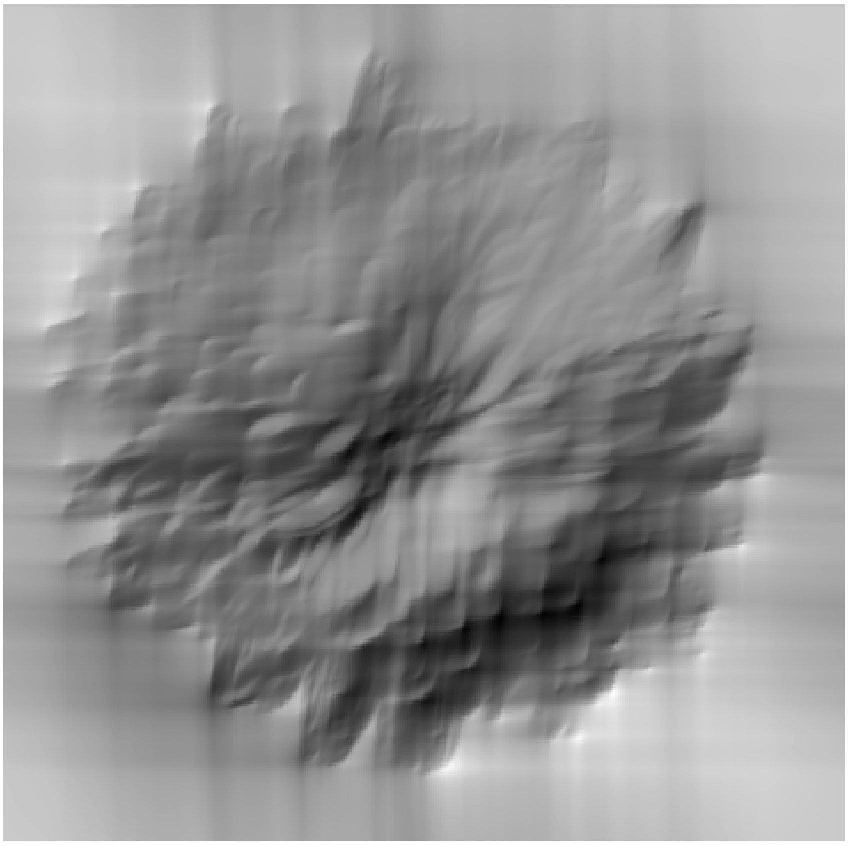
Introduction to image and video processing



Project 2:
Frequency domain filtering, processing

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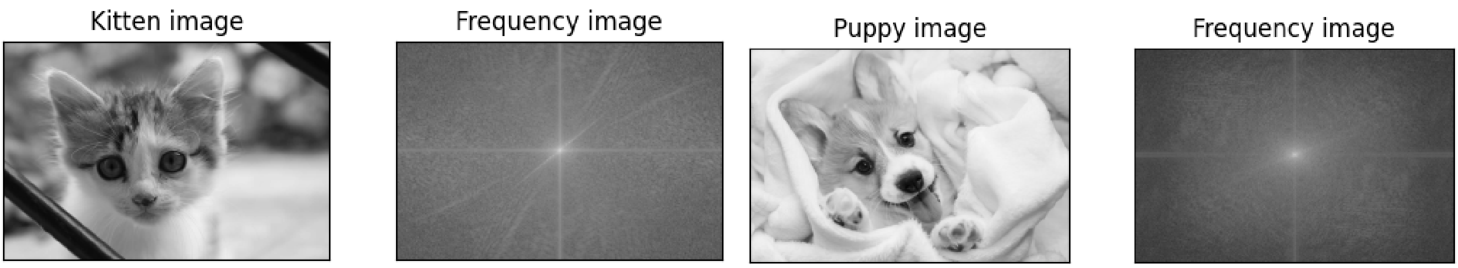
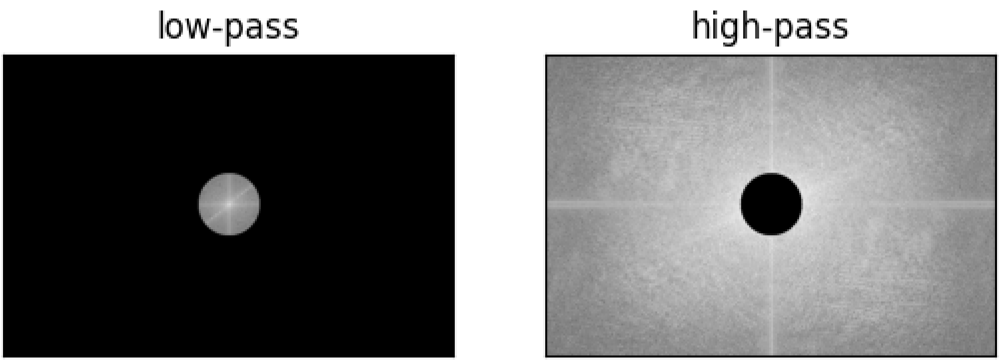
Exercise 1:

