Final Project

Multiresolution Methods in Image Restoration

Nelly Pustelnik, Elisa Riccietti, Edgar Desainte-Maréville

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1 Project guidelines

Each group chooses one article from the list in Section 2.
The choice must be made by **Wednesday, October 21, 2026** at the latest. Each article can be assigned to only one group, on a **first come, first served** basis.
The project consists in studying the article in depth and presenting it. The written report and the presentation must address the following four points.

1. **The problem.** Describe the inverse problem considered in the article: the observation model (forward operator, noise), the quantity to be recovered, and the application context (deblurring, tomography, ...).
2. **The method and its link with the course.** Present the method proposed by the authors and explain how it relates to the course (smooth and nonsmooth optimization, proximal operators and proximal algorithms, Fenchel duality, plug-and-play / unrolled schemes, neural networks). Identify clearly which ingredients come from the course and which are new.
3. **The role of multiscale.** Explain what multiresolution brings to the method: where the multiscale structure appears (wavelet representation, coarse/fine levels, multilevel optimization, network architecture, ...) and what is gained from it (computational cost, convergence speed, reconstruction quality, modelling).
4. **Implementation in DeepInv.** Implement the method, or a simplified version of it, using the DeepInverse (DeepInv) library, and illustrate its behaviour numerically. Comparisons with a baseline (e.g. a single-scale counterpart) are encouraged.

Report format

The report must follow the IEEE two-column conference format:

- **4 pages** maximum for the content (text, figures, tables);
- a **5th page** containing **only the references**;
- use the ICASSP 2027 paper template (LaTeX and Word versions), available at https://cmsworkshops.com/ICASSP2027/papers/PaperFormat/ICASSP2027_Paper_Templates.zip
- **Deadline:** the report must be submitted by **Sunday, November 8, 2026**.

Oral presentation

- **Duration:** 15 minutes of presentation followed by 5 minutes of questions;
- **Date: Monday, November 9, 2026**.

2 List of articles

1. Multilevel stochastic plug-and-play. A. De Paepe, A. Bousse, D. Visvikis. *Multilevel Stochastic Plug-and-Play for Sparse-View CT Reconstruction.* Preprint arXiv:2606.24567, 2026.
PDF: https://arxiv.org/pdf/2606.24567

2. Deep CNN for inverse problems. K. H. Jin, M. T. McCann, E. Froustey, M. Unser. *Deep Convolutional Neural Network for Inverse Problems in Imaging.* IEEE Transactions on Image Processing, 26(9):4509–4522, 2017.
PDF: https://arxiv.org/pdf/1611.03679

3. Multilevel plug-and-play. N. Laurent, J. Tachella, E. Riccietti, N. Pustelnik. *Multilevel Plug-and-Play Image Restoration.* IEEE Transactions on Computational Imaging, 2025. PDF: https://hal.science/hal-05004914v3/file/paper_accepted_HAL.pdf.

4. EM algorithm for wavelet-based restoration. M. A. T. Figueiredo, R. D. Nowak. *An EM Algorithm for Wavelet-Based Image Restoration.* IEEE Transactions on Image Processing, 12(8):906–916, 2003.
Link: https://www.lx.it.pt/~mtf/IEEE_TIP_2003_Figueiredo_Nowak.pdf

5. Operator sketching. J. Tang, G. Xu, S. Mukherjee, C.-B. Schönlieb. *Practical Operator Sketching Framework for Accelerating Iterative Data-Driven Solutions in Linear Inverse Problems.* Journal of Mathematical Imaging and Vision, 67, article 46, 2025.
PDF: https://research.birmingham.ac.uk/files/271575921/s10851-025-01263-9.pdf

6. Fast multilevel wavelet-regularized restoration. C. Vonesch, M. Unser. *A Fast Multilevel Algorithm for Wavelet-Regularized Image Restoration.* IEEE Transactions on Image Processing, 18(3):509–523, 2009.
PDF: https://bigwww.epfl.ch/publications/vonesch0901.pdf

7. Multi-scale learned iterative reconstruction. A. Hauptmann, J. Adler, S. Arridge, O. Öktem. *Multi-Scale Learned Iterative Reconstruction.* IEEE Transactions on Computational Imaging, 2020. PDF: https://arxiv.org/pdf/1908.00936

8. Wavelet score-based generative modeling. F. Guth, S. Coste, V. De Bortoli, S. Mallat. *Wavelet Score-Based Generative Modeling.* NeurIPS, 2022.
PDF: https://arxiv.org/pdf/2208.05003