Université de Genève

Imagerie Numérique
13X004

TP 12: Frequency domain filtering

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June 4, 2021

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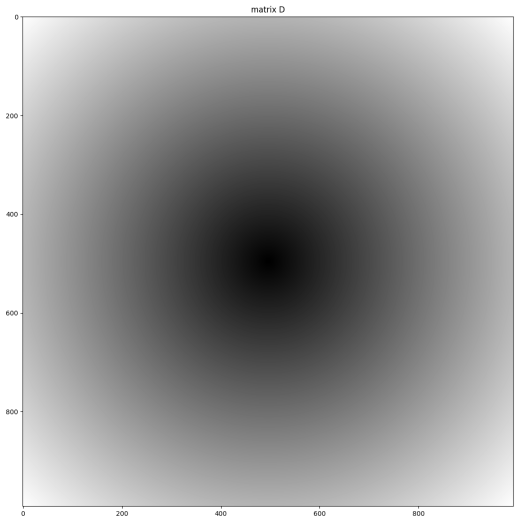
Intro

For the exercises that require the use of a distance matrix, I will us the following, as said matrix. Where the furthest point from the center is at around a distance of 700.

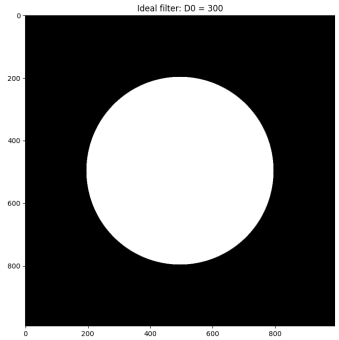


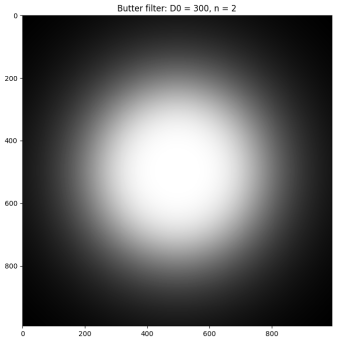
Exercise 1

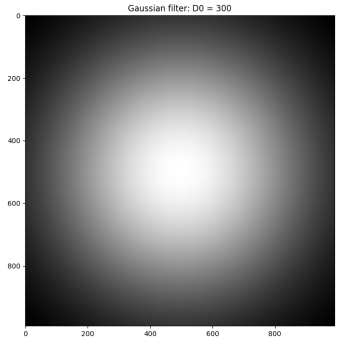
(pre a) First we have to create the noisy lena: MSE(lena, lena noisy) = 15822

(a) We now apply a Gaussian filter in the time domain, like in the previous TP6, we get a better quality visually, as e distribute the noise, but in regards to the mse, the filter got us a worse result: MSE(lena, lena gaussian filter) = 15824

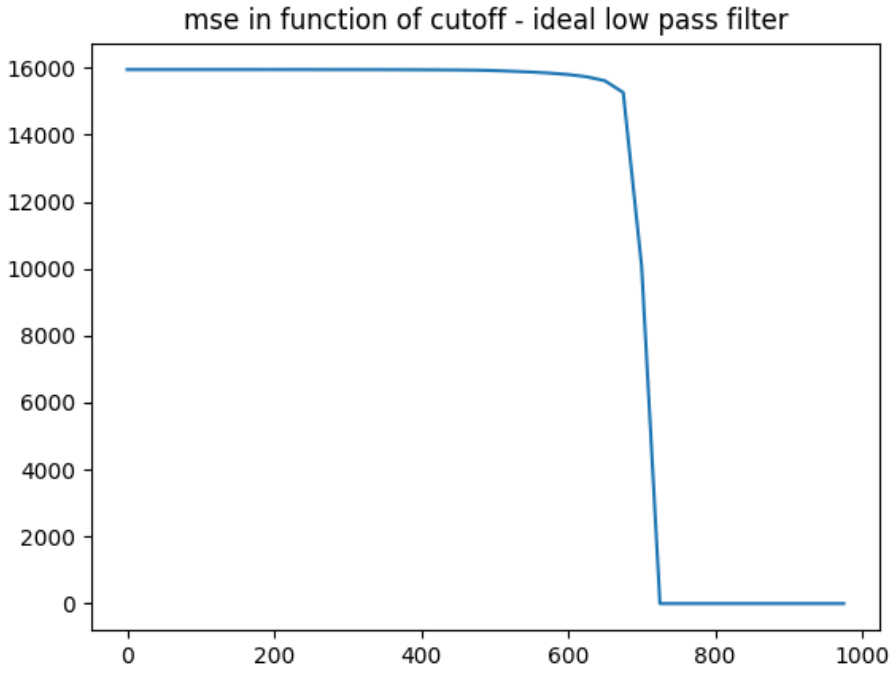
(b) In this exercise we will test 3 different low pass filters. I will now display what the filter matrices look like for every filter:

