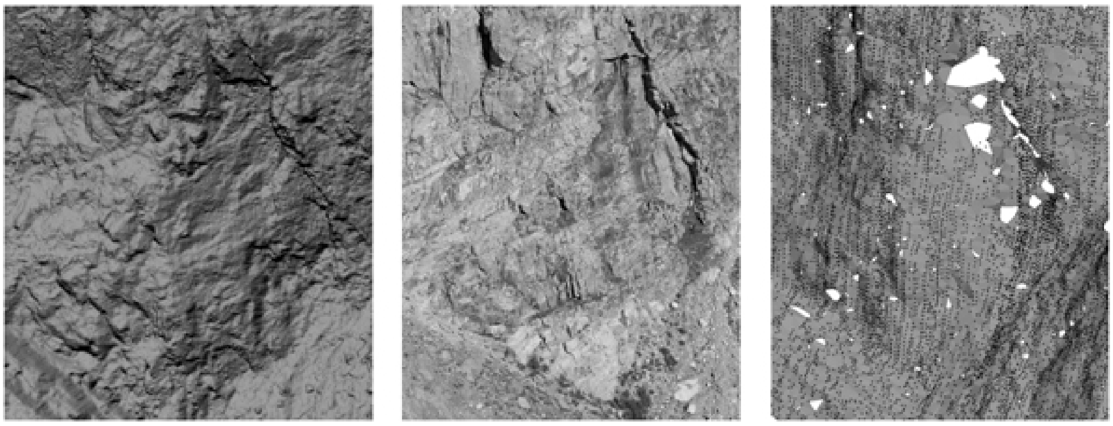

Figure 6: Left: Derived surface model from image matching, Middle: Zoom-in of an UAV-image, Right: Point cloud of Helicopter-based LiDAR projected on the derived surface model.

However, using the LiDAR DSM and the generated orthoimages, finally a complete 3D model was generated from the site Randa (see Figure 4). Using this data set, the geologists did the first measurements of fractures and shearing of intact rock and combined them with DINSAR measurements.

Integration of photogrammetric data into the COGEAR WMS

The spatial data produced by PRS are currently being made available via IKA's geospatial data viewer GeoVITe and will be available soon as a Web Map Service.

Metadata

The metadata which describe the spatial data will be available as feature information in the Web Map Service that will be provided by IKA. A data model containing the metadata structure was already included in our first year's report.

A Web Mapping Service for the spatial data

In order to provide our spatial data for the GeoVITe tool developed by partner IKA, we generated a WMS using the UMN MapServer (http://mapserver.org), an Open Source software for providing map data via the internet. Due to the situation of PRS in terms of personnel and hardware infrastructure (our server was not suited for the large raster data), in the meantime we decided to set up the WMS at IKA within their QGIS mapserver environment. Actually the data was transferred to IKA and is being integrated into their server. The WMS allows for simple data display using a web browser or more advanced capabilities by integrating the WMS in web-based viewers such as GeoVITe. Furthermore, the WMS can also be included into GIS software packages, e.g. ArcGIS (ESRI) or QuantumGIS (Open Source) and others which support WMS layers. In particular, the following datasets are being provided by the WMS:

- DSM generated from Helimap helicopter-borne LIDAR (mosaicked)
- LIDAR DSM and DTM generated by swisstopo (mosaicked)
- UAV images of the Randa rock face, stereo pair
- Orthoimages from Helimap aerial images

Together with IKA we agreed to migrate the data back to a new PRS server once the successor of Prof. Gruen started at ETHZ and the required hardware in terms of a new server is available in order to provide the data continuously for the COGEAR partners. Please note that for the use of the Helimap images and LiDAR data PRS has to confirm the rights for each user. For the original aerial and Helimap images please contact PRS directly. These data are not available via WMS, due to the reasons described above.

