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Mapping the crop row direction by using Formosat-2 panchromatic images.

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The detection of crop row direction is a key factor for landscape analyses from satellite images. In optical and microwave frequency domains, Kimes and al, 1983 and Ulaby and al, 1984 shown the strong impact of the crop row orientation on the optical reflectance (Bidirectional reflectance distribution function) and on the radar backscattering coefficient (from L to X band). Consequently, it is particularly important to consider this parameter for remote sensing analyses but also in the physical and empirical approaches intended to the estimation of biophysical parameters (vegetation biomass, humidity, soil moisture content, tillage, runoff, erosion...) at the agricultural field scale.

The studied area is located near Toulouse (South-west of France) in a region of alluvial plains and hills, which are mostly mixed farming and governed by a temperate climate with an annual rainfall of about 600mm per year. The region is composed of a wide variety of irrigated and non-irrigated crops (wheat, sunflower, corn, hemp...). Agricultural fields are strongly contrasted in terms of geometric forms, surface area (from 1ha to 50ha), type of soils, slopes... The remote sensing analyses are based on a time series of 13 panchromatic Formosat-2 images, acquired with a spatial resolution of 2 meters, and processed with a TOA (Top of Atmosphere) radiometric correction. Ground data are collected, the closest of satellite acquisitions, over 232 plots during the MCM'10 experiment (Multispectral Crop Monitoring, http://www.cesbio.ups-tlse.fr/us/mcm.html) conducted by the CESBIO laboratory in 2010.

The proposed approach consists in estimating row direction, by using directional convolution filters and operators of mathematical morphology. First of all, one date capabilities is discussed, improved by multi-temporal analyses. Then, an original method is proposed for extrapolating the estimated row direction to the scene (over the Formosat-2 swath).

Best results, obtained for multi-temporal approach, show contrasted performances, depending on the crop type and cultural practices. Despite 90% of the row direction are well estimated for the whole landscape, best results are obtained over winter crops (wheat, barley and rapeseed). For example, the correlation coefficient (r^2) estimated between the calculated and the measured row direction is equal to 0.91 for the wheat. The row direction of irrigated summer crops is more difficult to detect, probably due to the irrigation events and pivot effects. Concerning the sunflower, the difficulties come from the high heterogeneity cover of the crop.
In many cases, three temporal phases appear well adapted to estimate the row detection of crops:
- Tillage period, which occur just before sowing
- Maximum NDVI period.
- The harvest period for straw's cereals.

The use of these exogenous data will be then evaluated in physical and empirical models to improve the estimation of landscape biophysical parameters (crop biomass, vegetation height, soil moisture, run off...).