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HSI RESTORATION BY SPARSE CODING

TOPIC 1 - GROUP 2

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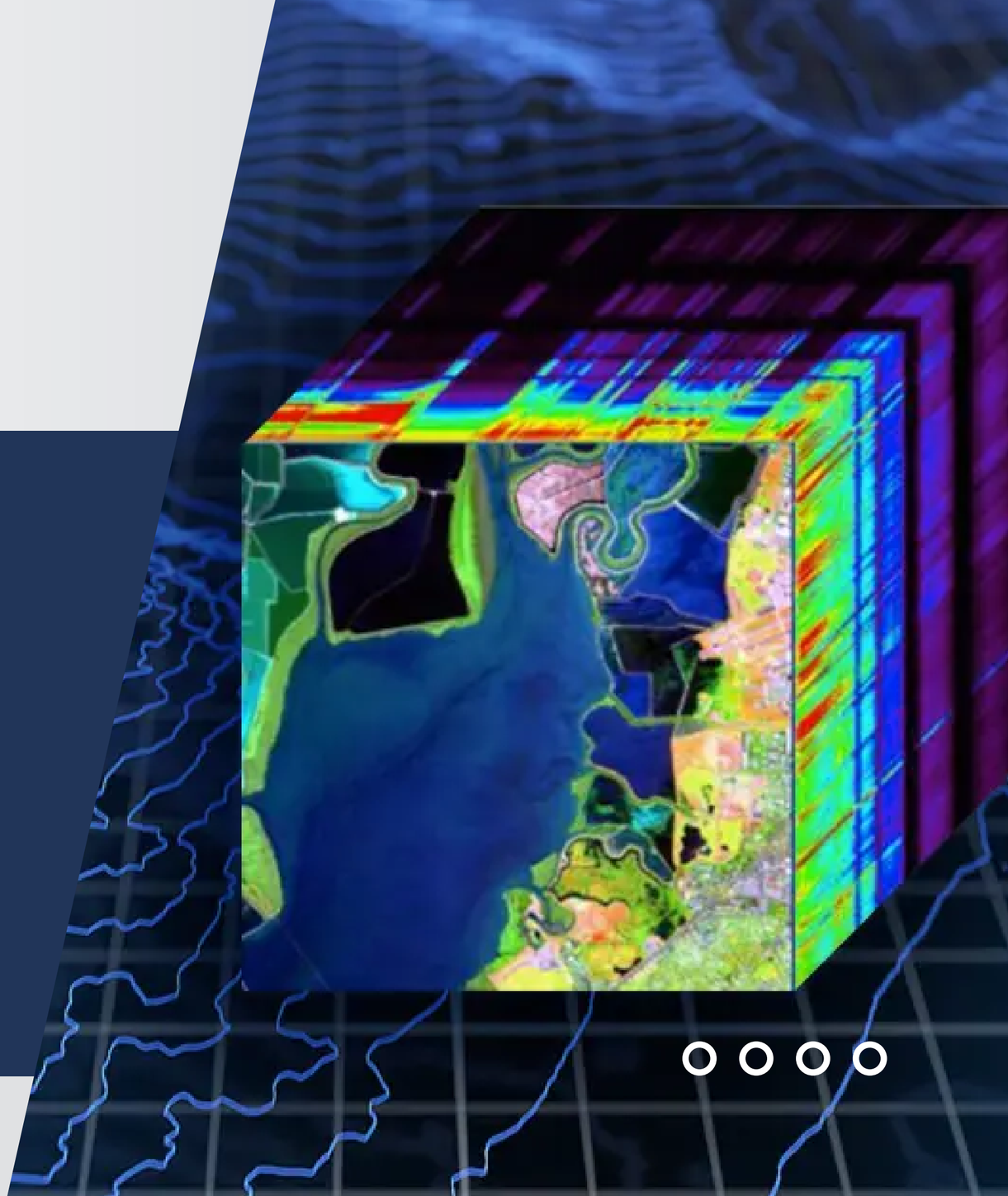
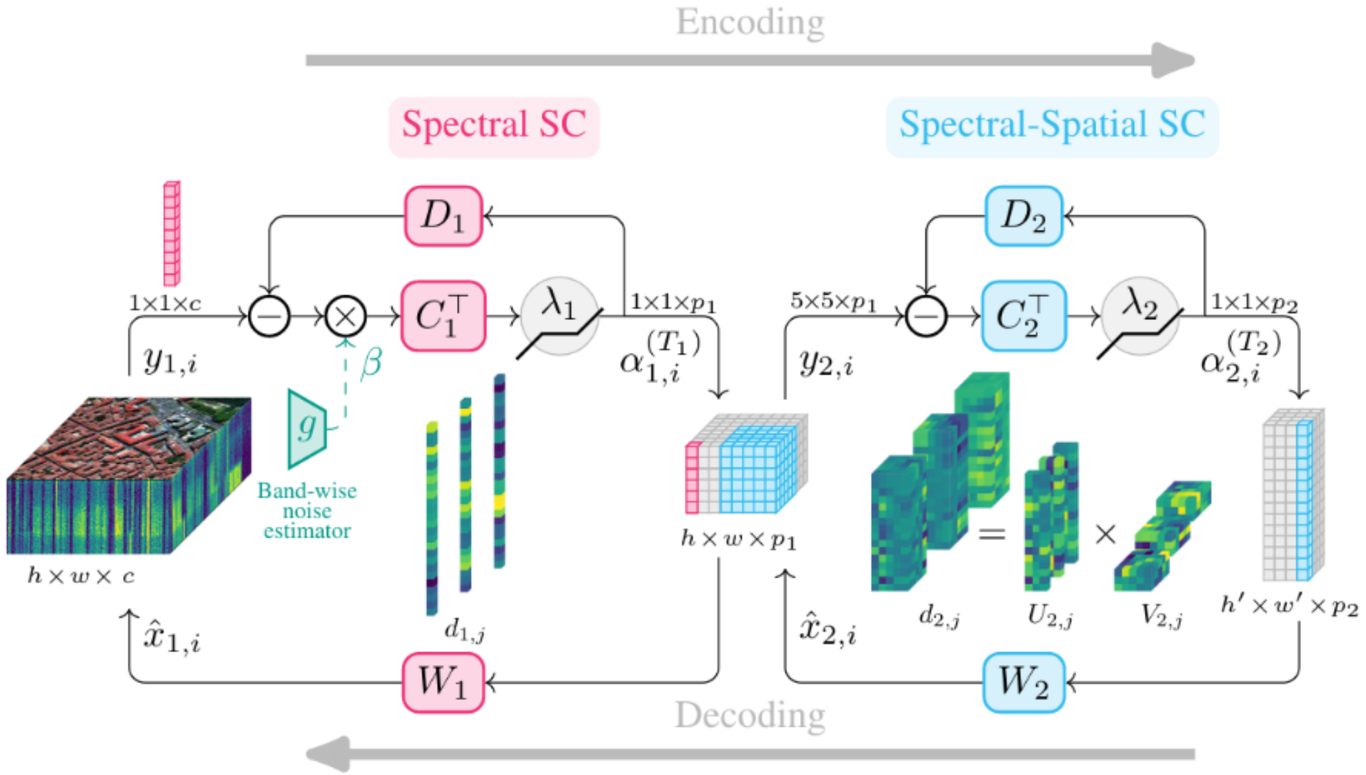


