Data Processing for a Filter based Miniature Photo-Spectrometer – Master Thesis

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In the last years the needs for miniature photo-spectrometers (< 250cm^3) has significantly increased. The main drivers are: reduced time for results, analyzing in situ, decreasing cost and increasing ease-of-use of systems for use by non experts. A prominent manufacturer of such spectrometers is Hamamatsu. Such a spectrometer e.g. for the visible has a size of 20.1 × 12.5 × 10.1mm^3 and resolution 15nm. A promising application of such miniature spectrometer was recently reported as non-destructive testing of fruit ripeness (Scientific Report 6 32504 2016 Das "Ultra-portable, wireless smartphone spectrometer for rapid, non-destructive testing of fruit ripeness").

CSEM carried out a first phase optics development of a miniature photo-spectrometer. The data processing is not yet established.

The core components of the photo-spectrometer are N transmissive filters of a few micrometer size mounted on top of a N photo-sensor array. An sketchy illustration of the optical set-up is shown in **Figure 1**.

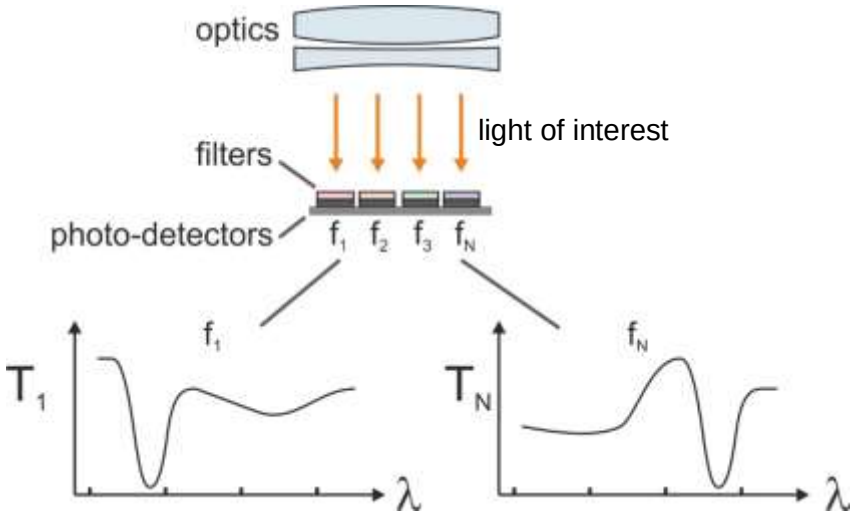

***Figure 1** miniature photo-spectrometer based on optical filters f_1 – f_N, with its filter transmissions T_i depending on wavelength λ*

Characterization of the filter / detector system

First the filter / detector system is characterized by acquiring the photo-sensor signals when the system is exposed to scanning narrow-band light from a monochromator illuminated with a broadband light source. For a wavelength range from λ_{lo} to λ_{hi} and a fixed narrow-bandwidth of $\Delta\lambda$ M = (λ_{hi} - λ_{lo})/$\Delta\lambda$ measurements are carried out. Thus a "filter matrix" F with M x N measurement points are generated.

Measurement of a unknown light source

For a modest number of filters/photodetectors N < M an unknown light source is illuminating the spectrometer and N photodetector signals are acquired Y_i, i = 1..N. The true spectrum of the light source is X(λ).

Objective

The objective is now to estimate the spectrum of the unknown light source as good as possible by processing the "filter matrix" and the measurement Y_i, i = 1..N.