Automated forest mapping from old aerial photos using deep learning

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ABSTRACT

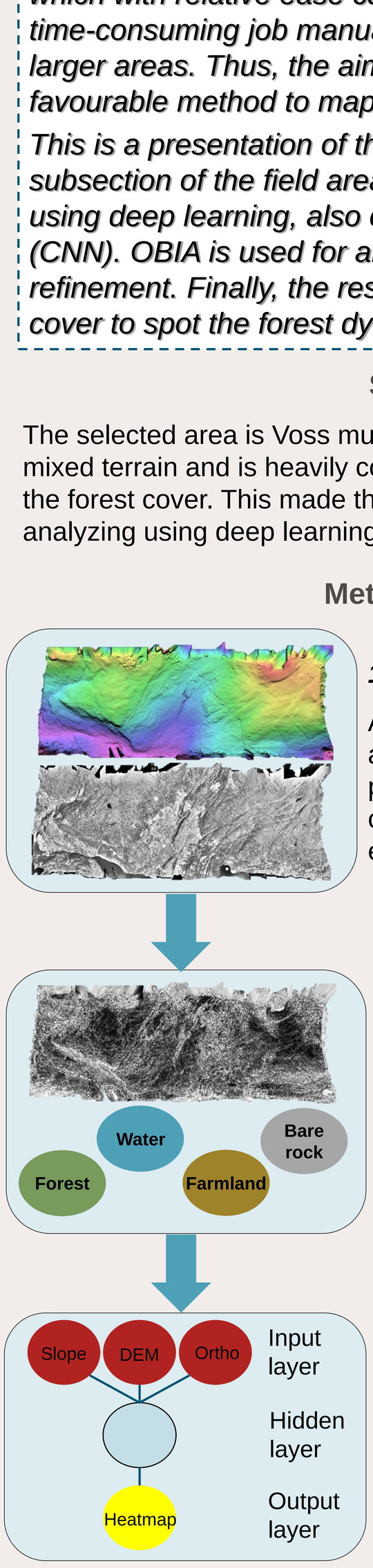
Natural fluctuation of the forest is an ongoing process that affects most areas with unregulated forest. The need for documenting those changes are greater than ever with climate changes in mind. Aerial images are a reliable source for past forest boundaries. Although old aerial images are available, they lack the ability to utilize features such as nDSM and NDVI, which with relative ease can be used to map forest. It is also a time-consuming job manually mapping the forest, especially for larger areas. Thus, the aim of this project is to find a more favourable method to map forest from old aerial images.

This is a presentation of the preliminary results from a subsection of the field area where possible forest is identified using deep learning, also called Convolutional Neural Networks (CNN). OBIA is used for analyzing, classification and refinement. Finally, the result is compared to a newer forest cover to spot the forest dynamics of the area.

Study area

The selected area is Voss municipality in Norway. The area has a mixed terrain and is heavily covered with forest, with visible changes in the forest cover. This made the area very suitable for mapping and analyzing using deep learning.

Methods and data



1. Preprocessing

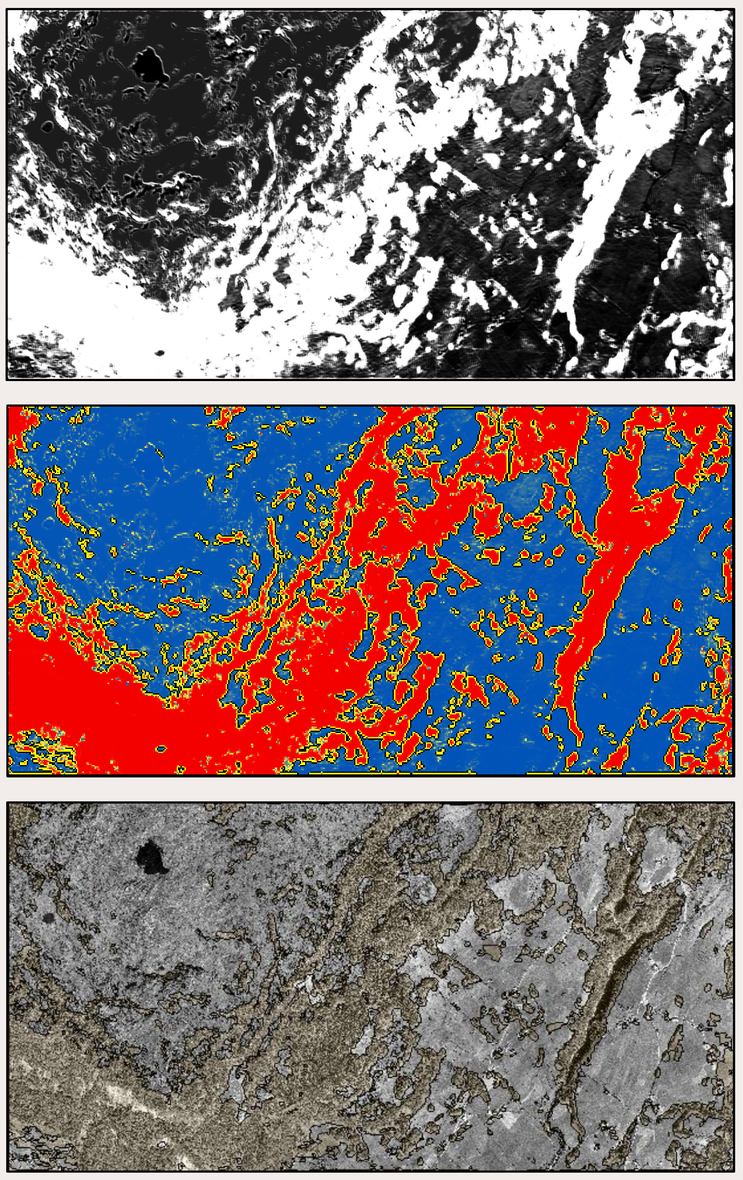
A set of unprocessed aerial photos for the area were acquired for the project. The photos were processed in OrthoEngine to create an orthomosaic and a digital elevation model (DEM).

