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Masterarbeit

Adaptive Frequency-Domain Supervision for Generative Image Reconstruction

Description

Generative models, especially diffusion models and flow-matching architectures, have recently achieved impressive results in image restoration and inverse imaging problems. However, many reconstruction methods are still trained or guided primarily using pixel-space losses such as L1, L2 or perceptual losses. These objectives often fail to explicitly model how different frequency components are reconstructed during the generative denoising process. In particular, high-frequency structures such as edges, textures and fine details can be suppressed, distorted or hallucinated.

The goal of this thesis is to investigate adaptive frequency-domain supervision for generative image reconstruction. Instead of supervising only pixel values, the thesis studies how spectral residuals can be modeled and weighted dynamically during reconstruction. The central hypothesis is that different frequency bands become reconstructable at different stages of the denoising process. A lightweight Spectral Weighting Module should learn how to adaptively weight frequency bands depending on the noise level, reconstruction stage and image content. This follows the proposed direction in the uploaded thesis draft, including adaptive spectral supervision, spectral residual learning and evaluation on inverse imaging tasks.

Tasks:

1. Review diffusion-based image restoration and frequency-domain learning.
2. Analyze reconstruction errors in the frequency domain.
3. Develop an adaptive spectral supervision strategy.
4. Implement a lightweight frequency-weighting module.
5. Evaluate on tasks such as super-resolution and deblurring.
6. Compare against standard pixel-space and frequency-domain baselines.

The work can be done in German or English.

Prior knowledge

- Good programming skills in Python and PyTorch
- Good understanding of machine learning and deep learning
- Basic knowledge of image processing, Fourier analysis or signal processing
- Willingness to work with experimental deep learning pipelines and GPU-based training

Research area

- Image Processing; Computer Vision
- Generative Models
- Diffusion Models
- Inverse Problems
- Frequency-Domain Learning

Studiengang

- [x] Elektro- und Informationstechnik
- [x] Informatik
- [x] Mathematik
- [x] Physik

Alignment

- [x] Research
- [x] Implementation
- [x] Analysis and evaluation
- [x] Method development
- [ ] Simulation

Start

At any time

Links

Mitarbeiterseite

Ansprechpartner

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