GAN Image Denoising

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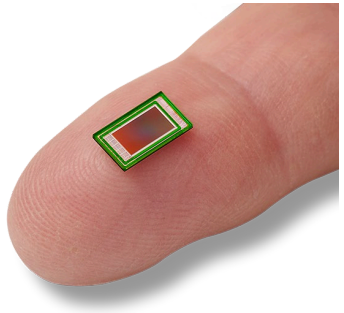
'Introduction to Scientific Computing'

Introduction

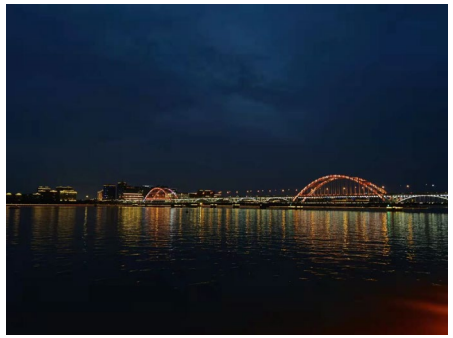
- Where does the image noise come from?



Sensor limitations
(cannot obtain enough light)

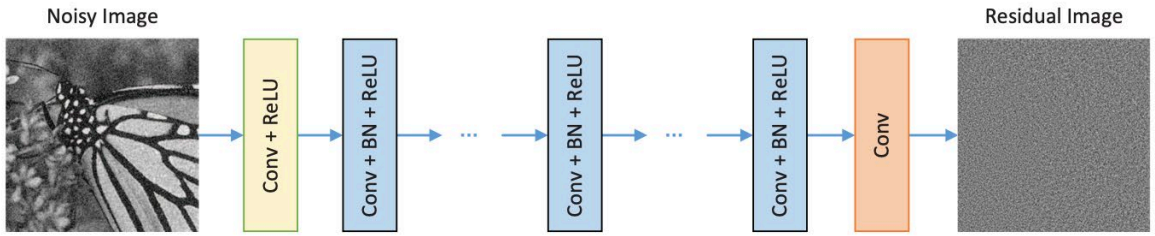
Environmental Factors
(dust on the lens)

- Denoising -- Break the sensor limitations to gain better image quality

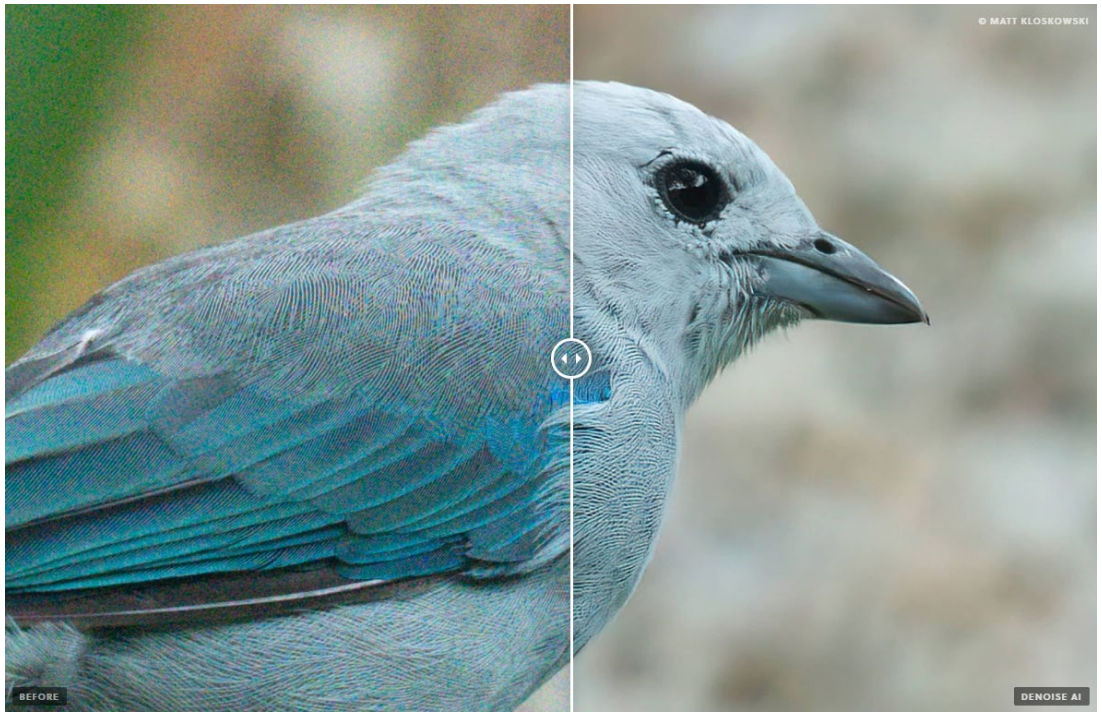


Background

- Traditional methods using filters:
  - mean, median, biliteral, wavelet filtering
  - Non-local-mean, BM3D(2010)
- Neural network methods:
  - CNNs: Deep Denoising CNN(DnCNN)
  - GANs: Noise2Noise (N2N) / CycleGAN
  - Newer… Transformers

