

Dictionary Learning and Denoising

**Mathematical Models and Methods for Image
Processing**

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Assignment 1: Implement the KSVD algorithm

- Extract random patches from an image (e.g., *barbara.png* and *cameraman.png*)
- Put the random patches to zero mean
- Randomly initialize the dictionary
- Use the KSVD algorithm to learn D
- Start with few patches, the KSVD can be computationally expensive

Image cameraman.png



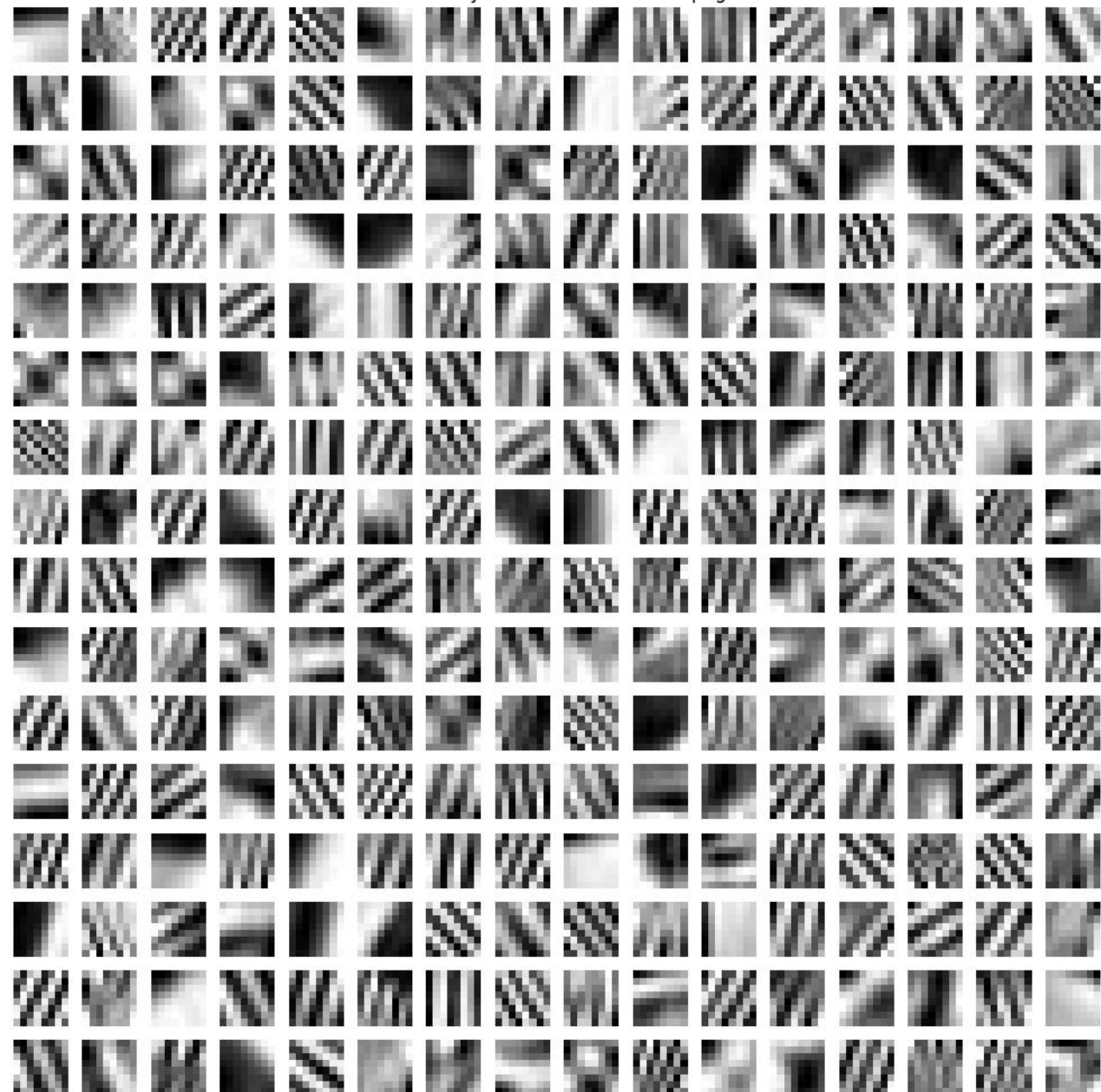
Dictionary learned from cameraman.png



Image barbara.png



Dictionary learned from barbara.png



Assignment 2: Denoising with learned dictionaries

Denoise the image *barbara.png* with OMP using learned dictionaries

Original image (barbara.png)



