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LiDAR Vegetation Investigation and Signature Analysis System (LVISA)

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Our physical environment undergoes constant changes in space and time with strongly varying triggers, frequencies, and magnitudes. Monitoring these environmental changes is crucial to improve our scientific understanding of complex human-environmental interactions and helps us to respond to environmental change by adaptation or mitigation. The three-dimensional (3D) description of the Earth surface features and the detailed monitoring of surface processes using 3D spatial data have gained increasing attention within the last decades, such as in climate change research (e.g., glacier retreat), carbon sequestration (e.g., forest biomass monitoring), precision agriculture and natural hazard management.

In all those areas, 3D data have helped to improve our process understanding by allowing quantifying the structural properties of earth surface features and their changes over time. This advancement has been fostered by technological developments and increased availability of 3D sensing systems. In particular, LiDAR (light detection and ranging) technology, also referred to as laser scanning, has made significant progress and has evolved into an operational tool in environmental research and geosciences. The main result of LiDAR measurements is a highly spatially resolved 3D point cloud. Each point within the LiDAR point cloud has a XYZ coordinate associated with it and often additional information such as the strength of the returned backscatter. The point cloud provided by LiDAR contains rich geospatial, structural, and potentially biochemical information about the surveyed objects.

To deal with the inherently unorganized datasets and the large data volume (frequently millions of XYZ coordinates) of LiDAR datasets, a multitude of algorithms for automatic 3D object detection (e.g., of single trees) and physical surface description (e.g., biomass) have been developed. However, so far the exchange of datasets and approaches (i.e., extraction algorithms) among LiDAR users lacks behind. We propose a novel concept, the LiDAR Vegetation Investigation and Signature Analysis System (LVISA), which shall enhance sharing of i) reference datasets of single vegetation objects with rich reference data (e.g., plant species, basic plant morphometric information) and ii) approaches for information extraction (e.g., single tree detection, tree species classification based on waveform LiDAR features). We will build an extensive LiDAR data repository for supporting the development and benchmarking of LiDAR-based object information extraction. The LiDAR Vegetation Investigation and Signature Analysis System (LVISA) uses international web service standards (Open Geospatial Consortium, OGC) for geospatial data access and also analysis (e.g., OGC Web Processing Services). This will allow the research community identifying plant object specific vegetation features from LiDAR data, while accounting for differences in LiDAR systems (e.g., beam divergence), settings (e.g., point spacing), and calibration techniques.

It is the goal of LVISA to develop generic 3D information extraction approaches, which can be seamlessly transferred to other datasets, timestamps and also extraction tasks.

The current prototype of LVISA can be visited and tested online via http://uni-heidelberg.de/lvisa. Video tutorials provide a quick overview and entry into the functionality of LVISA. We will present the current advances of LVISA and we will highlight future research and extension of LVISA, such as integrating low-cost LiDAR data and datasets acquired by highly temporal scanning of vegetation (e.g., continuous measurements). Everybody is invited to join the LVISA development and share datasets and analysis approaches in an interoperable way via the web-based LVISA geoportal.