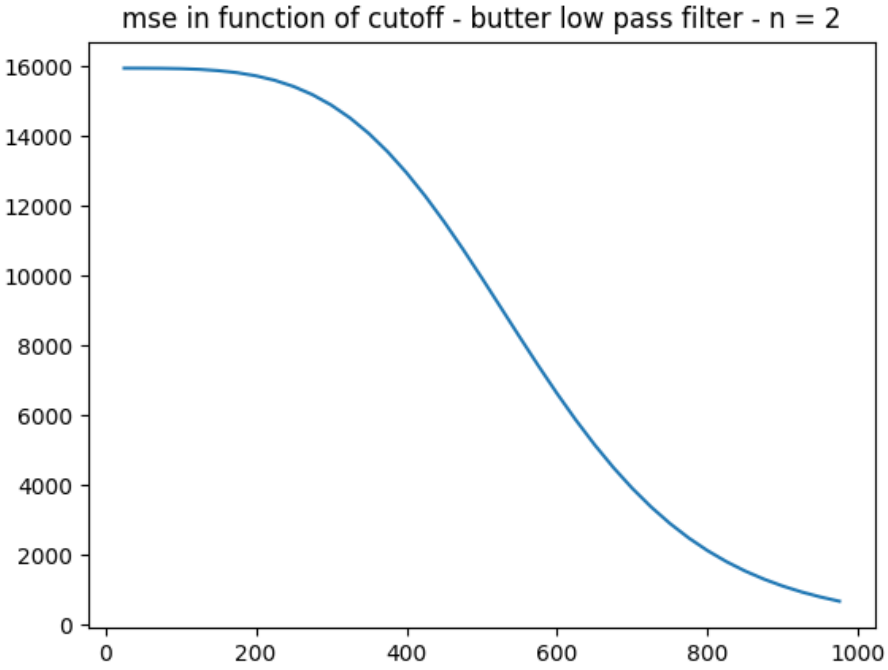


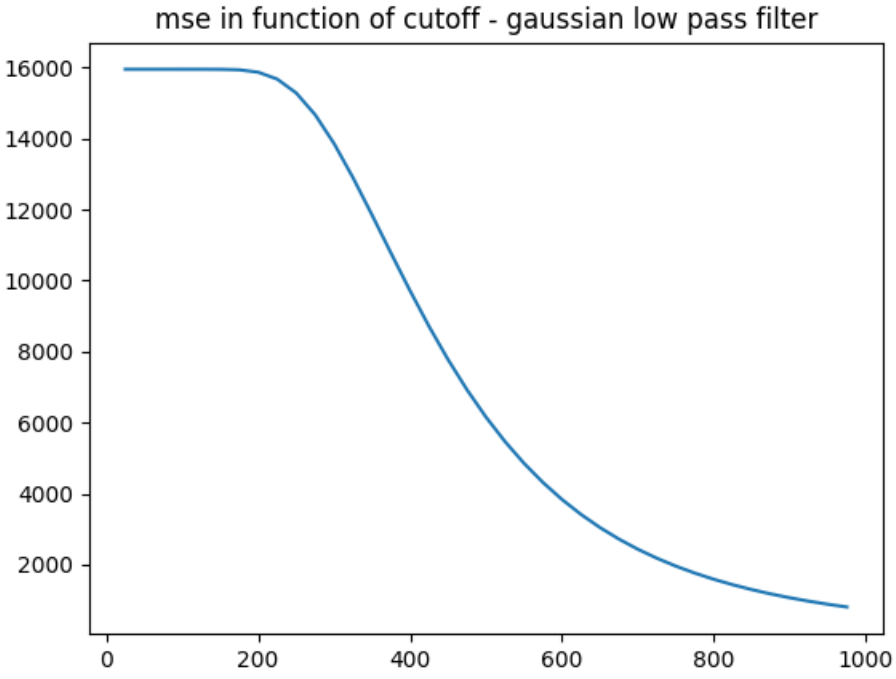




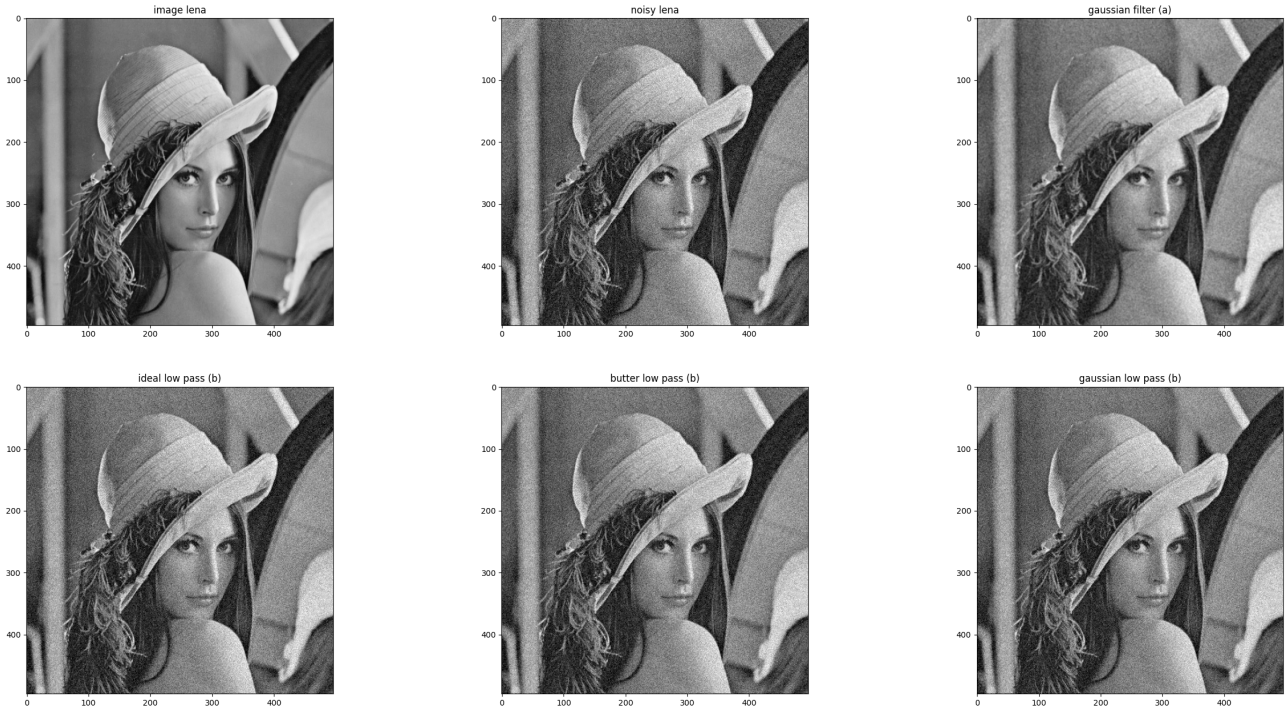
To find the best values, I brute forced it, and ploted the results for each filter:







As we can see the results of all three low pass filters only become good when the H matrix is mostly full of ones.



(c) As we can see from the mse results, these filters didn't do a good job at all.

```
MSE -> lena & lena noisy -> 15822.758827057569
