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| **Single vs. Multi-Sensor Approaches in UAS-Based Tree Species Classification in boreal forests.** |
| Boreal forests are crucial for maintaining biodiversity, offering habitats for various wildlife species, and contributing to the ecosystem's resilience. Among these, old deciduous trees, particularly European Aspen, play a pivotal role by providing unique ecological niches. However, the economic value and sparse and scattered occurrence of aspens address challenges in acquiring accurate spatial and temporal data. This gap hinders the effective planning and execution of sustainable forest management and conservation efforts. Additionally, standing dead trees play a significant role in maintaining biodiversity in a boreal forest, offer essential habitats for numerous species and serve as indicators of forest health. Therefore, precise identification and mapping of tree species and standing dead trees are essential for monitoring biodiversity and forest health.  Recent advancements in unmanned aerial systems (UAS) based remote sensing have shown promise in addressing these challenges. The capability of UAS to provide ultra-high spatial and temporal resolution imagery at a lower cost compared to manned aircraft operations makes it an efficient tool for detailed forest property assessments. The flexibility and customizable sensor payload of UAS enable rapid and cost-efficient data acquisition in forested areas, which are often inaccessible or challenging for traditional aerial survey methods.  This study aims to evaluate the accuracy of various UAS-based sensors, both individually and in combination, in classifying Scots pine (Pinus sylvestris), Norway spruce (Picea albies), birches (Betula pendula and Betula pubescens), European aspen (Populus tremula L.), and standing dead trees in boreal forests. Classifications were performed with several machine learning algorithms using spectral and structural features derived from automatically segmented LiDAR, high-resolution RGB, and multispectral photogrammetric point clouds at the individual tree level. In our approach, we evaluated data from each source independently and also supplemented LiDAR and RGB dense point clouds by integrating information from NIR and RedEdge bands of multispectral imagery. For the analysis, 1,250 trees were measured in the field, with 250 trees representing each species class. Of these, 70% were allocated for training the model, while the remaining 30% were used for validating the results.  Preliminary results show promising potential in merging multispectral data with dense point clouds for effective classification of main tree species in boreal forests and will significantly contribute to the current body of knowledge by providing insights into optimizing UAS-based remote sensing for forest biodiversity monitoring. This research underscores the need for innovative approaches to support sustainable forestry practices and conservation strategies effectively. |