UMR CNRS 6164
Site de Lannion
Signals and Multicomponent & multimodal Images processing

PhD thesis project:

Blind restoration of hyperspectral images acquired by drone

The new generation of airborne hyperspectral imaging sensors, embedded on light aircraft or UAVs, is of great economic, technical and scientific interest. These datasets allow retrieving valuable information on the nature (content) and the spatiotemporal evolution of over flown areas. However, their analysis and interpretation remain difficult in practice, when the acquired data are distorted by several sources of degradation related to the acquisition system and/or to its environment.

Some solutions have already been developed in the literature, but they are limited in their exploitation in terms of accuracy, robustness and automatic implementation. These methods are in most cases not blind but rather semi-blind. That is to say they require knowledge a priori related to the degradation function and / or the image to be restored. In addition, they are sensitive to the choice of values of the regularization parameters of the cost functions used. In fact, they require a priori knowledge related to the degradation function and / or the image to be restored. Furthermore, they are sensitive to the choice of the regularization parameters values of the cost functions used.

To interpret the content of such data in an optimal way (so as to reveal, for instance, the accurate spectral signature of in-situ minerals and vegetable species imaged on the whole available spectrum), a preliminary stage of restoration (including denoising and deconvolution) must be introduced to compensate for the different sources of degradation, either depending on the sensor and/or the acquired scene.
To solve this complex problem the development of a restoration approach introducing a minimum of *a priori* knowledge and a joint exploitation of local spatial and spectral information of acquired images is necessary.

To achieve this goal, we propose in this thesis to develop an original multi-criteria restoration approach both taking into account the heterogeneity of involved environments and being adaptive to the acquisition conditions and the content of over flown areas. Three components will therefore be considered together to restore the informational content of hyperspectral images:

• The first component focuses on the analysis and the estimation of the characteristics of a signal dependent observation noise (and therefore not stationary), especially for images acquired with the last generation of hyperspectral sensors.

• The second component relates to the deconvolution problem of hyperspectral data. It requires first an advanced modelling of the point spread function (PSF) of the whole imaging system. The objective is to estimate both the dimension and the variability of the PSF spatial and spectral spreads by integrating the information of all the spectral bands of the acquired image.

• The third component aims to formalize the impact on the efficiency of the subsequent processings of uncertainty on the estimated characteristics of the PSF and the observation noise. The goal is essentially to adapt these correction procedures so as to make them robust to uncertainties of the observed models and to their estimated parameters.

The methodological contribution of the restoration approach proposed in the thesis will be directly evaluated on targeted topics conducted in collaboration with our partners.

N.B: This project follows the work of a PhD thesis defended in our laboratory (December 2018).

Keywords: inverse problems, modelling, estimation, filtering, restoration, deconvolution, optimization, multi-criteria, regularization, big data, drones.

Eligible Skills:
- Applied mathematics and/or signal and image processing
- Object-oriented programming and/or, Matlab, correct level in French and English.

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