MSE -> lena & lena gaussian (a) -> 15824.11295402213
MSE -> lena & ideal low pass (b) - cutoff = 700 -> 15910.862497483628
MSE -> lena & butter low pass (b) - cutoff = 1000 - n = 2 -> 15846.537275547367
MSE -> lena & gaussian low pass (b) - cutoff = 1000 -> 15849.604313967264
```

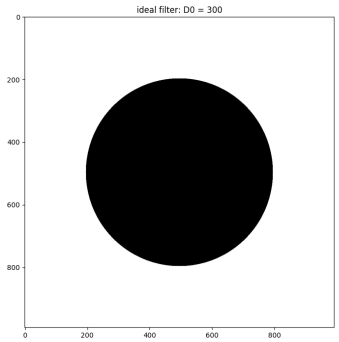
(d)

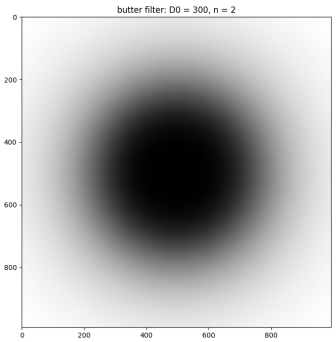
Exercise 2

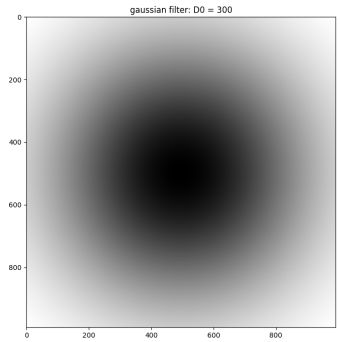
(pre a) First we have to create the lena with box filter: MSE(lena, lena box) = 173

