Spectro-polarimetric BRDF measurement of leaves and reflectance model

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Spectral reflectance of a plant is one of the major methods of the modern remote sensing, which strongly depends on the combination of the sunlight incidence and observation view angle of the satellite camera. In this study, single leaf' s spectral images of Coffea canephora Pierre, Epipremnum aureum, and Fragaria ×ananassa are taken by Liquid Crystal Tunable Filter (LCTF) camera with rotating linear polarizing film at hundreds of different angles for Bidirectional Reflectance Distribution proposals in a laboratory. The advantage of using an image of the multispectral camera is able to crop surface area of a leaf that means it is possible to select an arbitrary size of the field of view. This kind of measurement setup produces an error less than a spectroradiometer. We separated polarized and unpolarized reflectance of a leaf and the product of those two parts is the total reflectance which is equal to reflectance measurement result without a linear polarizer. The result showed that polarized reflectance strongly depends on relative azimuth angle and zenith light source angle relative to the camera and unpolarized part almost does not depend on angles. Results indicated that polarized part is caused by waxy cuticle which is a transparent outer layer, there is no relationship between polarization degree and chemical compounds inside a healthy leaf, and it became a problem of multilayered structure scattering. These indicators lead to reflectance model of a leaf which consists of two layers which are transparent layer and structure layer. This simple model shows an almost same spectral signature as that produced without a linear polarizer. The model explains bidirectional reflected light on the plants, allowing to take an image of slope downward angle.

Keywords: Unpolarized reflectance, polarized reflectance, waxy cuticle, BRDF model, two-layer reflectance, spectral imaging

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