International Benchmarking of terrestrial Image-based Point Clouds for Forestry

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The overall goal of the ongoing project funded by ISPRS Scientific Initiative is to evaluate the performance of terrestrial image-based point clouds in plot-level forest inventory through an international benchmarking. In detail the project will investigate whether the image-based point clouds can be an alternative solution to the more expensive terrestrial laser scanning (TLS) derived point clouds.

In recent years, the photogrammetric technique based on structure from motion (SfM) and dense image matching showed the capability of generating accurate dense point clouds from different platforms and for different purposes. However, the implementation of this technology in real forest environments is practically challenging due to the difficulty of correspondence recognition in complex forest stands.

Based on recent studies on TLS (e.g. Liang et al., 2018), it is recognised that terrestrial point clouds are competitive for the estimation of tree characteristics such as the taper function and the stem volume, which are hardly achievable with non-destructive measurements. Several applications showed the similarity of TLS and terrestrial image-based point clouds (e.g., Liang et al., 2014, 2015; Medjkane et al., 2018; Riquelme et al., 2017; Wilkinson et al., 2016). Moreover, for a practical use, the terrestrial photogrammetry offers a cheaper and lighter equipment (i.e. handheld camera) in comparison with the TLS.

The main differences between the image- and TLS-based point clouds include the geometric precision, the point density, the noise ratio and the plot coverage, which might lead to differences on the measurements of tree attributes such as the tree position and the diameter at breast height (DBH). Thus, an essential question for image-based point cloud is in which forest stand condition and with which strategy of image acquisition can the image-based point clouds carry out a similar performance as TLS for tree detection and modelling?

To answer these questions, we acquired image- and TLS-based point clouds of ten forest plots situated in Austria, China, Czech Republic, Finland and Slovakia. These test plots differ in size, tree species composition, density, shape (i.e. circular, square, rectangle) and the amount of understory.

All participants of the benchmark have to process the point cloud data of all test plots with their own algorithm for tree mapping (i.e. position of trees) and modelling (i.e. DBH). Furthermore, the digital terrain model (DTM) have to be extracted. The results of all partners will be evaluated with respect to field collected reference as well as TLS data. Findings of the project will be published in the international as well as country specific forest journals.

The main outcome of the project is to gather scientist around the world who are focusing on the algorithm development for tree detection and DBH estimation from point clouds. Establishing such a network will provide a thorough knowledge of the status of the research on this subject.

Based on the findings of this study shortcomings of the workflow can be identified and consequently future developments can be suggested.

All images and point clouds collected for this project will be available as open access data for non-commercial uses.