Southern University of Science and Technology

Digital Image Processing

Lab 3 Report

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Frequency Domain Filtering

Question 1: Frequency domain Sobel Filter

According to the procedure of frequency domain filtering, there are eight steps to apply the computation. In fact, step no.5, generating filter function, consists of multiples steps. Here I will show some of the step's result:

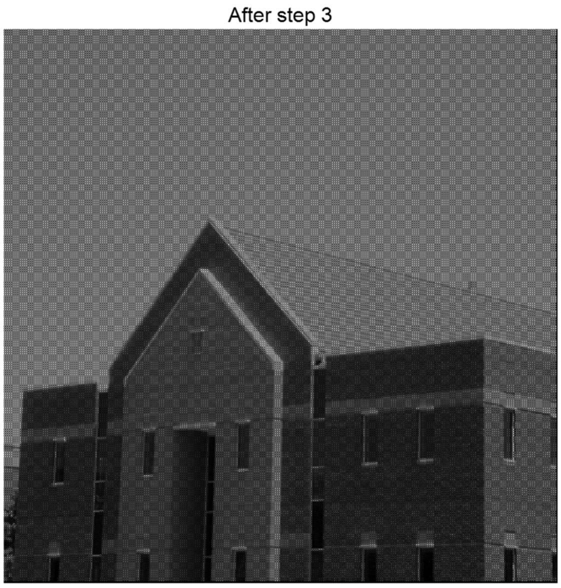

Figure 1, padded and shifted

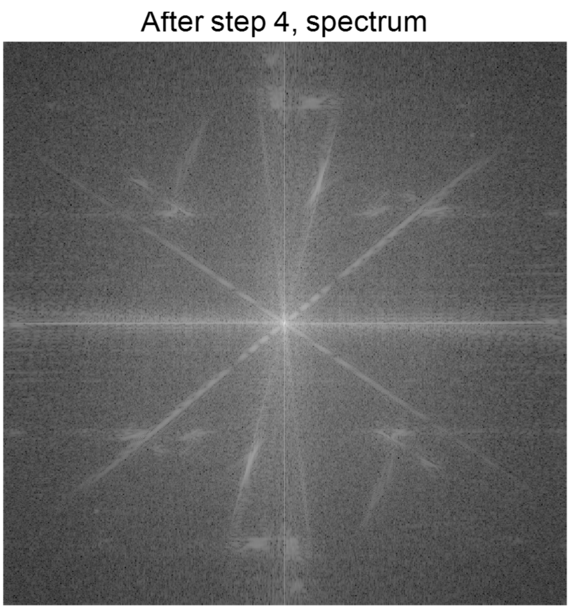

Figure 2, spectrum

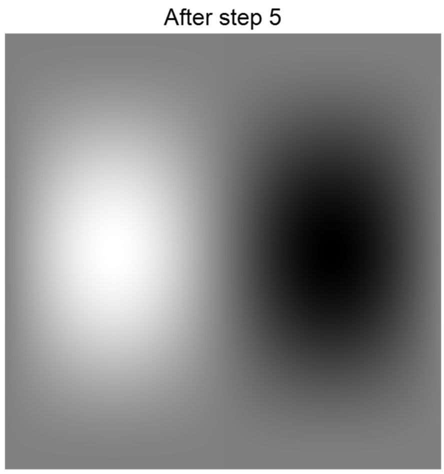

Figure 3, Sobel filter in frequency domain

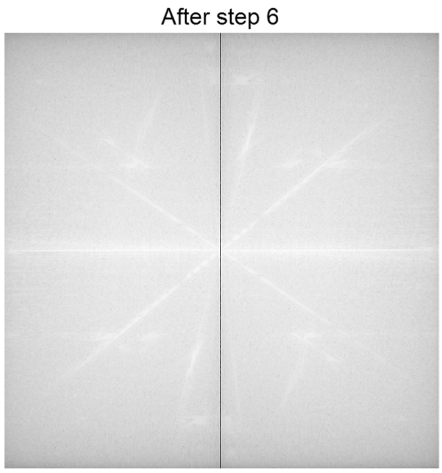

Figure 4, Filtered spectrum of input image

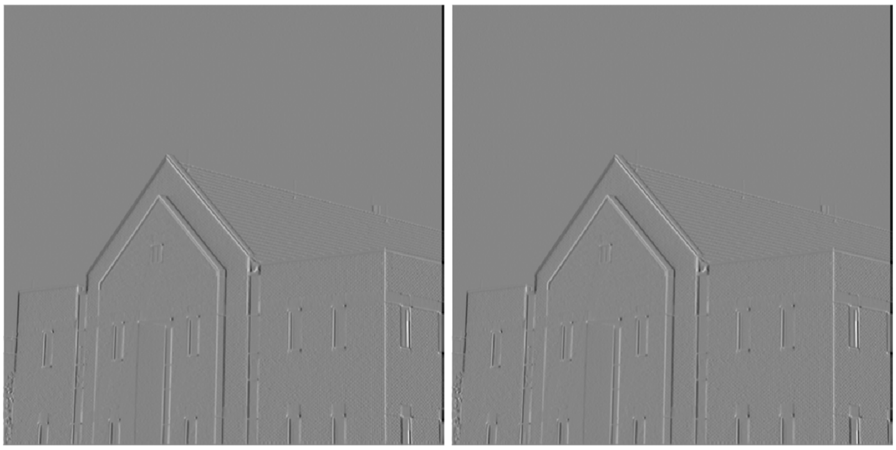

Figure 5, Left: Sobel of frequency domain Right: spatial domain

Finally, we can see the result of two domains are almost the same.