1. RECALL

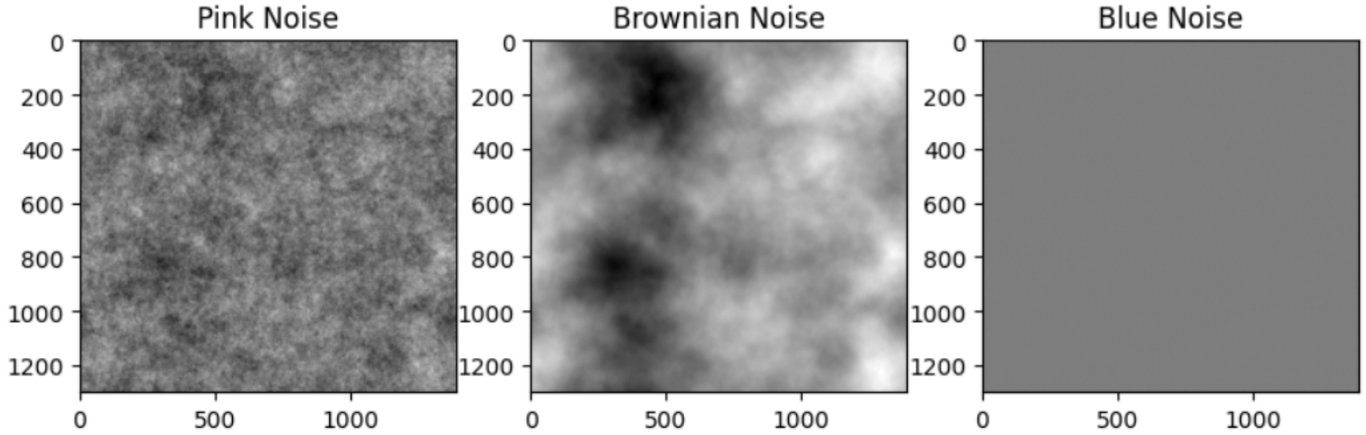
Spectral-Spatial Sparse Coding Model (T3SC):

