IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

Computational Imaging

SOMMAIRE

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CHAPITRE 1
SCIENTIFIC PAPER

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A Trainable Spectral-Spatial Sparse Coding Model for Hyperspectral Image Restoration. Bodriot et al, 2021

🎯 Denoise hyperspectral images

Metrics : Peak Signal-to-Noise Ratio

$$\begin{aligned} PSNR &= 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \\ &= 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \\ &= 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE). \end{aligned}$$

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2.$$

With I the noise free image and K the noisy image

Structural similarity index measure

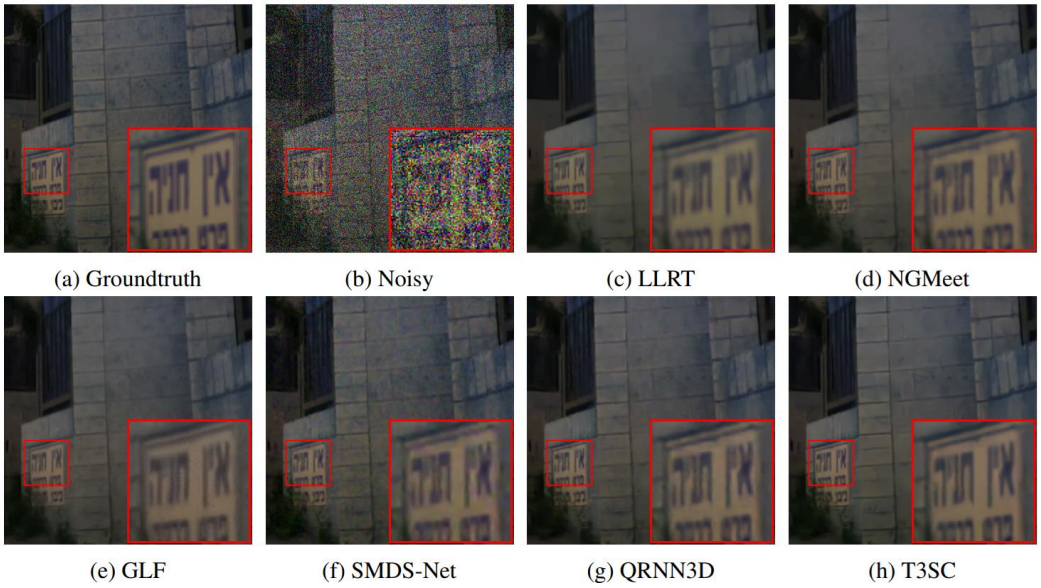
$$\mathrm{SSIM}(x,y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)} = l(x,y)^\alpha \cdot c(x,y)^\beta \cdot s(x,y)^\gamma$$

- μ_x the pixel sample mean of x;
- μ_y the pixel sample mean of y;
- σ_x^2 the variance of x;
- σ_y^2 the variance of y;
- σ_{xy} the covariance of x and y;
- $c_1 = (k_1 L)^2$, $c_2 = (k_2 L)^2$ two variables to stabilize the division with weak denominator
- L the dynamic range of the pixel-values (typically this is $2^{\#bits\ per\ pixel} - 1$);
- $k_1 = 0.01$ and $k_2 = 0.03$ by default.

$$l(x,y) = \frac{2\mu_x\mu_y + c_1}{\mu_x^2 + \mu_y^2 + c_1} \qquad c(x,y) = \frac{2\sigma_x\sigma_y + c_2}{\sigma_x^2 + \sigma_y^2 + c_2} \qquad s(x,y) = \frac{\sigma_{xy} + c_3}{\sigma_x\sigma_y + c_3}$$

