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Digital forest inventory based on UAV imagery

Steffen Dietenberger[1], Marlin M. Mueller[1], Felix Bachmann[1], Markus Adam[1], Friederike Metz[2], Maximilian Nestler[1], Sören Hese[2], and Christian Thiel[1]

[1]German Aerospace Center (DLR), Institute of Data Science, Jena, Germany (steffen.dietenberger@dlr.de)

[2]Friedrich Schiller University Jena, Institute of Geography, Department of Earth Observation, Jena, Germany

Data on forest parameters defining the structure, health and condition of a forest stand is essential for forest management and conservation. The increasing frequency of forest changes, such as those caused by climate change-related drought and heat events, highlight the importance of having a forest database with high spatial and temporal resolution. Automated forest parameter extraction based on unmanned aerial vehicle (UAV) imagery is a cost-effective way to address the need for accurate and up-to-date forest data.

The aim of this project is to develop user-friendly tools based on optical data from UAVs that can be applied to accurately and efficiently conduct digital forest inventories. We are using spectral and geometric information from UAV data to create methods for automated derivation of forest parameters such as diameter at breast height (DBH), tree stem positions, individual tree crown delineation, and coarse wood debris. These methods are being designed with the practical needs of potential users from the forestry sector in mind. Different flight configurations, such as nadir and oblique camera angles, as well as different acquisition times, were combined to generate structure from motion (SfM) data products (dense 3D point clouds, orthomosaics and height models) containing both ground and canopy information. For a study site within the Hainich National Park, Germany, we analyzed how leaf-off and leaf-on data can be combined to improve the derivation of stand parameters, such as tree stem positions and individual tree crowns, using point- and raster-based algorithms. Additionally, DBH on an individual tree basis was derived for the same study site using the cast shadows of tree trunks. To do so, a deep learning model was trained to identify stem shadows based on an orthomosaic of only ground points acquired during sunny and leaf-off conditions.