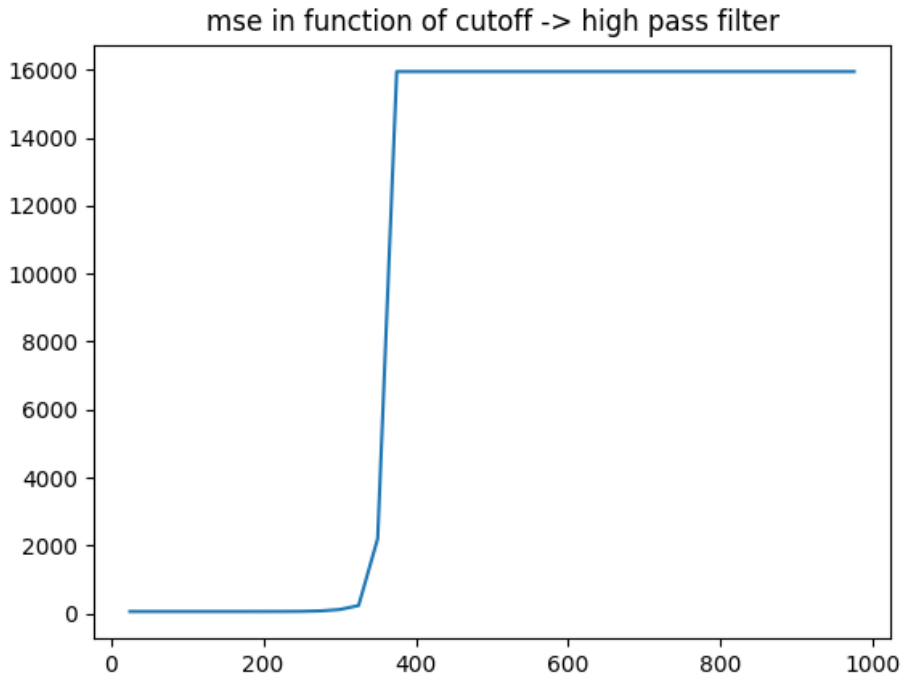
(a) We now apply a Gaussian filter in the time domain, like in the previous TP6, it results in a good mse: MSE(lena, lena gaussian filter) = 55

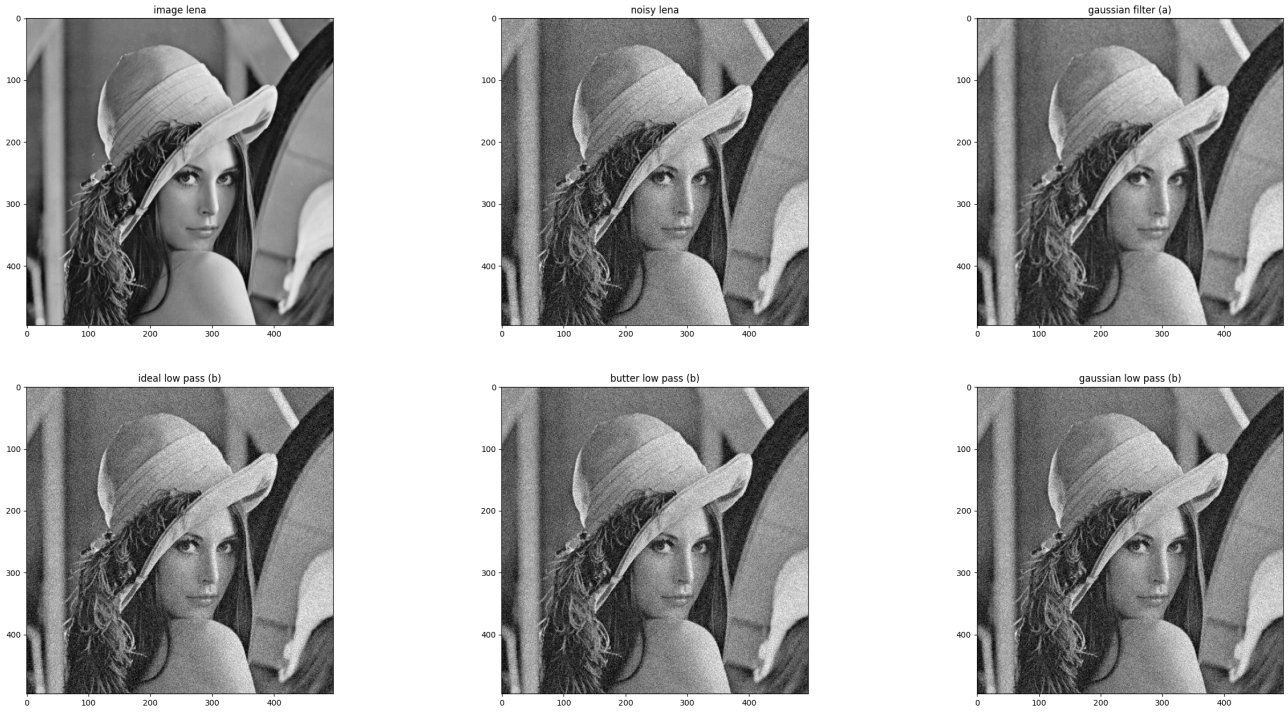
(b) I chose ideal high pass filter, it is a good filter for this problem, gaussian high pass filter would have worked as well. The bes mse looks to be at around cutoff = 200