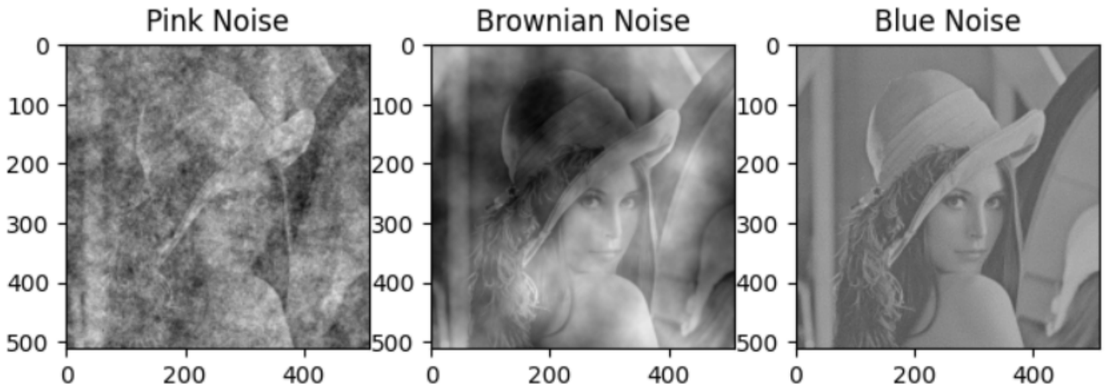
- **A hybrid approach** - Deep Learning and Sparse Coding
- **Encoder-Decoder** architecture
- Learn dictionaries **(low-rank representations)** to **map an HSI to a vector**
- This vector is **sparse** → Noise can be eliminated when reconstructing the image in the decoding step
- **Train** this model by **adding noise to HSI** and make the model learn to denoise by **optimizing MSE loss**

