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# Investigating barrier effects of Alpine forests: 3D data acquisition methodologies and results analysis

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The most natural type of rockfall protection is a forest. Indeed, existing forest covers have a mitigating effect, thanks to standing and lying trees and their energy dissipative capacity. One of the most common measurement in forestry science is the basal area, which can be an indicator for the description of the effectiveness of the protection activity of woods. The basal area includes both the density of the forest (how many tree stems per hectare) and the diameters distribution of the trees, as well as the rock energy, species and length of forest slope, etc. The definition of the total basal area is the total area covered by all trunks in cross section, usually measured at breast height per hectare. Moreover, not only large trees, but even trees with small diameter and well distributed provide the rockfall protection. This contribution aims at analyzing different techniques for the measurement of these parameters, in order to use them to evaluate the ecological and social function of forests. In the first part of this research work was investigated the application of different methodologies, photogrammetric technique and laser scanning, for forest inventory. In the last decade, numerous studies have shown the efficiency of terrestrial and airborne laser scanner, UAV and UGV, which allow to quickly capture data and get accurate three-dimensional models, but require a careful survey planning phase, a great experience of the operator who manages them and are highly expensive. In order to obtain geospatial data in a quick and easy way, low-cost tools that integrate different sensors will be analyzed. A first solution is given by the GeoSLAM Zeb-Revo, which combines a handheld laser scanner with a video camera for the automatic 3D point cloud generation. Then, were analyzed the potentialities of the use of a common smartphone for the image acquisition and 3D model reconstruction through photogrammetric technique. These devices are easy-to-use and their small sizes allow to acquire three-dimensional data and generate or update models of the environment even in areas difficult to access by other means or small spaces where it is not possible to introduce more bulky devices or where these cannot be maneuvered. As the products of these acquisition methodologies are three-dimensional point clouds, the second part of this work aimed at the analysis of these data and at the assessment and evaluation of different algorithms for single tree identification, based on the tree trunk detection, and for the estimation of its diameter and area. This contribution will describe acquisition tests conducted with the different approaches, evaluating the reached accuracy, and the results obtained by the point clouds analyses.