When generating the frequency domain filter, step 4 is to multiply the result by $(-1)^{u+v}$. This is to move the padded filter to the center, so that the correct part of the image and the filter could be multiplexed.

Question 2: Gaussian Filter

In order to generate the Gaussian filter, we must generate the distance matrix D(u,v) in advance. Then we can generate the Gaussian filter, according to the equation in slide 97.

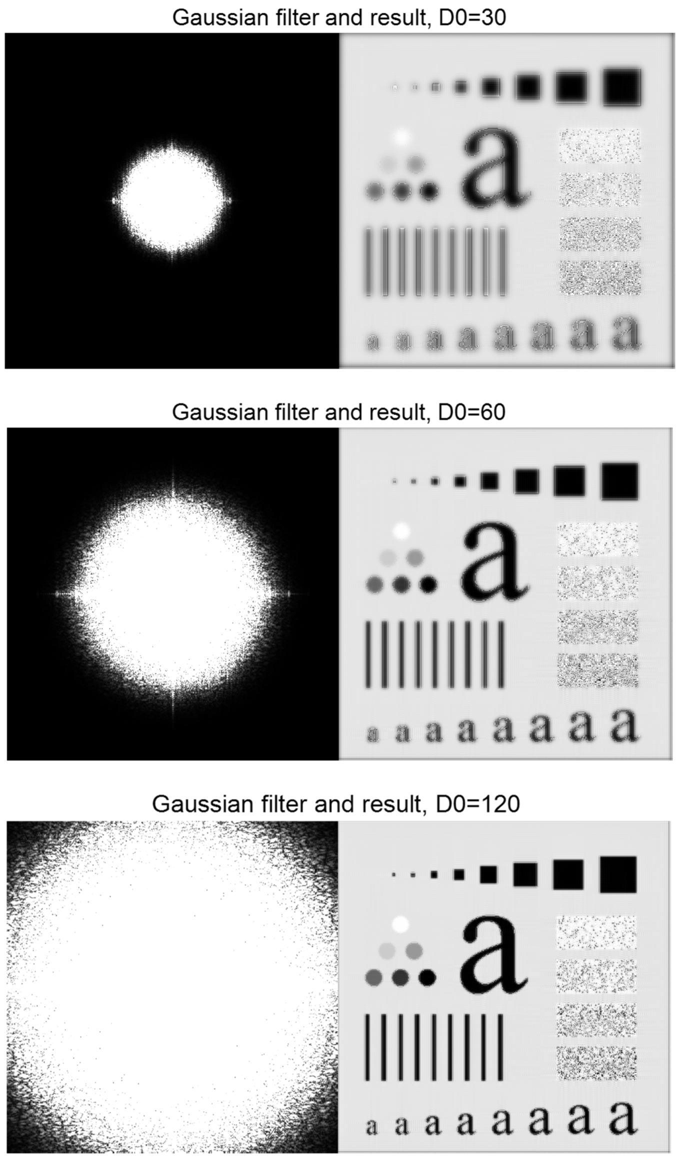

Figure 6, Results of Gaussian filter with different D0

When D0 increases, the output image becomes less vague. Therefore, on the contrary, the smaller D0 makes the image vaguer.

Since D0 has a similar effect of cut-off frequency, smaller D0 means less high frequency components, which makes the image vaguer. If there is high frequency noise in the filter, it is better to apply smaller D0. However, this will also filter out the edges of the image, so be careful when the input image contains much information with edges.

Question 3: Butterworth Notch Filter

When observing the spectrum of the input image, we can see four pairs of highlighting dots. Therefore, we need to use a cascade of four Butterworth notch filters. Since the filtering is in frequency domain, I compute the multiplication of those four filters in advance, then multiply the filters with the spectrum of input image. Each of the four filters consists of two symmetrical parts, in order to keep the zero-phase property of the filter.

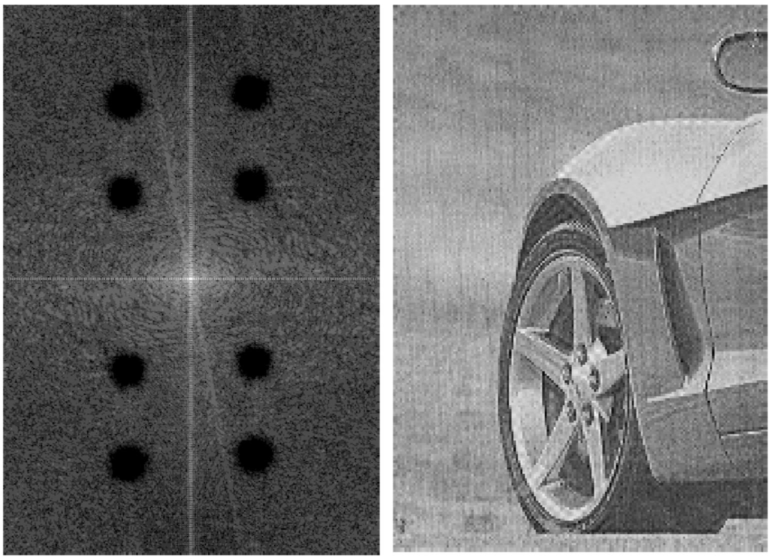

Figure 7, Left: Filtered frequency domain Right: Filtered special domain

For uk and vk, which are the position of the center of the notch filters, I manually figured out the coordinate of the highlighting dots on the spectrum. I think that there might be smarter method to automatically get the positions, but I couldn’t figure out. Even though, the filter works perfectly with this specific input image, cleans out the moiré pattern of the original image.