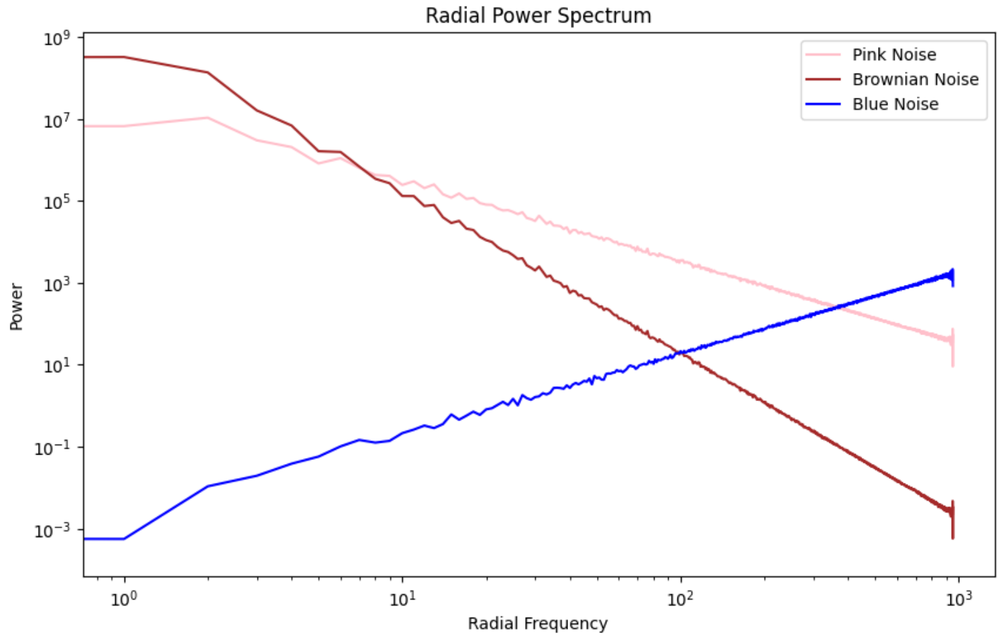


2. COLOR NOISE

Study the model performance on more complex noise: Brownian, Pink and Blue noise





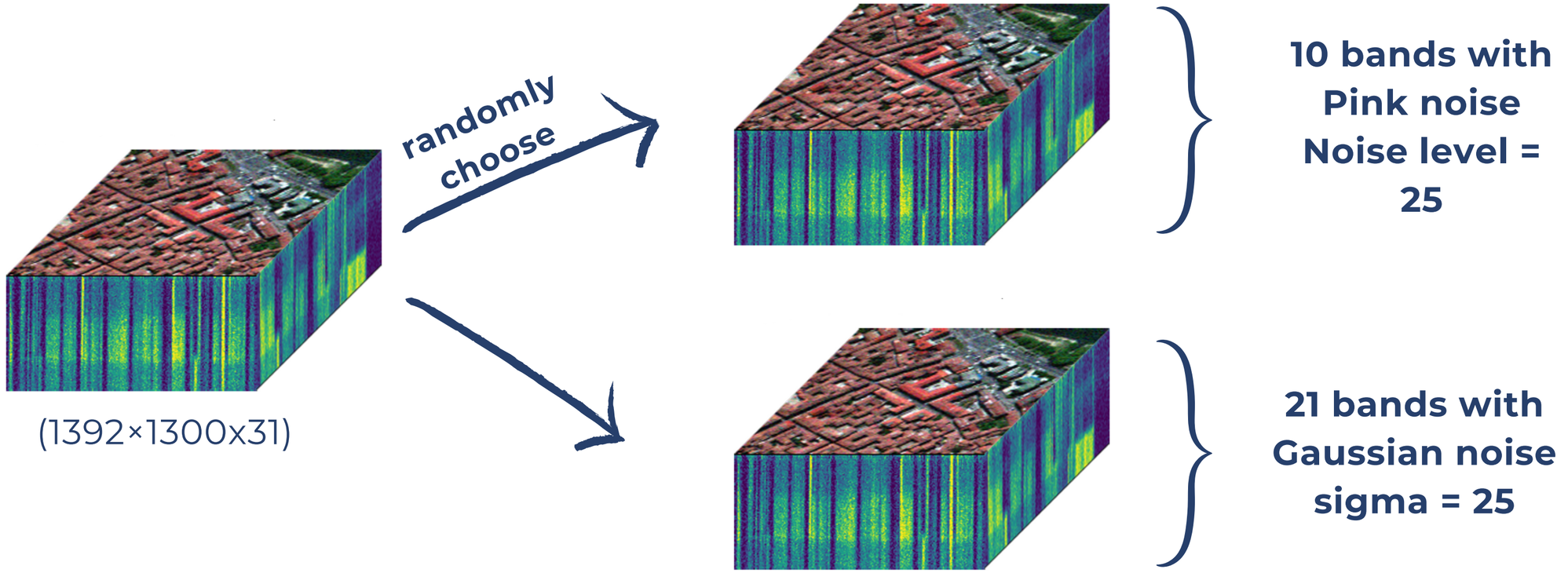


$S(f) \propto 1/f^{\alpha}$

2. COLOR NOISE

How we test it (Pink noise)?