1) The two pictures used for this exercise are the following:

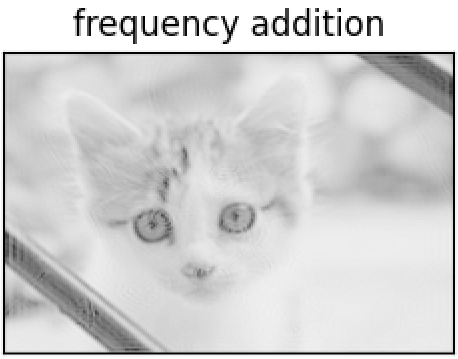
a) We want to apply a low-pass filter on the first image and a high-pass filter on the second one. It is therefore necessary to import the two images in gray-scale and apply the Fourier transform and both images. Once the resulting images shifted we have:

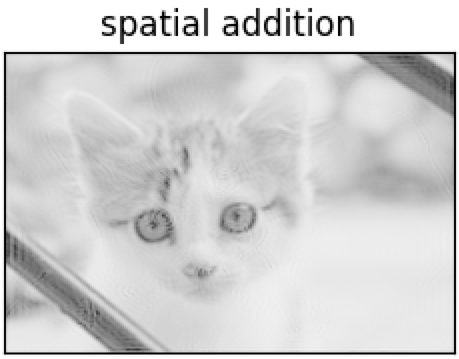


Afterwards, we can compute and apply the low and high-pass filters on the image in the frequency domain. We get the following images in the frequency domain:



We can now add, at first, both image in the frequency domain, then apply the inverse shift and the inverse Fourier transform to get a final image in the spatial domain.
We also add both images in the spatial domain after applying the same transformations stated above. We get the following images:

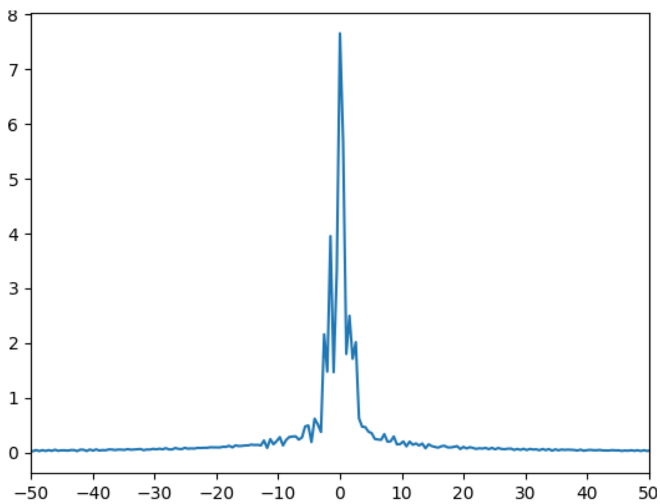


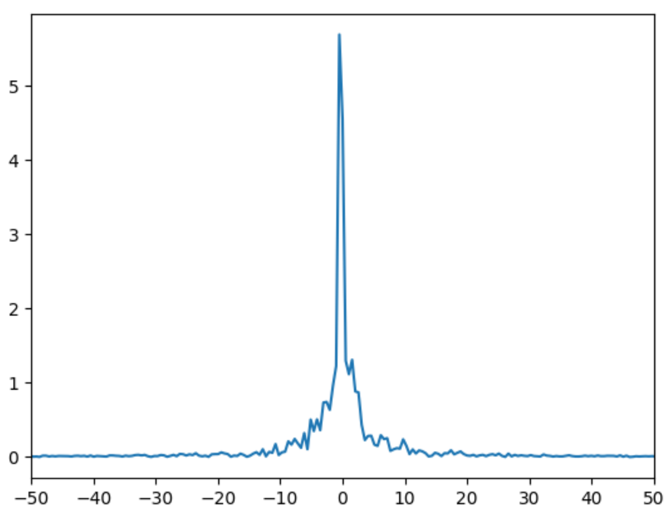


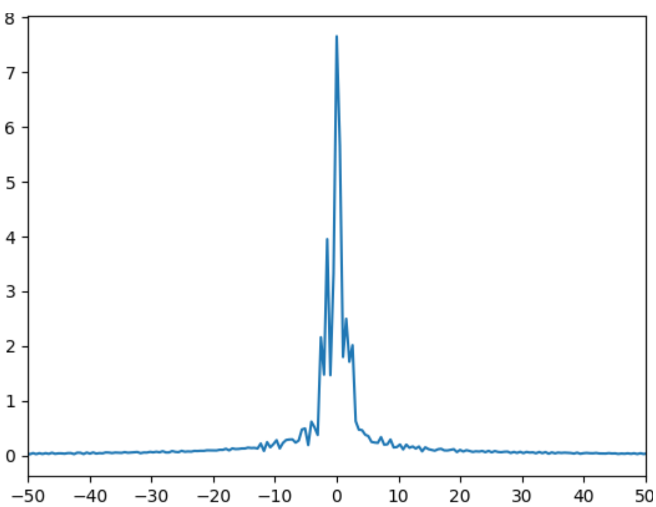
In addition, we can now compute the mean squared error(MSE) to determine whether the images are similar or not. The lower the MSE the more identical the images.
After computation we get the value: 4.505964894337213e-14
This value although infinitely close to 0 clearly shows that both images are almost identical.

b) Low-pass filtering alters the image by blurring all the sharp edges since it cuts down on high frequencies and magnifies lower frequencies. This allows us to see the shapes in the images and recognize objects even without all the details. On the other hand, the high-pass filter does the opposite. It tones down the lower frequencies and improves upon the higher ones. This creates clearer edges on the image.
Hence, it is easier to see the low-pass filtered image as shapes are easier to distinguish than edges.

c) We first plot the magnitude of the FT over the sampling frequencies of the two original images. We do the same for the produced image in question (a).







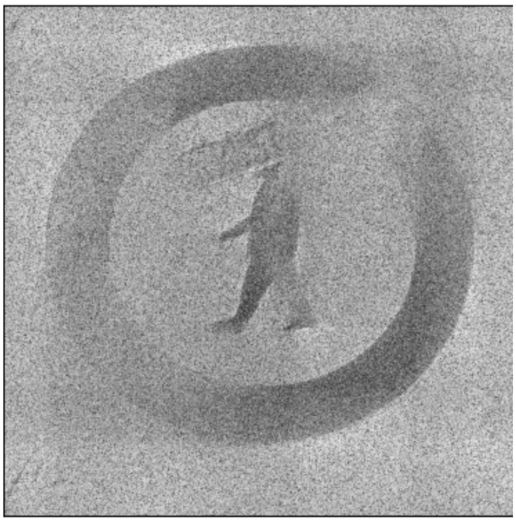
We can see that the frequency distribution of the two first images is similar, although values being larger for the first image. As for the produced image, we have the same plot as for the first original image since it is dominant over the second picture.

Exercise 2:

1) We want to apply the frequency degradation to an image. We must first convert our image from the spatial domain to frequency domain. Hence, we apply the Fourier transform and center it. We can now apply the filter to the FT of the original image and convert it back to spatial domain by decentering it and apply the inverse Fourier transform.

2)We now want to add random noise on the processed image. We do this by adding a random number between 150 000 and 200 000 black and white pixels on the processed image. Each added pixel has random coordinates. This ensures a different noise each time the image is processed.

seasoned image



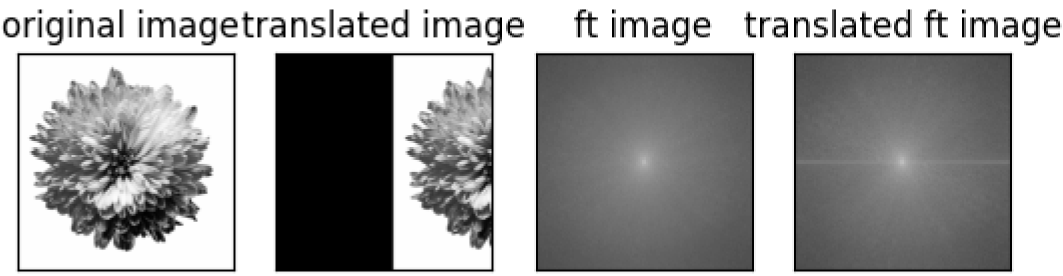
Exercise 3:

1) For this exercise the image that will be used is:

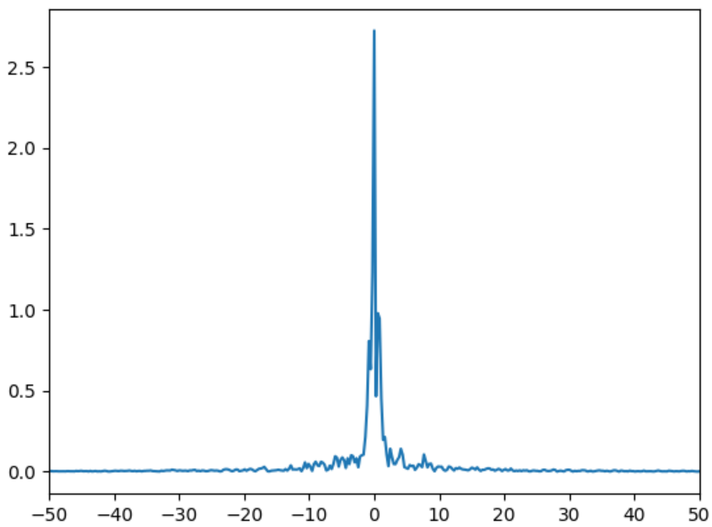
a) We want to compute the 2D FFT of the translated version of this image.

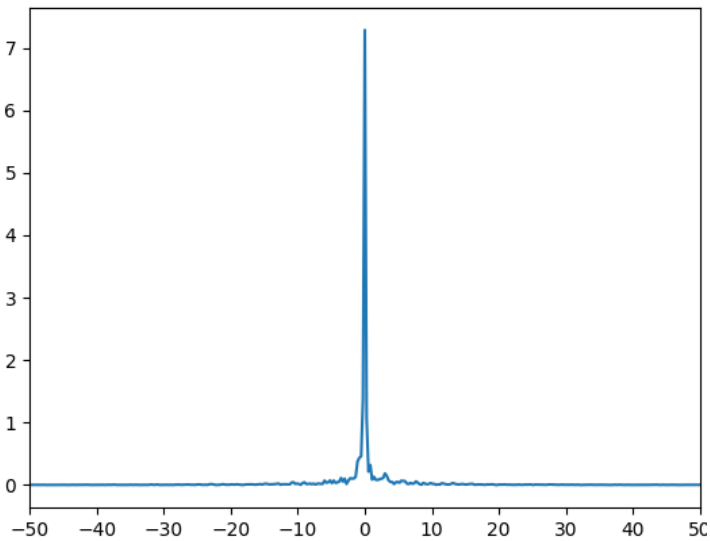
We first convert the original image in a gray-scale image to allow the FFT to be computed. We need to translated the image. We translate the image by 600 pixels to the right using a translation matrix.

Afterwards, we can compute the 2D FFT of the original image and its translated version. We have:



We can see that both images look different form each other. The process of shifting the original image affects its 2D FFT. This does also shows shows in the magnitudes of both images. We have much higher magnitudes on the translated image and fewer additional frequencies.

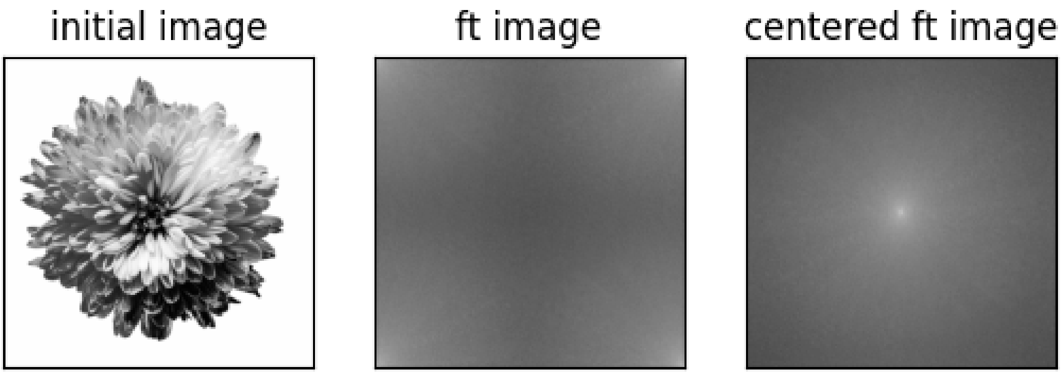




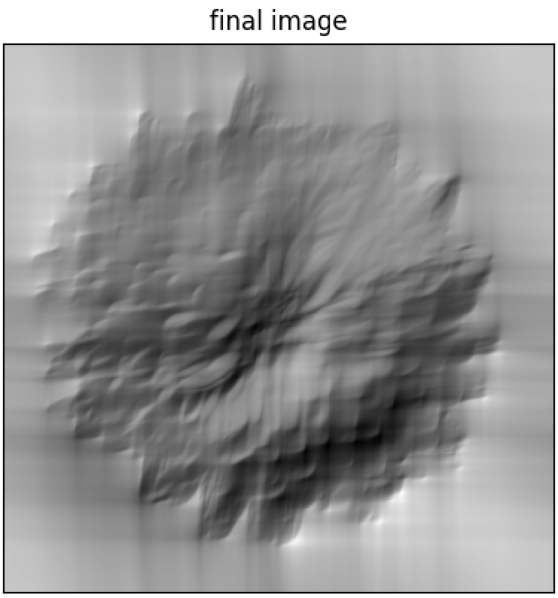
Exercise 4:

1) For this exercise the image that will be used is:

We first convert it to gray-scale, apply the Fourier transform and center it. We have the following images:



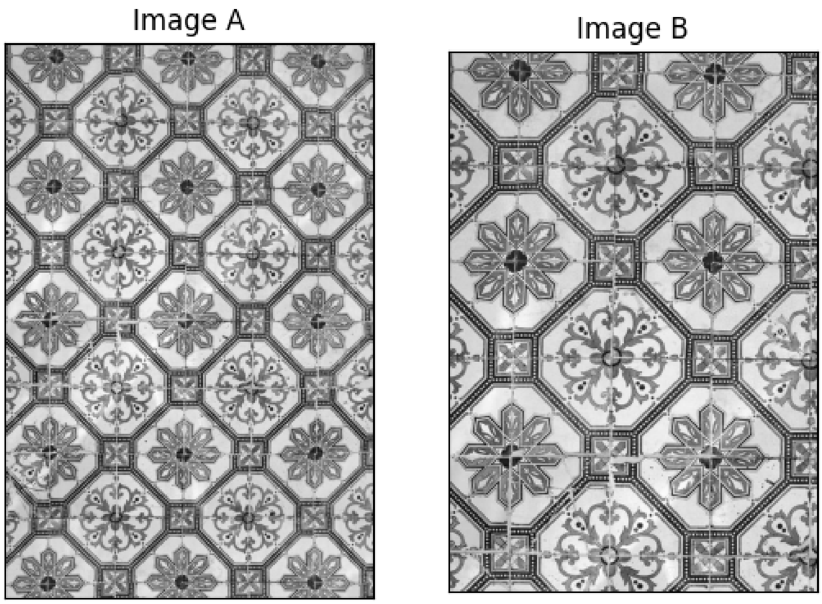
We can now apply the filter in the frequency domain with a x0 and y0 of 10. Afterwards, we convert it back to the spatial domain by decentering it and applying the inverse Fourier transform.



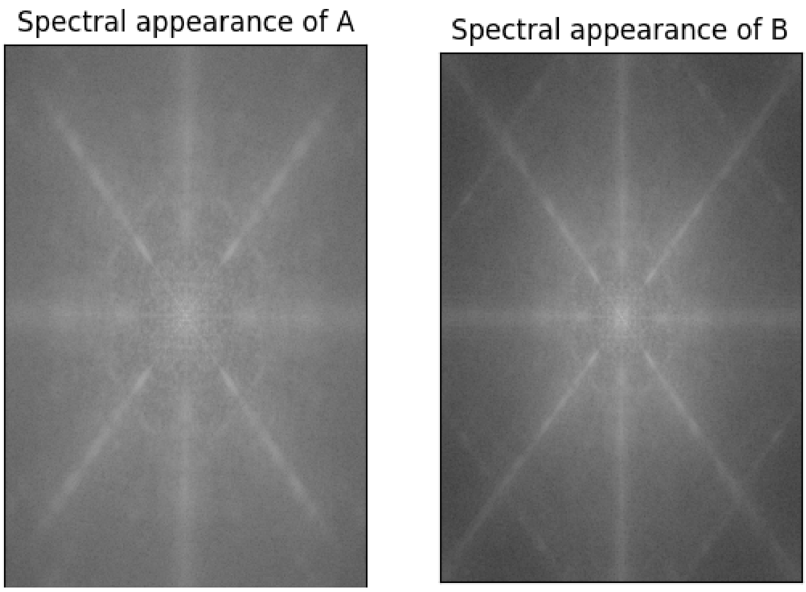
We can see that the filter works similarly to a blur.

Exercise 5:

For this exercise the images that will be used are:



After applying the Fourier transform and centering it we obtain:



We can see that the spectral appearance of image A shows a larger pattern than the spectral appearance of image B. It seems that the tendencies of the original images are inverted in the frequency domain images. Image A is wider photo of image B, but their spectral appearances shows the opposite, the FT of A is a zoomed in version of the FT of B.