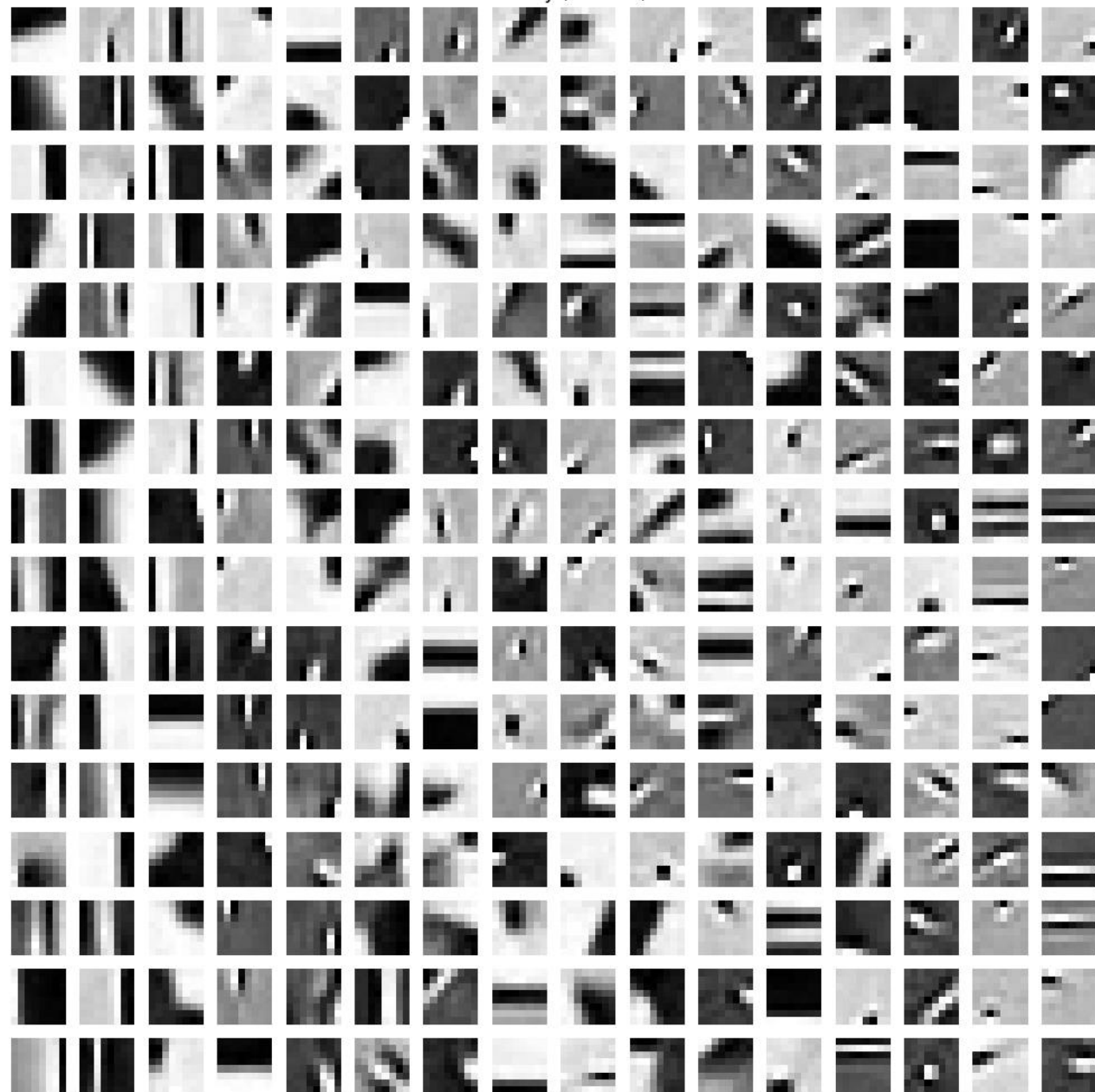
Noisy image, PSNR = 22.12



Assignment 2: Denoising with learned dictionaries

- Learn distinct dictionaries:
 - D_{diff} from a different image (e.g., *cameraman.png*)
 - D_{noisy} from the noisy image
 - D_{clean} from the clean image