- Dataset: ICVL (1392×1300x**31**)
- Due to complexity, at first we randomly choose 10 bands (33%) to add pink noise, other bands we add Gaussian noise



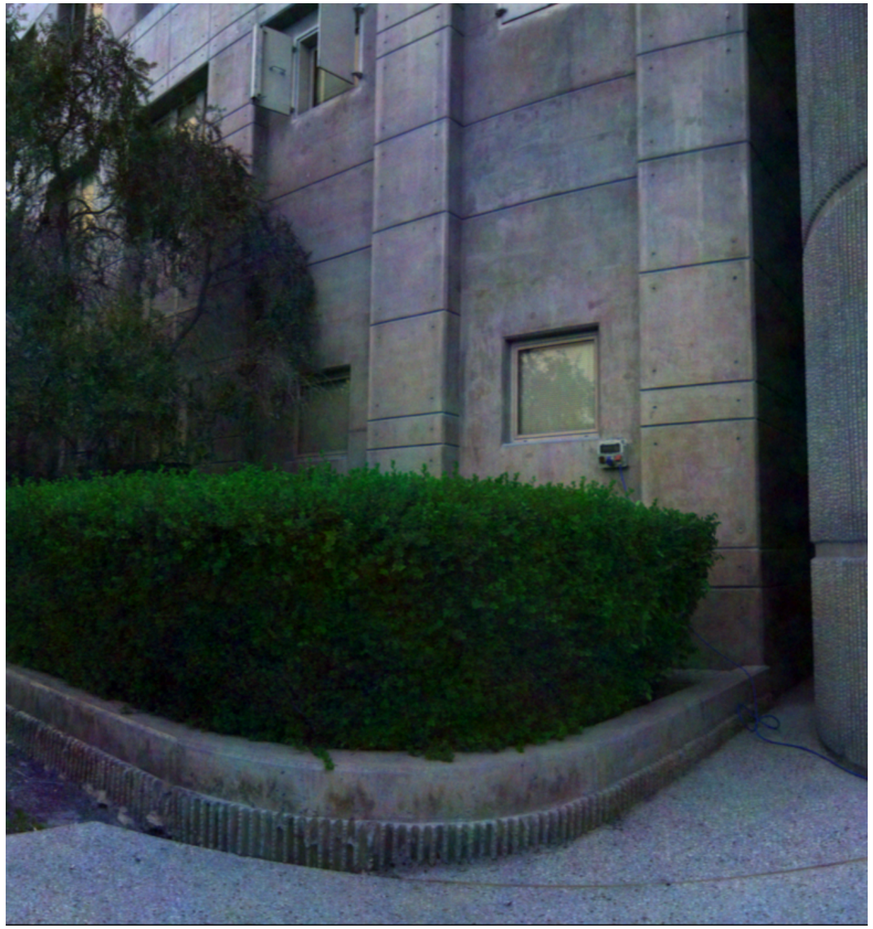
2. COLOR NOISE

How we test it (Pink noise)?

We pick 3 pink noise-added bands and visualize it

Ground truth

Noise level = 25 on 10 bands



MPSNR: 25.0

MSSIM: 0.39

2. COLOR NOISE

We use pretrained models to denoise first

Pretrained model on Gaussian noise with sigma = 25

MPSNR: 41.46
MSSIM: 0.97

The model can adapt to color noise.

What if we add pink noise to 100% bands

2. COLOR NOISE

We use pretrained models to denoise first

Pretrained model on Gaussian noise with sigma = 25

MPSNR: 38.45
MSSIM: 0.96

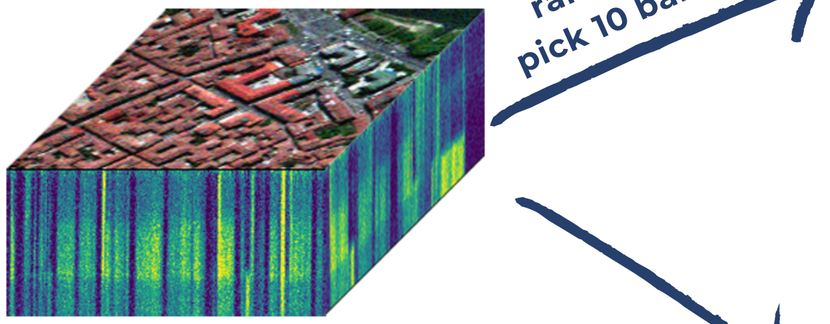
The model can still perform well despite a slight decrease in the metrics

3. OCCLUSION

What if we have a noisy image but also losing some information in some bands?