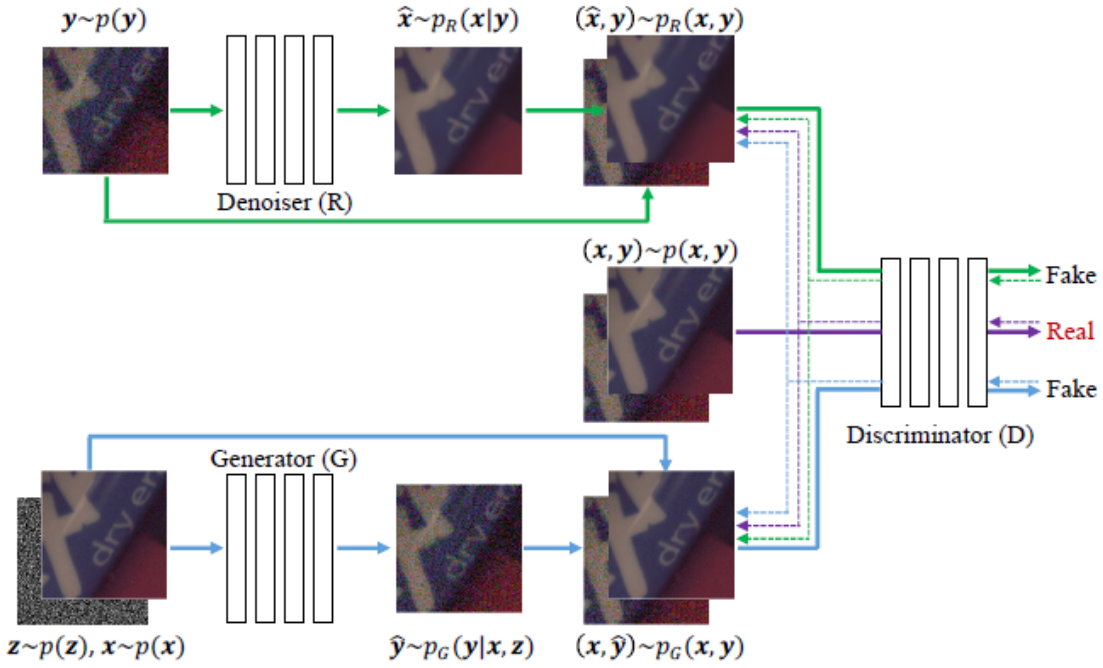


DnCNN Network



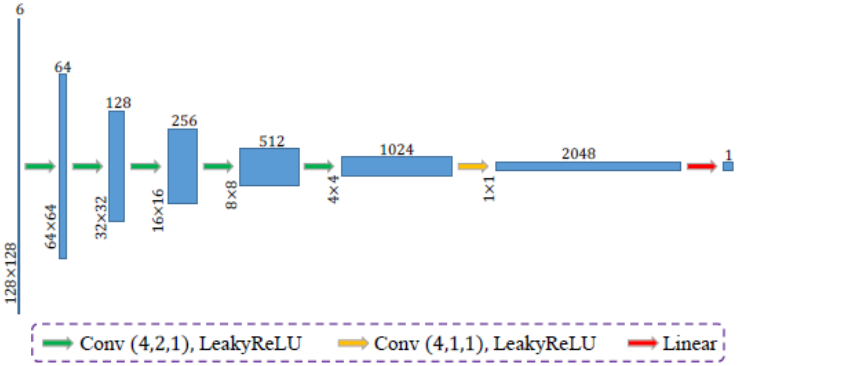
https://www.topazlabs.com/denoise-ai

Network Structure

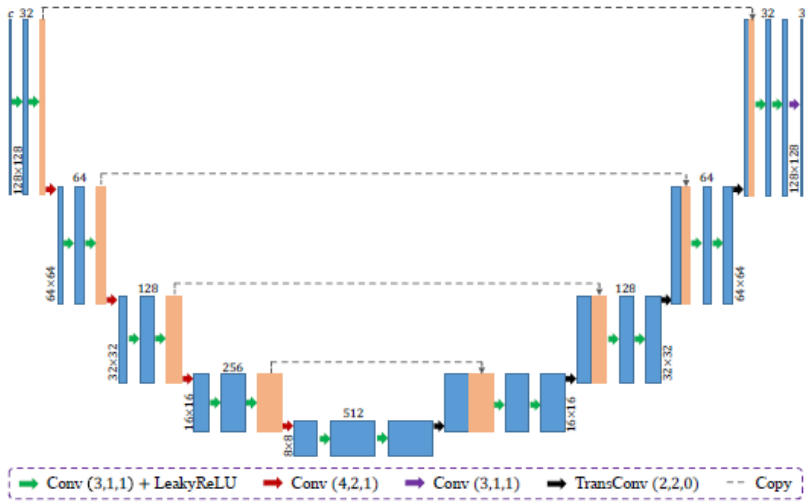


Overall Network Structure

- 3 components
- Train end-to-end



Discriminator

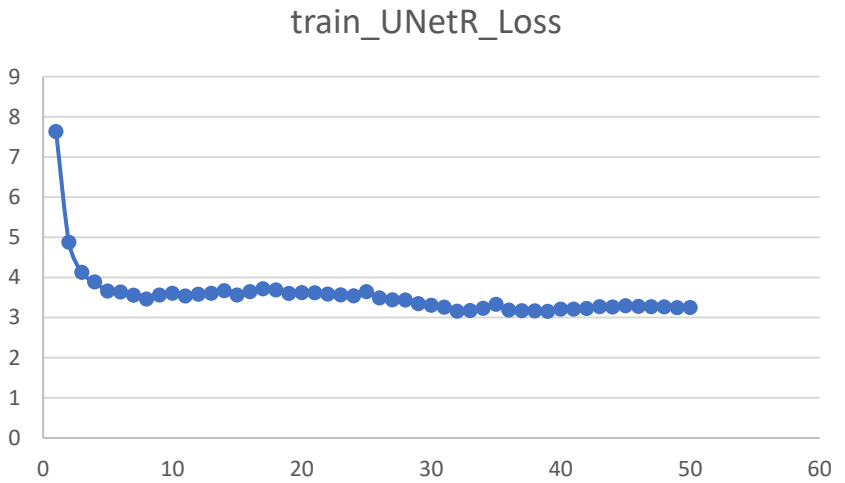