- Perform OMP denoising using the generic dictionary of the previous assignment, D_{diff} , D_{noisy} and D_{clean}
- Compare the results

Dictionary (Generic)



Denosed image, PSNR = 27.68



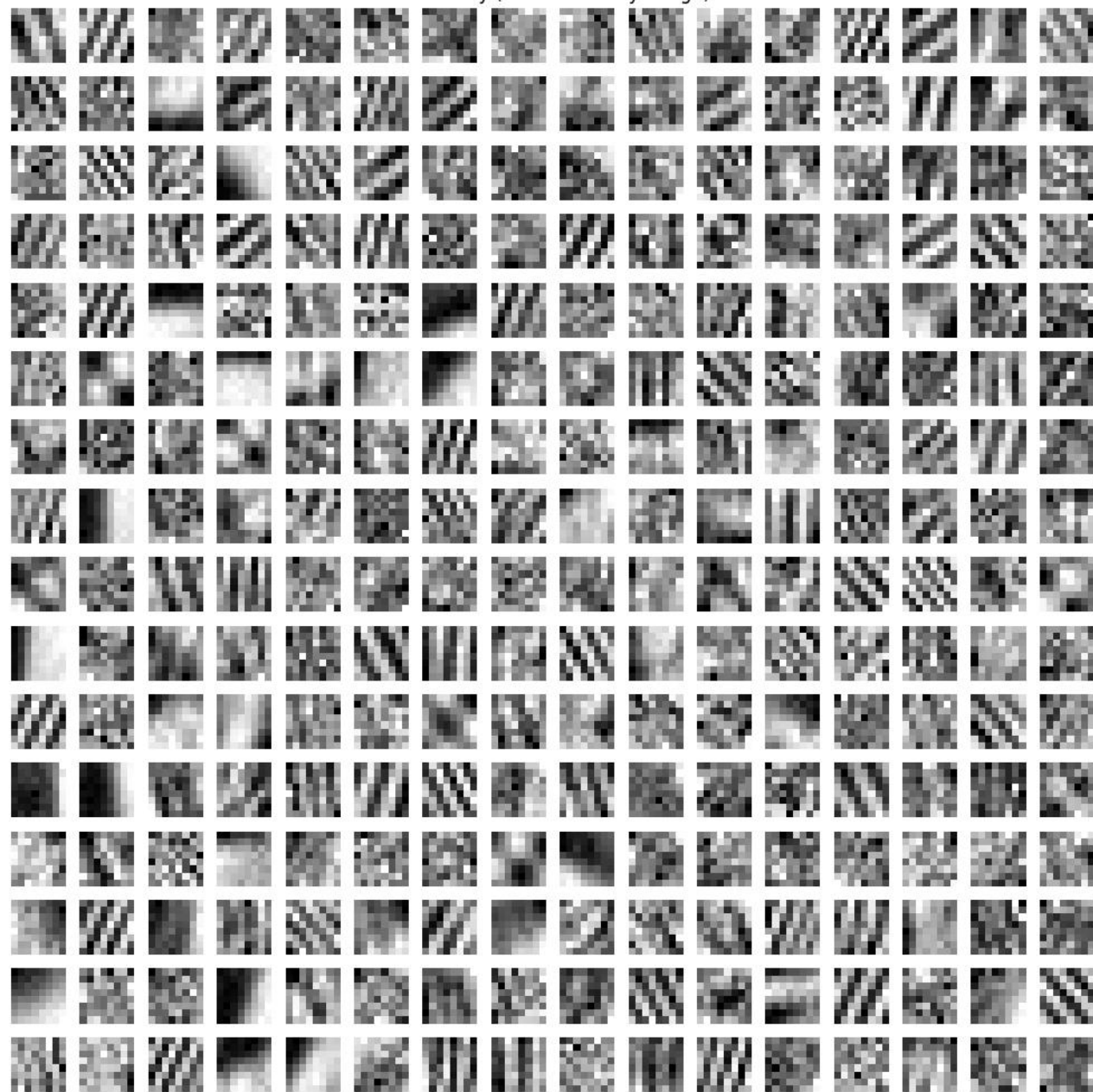
Dictionary (From a different image)



