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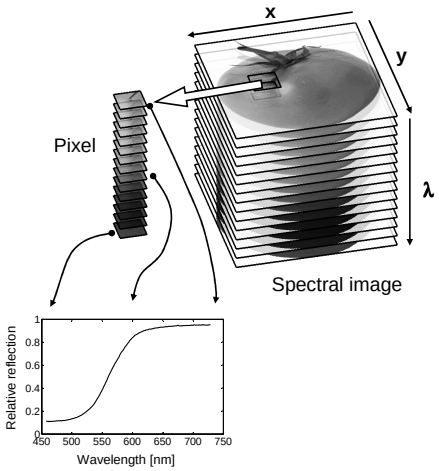
Imaging Spectroscopy: Applications in Agriculture

GreenVision

Introduction

Imaging Spectroscopy is the study of light as a function of spatial distribution and wavelength that has been transmitted, emitted, reflected or scattered from an object. This allows us to derive information about the spatial relation of the chemistry of the object.



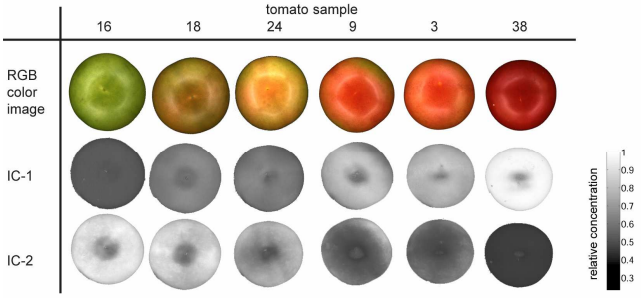
A spectral image is a three dimensional data cube with two spatial dimensions (x and y) and one spectral dimension (λ) resembling the reflection spectrum at every pixel.

Imaging spectroscopy is suited for the following tasks:

- Quality control: detection of latent defects in agri-products, e.g. vegetables and fruit.
- Quantification of compounds: carotenes, proteins, sugars, moisture etc.

Application 1: Measuring of compounds in tomatoes

Independent Component Analysis is one of the most widely used methods for blind source separation. We used this technique to estimate the most important compounds which play a role in the ripening of tomatoes.

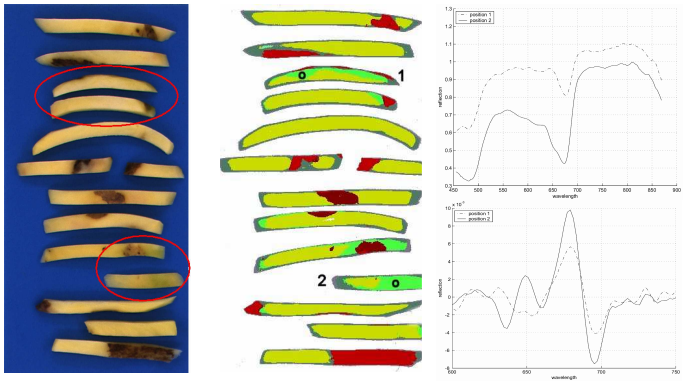


Concentration images of these compounds show increase of one compound and decrease of the other during ripening.

Two main components were found. These resemble the actual absorption spectra of lycopene and chlorophyll. The method can be implemented in an unsupervised real time sorting machine, using the total compound concentrations and the spatial distribution of the concentrations as criteria.

Application 2: Detection and classification of latent defects in French Fries

New developments in French Fries production are Fries that are still (partially) covered with peel. Traditional French Fries inspection systems equipped with 3CCD cameras cannot differentiate between good product, peel and various defects successfully because these systems lack spectral resolution. It shows that imaging spectroscopy outperforms RGB images in terms of classification accuracy, yield and purity. More importantly, multispectral images show defects which are invisible in color images.



Color image with good fries (upper circle) and green fries (lower circle) (left), Segmented multispectral image (middle) and spectrum plot (right) at position 1 and 2. The plot shows the chlorophyll absorption spectra in both fries. Here, green fries are falsely labeled (upper circle) by a product expert as good fries.

References

- J.C. Noordam, Chemometrics in multispectral imaging for quality inspection of post-harvest products, PhD project, Radboud Universiteit Nijmegen
- G. Polder, Spectral imaging for measuring biochemicals in plant material, PhD project, TU Delft

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