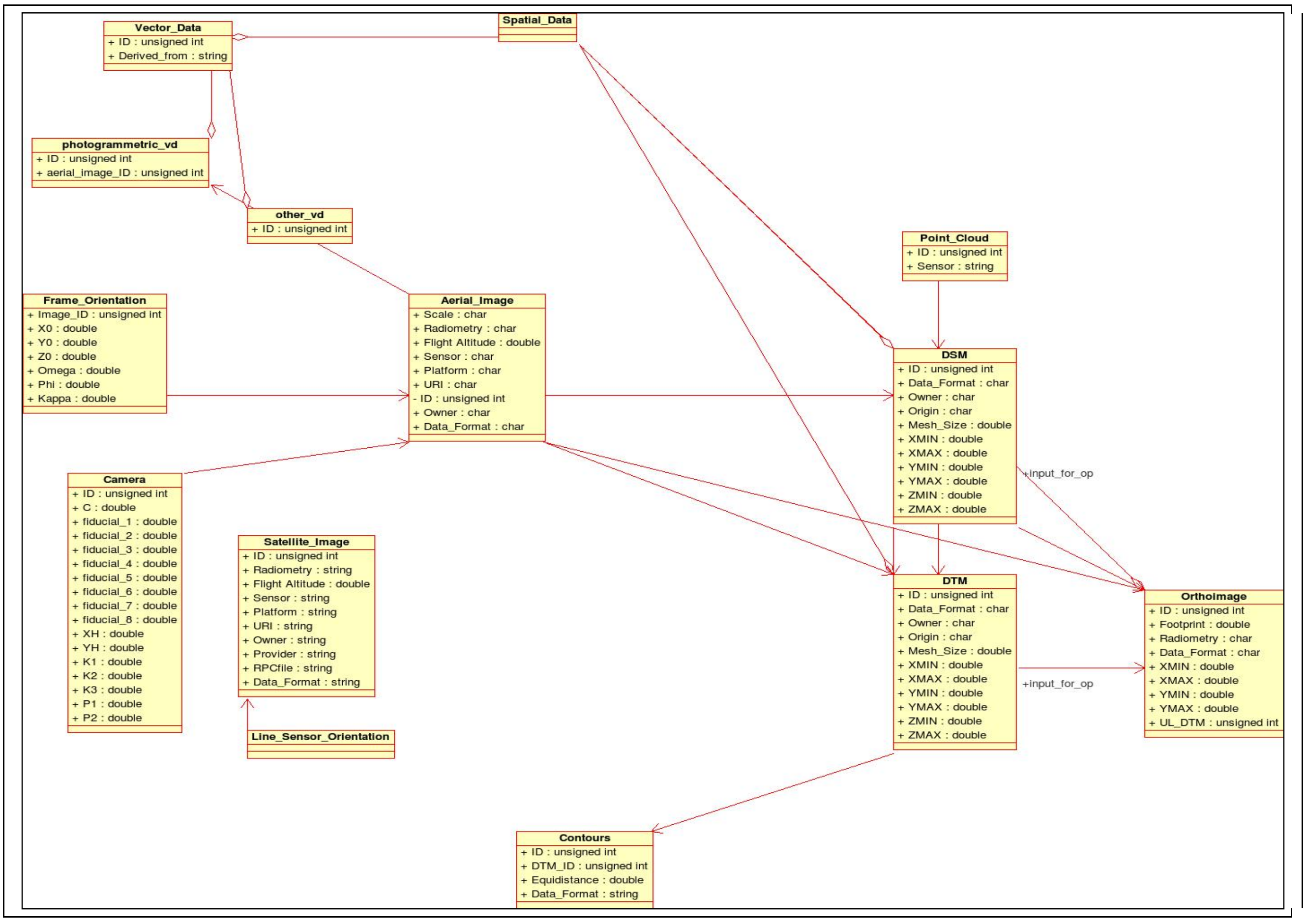

Figure 7: Conceptual UML model for the metadata structure