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| **Completing 3D point clouds of individual trees using deep learning** |
| **Introduction:**  In close-range lidar data collected in a forest, occlusion and increasing distance from the scanner often cause incomplete or sparse point cloud representations of individual trees, impeding accurate 3D reconstruction of tree architecture and estimation of tree height and volume.  In various other fields, point cloud completion tasks are increasingly solved by applying deep learning models [1]. However, so far, little attention has been paid to addressing gaps in 3D point clouds of natural objects such as trees using deep learning (DL) approaches.  Here, we present our findings from first experiments on fine-tuning an existing DL network to fill gaps in point cloud representations of individual trees.  We first focused on filling smaller gaps within dense point clouds of broadleaf trees, particularly in their main structures such as the stem and large branches. Currently, we focus on completing the crown shape of coarser point clouds of conifers.  **Methods:**  We used an existing state-of-the-art transformer-based model with an encoder-decoder architecture, which was pre-trained on diverse artificial objects [2]. Complete point clouds are required as training data, but even dense terrestrial laser scanning (TLS) datasets often contain gaps caused by occlusion. We therefore investigated the ability of point cloud completion models fine-tuned on a range of synthetic datasets to handle occlusion patterns in real-world point clouds. We explored whether simple cylinder tree models or more naturalistic 3D meshes are sufficient as training data and tested the benefit of using simulated lidar scan patterns as input for fine-tuning the model [3]. To test the models, we used independent real-world TLS data.    **Results and Conclusion:**  Using a limited number of real and synthetic broadleaf trees, we successfully fine-tuned a general pre-trained completion model to close holes in the surface of branches and to fill gaps between unconnected branch parts, while retaining their organic shape. Our findings indicate that fine-tuning a network on synthetic tree data can enhance the model's ability to complete tree objects compared to a general model trained on diverse artificial objects. Generally, 3D point cloud completion with DL has shown the potential to enhance point clouds of individual trees, thus facilitating further steps in the processing and analysis of 3D forest data.    **Outlook:**  In dense conifer stands, occlusion commonly occurs at the treetops in TLS scans or at the lower stem portions in UAVLS scans. Unlike deciduous trees, detailed reconstruction with cylinders is less common for conifers. Instead, there is greater interest in assessing stem volume and overall crown shape [4]. Consequently, our current focus lies on completing the crown shape and height of coarse point clouds of individual conifers, particularly those with missing treetops. To achieve this, we use an international collection of segmented individual tree point clouds derived from TLS and UAVLS data sources. |

**References**

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