Success Story
COMET

alpS – Centre for Climate Change Adaptation
Programme: COMET – Competence Centers for Excellent Technologies
Programme line: K1-Centres
COMET subproject, duration and type of project:
L02 CCID II, 04/2014 – 03/2017, multi-firm

CCID II – Information Extraction from LiDAR Pointclouds for forest assessment

In remote sensing, information extraction is a crucial point for the provision of target-oriented information for practitioners. In the field of forestry, multitemporal LiDAR data can be used for the generation of detailed 4D forest models, including geometry and temporal dynamics. In order to make this possible, a broad range of complex tools has to be combined in a processing workflow. In the project CCID II, user-friendly tools are developed, incorporating state of the art processing procedures and providing their capabilities to Non-LiDAR-Experts for effective 4D forest modelling.

Creation of 4D forest models by remote sensing

Detailed knowledge on three-dimensional distributions of leafs, branches, wood volume and biomass of single trees and forest stands are crucial parameters for the understanding of a wide range of ecosystem functions. Generating detailed geometrical forest models allows the plausible quantification of material distributions. In such a detailed 3D model, e.g. light availability can be linked to foliage characteristics.

Plant phenology, which is the study of recurring events in the life cycle of plants, is a sensitive indicator for the ecological impacts of climate change. It can be addressed by modelling three-dimensional distributions over time (4D model). This can contribute to a deeper understanding of the physiological mechanisms controlling the dynamics of canopy and understory in forests over time.

While true tree characteristics can only be derived by tree cutting and leaf harvesting, Light Detection and Ranging (LiDAR) is a powerful non-destructive alternative in order to sample material densities. With multiple LiDAR acquisitions 4D forest models can be created.

Fig. 1: Terrestrial LiDAR (tLiDAR, © alpS/Bremer).

Federal Ministry of Science, Research and Economy
Austrian Ministry for Transport, Innovation and Technology

Challenging Complexity

Although raw LiDAR point clouds can describe three-dimensional material density distributions, no knowledge on the real forest architecture is available. Thus, no distinction of tree trunks, branches and leafs is possible. Furthermore, no knowledge on single tree delineation and dimensions is given. While leaf density distributions can be approximated by statistical approaches, the estimation of wood volume and biomass is rather difficult without any knowledge on the thickness and orientation of branches.

Nevertheless, these parameters (and their temporal variability with climatic impacts) are of importance for a wide range of practitioners ranging from the fields of commercial forestry to ecology.

Within CCID II, methods are developed in order to extract object knowledge from the raw point cloud data. These methods include complex tools for the detection and delineation of individual trees in a forest stand, the reconstruction of the branching geometries as a 'pipe model' and the modelling of foliage densities. The complexity of the algorithms including a broad range of methodological approaches such as linear algebra, computational geometry and data organisation strategies are hidden within user-oriented software tools.

Impact and effects

By now, a powerful set of tools is available, allowing Non-LiDAR experts and forestry practitioners to effectively extract information on wood volume and foliage densities from LiDAR data. The tools have been integrated into the software product of a consortium company partner completing their forestry applications tool box. The tools have already proven their robustness in different environments, such as alpine forests and urban road environments and are applicable to terrestrial, mobile and unmanned-aircraft-system-borne LiDAR platforms. The latter will allow the application of the tools for larger areas and road trajectories, which already engaged the interest of non-consortium companies.

The developed tools and workflows have a high application potential in the science community and forest management industry, can easily be applied to different environments and provide means to detect ecological impacts of climate change

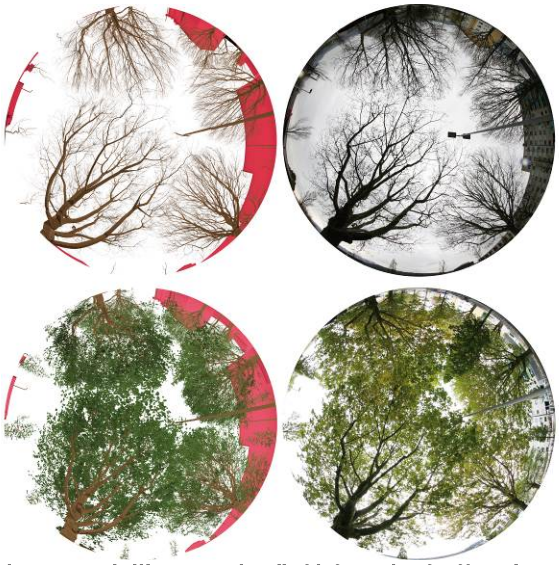

Fig. 2: Modelling results (left) for a leaf-off and a leaf-on situation compared to hemispherical photographs (right)(© alpS/ Bremer).

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Topscan GmbH	Germany