Section 2

The task: Consider the centered DFT for *dew on roses (noisy).tif* and *tulips irises.tif*, (i) resynthesize the images using the DFT coefficients inside the circular region with radius=30 pixels (based on the original image size), plot the resulted images; (ii) similar to problem (i), however, use the DFT coefficients outside the circular region.

Figure 2-1

Figure 2-2

Background

This section refers to Filtering in Frequency Domain problem. For such purpose given image *dew on roses (noisy).tif* (Figure 2-1) and *tulips irises.tif* (Figure 2-2).

Steps to implement this task:

1. Given an input image *f(x, y)* of size *MxN* obtain the padding parameters *P* and *Q*. Typically, we select *P=2*M* and *Q=2*N*. This process is called zero padding. I used two kind of padding (Figure 2-4, 2-5), but still got the same results.

2. Compute the DFT of input image, *f(x,y)*, Eq. (2-1) after zero padding (1024x1024).

$$F(u,v) = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x,y) * e^{-i*2*\pi*(u*\frac{x}{M}+v*\frac{y}{N})} \quad (2\text{-}1)$$

3. Translate to center of the frequency rectangle, Eq. (2-2), Figure 2-6:

$$F'(u,v) = F(u-\frac{M}{2}, v-\frac{N}{2}) \quad (2\text{-}2)$$

4. We have two problems: consider obtained DFT coefficients inside the circular region = 30 pixels (based on the original image size, it means that we will use value = 60 pixels, because of zero padding and increasing original image to 1024x1024); consider obtained DFT coefficients outside the same circular region.

5. Use Eq. (2-3) to get circle. Each pixel makes equal to zero when *D(u,v)>=60* for the first problem (Eq. (2-5), Figure 2-8, Figure 2-10) and makes each pixel equal to zero when *D(u,v)<=60* for the second problem (Eq. (2-4), Figure 2-7, Figure 2-9).

$$D(u,v) = [\left(u-\frac{P}{2}\right)^2 + \left(u-\frac{Q}{2}\right)^2]^{1/2} \quad (2\text{-}3)$$

$$G(u,v) = \begin{cases} F'(u,v), & D(u,v) \geq 60 \\ 0, & otherwise \end{cases} \quad (2\text{-}4)$$

$$G(u,v) = \begin{cases} F'(u,v), & D(u,v) \leq 60 \\ 0, & otherwise \end{cases} \quad (2\text{-}5)$$

6. Compute the IDFT for both problems by using Eq. (2-6).

$$f(x,y) = \frac{1}{MN} \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} F(u,v) * e^{-i*2*\pi*(u*\frac{x}{M}+v*\frac{y}{N})} \quad (2\text{-}6)$$