2. Preparation

Test samples from the images were created in ArcMap 10.7.1. by generating random points for the four most distinct classes. The classes selected were forest, water, farmland and bare rock. An image of the slope was also generated from the DEM in Focus.

3. Deep learning

Inputs were orthomosaic, DEM and slope. A 3m buffer was placed around sample points. A CNN with one hidden layer was created, resulting in a heatmap. The heatmap was reshaped based on pixel value, size and neighborhood using OBIA. Processing was done in Ecognition.

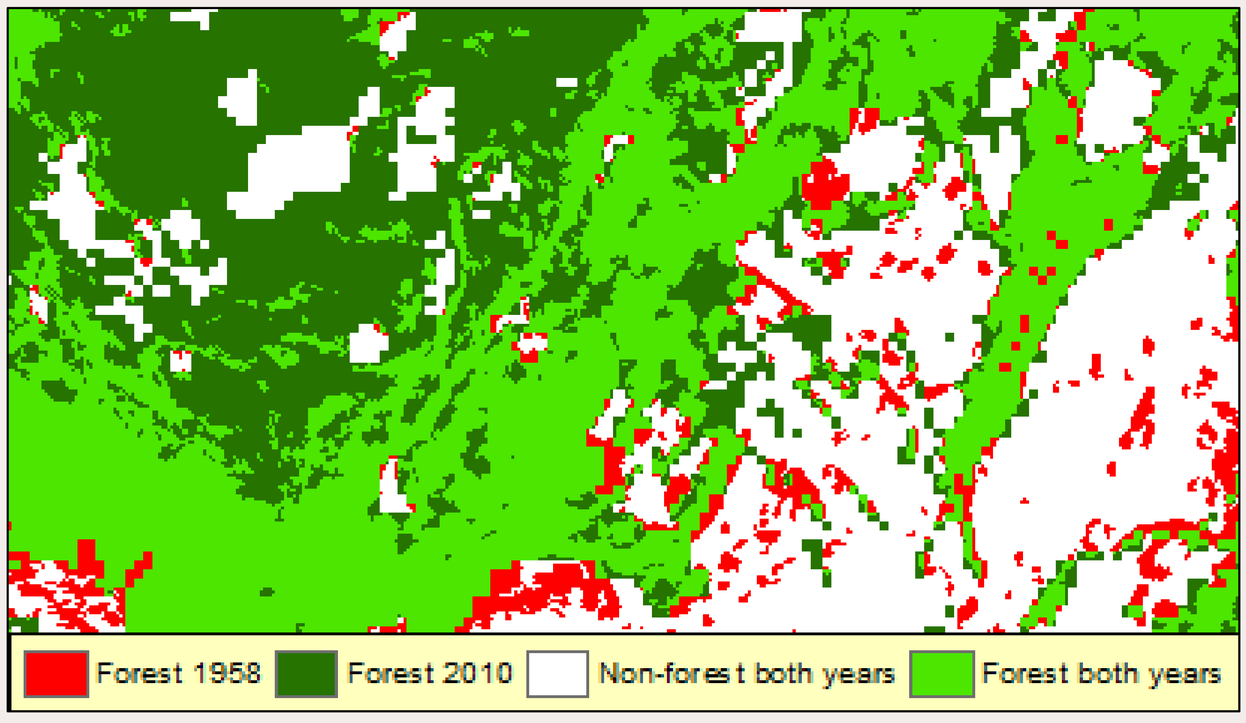


Results

The heatmap seems to line up well with forest in the area based on manually inspection. Few areas were missing, but some features such as smaller vegetation and farmland were included. This made it necessary to reshape the heatmap with OBIA to narrow the included result. Some problems were recognized using OBIA. Segmentation was difficult in capturing the forest due to a lot of small objects. Setting criteria for the classification were also an issue partly because of lower certainty along the borders.

Comparing with newer forest cover

A forest cover from 2010 was downloaded from Geodata.no and combined with the reshaped heatmap in ArcMap. The analysis reveals that most of the forest identified in 1958 corresponds with areas where there still is forest. The results also show how much the forest has expanded between the two datasets. The red areas mostly represent areas which are misinterpreted as forest. Nevertheless inspections of the images above clarify that some of the results are due to the CNN capturing single trees in the farm area as forest, while the forest cover doesn't include those areas. Other explanations such as logging or errors can also explain some of the missing forest in the newer image.



Further research

- Accuracy assessment
- Continue tweaking with the NCC and classifications
- Working with larger areas
- Comparing with accurate forest maps

ACKNOWLEDGEMENTS

This topic and design is inspired by the poster "*Automated mapping of rock-glaciers using deep learning*" by Robson, B. A., Bolch, T., Hölbling, D., MacDonell, S. & Rastner, P.

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