Postdoc Opening

Multi-sharpening for remote sensing

1) Announcement

Applications are invited for a **1-year postdoc position, from January to December 2020, in France**. The successful candidate will be supervised by Dr Matthieu PUIGT, Dr Gilles DELMAIRE, and Prof. Gilles ROUSSEL. The position is hosted by the SPeciFI team of the LISIC laboratory (http://www-lisic.univ-littoral.fr/) located in Calais and Saint-Omer, within the framework of a starting collaboration with the remote sensing team of the LOG laboratory (http://log.cnrs.fr/), located in Wimereux.

2) Scientific Context

Remote sensing instruments have known important improvements since several decades, with an increasing spatial or spectral resolution. A Multi-Spectral or an Hyper-Spectral Image (MSI/HSI) consists of a data cube (Fig. 1) whom two axes describe spatial variations and the third one axis provides spectral variations. The main difference between MSI and HSI lies in the very limited number of spectral band observed by the former (Fig. 2).

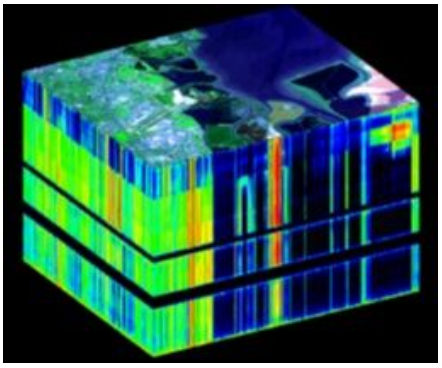

Figure 1: *HSI data cube example (source* https://www.sfpt.fr*).*

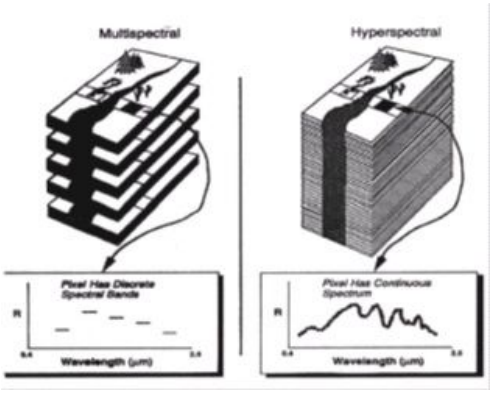

Figure 2: *Example of the spectral information contained in an MSI and a HSI pixel (source* https://www.sfpt.fr*).*

However, the Signal-to-Noise Ratio (SNR) of a MSI or HSI sensor is proportional to the ratio between the sensor surface and the number of observed spectral bands. As a consequence, in order to maintain a constant SNR, the increasing number of spectral bands in HSI yields a decreasing spatial resolution. Today, our planet is thus observed by several spatial MSI and HSI sensors, with diverse spatial and spectral resolutions.

Nowadays, remote sensing imagers are widely used to map several variables describing the biogeochemical dynamics of the marine environment (e.g., chlorophyll a, suspended matter, organic carbon). However, the study of specific environments such as coastal and estuarine zones using remote sensing requires observations with sufficiently fine spatial scale, whereas the exploitation of

water color MSIs requires a good spectral resolution to accurately estimate the different biogeochemical products which are present in these areas.

This postdoctoral position concerns the application of **multi-sharpening techniques** to fuse Sentinel-3 and Sentinel-2 MSIs. The former provides 21 spectral bands with a spatial resolution of 300 m, while the latter provides 5 spectral bands with a resolution between 10 and 60 m according to the spectral bands. In particular, it is expected to propose methods generating data cubes covering all the Sentinel-3 spectral bands with a spatial resolution of 60 m.

3) Job Description

The postdoc will be in charge of:

- proposing novel methods of multi-sharpening, e.g., based on matrix/tensor co-factorization or on deep learning (see Section 6 for some bibliographic references);
- implementing and comparing the proposed methods with state-of-the-art approaches, in the framework of Sentinel-2 and Sentinel-3 MSI data.

To that end, he/she will work within the SPeciFI team of the LISIC laboratory (http://www-lisic.univ-littoral.fr/) and will also collaborate with the remote sensing team of the LOG laboratory (http://log.cnrs.fr/). As the latter will provide the MSI data and its expertise in biogeochemistry, a close collaboration between both teams is necessary.

4) Host Institution and Place of Work

The successful candidate will be employed by the Université du Littoral Côte d'Opale (ULCO, https://www.univ-littoral.fr/). ULCO is a human-scaled university whose priority research policies are (i) Environment and Sustainable Development and (ii) Marine Environment.

The successful candidate will be hosted in the LISIC laboratory, which is the ULCO Computer & Information Science lab (and the second largest ULCO lab). In particular, he will join the SPeciFI team of LISIC, which develops novel signal processing methods for industrial and natural environment monitoring. In the framework of his postdoc contract, the recruited researcher will integrate a novel research environment with several permanent researchers and Ph.D. students involved in HSI/MSI and/or low-rank approximations. He will also actively collaborate with the LOG laboratory which is a joint CNRS/ULCO/Univ. Lille research lab.

Both laboratories are located by the Regional Nature Park of Opal Coast and Marshes (http://www.parc-opale.fr/), a touristic area which comprises varied landscapes (bays, dunes, marshes, rocks and fine sand beaches) and which is famous for its outdoor activities (e.g., trekking, biking, wind-surfing, kite-surfing, horsing, triathlon, https://en.wikipedia.org/wiki/C%C3%B4te_d%27Opale) and its proximity with Great Britain, Belgium, and Lille (the sixth largest French Metropole).

5) Candidate Profile and Application

Prospective applicants should hold a **PhD in Machine Learning, Signal/Image Processing, Applied Mathematics,** or any related discipline. Applications from candidates with a good background in (Non-negative) Matrix Factorization, (Non-negative) Tensor Factorization, Deep Learning, Optimization, with excellent programming skills (e.g., in Matlab, Python, C and/or C++) are particularly encouraged.

Applicants are also expected to show good communications skills, both written and oral. In particular, speaking fluently in English or French is required. Writing in English is mandatory.

The monthly gross salary is € 2500 (around € 2000 net salary). The position comes with health insurance and other social benefits.

Applicants are requested to send a resume (including a full list of publications), a brief statement of research interests and the contact details of two referees in a single PDF file **by October 10, 2019** to:

- matthieu.puigt [at] univ-littoral.fr
- gilles.delmaire [at] univ-littoral.fr
- gilles.roussel [at] univ-littoral.fr

Shortlisted candidates will be invited to a remote or a face-to-face **interview**.

6) Related Bibliography

[1] Bioucas-Dias, J. M., Plaza, A., Dobigeon, N., Parente, M., Du, Q., Gader, P., & Chanussot, J. (2012). Hyperspectral unmixing overview: Geometrical, statistical, and sparse regression-based approaches. *IEEE journal of selected topics in applied earth observations and remote sensing*, *5*(2), 354-379.

[2] Loncan, L., De Almeida, L. B., Bioucas-Dias, J. M., Briottet, X., Chanussot, J., Dobigeon, N., ... & Tourneret, J. Y. (2015). Hyperspectral pansharpening: A review. *IEEE Geoscience and remote sensing magazine*, *3*(3), 27-46.

[3] Zhu, X. X., Tuia, D., Mou, L., Xia, G. S., Zhang, L., Xu, F., & Fraundorfer, F. (2017). Deep learning in remote sensing: A comprehensive review and list of resources. *IEEE Geoscience and Remote Sensing Magazine*, *5*(4), 8-36.