

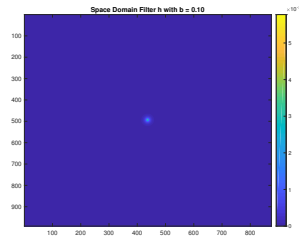
EECS 4422 Assignment 1 Report

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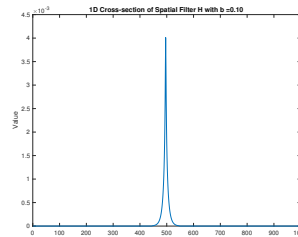
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1 Wiener Filter

1.1 Beta = 0.1

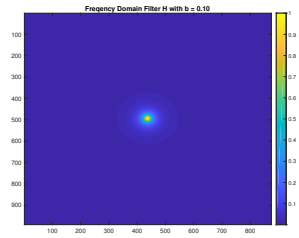


(a) Filter

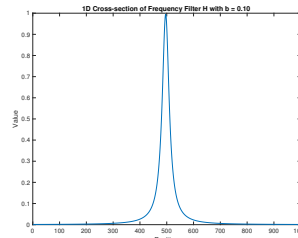


(b) 1D Cross-section

Figure 1: Spatial filter with beta = 0.1



(a) Filter



(b) 1D Cross-section

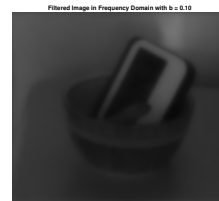
Figure 2: Frequency filter with beta = 0.1