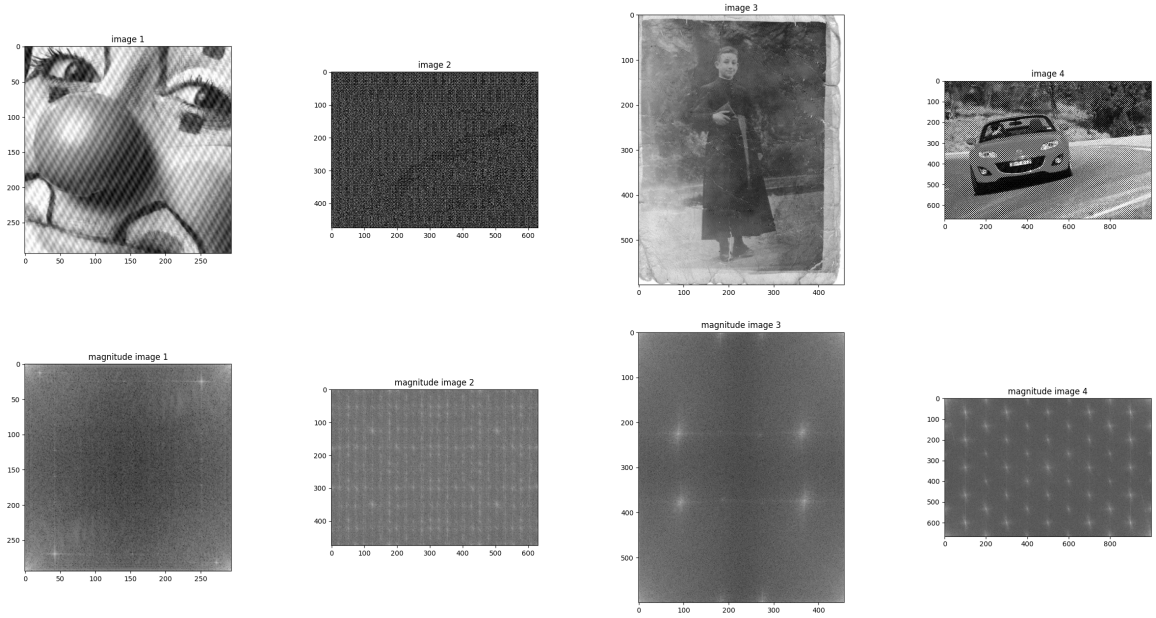
(c) As we can see from the mse results, unlike in exercice 1, we acutally got good results.

```
MSE -> lena & lena box filter -> 173.85126983610823
MSE -> lena & lena gaussian (a) -> 50.482484879032256
MSE -> lena & ideal high pass (b) - cutoff = 200 -> 50.6348272754163
```

(d)

