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Estimation of tree cover in orchards using a novel nonlinear hyperspectral mixture analysis technique

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The accurate monitoring of the spatial and temporal variation in tree cover provides critical information for steering management practices in orchards. In this light, the present study investigates the potential of Hyperspectral Mixture Analysis. Specific focus is on non-linear mixing effects caused by multiple photon scattering. A novel conceptual Nonlinear Spectral Mixture Analysis approach is presented and successfully tested on in situ measured mixed pixels in Citrus sinensis L. orchards. The rationale behind the approach is the redistribution of nonlinear fractions (i.e., virtual fractions) among the actual physical ground cover entities (e.g., tree, weed, soil). These 'virtual' fractions, which account for the extent and nature of multiple photon scattering only have a physical meaning at the spectral level but cannot be interpreted as an actual physical part of the ground cover. The linear approach provides a mean relative root mean square error (RMSE) for tree cover fraction estimates of 27%. The traditional nonlinear approaches only slightly reduce this error (RMSE = 23%). Yet, important improvements are obtained for the novel nonlinear spectral mixture analysis approach (RMSE = 12%). Results, as such, clearly illustrate that the effect of multiple scattering on Spectral Mixture Analysis is significant and should not be discarded when monitoring tree cover in orchards.