Webcam imagery rectification and snow classification

Potential for complementing satellite-derived snow maps over Switzerland

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INTRODUCTION

Outdoor webcams measure several environmental properties and have a huge, hidden potential to monitor global trends such as changes in snow cover. Therefore, the overall aim of this work is to elaborate a procedure to generate snow cover maps based on webcam imagery. Webcam data could not only complement satellite derived snow retrieval under cloudy conditions but also serve as a reference for improved validation of satellite based approaches. Our work mainly focuses on the implementation of fast and automatic procedures to

(1) orthorectify and

(2) snow classify webcam imagery.

DATA

Webcam Imagery

We use freely available webcam imagery of Swiss mountain landscapes. The high temporal and spatial resolution of webcam imagery and the increasing number of webcams offers a huge potential for extracting dense snow information.

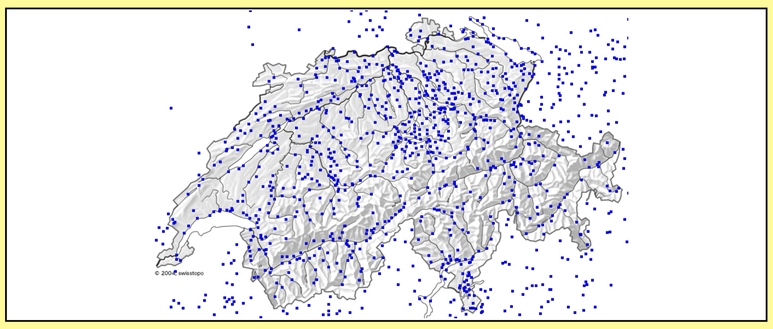


Figure 1: *A selection of webcams in and around Switzerland [http://www.camscollection.ch]. Even though this map is far from complete, it shows the high potential to ge dense snow information.*

Digital Elevation Model

The swissALTI3D is a precise georeferenced digital elevation model (DEM) with a spatial resolution of 2 meters. It describes the surface of Switzerland without vegetation and infrastructure. The DEM is used to register webcam imagery and to obtain a projection matrix to orthorectify webcam images.

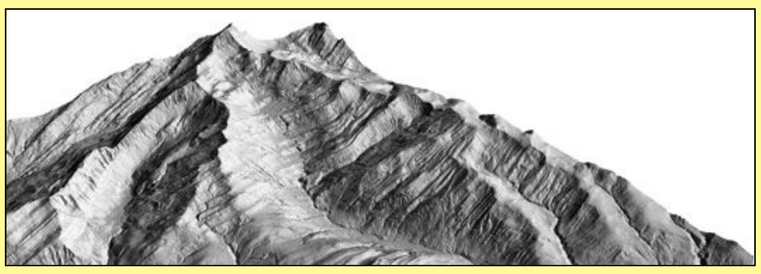


Figure 2: *The SwissALTI3D digital elevation model (DEM) from swisstopo with an aperture width of 2 meters [www.swisstopo.ch].*

