Promotionsthema

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Tree detection and characterization in temperate forests from point clouds

Forests cover earth's surface and play an important role as ecosystems, CO2-sinks and renewable energy resources. Forest structure parameters like tree species, timber volume, dead wood, regenerations and CO2 stock must be permanently captured and monitored in order to research the adaption and behavior of forest eco systems to climate changes.

Modern remote sensing sensors like airborne laser scanner or digital cameras render possible the large-area and detailed 3D detection of tree populations. Airborne full waveform LiDAR is well known to be advantageous in vegetation structure since it provides the entire echo profile of the returned pulse, whereas digital airborne cameras capture the canopy pixel-wise and add the near infrared channel as additional information to characterize tree species.

Especially, dead wood and regenerations are important forest structures which are captured in a forest inventory. So far, conventional manual methods are rather time consuming and do not operate area-wide. Also, due to the random statistical methods the results are not well suited for evidences about habitats and biodiversity.

The key idea of the thesis is to develop new methods for object detection by means of computer vision and pattern analysis methods from dense clouds captured by the aforementioned remote sensing techniques. Methods from computer vision and image analysis shall be pursued and modified. The following research directions shall be explored:

- using shape descriptors from the computer vision and robotics communities for shape detection, segmentation and classification of fallen trees
- analysis of most discriminative features for separation of dead wood from other forest structures
- formulation and solving of the problem of merging of fallen tree segments to form entire trees
- investigation of surface reconstruction methods together with shape correspondence and deformation distance as a framework for fallen tree detection
- determination of an efficient method of selecting representative training examples (fallen tree segments) which lead to classifiers that generalize well across different forest stands, including a procedure for semi-automatic labeling of reference segments for new areas
- generalizing the segment-based method to handle segments of different length and radii

As a result of the research, it is expected that area-wide statements about the spatial distribution and volume of dead wood (standing, fallen) and area coverage by regenerations can be obtained. The result shall be validated using reference data from natural and managed forests, in particular already available data from the Bavarian Forest National Park.