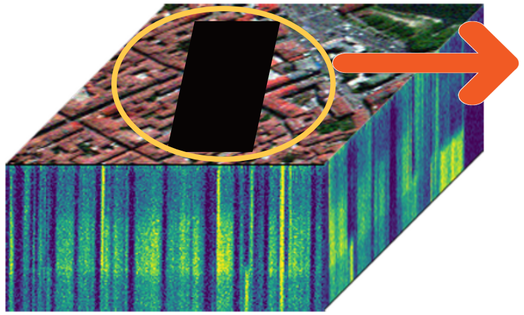
We cover some parts of some bands by zero value

In this case, we choose the same area of 10 bands (33%) to blind

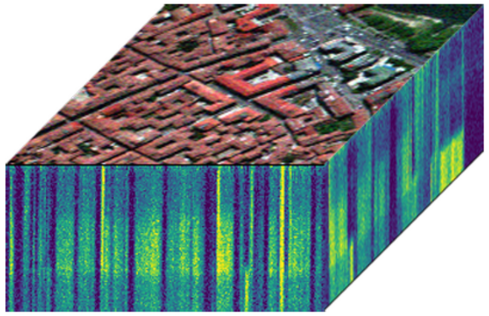


(1392×1300x31)

randomly pick 10 bands



cover an area on 10 bands



Add Gaussian noise to all bands

3. OCCLUSION

What if we have a noisy image but also losing some information in some bands?

Choose 3 blinded bands to visualize

MPSNR: 20.81
MSSIM: 0.15

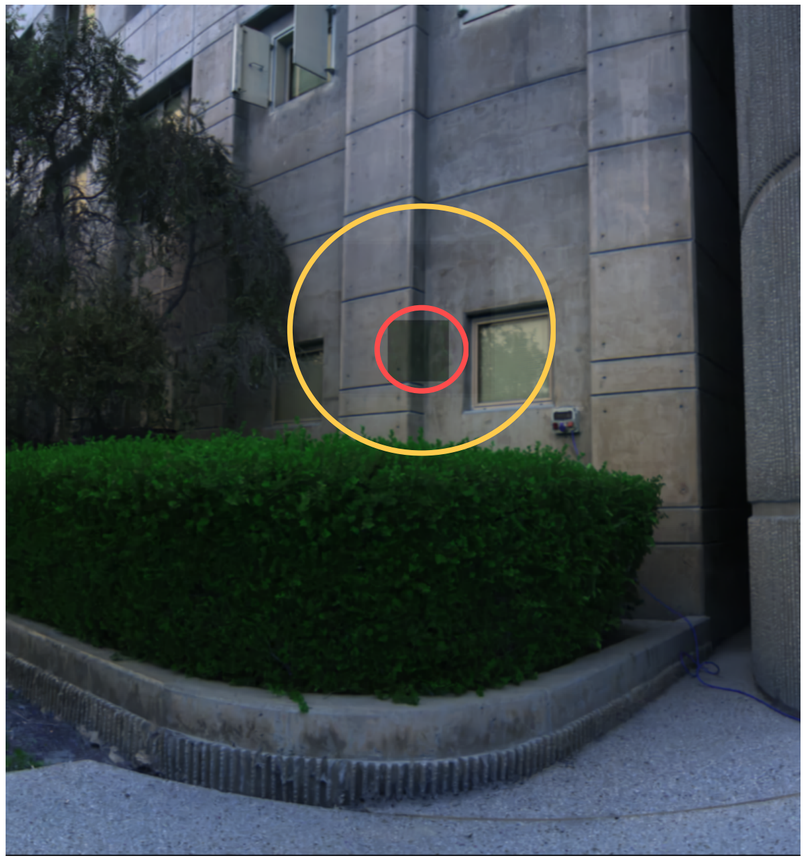
3. OCCLUSION

What if we have a noisy image but also losing some information in some bands?

Choose 3 blinded bands to visualize

MPSNR: 20.81
MSSIM: 0.15

Denoised + reconstructed by pretrained model



MPSNR: 39.23
MSSIM: 0.97

Good denoising but there are artifacts

3. OCCLUSION

What if we have a noisy image but also losing some information in some bands?

