LISTIC

Offre de stage 2022/2023

Titre	Design of an Unrolled Neural Network for Hyperspectral Pansharpening.
Niveau	M2 or engineer diploma in one or more of the following fields: applied mathematics, signal and image processing, computer science.
Date de début/ fin	6 months starting from February/Mars 2025
Ville, Pays	Annecy, *France*
Laboratoire	Laboratoire d'Informatique, Systèmes, Traitement de l'Information et de la Connaissance - LISTIC
Description du sujet	**Keywords** Hyperspectral imaging, pansharpening, convex optimization, deep learning, unrolled neural network **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, Chap1, Chap2], 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. **Environment** 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.

	References [1] Ballester, C., Caselles, V., Igual, L., Verdera, J., & Rougé, B. (2006). A variational model for P+ XS image fusion. International Journal of Computer Vision, 69, 43-58. [2] Loncan. L et al. "Hyperspectral Pansharpening : a Review". In: IEEE Geoscience and Remote Sensing Magazine. [3] Abergel, R. (2016). Quelques modèles mathématiques et algorithmes rapides pour le traitement d'images (Doctoral dissertation, Université Sorbonne Paris Cité). [4] Ciotola, M., Guarino, G., Vivone, G., Poggi, G., Chanussot, J., Plaza, A., & Scarpa, G. (2024). Hyperspectral Pansharpening: Critical Review, Tools and Future Perspectives. arXiv preprint arXiv:2407.01355. [5] Monga, V., Li, Y., & Eldar, Y. C. (2021). Algorithm unrolling: Interpretable, efficient deep learning for signal and image processing. IEEE Signal Processing Magazine, 38(2), 18-44.
Compétences requises	She/he should be enrolled in a 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. Send a detailed CV and motivation letter to yassine.mhiri@univ-smb.fr, ammar.mian@univ-smb.fr , argheesh.bhanot@univ-smb.fr.
Gratification	In accordance with current legislation
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