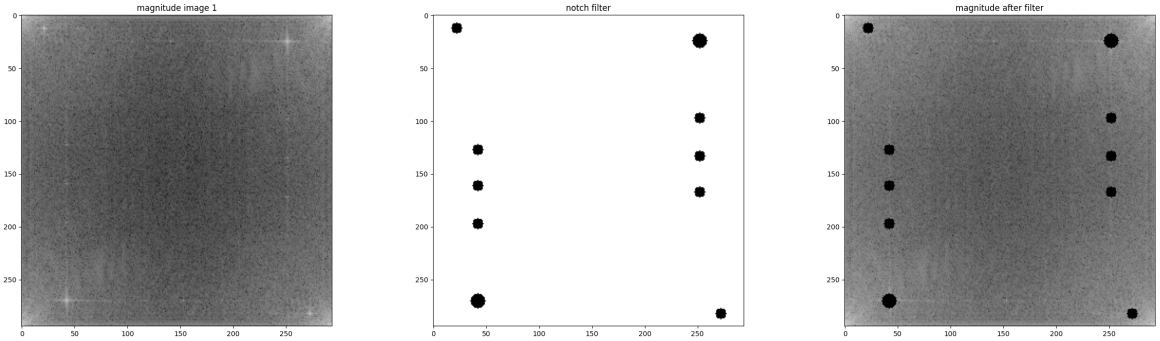
Exercise 3

First we can see the images and the respective magnitudes



For image 1, notch filter would be easy to apply, as there aren't that many bad spots, this can be done for image 3 as well. for image 4 notch looks like it could be good as well, but it is going to be much harder, as there are too many bad points.