Denosed image, PSNR = 27.94



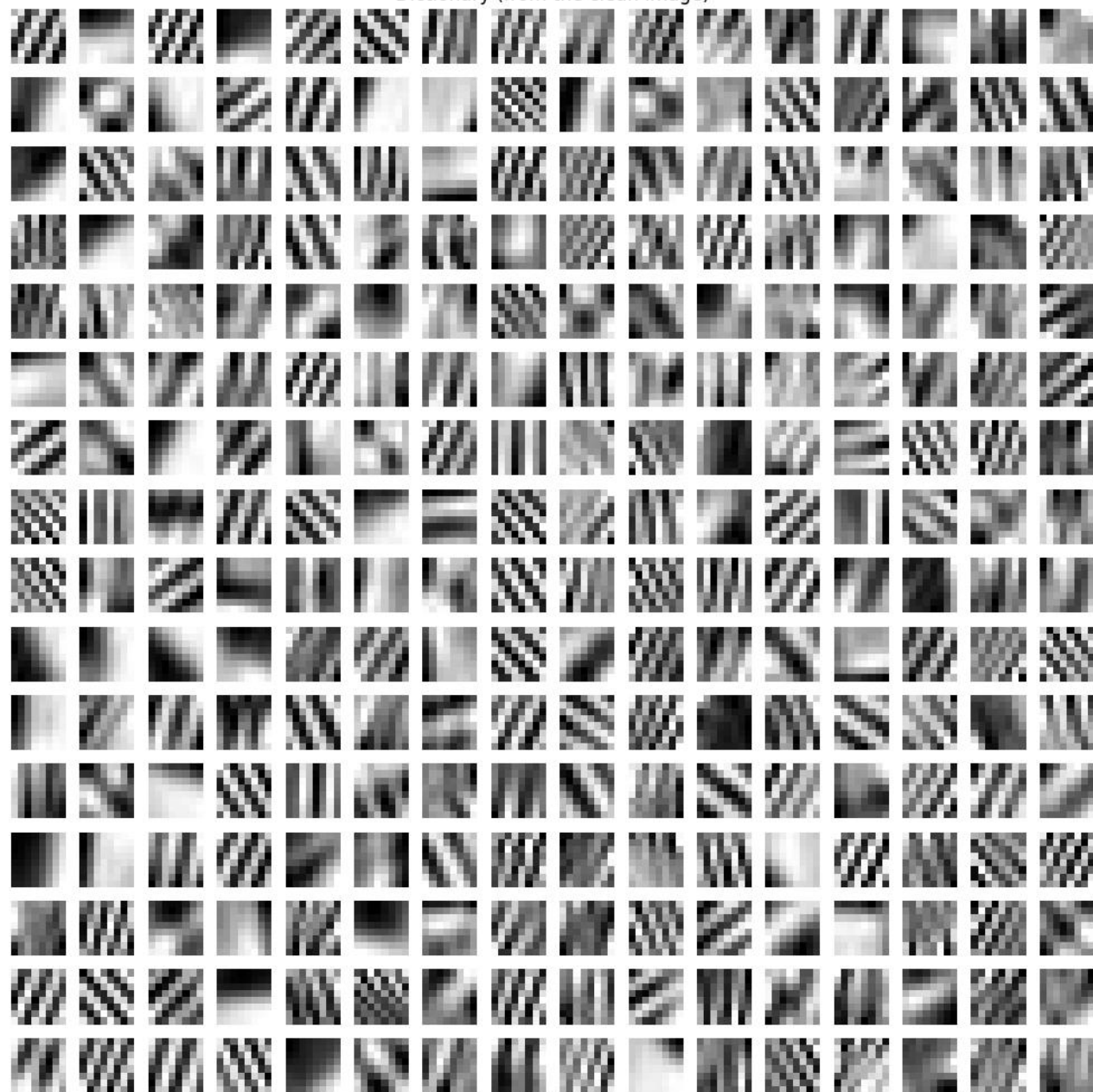
Dictionary (From the noisy image)



