Design of an Unrolled Neural Network for Hyperspectral Pansharpening.

Keywords: Hyperspectral imaging, pansharpening, inverse problem, convex optimization, unrolled neural network.
Gratification: In accordance with current legislation
Laboratory: LISTIC, Université Savoie Mont Blanc
Location: Annecy, France
Duration: 6 months starting from February/Mars 2025

Context:
Pansharpening is a fundamental and crucial task in remote sensing which generates a high-resolution hyperspectral image by fusing a low-resolution hyperspectral image and a high-resolution panchromatic image. A range of methods formulate pansharpening as a convex optimization problem derived from physical observation model [1, 2]. To do so, hand-crafted regularization functions are designed to describe the feasible set of natural hyperspectral images. Subsequently, iterative algorithms are implemented to restore a high-resolution hyperspectral image.
The Total Variation (TV) [3, Chapter 1-2], one of the most popular regularizers in image processing, assumes that natural images are made of a few objects, resulting in sparse spatial gradients. This approach have been applied successfully to hyperspectral images but without including the spectral correlation between the observed bands.
More recently, deep learning approaches have been proposed for the pansharpening task [4]. Nevertheless, they demand a large amount of training data and resort to high computational cost for the training. Moreover, they often lack interpretability, crucial to scale to scientific applications. In contrast, Unrolled neural network are hybrid architecture derived from model based iterative algorithms. They provide a powerful architecture that demands significantly less training data and provides an improved interpretability [5].

Project summary:
The proposed work aims at designing an unrolled neural network architecture based on a specific pansharpening algorithm derived from a total variation prior. After a comprehensive study of the proposed iterative algorithm, the student will design an unrolled neural network based on the aforementioned methodology. Finally, a benchmark of various pansharpening methods will be conducted. Position can be started anytime from February 2025 for duration up to 6 months. The candidate will be based in Annecy. This internship will be hosted in the LISTIC laboratory, with regular meetings and exchanges with researchers from the project.

Candidate Profile: M2 or engineer diploma in one or more of the following fields: applied mathematics, signal and image processing, computer science. The candidate should have good writing and oral communication skills.

Contacts and Application procedure:
Students should send a detailed CV and short cover letter to Yassine MHIRI (yassine.mhiri@univ-smb.fr), Argheesh Bhanot (argheesh.bhanot@univ-smb.fr) and Ammar Mian (ammar.mian@univ-smb.fr).

References:

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[2] Laetitia Loncan et al. "Hyperspectral Pansharpening: a Review". In: *IEEE Geoscience and Remote Sensing Magazine* (2021).

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