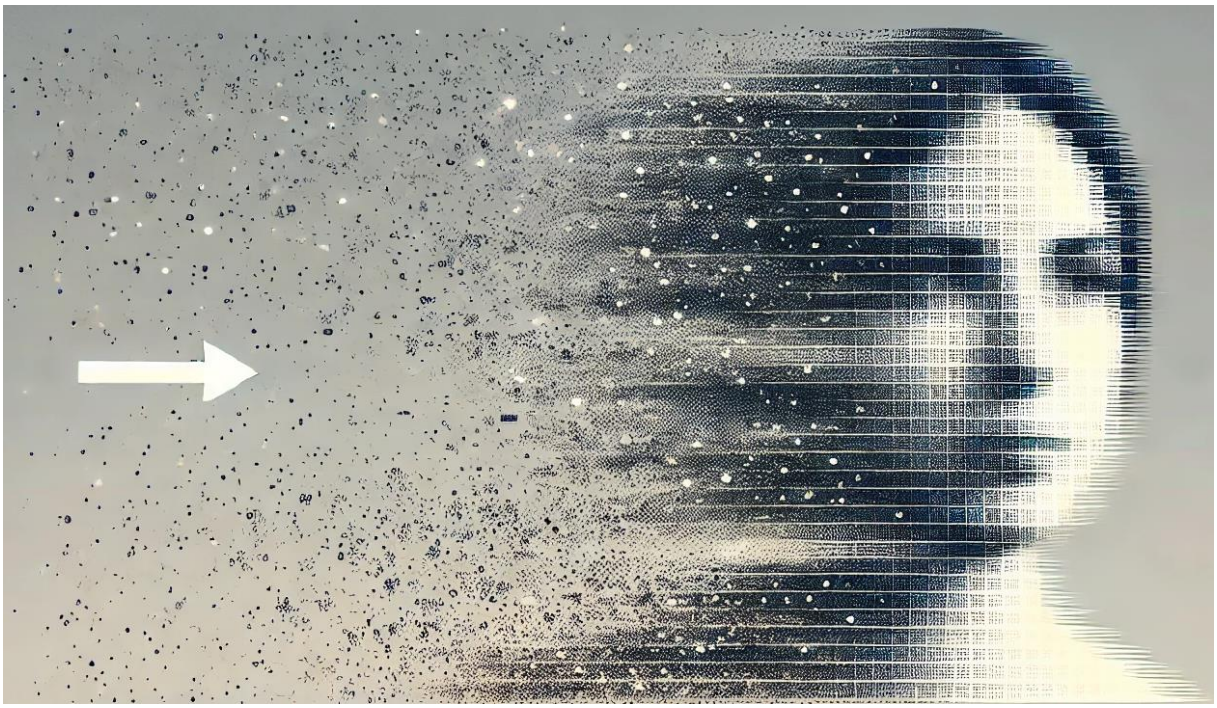
Investigating plug-and-play methods for image reconstruction



Background

Image reconstruction is a fundamental problem in computer vision and image processing, encompassing tasks such as deblurring, super-resolution, and inpainting. Traditional methods often rely on hand-crafted priors, which may not capture the complex statistics of natural images effectively. Plug-and-play (PnP) methods [1,2] have emerged as a promising approach, allowing the integration of sophisticated learned priors while maintaining the flexibility and interpretability of optimization-based methods.

Problem Specification

The Deep Plug-and-Play Image Restoration (DPIR) framework implements a half-quadratic splitting (HQS) optimization algorithm that alternates between data fidelity and prior terms. It specifically uses a pre-trained deep denoising prior network trained with a noise level map and periodic noise level adjustment strategy. When using a pre-trained denoising network, there are several points of interest for inference:

- How does the noise-level adjustment strategy affect reconstruction quality across different image degradation types?
- What is the impact of HQS hyper-parameters on reconstruction quality and convergence speed?
- What is the relationship between the number of HQS iterations and reconstruction quality?

Suggested Method

The study shall systematically investigate the performance of PnP-HQS on different inverse problems (e.g. de-blurring, super-resolution and completion) and how the different hyper-parameters affect convergence and performance. This shall be done using a range of different metrics including peak signal-to-noise ration (PSNR) and structural similarity index measure (SSIM). The work shall consider publicly available datasets such as set5 [3].

A good starting point is the implementation of [2] given at https://github.com/cszn/DPIR

Relevant Articles

[1] Venkatakrishnan, Singanallur V., Charles A. Bouman, and Brendt Wohlberg. "Plug-and-play priors for model based reconstruction." 2013 IEEE global conference on signal and information processing. IEEE, 2013.

[2] Zhang, Kai, et al. "Plug-and-play image restoration with deep denoiser prior." IEEE Transactions on Pattern Analysis and Machine Intelligence 44.10 (2021): 6360-6376.

[3] Bevilacqua, Marco, et al. "Low-complexity single-image super-resolution based on nonnegative neighbor embedding." (2012): 135-1.