image 1 We can see the differences between pre and post filter, notch cancelled out exactly where we want, and the resulting image is very nice quality.



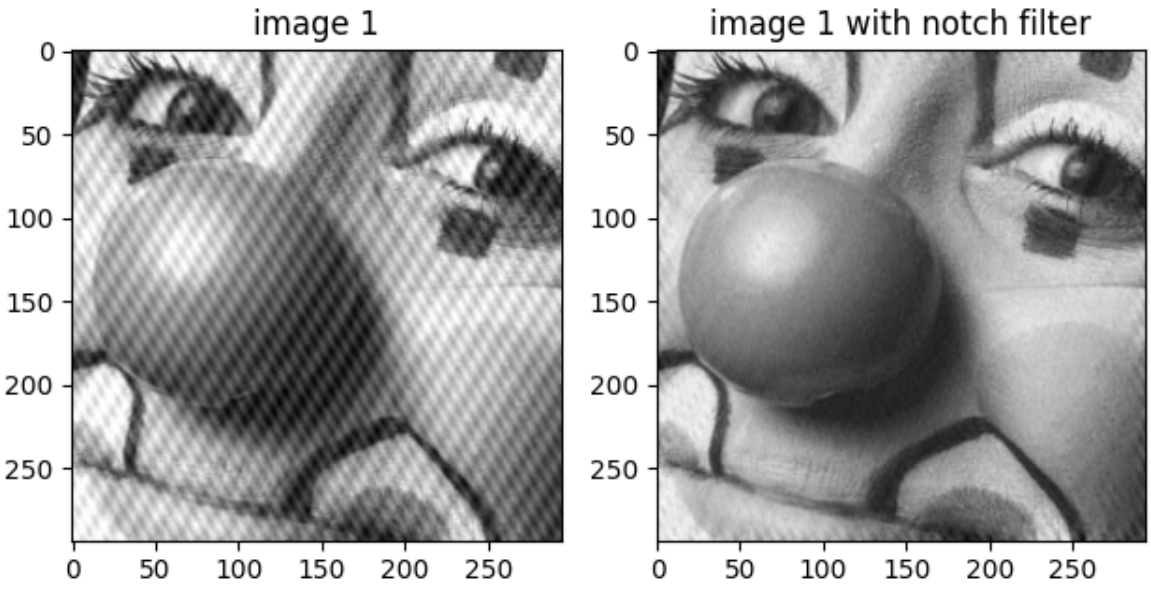
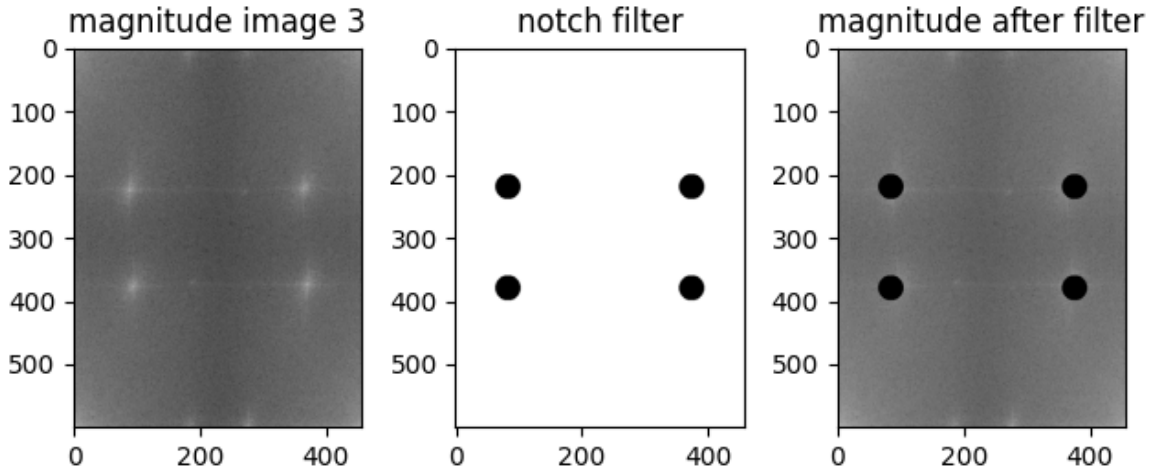
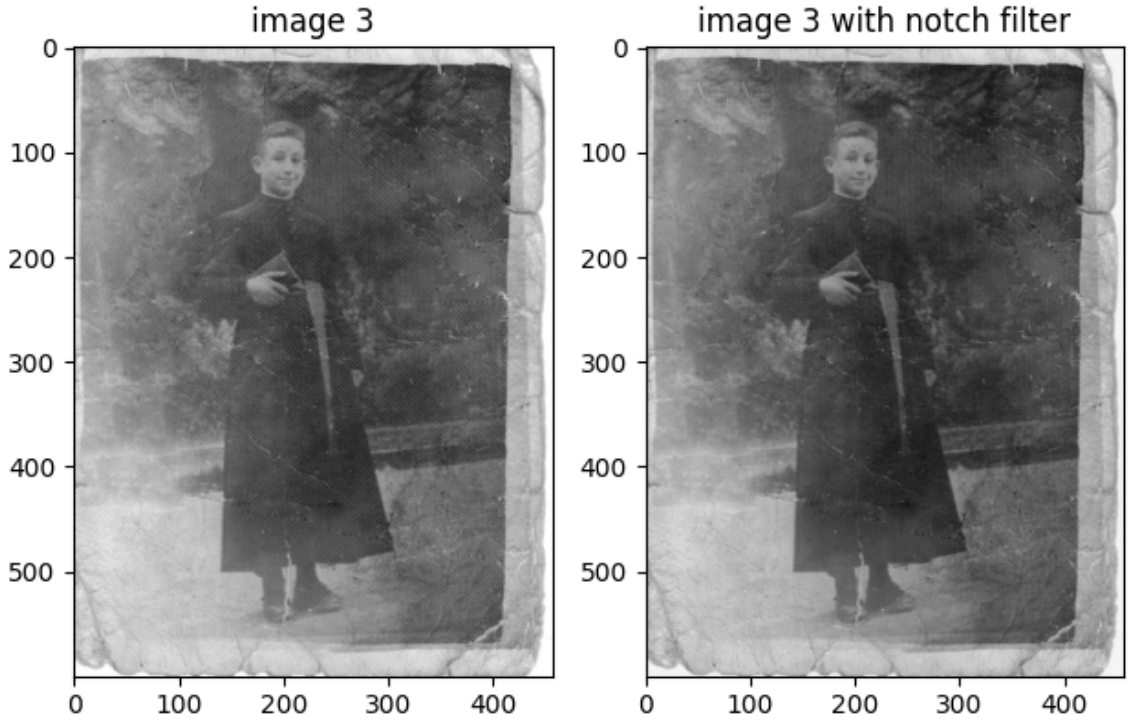


