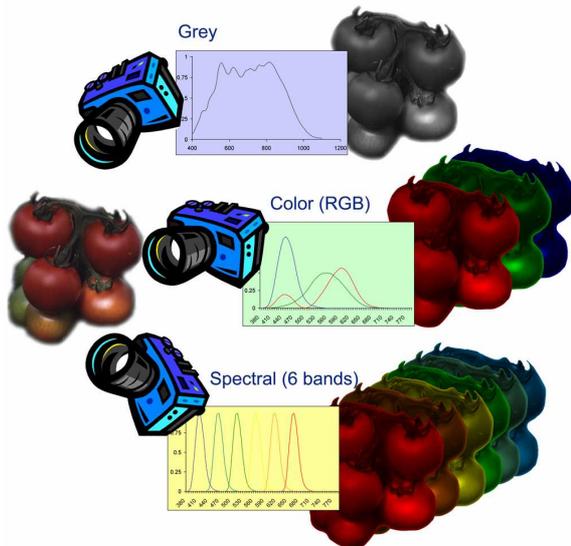


Measuring compounds in fruits using spectral image analysis

Spectral images

In a greyvalue (black&white) image, a pixel contains a single value, representing light intensity. In an RGB color image, a pixel contains three values, corresponding with the light intensity at the red, green and blue band of the electro-magnetic spectrum. In a spectral image, each pixel consists of an array of intensity values corresponding with small bands (<10 nm) of the spectrum. A typical spectral image consists of 100 – 300 wavelength bands.



Ripening of tomatoes

Color (RGB) and spectral images of five tomatoes, which slightly differ in maturity, were analyzed using linear discriminant analysis. From each tomato, 250 randomly chosen pixels were used for learning. The error rate for classification of the other pixels of the tomatoes in ripeness classes, was 40% for the RGB images whereas the error rate for the spectral images was 7%. The use of spectral information reduces the error rate significantly and allows for more accurate classification.

Imaging spectrometry

Spectroscopy is the study of light as a function of wavelength that has been transmitted, emitted, reflected or scattered from an object. The variety of absorption processes and their wavelength dependency allows us to derive information about the chemistry of the object. A spectral image gives a spectrum at each pixel of the image. This makes it possible to analyze the spatial relationship of the chemistry of the object.

Independent Component Analysis

Independent Component Analysis (ICA) is a technique that can recover independent sources given only sensor observations consisting of unknown linear mixtures of the unobserved independent source signals.

It is known that the major process in the ripening of tomatoes involves the breakdown of chlorophyll and the build-up of lycopene. A spectral image of four tomatoes of different maturity is analyzed using ICA.

The spectral image of the four tomatoes shown on top was analyzed using ICA. The spectral profiles of the two main components are shown in the middle. The spectrum of the first signal contains a dip in the spectrum, corresponding with the 670 nm absorption band of chlorophyll. The concentration of the first component decreases when the tomato matures and, simultaneously, the concentration of the second component increases.

On the bottom chemical images shows the spatial distribution of the concentration of the components.