WORKFLOW

1 Mountain Silhouette Extraction

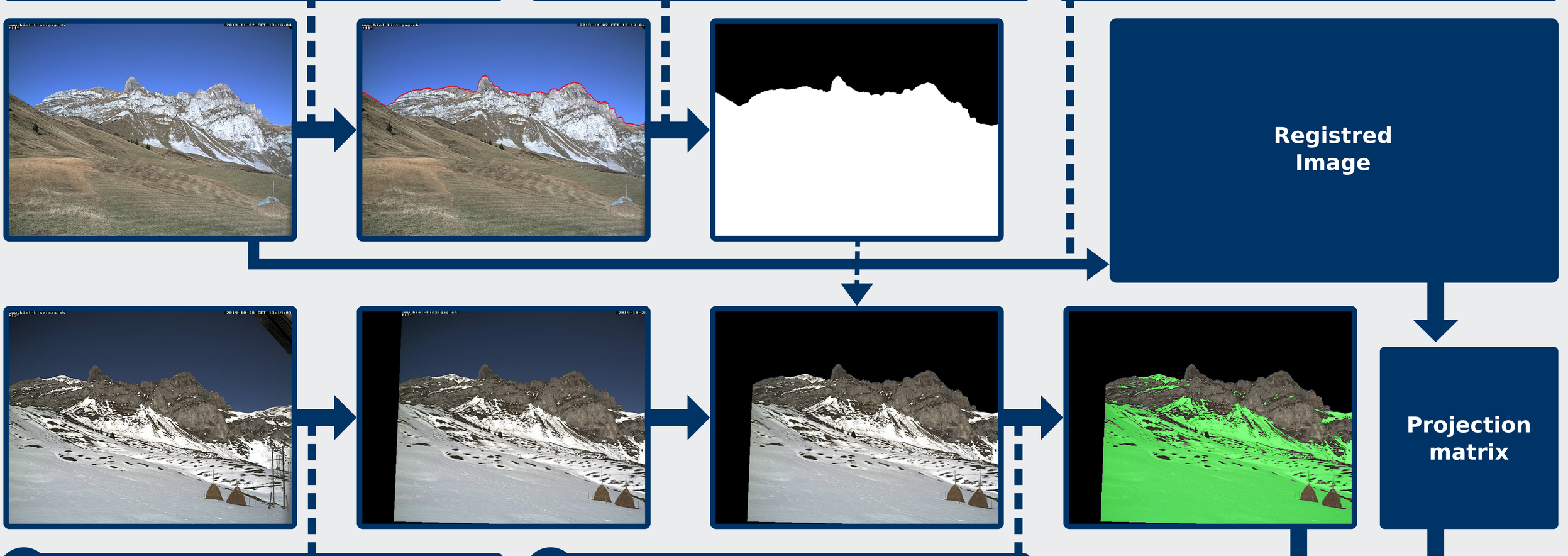
After the selection of one master image per webcam, the mountain silhouette is extracted automatically. This is achieved by implementing sobel edge detection, followed by seeking for the topmost connected edge pixels that span the full width of the master image.

2 Mask Generation

The extracted mountain silhouette is used to generate a binary mask for each master image, which allows to differentiate between the fore- and background of the image. This mask is applied in a subsequent step to all other images of the webcam to mask sky pixels for further processing.

3 Image Registration

To find the correlation between each image pixel and its 3D coordinate, the master image and the DEM are coregistered using edges and silhouettes from both, the master image and the rendered view of the DEM [Baboud et al. 2011]. The obtained matrix is used to project the image into a georeferenced map.



4 Image Alignment

In order to use the projection matrix and the silhouette mask obtained from the master image for arbitrary images of the same webcam, each image must be aligned to its master image. The implemented approach works automatically by using SIFT features and RANSAC.

5 Snow Classification

After applying the sky mask to the input image, an automatic classification approach by Härer et al. [2013] is used to classify snow pixels. It statistically analyzes the blue channel using a DN (digital number) frequency histogram to automatically select an appropriate snow treshold.

CONCLUSION

The presented procedure is expected to work under various weather conditions. The resulting snow cover maps will indicate for each grid cell whether the cell is snow-covered, snow-free or not visible from the webcams' positions and will offer a high temporal and spatial resolution. Moreover, outdoor webcams have a huge potential to monitor also other environmental properties such as weather or vegetation and are representing an underused resource of information.

OUTLOOK

Final challenges:

- Improve existing approaches (image alignment, snow classification)
- Continue with automatic image registration
- Implement automatic cloud detection by capturing statistical properties of the signal

REFERENCES:
Baboud, L., Cadík, M., Eisemann, E. & Seidel, H.-P. (2011) Automatic photo-to-terrain alignment for the annotation of mountain pictures. CVPR (p./pp. 41-48), : IEEE.
Härer, S., M. Bernhardt, J. G. Corripio, and K. Schulz (2013) Practise – photo rectification and classification software (v.1.0). Geoscientific Model Development 6 (3), 837–848.

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