Image Processing Homework 3 Report
Image Restoration

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1 Degradation Model

The point spread function of a linear motion blur is a line segment. By observation, I chose 25 as the kernel size, and the angle of motion is 45 degrees. After DFT the spectrum becomes a sinc function which met the function in the textbook.

$$H(u,v) = \frac{T}{\pi(ua+vb)}\sin[\,\pi(ua+vb)]e^{-j\pi(ua+vb)}$$

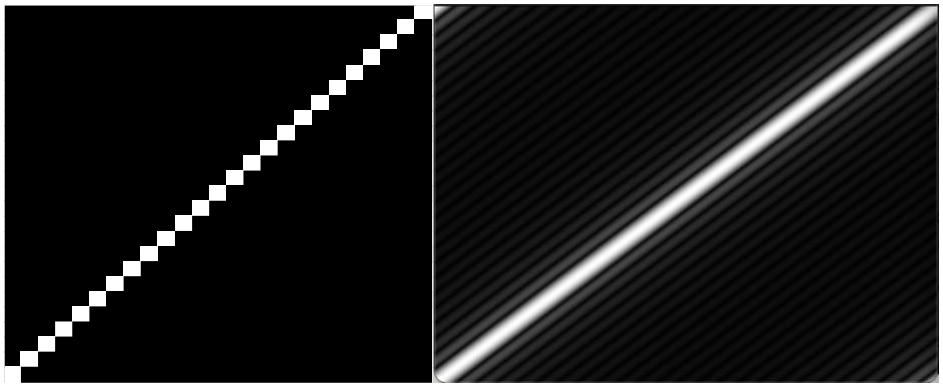

Figure 1. (left) Point spread function and (right) optical transfer function of motion blur.

Furthermore, the image is also blurred by a Gaussian smooth. So, the degradation function should be multiplied by the Gaussian smooth optical transfer function.

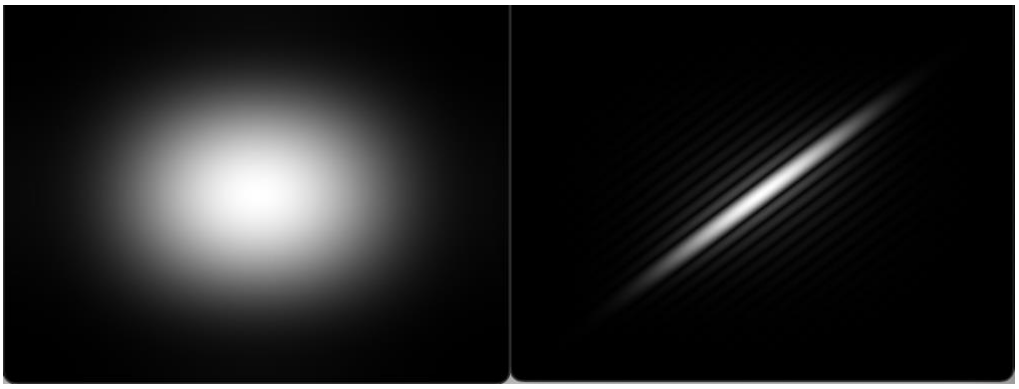

Figure 2. (left) OTF of Gaussian blur. (right) OTF of Gaussian + motion blur.

2 Restoration Method

To avoid the noise in the blurred image dominating the restored image. The Wiener filter is a good method. Assume the OTF of degradation function is given as H, Weiner filter H_W can be calculated by the following:

$$[\frac{1}{H(u,v)}\frac{|H(u,v)|^2}{|H(u,v)|^2+K}]$$, which K is constant.

The constant K is a hyperparameter, that should be set by a suitable value by testing. The value is close to the inverse filter in the low frequency and is suppressed in the high frequency. K = 0.05 is chosen after many times of test.

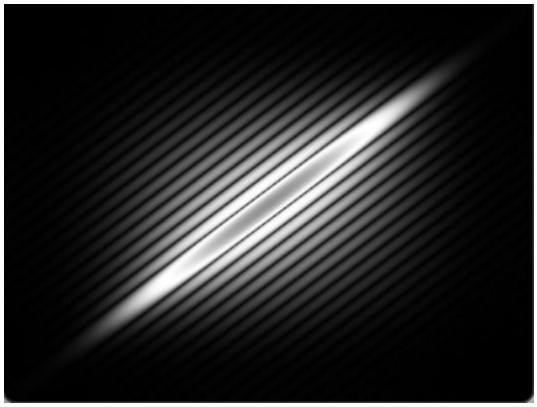

Figure 3. OTF of Wiener filter.

3 Result

The Wiener filter effectively restores the impact of motion blur. To see to number more clearly, I do the sharpness enhancement after Wiener filtering.

Figure 4. (left) Weiner filtering. (right) Wiener filtering + sharpness enhancement

Figure 5. Number in output2