University of Applied Sciences and Arts Northwestern Switzerland
School of Architecture, Civil Engineering and Geomatics

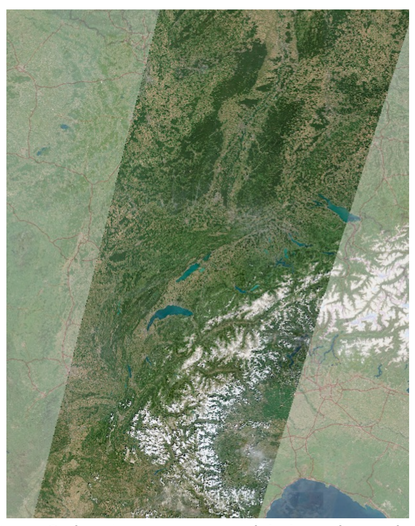
MASTER OF SCIENCE IN ENGINEERING

Creating a Gobal Image Dataset from Sentinel-2 Data using Color Harmonization and Seamless Tile Blending

Observing global changes from above ensures valuable information. To ensure different point of view is satellite images used. Creating global image dataset is complex process and include challenges of diverse imaging conditions. In order to ensure visual consistency are color harmonization techniques used. Goal is to harmonize color distribution of individual tiles to match reference color palette. On the other side, tile blending algorithms are employed to seamlessly integrate these harmonized tiles into a coherent global mosaic. Resulting image ensures visually appealing and spatially consistent representation of Earth's surface, simplify various applications like land cover mapping and environmental monitoring.

Download Sentinel-2 Images

During the practical part of the work, a script is created that allows the user to download a certain number of Sentinel-2 images depending on the production time of an image, the spatial coverage and the cloud percentage.
The combination of three bands (red, green and blue) produces a true-colour image.



Each Sentinel-2 image has unique Label, for example: S2A_33MNR_20240301
Created true-color image has 10980x10980px and cover area of 100x100km.
For the purpose of this project are Sentinel-2 images Level 2A used with spectral resolution of 10m.

Fig. 1: True Color Image – combining three bands

Cutting Tiles

Due to limitations of deep learning algorithms, which will be used in the later steps of the project is cutting orignal Sentinel-2 images necessary. Original images are separated into smaller pieces, called tiles. Each tile contains 256x256px and encompass area of 2.5x2.5km. Tiles are also georeferenced, based on the original images.

Each tile has unique label: tile_y_x.tif
X and Y are cordinate shifts from 0,0 of the original picture, adding in each step 256px.

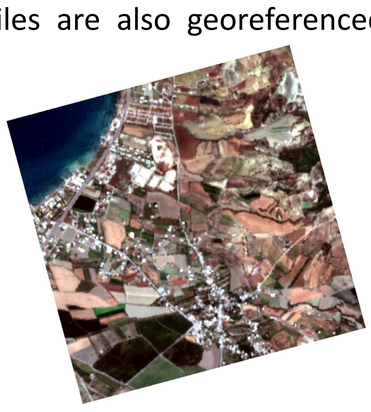


Fig. 2: Tile_7936_8448.tif

Global Image Mosaic

Each harmonized true-color image consists of 1849 harmonized tiles, which are also gereferenced.

1. Joining tiles into one image
2. Merging more images into one global image mosaic

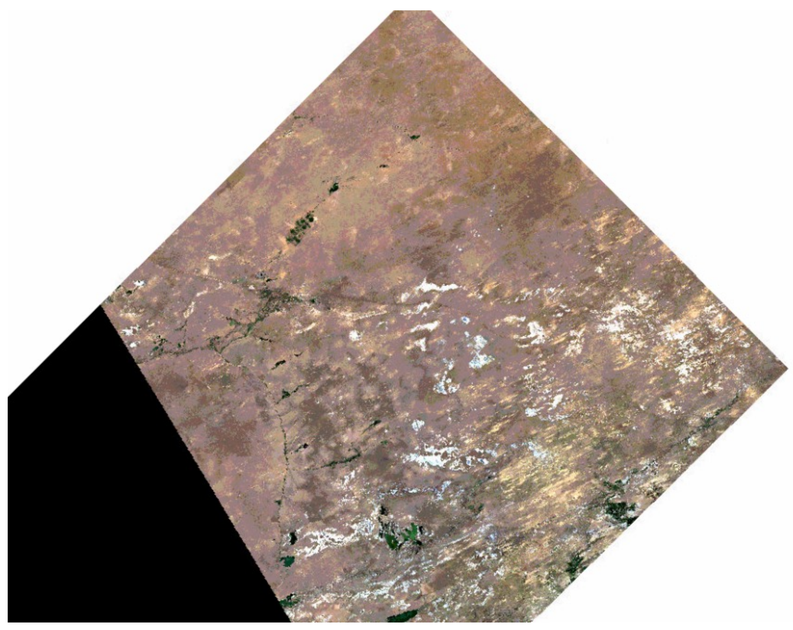


Fig. 4: Global Image Mosaic –over territory of Switzerland)

Deep Learning

Deep learning is a subset of machine learning that uses multi-layered (hence "deep") artificial neural networks to identify complex patterns in data sets. The structure and functionality of these networks are inspired by the human brain.

Cloud Detection and Removing

CloudGAN is a method to detect and remove clouds from a satellite RGB-image. This method uses an autoencoder for cloud detection, and the SN-PatchGAN image inpainting model for cloud removal.
CloudGAN is a deep learning-based method specifically designed to detect and remove clouds from satellite RGB images. It uses a combination of image inpainting and cloud detection techniques to achieve optimal results.

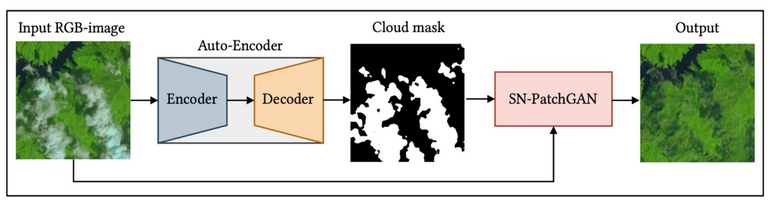


Fig. 2: Overview of CloudGAN for cloud detection and SN-PatachGAN for cloud removing

Color Harmonization

The goal is to achieve a harmonious alignment between the colors of objects and their surrounding background, creating a more visually appealing effect.
CycleGAN is particularly used for complex color transformations, as it is highly effective. It ensures bidirectional mappings between the source and target domains. The Network learns mapping between input and output images using unpaired dataset.

Fig. 3: Left– Original true-color Image; Right – Harmonized true-color image

Serving Mosaic Image over WMTS

In order that end-user could profit from the final product is setting up of WMTS service and implementation within GIS software or serving it over the Web. To make it possible, two steps are required:

1. Create Web Map Service (WMS) using MapServer
2. Create Web Map Tile Service (WMTS) by cutting WMS using MapCache

Future Investigations

For deep learning model creation are large number of images required, in order to ensure that model covers as many as possible solutions.
Radiometric resolution of image is very important, also for deep learning creation.
In order to reduce storage data needed and processing power, improvements of existing algorithms is needed. They should be able to manage more than 256px.

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Literature:
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