Good denoising but there are artifacts

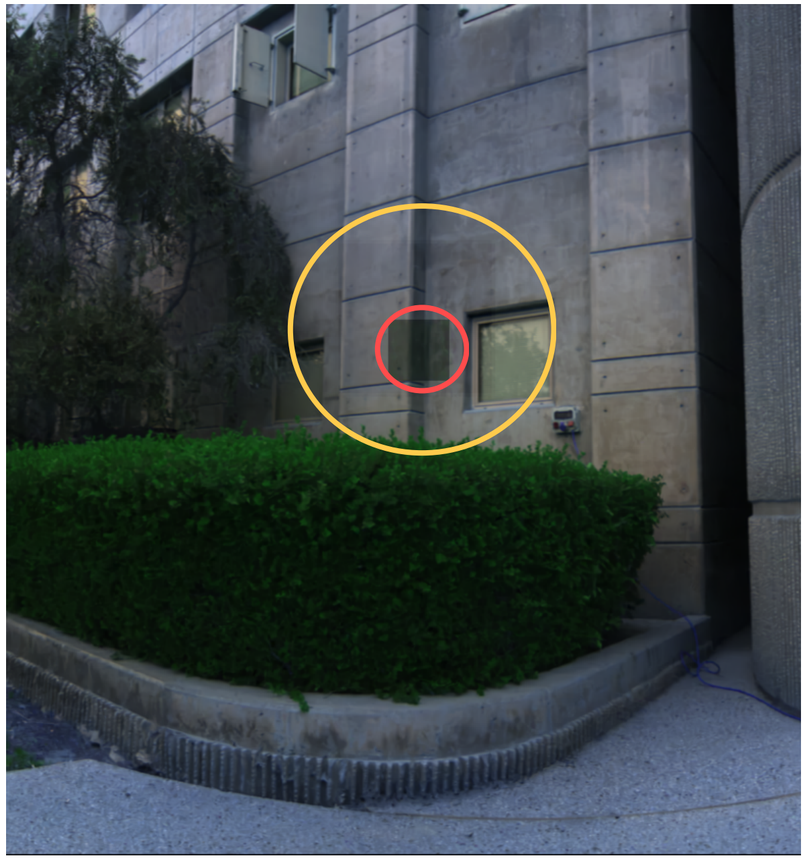
- **Use GPU V100 (GG COLAB PRO+) to re-train the model for 14h on ICVL dataset - 100 training samples - 50 testing samples**
- **Use the same pre-processing techniques as the authors**
- **We employ our blinding technique (different from Self-supervised leaning in the paper), details in our github**

3. OCCLUSION

What if we have a noisy image but also losing some information in some bands?

Denoised + reconstructed by pretrained model

MPSNR: 39.23
MSSIM: 0.97
MSE: 0.0002



Denoised + reconstructed by our re-trained model

MPSNR: 39.87
MSSIM: 0.97
MSE: 0.0001

FEWER ARTIFACTS WHILE MAINTAINING DENOISING CAPABILITY

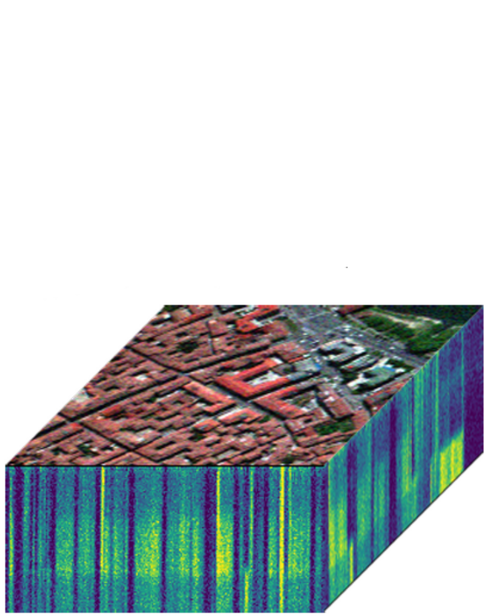
4. CONCLUSION

- **The model proves the robustness not only for Gaussian noise but also its variants for certain percentages of affected bands**
- **The model shows a high potential to interpolate missing information of several bands from information of other bands**
- **However, it needs to be re-trained or requires other blinding techniques to perform better**
- **More tests and used techniques are available on our github: https://github.com/tluc51/COMPI_2024_TS3C/tree/main**

THANK YOU FOR YOUR ATTENTION

APPENDIX

Our training technique in occlusion case



...

Divide to 64x64x31 batches

...

Randomly mask a square with size (20x20) in 10 bands of all batches

Note: We have 2 models trained with square mask sizes (20x20) and (32x32)

Feed to the model to train