Data preparation for tree species classification using airborne hyperspectral and LiDAR point clouds

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The study and classification of Alaska's boreal forests are crucial for understanding their environmental processes and distribution, enhancing our ability to predict their response to climate change. The research group aims to map the forest types in western Alaska using remote sensing supervised classification and explore how climatic variables shape forest distribution. Previous stages analyzed diverse forest data types. A developing approach combines these data using sensor fusion to gather more spatial information (Brell et al., 2019). We proposed combining hyperspectral imagery (HSI) and point cloud data to create a Hypercloud, enabling the derivation of classical orthomosaics or working with multispectral colored points (Iseli & Lucieer, 2019). This new data product helps distinguish and classify tree species and features. As it was the first trial of this approach by the research group, identifying missing data from previous campaigns and defining new data collection methods for future surveys was also crucial.

The project was focused on the field survey done by the research group in the boreal forests in western Alaska. It covered a 500 m x 50 m area of the forest, close to Fairbanks City. The data collected in the field survey consisted of 54 GeoTiff RGB images and HSI (502 nm - 997 nm) sequentially taken by a BlackBird V2I Camera drone and a point cloud of the area.

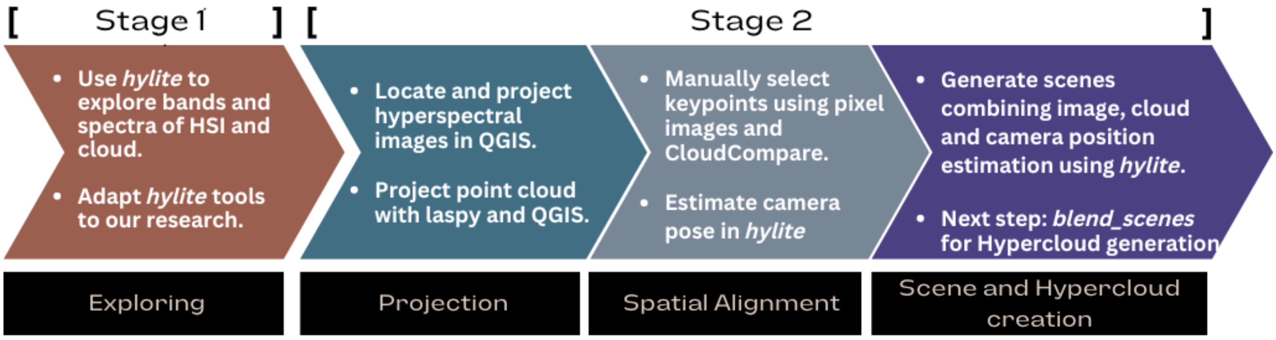

Figure 1: Workflow for the Processing and Analysis of Boreal Forest Classification Data

The workflow used during this project is shown in Figure 1. The code created can be found in the Repository. The data collection process took two stages. The first maximized the exploratory analysis of the raw data, using *hylite* (Thiele et al., 2021), as a new tool to process and analyze it. As the first use of *hylite* by the group and given its previous geological focus, it was required to understand the scope and limitations of this tool when working with forest data and to define the possible uses of it to the available data. It was possible to plot hyperspectral images in different bands, particularly in relevant bands for vegetation analysis, and to plot the whole spectra of chosen pixels of the image and the median spectrum of the whole image. The cloud was also able to be visualized as an image in its eight different bands.

The second stage consisted in experiment data aggregation possibilities, in order to obtain a useful product of the combined HSI and point cloud data. First, the data locations were homogenized: HSI location metadata projected in QGIS, and the cloud projected using *laspy* library. Both were visualized in QGIS.

Using *hylite, a* spatial alignment was made between both HSI and the point cloud. Firstly, as the camera pose when capturing the cloud was not in our data, the alignment was done manually. This means that keypoints were manually selected to align real-world coordinates of the cloud and HSI to solve the sensor position and orientation. For this purpose, some pixels of the image were selected, considering that these pixels should be recognizable in the cloud. CloudCompare, a software to work with point clouds, was used to interactively select the points associated with each pixel (Thiele et al., 2021). Using the selected pixels and points, it was possible to match the features between the cloud and HSI and then solving a Perspective-n-Point (PnP) equation. The estimation of the camera position was then stored in the image header. The point cloud was then projected as an image using the camera position estimation and both the image and the cloud are projected in the same view.

Once aligned, it was possible to create a scene with the image, the cloud and the camera pose estimation. This scene is a data type in *hylite* that contains a projection map for transferring information between a point cloud and a hyperspectral image. The whole process was repeated for different images.

The following step proposed was to use a *hylite* function that allows blending the created scenes to form the Hypercloud. It was noticed that the images did not fully cover the study area, and more overlap was needed to blend the aligned scenes. Additionally, it was noted that a reflectance reference panel for illumination correction was also necessary to improve the resulting scenes obtained before using the blend scenes tool. These findings were taken into account to improve the data acquisition in the next field survey.

References

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