(a) Original image



(b) Space domain



(c) Frequency domain

Figure 3: Filtered images with beta = 0.1

1.2 Beta = 10

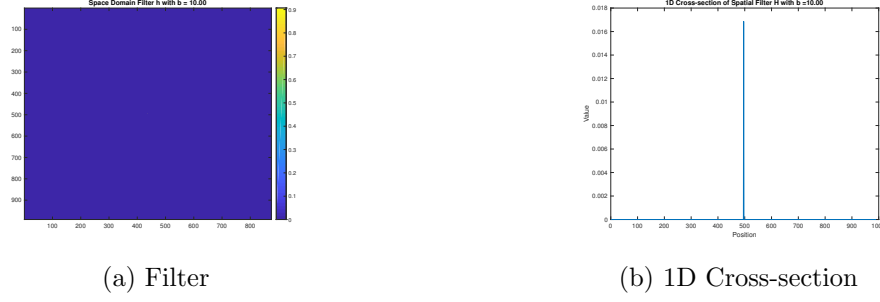


Figure 4: Spatial filter with beta = 10

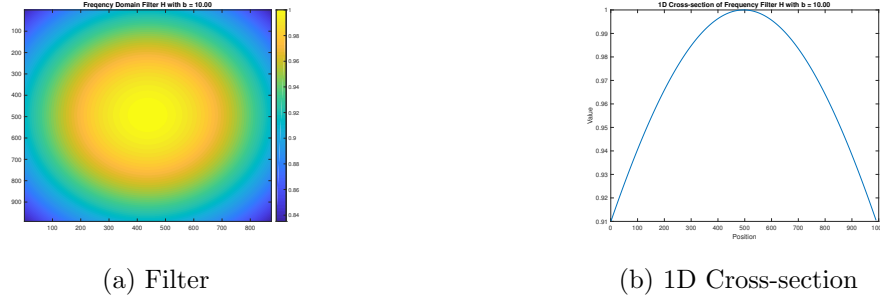


Figure 5: Frequency filter with beta = 10

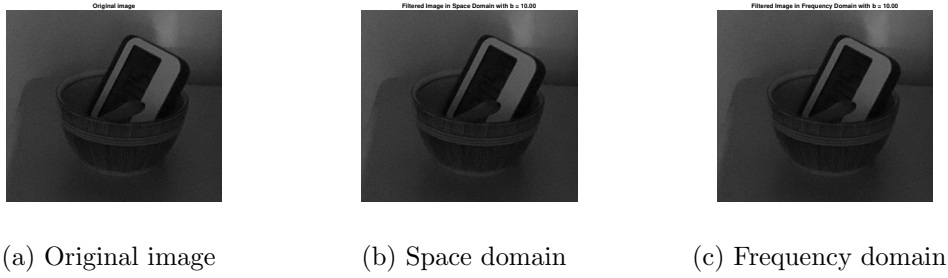


Figure 6: Filtered images with beta = 10

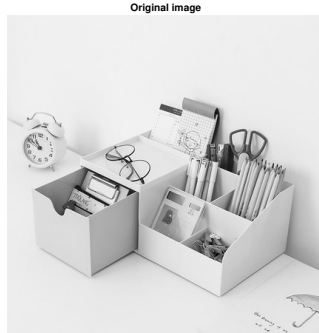


Figure 7: Best perceptual result

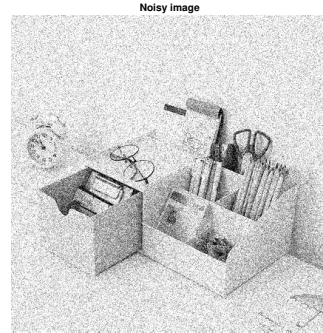
The execution time in space domain and frequency domain are, 0.3955 and 0.3174, respectively, when β is equal to 0.1. The execution time in space domain and frequency domain are, 0.0831 and 0.0452, respectively, when β is equal to 10. I may use frequency filter for both $\beta = 0.1$ and $\beta = 10$ since the calculation is faster and the frequency filtered

image looks the same as spatial filtered image but without dark boundary. When β is less than 4, I would switch from filtering in the space domain to filtering in the Fourier domain. When $\beta = 0.25$, it produces the best perceptual result.

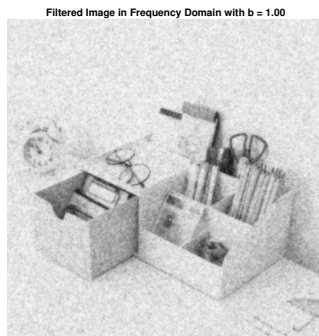
2 Wiener and Gaussian Filters



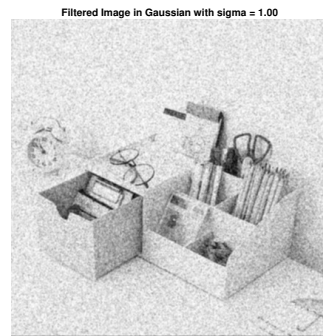
(a) Original image



(b) Noisy image

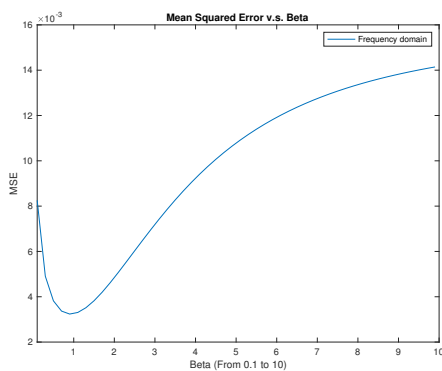


(a) Wiener filter

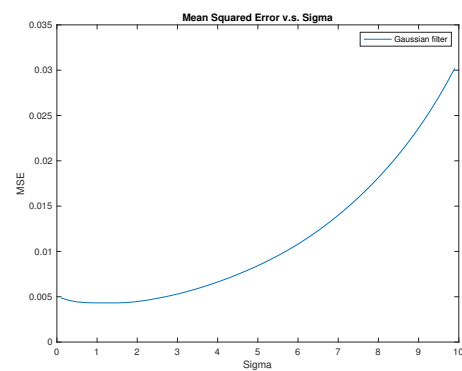


(b) Gaussian filter

Figure 9: Filtered image with optimal value that minimize the MSE



(a) MSE vs. Beta



(b) MSE vs. Sigma

Figure 10: MSE plot as a function of parameter

The standard deviation of the original image is 0.1512. The execution time for Wiener filter and Gaussian filter are 0.0232 and 0.0050, respectively with optimal parameter value

that $\beta = 1.00$ and $\sigma = 1.00$. The MSE of Wiener filtered image is 0.0033 and the MSE of Gaussian filtered image is 0.0044 compare with original image without noise.

Wiener filter has less MSE and it works better with random noise, but the results are often too blurred and loss details on edges. Wiener filter is slow since it works in frequency domain. Gaussian filter has less execution time and it reduces the edge blurring, but it doesn't have better performance for denoising.

3 Bilateral Filter



Figure 11: Bilateral filtered image

By using bilateral filtering, I can obtain superior MSE which is 0.0028 and the perceptual quality is slightly better compare with the results of Wiener filter and Gaussian filter. It doesn't remove all the noise, but it makes some improvement for denoising.