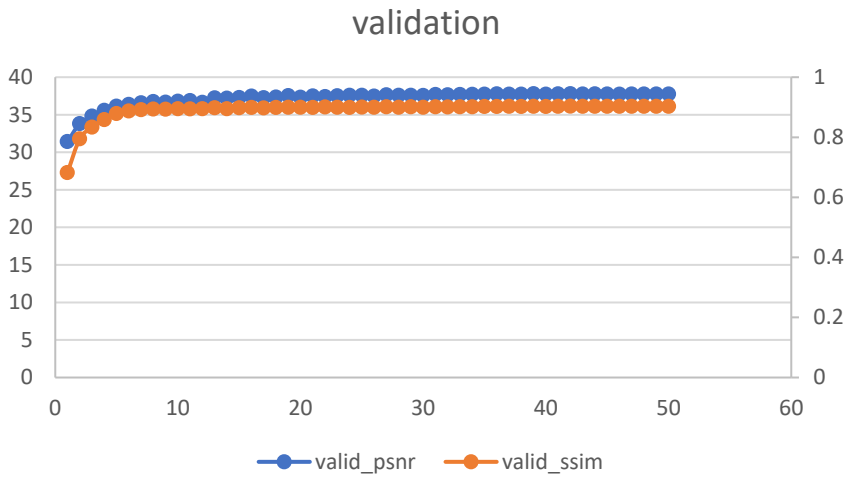
Denoiser & Generator

Yue, Zongsheng, Qian Zhao, Lei Zhang, and Deyu Meng. "Dual adversarial network: Toward real-world noise removal and noise generation." In Computer Vision–ECCV 2020: 16th European Conference, Glasgow, UK, August 23–28, 2020, Proceedings, Part X 16, pp. 41-58. Springer International Publishing, 2020.