Denosed image, PSNR = 28.89



Dictionary (from the clean image)



Denosed image, PSNR = 29.39



Extra Assignment 1: Learn textures

- Download few texture-rich images from the Brodatz dataset (<https://sipi.usc.edu/database/database.php>)
- Use KSVD to learn dictionaries from these images
- Try with different patch sizes

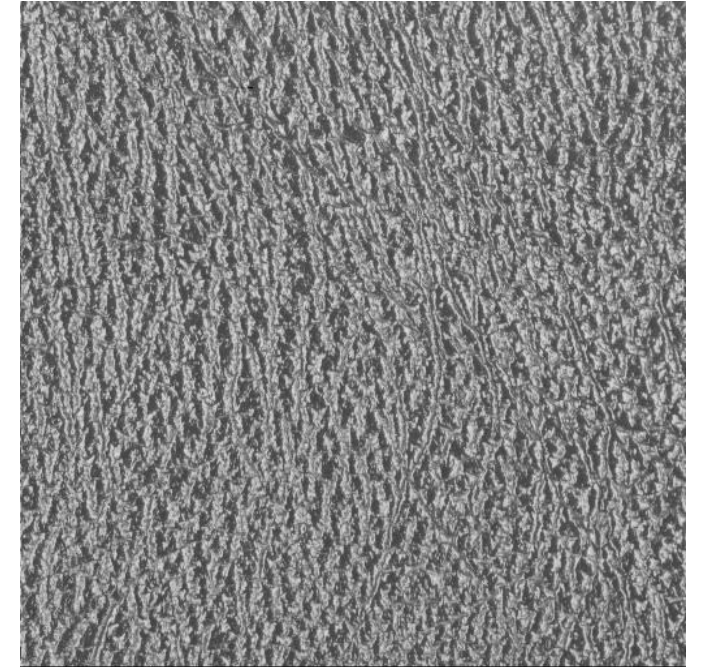
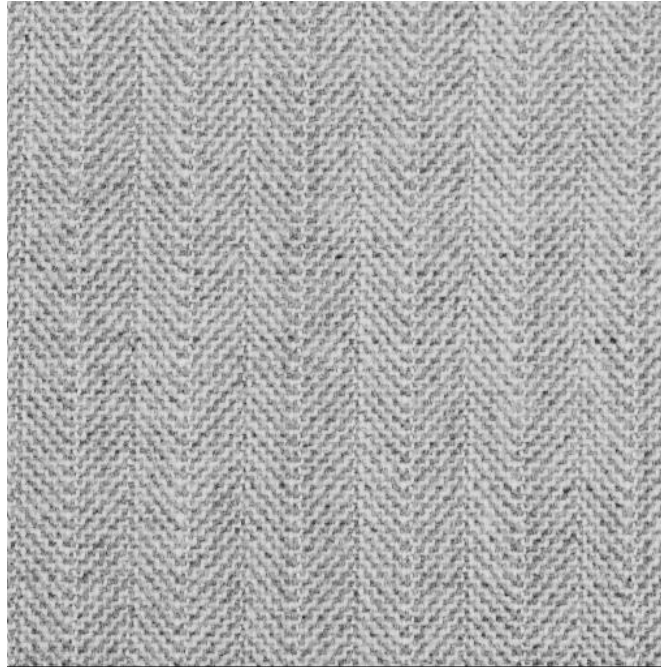
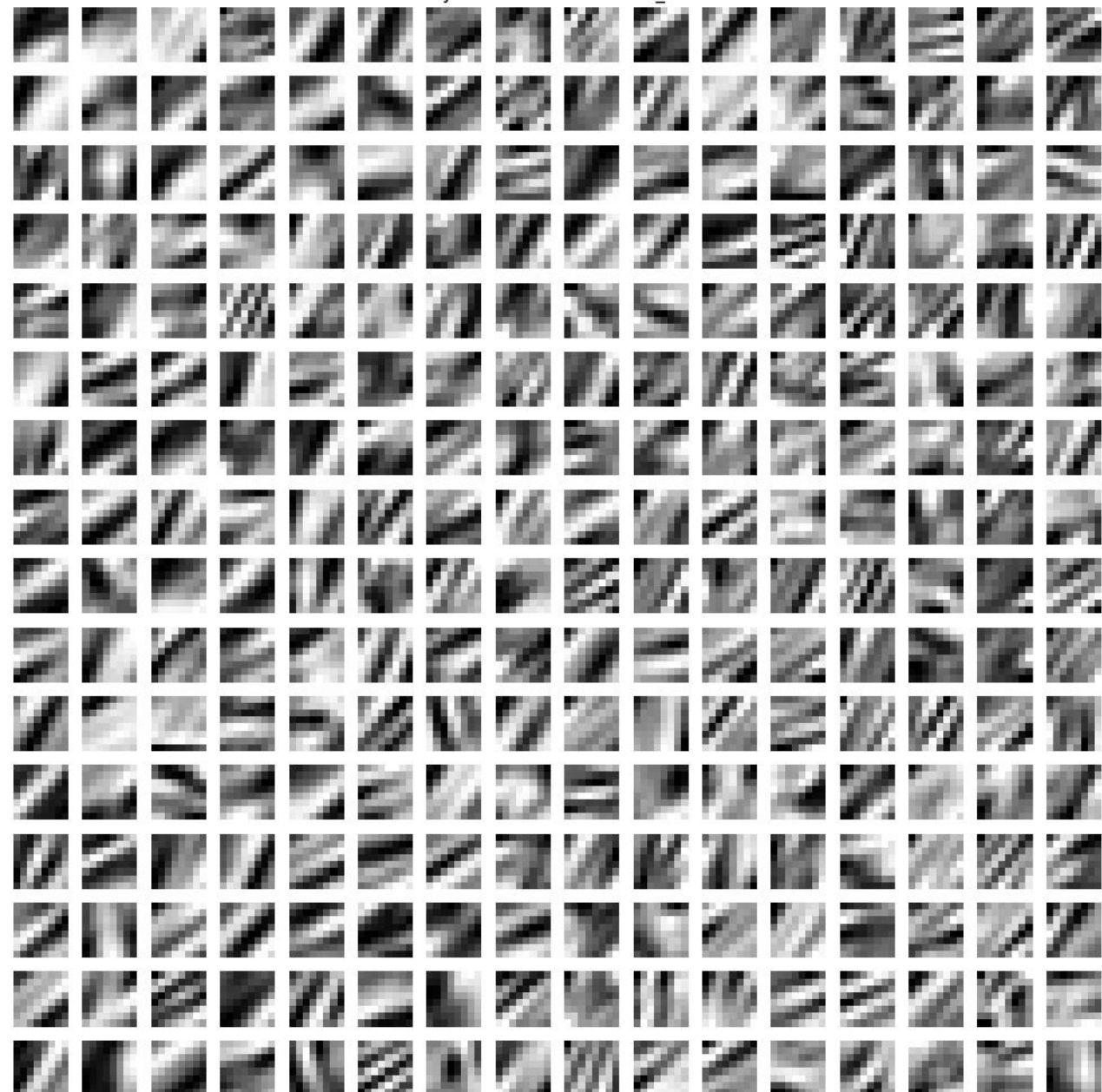


