



Laser Scanning for 3D Object Characterization: Infrastructure for Exploration and Analysis of Vegetation Signatures

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Mapping and characterization of the three-dimensional nature of vegetation is increasingly gaining in importance. Deeper insight is required for e.g. forest management, biodiversity assessment, habitat analysis, precision agriculture, renewable energy production or the analysis of interaction between biosphere and atmosphere. However the potential of 3D vegetation characterization has not been exploited so far and new technologies are needed. Laser scanning has evolved into the state-of-the-art technology for highly accurate 3D data acquisition. By now several studies indicated a high value of 3D vegetation description by using laser data. The laser sensors provide a detailed geometric presentation (geometric information) of scanned objects as well as a full profile of laser energy that was scattered back to the sensor (radiometric information). In order to exploit the full potential of these datasets, profound knowledge on laser scanning technology for data acquisition, geoinformation technology for data analysis and object of interest (e.g. vegetation) for data interpretation have to be joined.

A signature database is a collection of signatures of reference vegetation objects acquired under known conditions and sensor parameters and can be used to improve information extraction from unclassified vegetation datasets. Different vegetation elements (leaves, branches, etc.) at different heights above ground with different geometric composition contribute to the overall description (i.e. signature) of the scanned object. The developed tools allow analyzing tree objects according to single features (e.g. echo width and signal amplitude) and to any relation of features and derived statistical values (e.g. ratio of laser point attributes). For example, a single backscatter cross section value does not allow for tree species determination, whereas the average echo width per tree segment can give good estimates. Statistical values and/or distributions (e.g. Gaussian distribution) of signatures allow identifying the difference or the similarity of varying kinds of trees (e.g. coniferous and deciduous tree). Furthermore, the different geometric shape and vertical structure of a tree in combination with the signature enables the identification of tree species.

This contribution reviews the potential of such a reference database, exploration and analysis infrastructure for the identification and extraction of unique characteristics of selected vegetation objects (e.g. trees). The developed tools include web-based modules for exploration and analysis of the 3D laser point cloud. The signature database reveals the need for standardization of features and metadata to achieve interoperability between tools and web services.

Object-based point cloud analysis shows a great potential for integration into ecological research, particularly in combination with reference tables such as the specific values of evapotranspiration of tree species. The third dimension allows a precise view on biophysical characteristics of plant communities and vegetation parameters such as leaf area index and above ground biomass.