Detection of plant infections, mutations and stresses using chlorophyll fluorescence imaging

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Small fraction of the light energy absorbed by the leave is emitted in the form of the fluorescence. Amount of the chlorophyll fluorescence emission displays the efficiency of the plant photosynthesis. The photosynthetic efficiency is usually strongly modulated by external factors e.g. stresses, infections, mutations etc. All these effects might be possibly detected by the changes in fluorescence emissions. When exciting the plant by light, fluorescence transient can be observed. This transient depends on the light intensity, wavelength and many other factors (Nedbal and Whitmarsh 2004). To the detection of e.g. infection we need to choose light input (in our case sequence of light pulses and levels of light), which leads to the expression of this infection in fluorescence.

Sensitivity of present CCD-chips is sufficient to detect chlorophyll fluorescence. They allow capturing image sequences of chlorophyll transients. For researcher, it is very difficult task to find highly contrasting images showing e.g. infection without using computation methods. Often, combination of more images is needed to get reasonable results. One of the solutions is to apply classifier. Using classifier the accurate segmentation can be performed. Classifiers are typically more effective in this kind of detection than standard fluorescence parameters used in plant science (image combinations with biological interpretation). Using of feature selection methods, in our case Sequential Forward Floating Search (Pudil et al. 1994), we were able to dissect small subsets of images from the whole image sequence. This statistical approach can help researcher to make measuring protocols more effective. Combination of feature selection method and classification allows detection of the infection phases.

We realized all of our analysis under the Matlab environment. Matlab is common programming language in this area and a lot of signal processing toolboxes are available. Solving this kind of tasks is more time efficient in the Matlab, comparing other programming environments? Programming of task adjusted to individual experiments including graphical user interface is time effective.

References:

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