$$c_3 = c_2/2$$

l: luminance, c: contrast, s: structure



(a) Groundtruth (b) Noisy (c) LLRT (d) NGMeet

(e) GLF (f) SMDS-Net (g) QRNN3D (h) T3SC

σ	Metrics	Noisy	BM3D	BM4D	GLF	LLRT	NGMeet	SMDS	QRNN3D	T3SC
5	MPSNR	34.47	46.17	48.85	51.25	51.86	**52.74**	50.91	48.80	52.62
	MSSIM	0.7618	0.9843	0.9916	0.9949	0.9951	**0.9960**	0.9944	0.9918	0.9959
25	MPSNR	21.44	37.86	39.89	43.16	43.43	44.74	42.83	44.20	**45.38**
	MSSIM	0.1548	0.9269	0.9510	0.9695	0.9746	0.9796	0.9700	0.9782	**0.9825**
50	MPSNR	16.03	34.22	34.22	39.26	39.69	41.08	39.25	41.67	**42.16**
	MSSIM	0.0502	0.8654	0.8654	0.9197	0.9504	0.9602	0.9382	0.9655	**0.9677**
100	MPSNR	10.85	30.43	32.47	34.79	36.39	37.55	35.64	37.19	**38.99**
	MSSIM	0.0144	0.7557	0.8155	0.7982	0.9182	0.9311	0.8815	0.9140	**0.9439**

CHAPITRE 2
PROJECT

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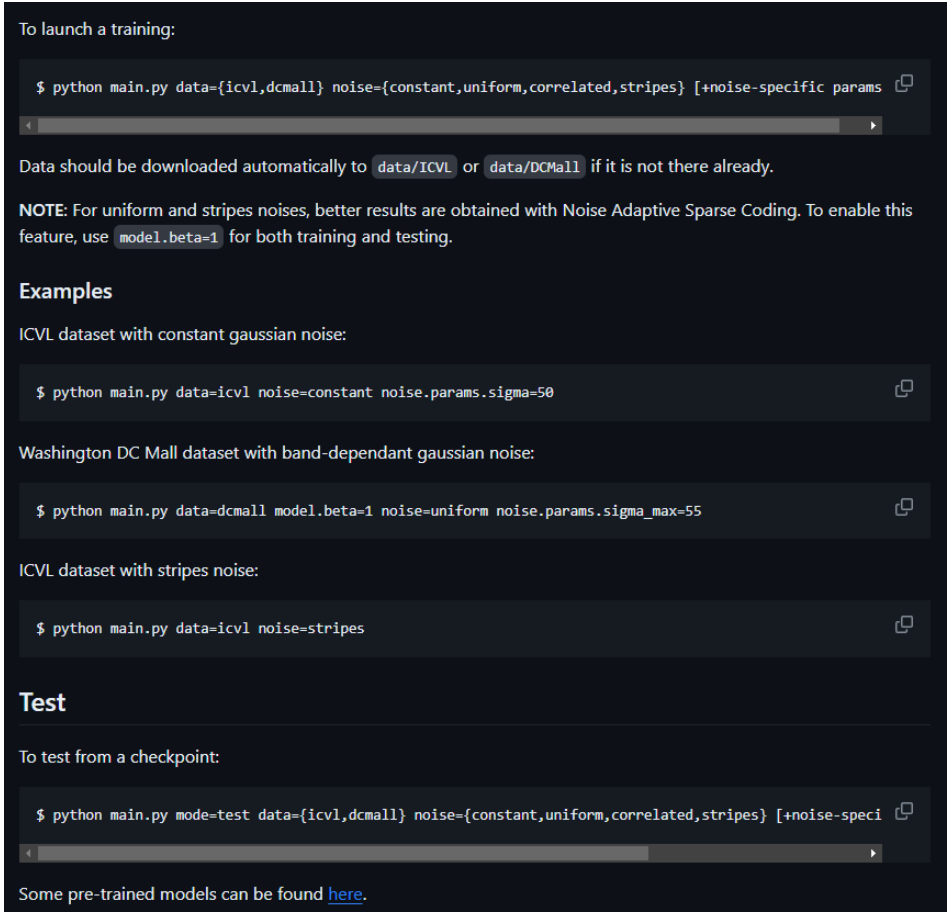
Official Github implementation in Pytorch: Inria-Thoth/T3SC

Well explained “readme”, seemingly easy to use

last-modified 2-3 years ago
7 forks
1 issue reported



To launch a training:

```
$ python main.py data={icvl,dcmall} noise={constant,uniform,correlated,stripes} [+noise-specific params
```

Data should be downloaded automatically to `data/ICVL` or `data/DCMall` if it is not there already.