Training

- Datasets
  - ✓ SIDD: Smartphone Image Denoising Dataset(2018)
  - ✓ Images captured by 5 different smartphones
  - ✓ Aligned noisy / ground-truth image pairs(use image sequences to obtain high-quality gt)
- Data Augmentation
  - ✓ Random Crop / Flip / Rotate(90/180/270)
  - ✓ No arbitrary rotation and global color or light adjustment augmentation
- Training progress
  - ✓ Trained on a local desktop with GPU/CUDA acceleration(i7 12700k + RTX 4090)
  - ✓ 50 epochs / AdamW Optimizer / batch size 16
  - ✓ Cost about 6.5 hours
  - ✓ Loss on validation set during training

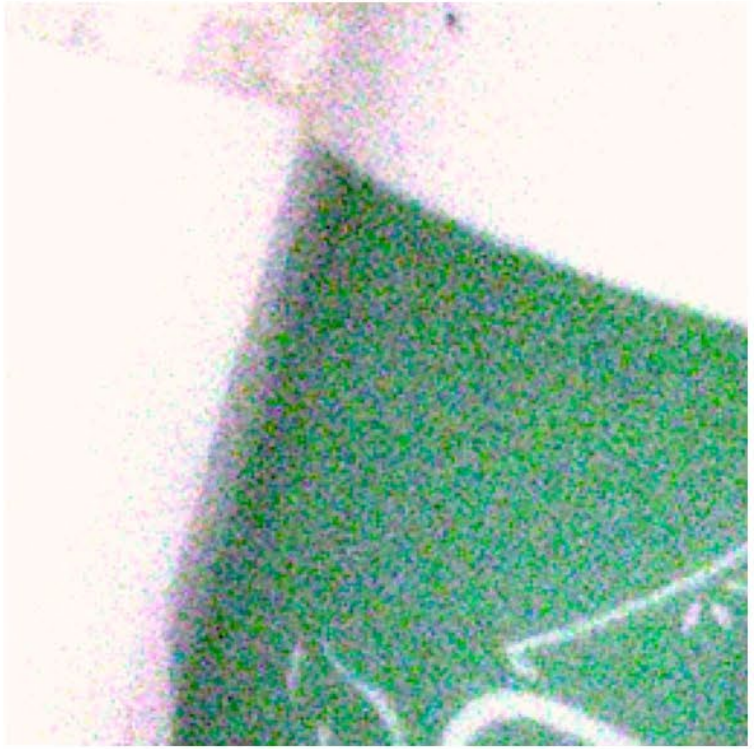




Results

- Results on validation datasets

Noisy Image



Gt Image

Denoised Image

Noise has been removed.

Results

- Results on validation datasets

Noisy Image

Gt Image

Denoised Image

Noise has been removed.

