Mapping Density of Harvest Residues from Terrestrial Laser Scanning and RGB Imagery

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Abstract
In precision agriculture detailed geoinformation on plant and soil properties plays an important role. Laser scanning has been already used to describe in-field variations of plant growth in 3D and over time and can serve as valuable complementary topographic dataset for remote sensing, such as for deriving soil properties from hyperspectral sensors. In this study full-waveform laser scanning data acquired with a Riegl VZ-400 instrument is used to classify 3D point clouds into post-harvest straw residues and bare soil. A workflow for point cloud based classification is presented using radiometric and geometric point features. A radiometric correction is performed by using a range-correction function, which is derived from lab experiments with a reference target of known reflectance. Thereafter, the corrected signal amplitude and local height features are explored with respect to the target classes. The following procedure includes feature calculation, decision tree analysis, point cloud classification and finally result validation using detailed reference images. Once the individual laser points are classified, the position of the harvest residues can be used to evaluate and model biomass distribution or can serve as input for hyperspectral remote sensing analyses in agricultural management. The classification tree separates the classes of harvest residues and bare soil with an accuracy of 96% by using geometric and radiometric features. If only using geometric or radiometric features, the classification tree separates both target classes with accuracies of 86% and 95%, respectively. The LiDAR-derived harvest residue coverage value of 75% lies in accordance with the image-based reference (coverage of 68%). The results indicate the high potential of radiometric features for natural surface classification, particularly in combination with geometric features. Future research should concentrate on the analyses of different soil conditions like dry, wet or mossy affecting the backscatter strength of the signal (e.g. signal amplitude).

Keywords: Terrestrial laser scanning, Radiometric correction, Signal amplitude, Classification, Harvest residues

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