Image brodatz_1.1.03.tiff



Dictionary learned from brodatz_1.1.03.tiff

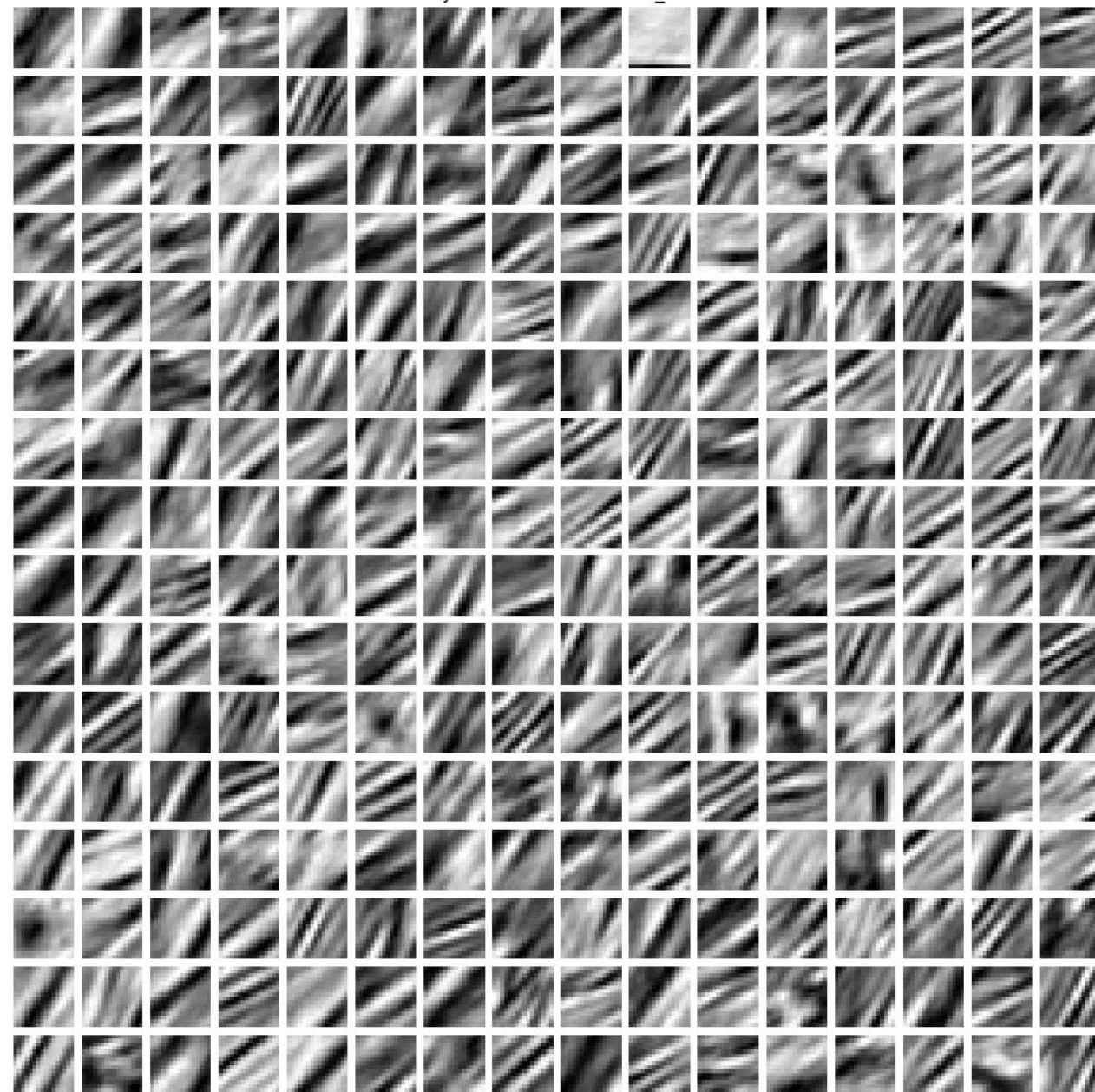


$p = 8$

Image brodatz_1.1.03.tiff



Dictionary learned from brodatz_1.1.03.tiff



$p = 16$

Extra Assignment 2: Inpainting with learned dictionary

- Use KSVD to learn the dictionary D from the clean image
- Use this image-specific dictionary to perform inpainting