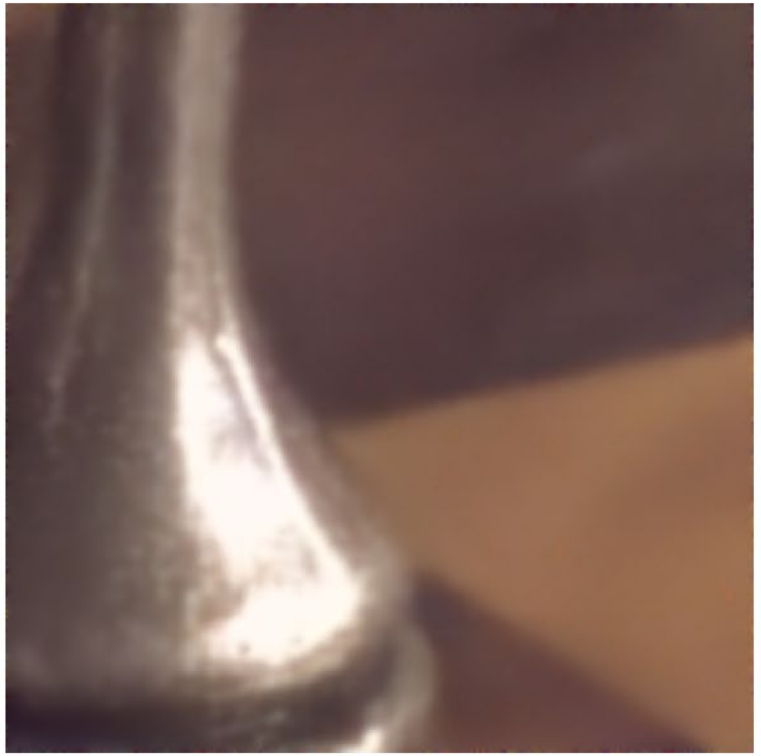
Results

- Results on validation datasets

Noisy Image

Gt Image

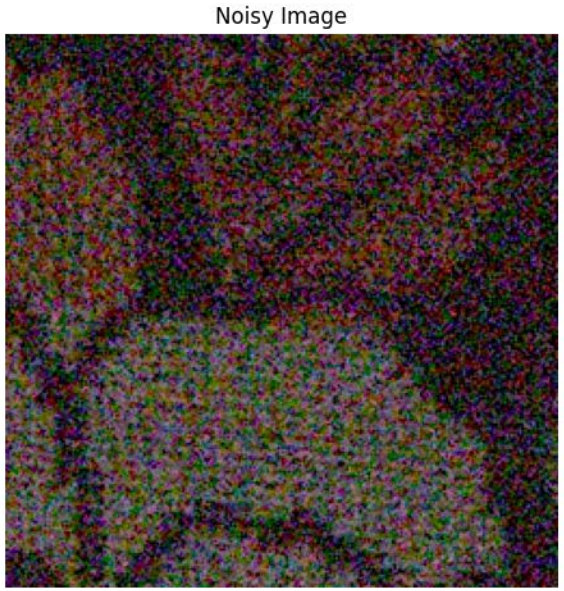
Denoised Image

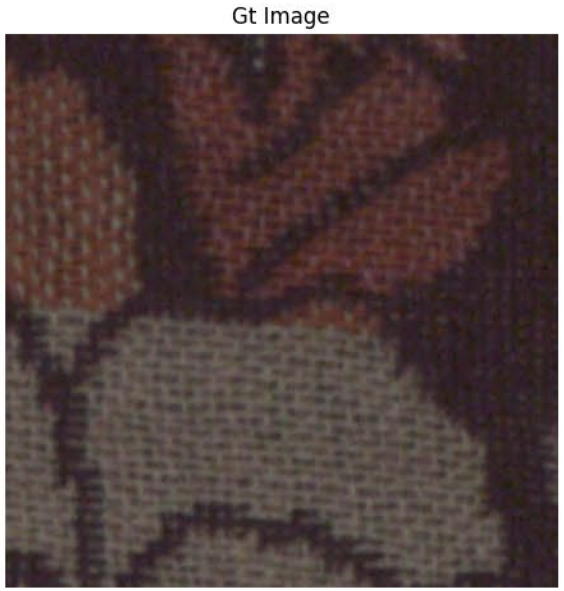


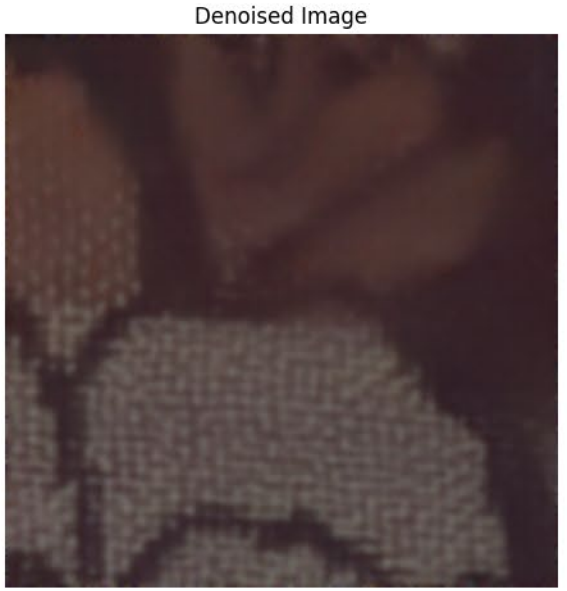
Noise has been removed.

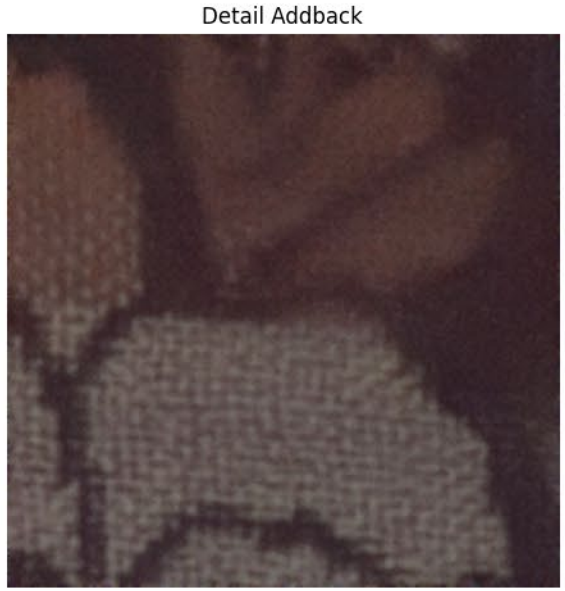
Discussions

- Better metrics on image quality
  - ❖ Cleaner, better?









Thank you for listening