Texture-based classification of forest types using high resoultion aerial photographs

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The classification of forest types is an essential element in both forest management and monitoring. Regarding the assessment of forest areas, regularly acquired aerial images from land surveying campaigns offer a value, which is generally not employed to its full potential. A nationwide documentation of forest areas at high spatial resolution of pixel sizes in the sub-meter range compromise the capability of information assessment at comparable scales of analogue inventory results. At those scales, radiometric information alone provides limited information, since natural objects of interest consist of numerous pixels. Consequently, at spatial resolutions of about 1 m or less, textural information can become more decisive than spectral information alone. Thus, the assessment of textural properties of forest canopies at a scale where the spatial distribution of gray level variations can be used to identify associated forest types could lead to high resolution forest type maps. The objective of this work was the assessment of texture-based classifications from high-resolution aerial images (0.4 x 0.4 m) using two texture analysis methods: the statistical methods of spatial gray level co-occurrence (GLCM) features and the frequency and orientation selective Gabor filter. For the area of the recently established National Park Hunsrück-Hochwald in south-western Germany, the capabilities of texture features in the classification task of forest types were evaluated. The discrimination between coniferous and deciduous trees was approached with the use of a supervised ensemble classification based on one-level decision trees. Different setups for both texture extractions methods were utilized and parameterized by spectral input channels, varying window sizes, filter orientations and frequencies. Boosted decision stumps based on the generated texture feature vectors and trained with reference data from forest inventory campaigns lead to accurate predictions of validation data. Depending on the parametrization maximal Kappa coefficients (5-fold cross validation) of 0.97 for a heterogeneous stand (2.5 km^2) acquired in May 2012 and 0.94 for a heterogeneous subset (4 km^2) from July 2013 could be reached. Highest accuracies were associated with classifications based on the near-infrared and green channel and a derived luminance representation. Moreover, an influence of the processing window size on the proportions of correct predictions could be recognized. Within the study site an optimal processing window site for the GLCM features was identified between 4 x 4 and 7 x 7 m. Both texture analysis achieved comparable accuracies, yet the classification maps derived from Gabor energy features were influenced by shaded areas between individual trees and interclass variations of the forest type textures. The assessment of the entire texture extraction setups led to the conclusion, that texture information alone was sufficient to generate accurate forest type maps at a spatial resolution in the sub-meter range. Nonetheless, the sensitivity of few texture features to gray level shifts influenced classification accuracies of several setups. Besides the direct use be forest management, the generated forest type maps could be included as ancillary data set into other classification approaches concerning e.g. tree species compositions.