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Implementing a tree detection technique from Lidar data using wavelet – based algorithms

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In the field of remote sensing image analysis, object detection constitutes an increasingly important study subject due to the extensive role in a wide range of applications. Although essential, as powerful tools for describing complex features and phenomena, many object detection techniques remain challenging to adjust for multi-scale analyses and for different data sources. In addition to the concept of detection, the assessment of vegetation attributes and dynamics is a more complex matter due to the frequent use of 3D data, but still of central importance in many ecological studies that handle remote sensing imagery.

We applied wavelet – based techniques, adapted from the field of signal processing, which are filtering methods used for detecting various features in data. Our aim was to detect vegetation features and species related ecological characteristics from Canopy Height Models (CHM) derived from LiDAR point cloud data. The Mexican Hat (Ricker wavelet) was used considering the resemblance to the shape of various vegetation features (coniferous trees, bushes). We chose two study sites in the Romanian Carpathians, consisting of forested pastures with different vegetation characteristics (mixed coniferous – deciduous trees and juniper - only landscape, respectively). We used a CHM of 1 meter resolution, derived from high density LiDAR data. The mathematical convolution operation was applied on the LiDAR derived CHM, with the Mexican Hat wavelet serving as a filter to compare the surface features. By adjusting the dilation parameter of the Mexican Hat wavelet, we compared the input signal (CHM) on a wide range of scales, allowing us to detect objects of different shapes and sizes. A high convolution value indicated a strong resemblance between the wavelet filter and the feature (tree, bush) in the data. The results showed high detection percentages (70 - 80%) for different tree species (*P. abies, F. sylvatica*) as well a slightly higher detection percentage ($\sim$90%) for the bushes features (*J. communis*).

This study presents a method to detect fine-scale ecological features such as trees and bushes and to quantify their morphological traits, from a high – resolution CHM, while adapting for the local particularities found at different scales.