NOTE: For uniform and stripes noises, better results are obtained with Noise Adaptive Sparse Coding. To enable this feature, use `model.beta=1` for both training and testing.

Examples

ICVL dataset with constant gaussian noise:

```
$ python main.py data=icvl noise=constant noise.params.sigma=50
```

Washington DC Mall dataset with band-dependant gaussian noise:

```
$ python main.py data=dcmall model.beta=1 noise=uniform noise.params.sigma_max=55
```

ICVL dataset with stripes noise:

```
$ python main.py data=icvl noise=stripes
```

Test

To test from a checkpoint:

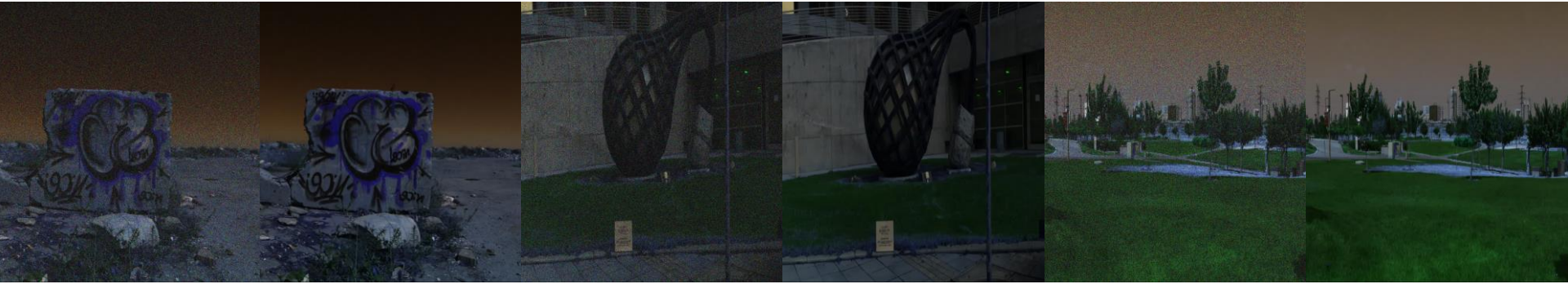
```
$ python main.py mode=test data={icvl,dcmall} noise={constant,uniform,correlated,stripes} [+noise-speci
```

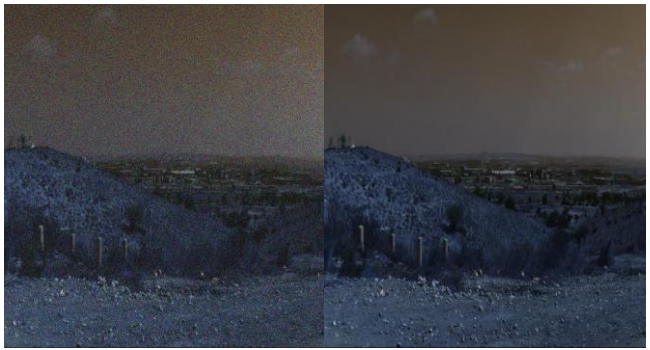
Some pre-trained models can be found here.

Original goal:

- Retrieve the code
- Train the model
- Test (inference)
- Observe results & Compare

Issues	Solutions
Python/Lib version issues	Decreased versions for some libs
Cuda use issues	Do not use several workers as we only have one GPU
Training time	No training
Pretrained weights available only for 1 dataset	Only 1 dataset for test
Dataset size (20GB)	Managed to DL + do inference





white gaussian noise σ=50

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Specifications:

- GPU: NVIDIA GeForce RTX 3060 | VRAM 6GB
- CPU: i7-11800H @ 2.30GHz | 8 core | L1 cache 640kB | L2 cache 10MB | L3 cache 24MB
- RAM 16GB

Metrics:

- mpsnr = 42.17 +/- 3.55
- mssim out = 0.97 +/- 0.016

Confidence interval 95%
inference_time: 15.9

σ=100

Questions ?

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