Vast amounts of data

The recent development of hyperspectral sensors is bringing the need to explore a vital avenue of research: the development of methods to process the vast amounts of data generated by this observation technique. Two major projects have focused on this methodological exploration, bringing together scientific teams with complementary expertise in the pre-processing of data, classification methods and post-classification processing in order to permit the interpretation of images. The HYPERPEACH project is a concrete application of these investigations.

HYPERCRUNCH

Improving data mining

The high spectral resolution that is intrinsic to hyperspectral remote sensing produces a vast quantity of data. It is therefore essential to arrive at a better extraction of data – or data mining – from hyperspectral datacubes. At an initial stage, the project sought ways of selecting a limited number of relevant bands for a specific application without loss of essential information.

At a later stage, acquisition protocols were developed to improve classification performance. The mathematical algorithms were developed as independently as possible of applications and sensor specifications in such a way as to permit their implementation in operational data processing chains, for example in the future APEX sensor data chain.

The data reduction techniques and mathematical algorithms were made available to the scientific community. The field of application explored is precision farming and more particularly stress monitoring (for mildew, nitrogen deficiency) in Jonagold and Golden Delicious apple orchards.

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HYPERWAVE

Applying and validating algorithms

HYPERWAVE's aim is to validate and apply the algorithms developed by the HYPERCRUNCH project that developed a toolbox prototype making it possible to apply these algorithms whatever the subjects studied. To test and validate the prototype, it needs to be confronted with numerous hyperspectral datacubes supplied by different sensors over a wide field of applications. The data and expertise acquired by other STEREO programme projects or research carried out within VITO were used for this purpose. Initially developed for the ecosystem of orchards, the algorithms were integrated into the analysis of aquatic environments or dune vegetation. This latter investigation made it possible to produce a map of the dune vegetation for the Belgian coast (HYPERKART project).

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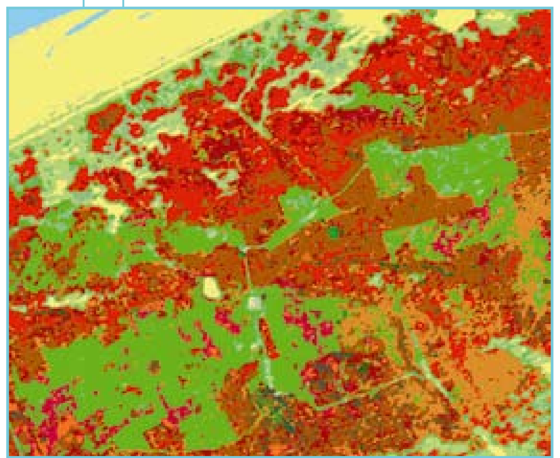

HYPERPEACH

Peach trees under the hyperspectral magnifying glass

The modelling of growth processes in fruit trees could make it possible to develop effective monitoring tools that are essential to an effective management of this kind of intensive cultivation. In this context, the project studied the biochemical parameters of peach tree leaves and in particular iron deficiency, a factor that inhibits plant growth and reduces the production quantity.

In the Saragossa region of Spain, almost two hundred peach trees were given different amounts of iron supplements and then subjected to hyperspectral reflectance measurements, both on the leaf itself and on the canopy by means of field and airborne hyperspectral measurements. This multiple approach enabled to test the traditional vegetation indexes and successfully generate new robust indexes designed to detect and quantify growth anomalies. It allowed providing a satisfactory estimate of chlorophyll *a* and *b* in leaves on the basis of hyperspectral data. The new indexes also made it possible to detect changes in the chlorophyll concentration, such as a reduction in this pigment due to iron deficiency, before it becomes visible to the naked eye.

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Precision agriculture and imagery

There is more to modern agriculture than production alone. It must also reduce the environmental impact, protect rural areas and ensure their durability. In the context of agri-environmental measures, the monitoring of agricultural parcels requires the use of specific management tools. Although information can be collected through systematic observations on the ground coupled with laboratory analyses, this remains a costly and laborious approach, due in particular to the variability between parcels and even within the same parcel. Hyperspectral remote sensing provides a detailed analysis that offers promising new perspectives for what is known as precision farming, namely the provision of the right amount at the right place at the right time.

GRASS

Observing grassland

Grassland is a significant component of the regional and national agricultural landscape. Although remote sensing has been used for some time already to monitor agricultural land, until now its spatial resolution has been too weak to envisage ecological studies or monitoring of semi-natural grasslands. The GRASS project looked at how data obtained by the CASI and SWIR sensors could be used to provide a continuous spatial and temporal monitoring of grassland characteristics in the Belgian Lorraine region. It identified relations between the physico-chemical parameters of grassland and various spectral components such as the reflectance curve R(λ), spectral indexes and the first derivative of R (λ) to characterise, for example, the slope in the "red edge" zone (inflexion point on the borders of the red and near infrared distinctive for a sharp increase in plant reflectance), making it possible to distinguish between different types of grassland (pastures, hay fields, etc.). Information is also provided on the quality of the plant cover (energy values, etc.) that is a factor in estimating potential grass production, which is crucial to farmers.

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