7. Crop obtained image (512x512).

Algorithm, Flow chart

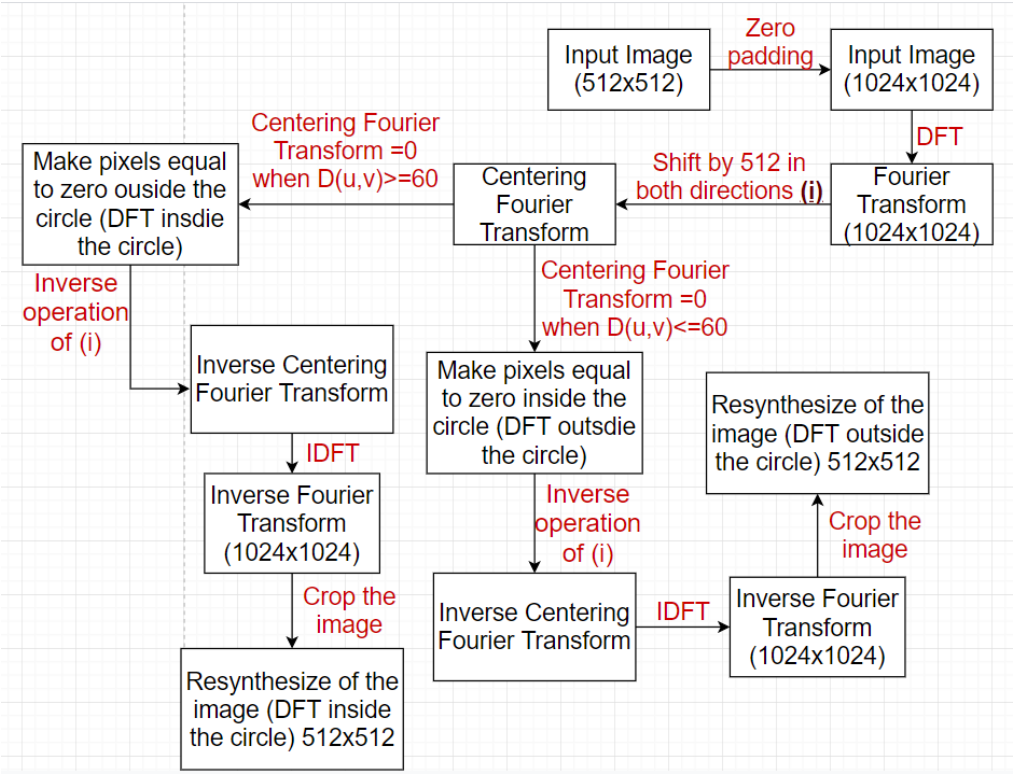

Figure 2-3

Results

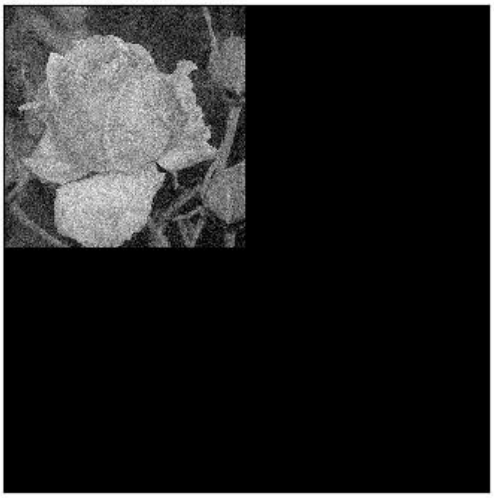

Figure 2-4

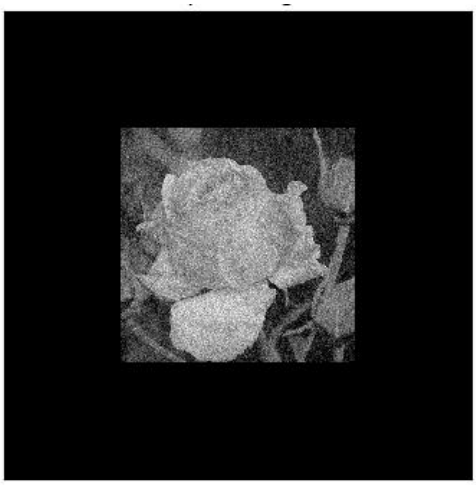

Figure 2-5

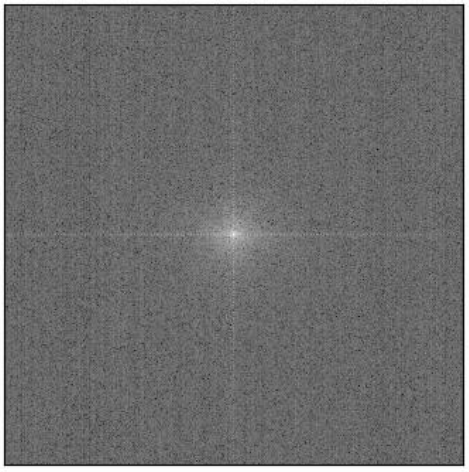

Figure 2-6

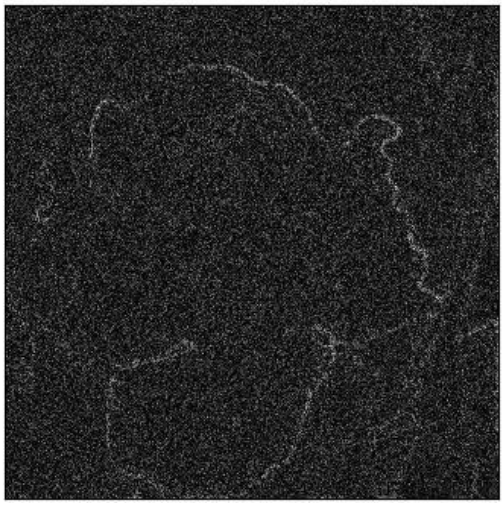

Figure 2-7

Figure 2-8

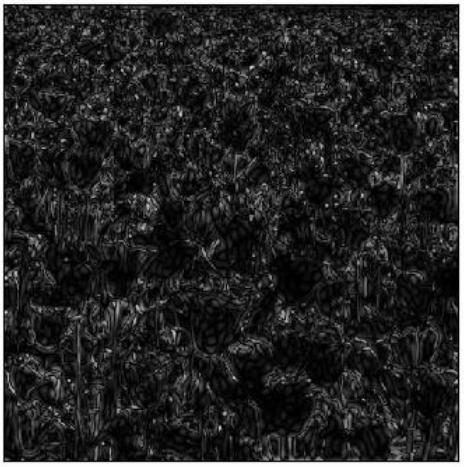

Figure 2-9

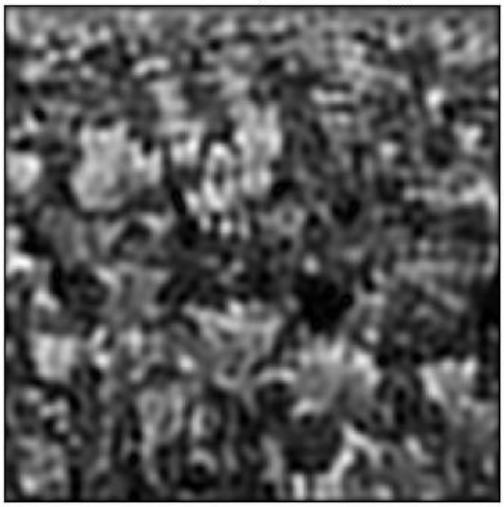

Figure 2-10

Discussions

We can notice that in the first problem (using the DFT coefficients inside the circular region) we are dealing with Lowpass filter and in the second problem it is Highpass filter.