2027 Research Internship – Master 2 Level

Title of the project:
Learning-based approaches for informed multi-scale hyperspectral image completion. Application to coastal ecosystem monitoring.

Keywords:
Statistical learning; machine learning; data completion; hyperspectral imaging; remote sensing; physics-informed neural networks; coastal monitoring.

Project description:
Observation and high-resolution mapping of coastal ecosystems are critical challenges for monitoring marine biodiversity in the face of global environmental changes [1]. Hyperspectral imaging provides rich 3-D information (2 spatial dimensions and 1 spectral dimension), making the identification of unique spectral signatures of coastal species and habitats possible. However, remote sensing techniques face a fundamental trade-off: satellite platforms (e.g., Sentinel-2) offer broad spatial coverage but limited spatial-spectral resolution, whereas airborne sensors (ULM or drones) provide high spatial and spectral resolution over limited areas. The goal of this project is to bridge this gap by developing informed data completion methods. By leveraging spatially localized, high-resolution airborne hyperspectral acquisitions, the project aims to recover high-resolution information over large-scale satellite images of coastal intertidal zones.

Building upon initial exploratory work and multi-sensor datasets acquired during a field campaign (combining ULM airborne hyperspectral acquisitions and Sentinel-2 satellite scenes), this internship aims to transition from initial simulated proofs-of-concept to real-world tests on complex coastal environments. The project is structured around the following steps:

1. **Bibliographic review & framework setup:** Review existing informed data completion architectures including our proof-of-concept algorithm.
2. **Guided multi-scale fusion:** Integrate intermediate-resolution panchromatic guiding images to constrain the spatial super-resolution process for large spatial scale gaps [2].
3. **Physical regularizations & parametric modeling:** Incorporate physical domain constraints (e.g., physics-informed loss functions, sensor responses constraints) and parametric spectral representations to stabilize training on sparse real-world data [3].

The primary application focuses on generating exploratory distribution maps of Roscoff worm (*Symsagittifera roscoffensis*) colonies—a key bio-indicator of intertidal ecosystem health—in collaboration with biologists from the UGSF laboratory. The developed methodology will be generic, with potential extensions to other coastal indicators.

This topic is the subject of a PhD funding request for autumn 2027. If granted, the selected student may continue this work towards a doctoral thesis.

Supervision:
The internship will take place at the Longuenesse(62) branch of LISIC. This branch, created in 2020, currently hosts 8 permanent researchers, 1 postdoctoral researcher and 8 PhD students. The intern will be supervised by Claire Guilloteau and Gilles Roussel, who will provide their respective expertise in hyperspectral image processing and machine learning for satellite imaging. The intern will also have the opportunity to collaborate with Christophe Colleoni and Anne Créach, researchers specialized in the integrative biology of storage polysaccharides at the UGSF laboratory (Unit of Structural and Functional Glycobiology) at the University of Lille.

Application:
With a scientific background in data science (signal and image processing, computer science with a focus on artificial intelligence/learning/machine learning, applied mathematics), you are curious and highly comfortable with programming (Matlab, Python, C). You read and speak English with ease. Although not required, prior experience in hyperspectral satellite image processing or deep learning will be appreciated.

To apply, please send an email to `{claire.guilloteau, gilles.roussel} [at] univ-littoral.fr` including the documents supporting your application:

- your CV,
- a motivation letter,
- your academic transcripts from Bachelor year 3, Master 1, Master 2 (if available), or Engineering School (first to third year),
- up to two recommendation letters, or the names and contact details of two referees.

Applications will be reviewed on a rolling basis until the position is filled.

References

[1] Heidi M. Dierssen, Steven G. Ackleson, Karen E. Joyce, Erin L. Hestir, Alexandre Castagna, Samantha Lavender, and Margaret A. McManus. Living up to the hype of hyperspectral aquatic remote sensing: Science, resources and outlook. *Frontiers in Environmental Science*, Volume 9 - 2021, 2021.

[2] Laetitia Loncan, Luis B. de Almeida, Jose M. Bioucas-Dias, Xavier Briottet, Jocelyn Chanussot, Nicolas Dobigeon, Sophie Fabre, Wenzhi Liao, Giorgio A. Licciardi, Miguel Simões, Jean-Yves Tourneret, Miguel Angel Veganzones, Gemine Vivone, Qi Wei, and Naoto Yokoya. Hyperspectral pansharpening: A review. *IEEE Geoscience and Remote Sensing Magazine*, 3(3):27–46, 2015.

[3] Zuzanna Gawrysiak and Krzysztof Krawiec. Physics-informed spectral modeling for hyperspectral imaging. *IEEE Geoscience and Remote Sensing Letters*, 23:1–5, 2026.