image 3 We can see the differences between pre and post filter, however, as the quality of the image is very bad, even if as we managed to clear the moire pattern, we couldnt make it a good image.

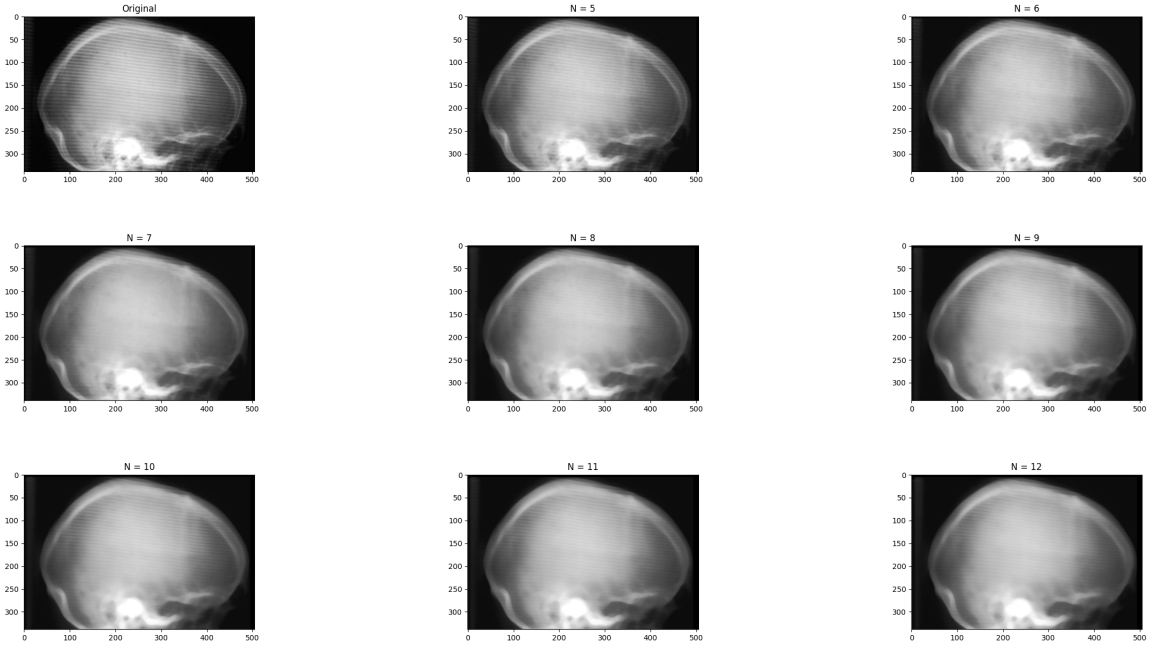




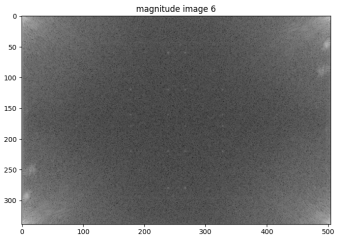
c For both images I used notch filter, and the parameters for image 1 were :
centers = [[123, -105, 7], [135, 125, 5], [14, -105, 5], [-20, -105, 5], [50, -105, 5]].
For image 3:
centers = [[80, 145, 20], [-80, 145, 20]]

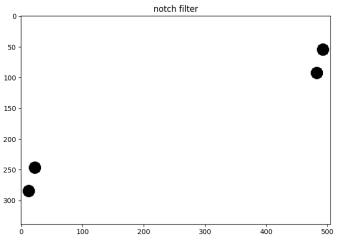
Exercise 4

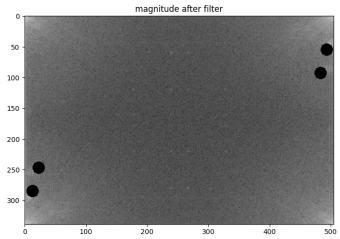
(a) I applied the median filter to the image 6, I got the best results with N = [8, 9, 10]. I used a padding of filling with 0, as the information wasn't near the extremities, it wasn't too important.

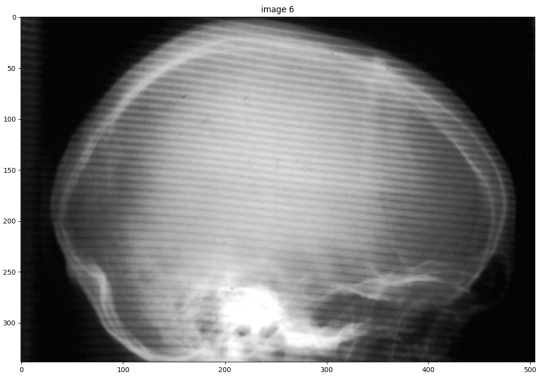


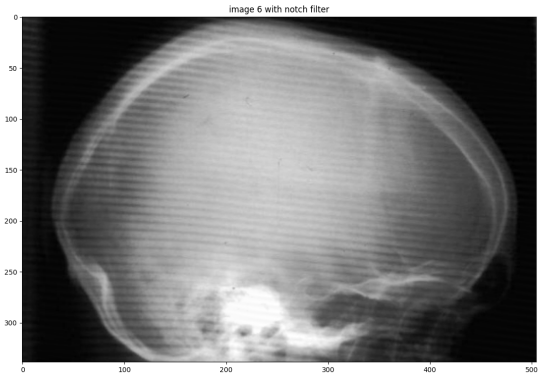
(b) for the Fourier Domain I chose a notch filter, as the magnitude was in the perfect use case.











(c) With the notch filter we couldn't clear everything, but the result was definitely good, as the noisy pattern was smoothed out a bit, and with the notch filter we don't have a blurry result as we did with median filter, as we can see in the image below: