Advanced Digital Image Process

HW#6

作業#6
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Development environment：

OS：unbuntu18.04

Editing tools：VScode

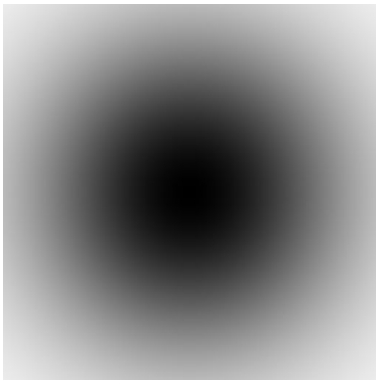
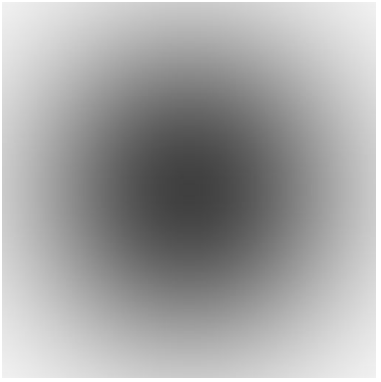
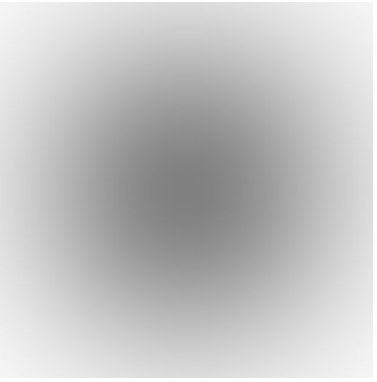
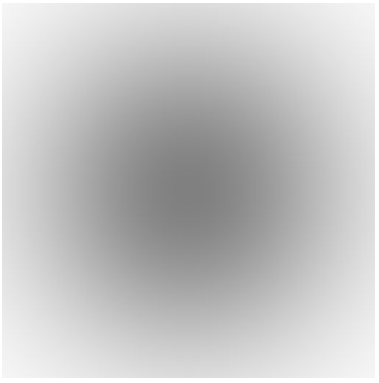
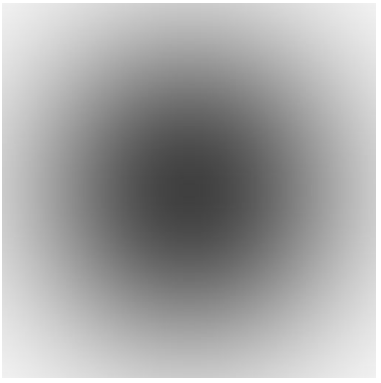
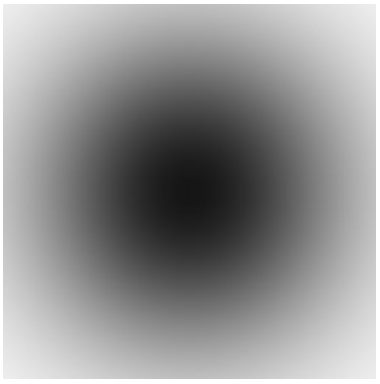
complilation tools：CMake

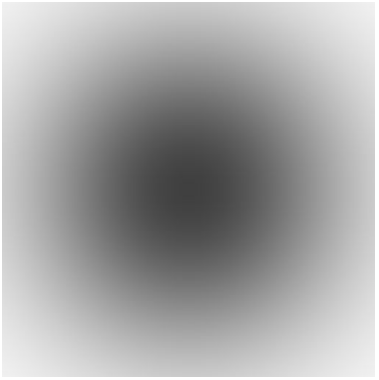
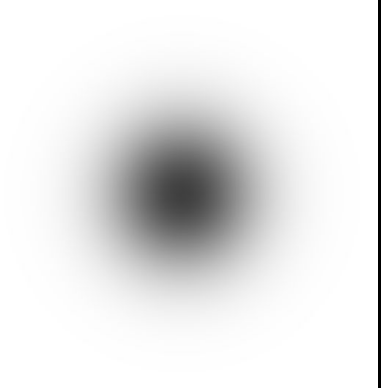
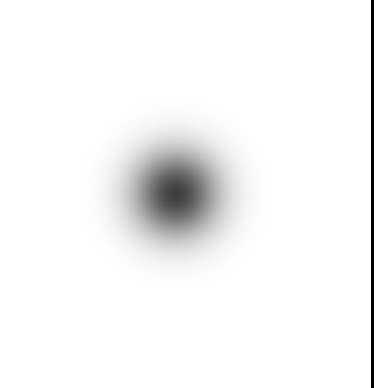
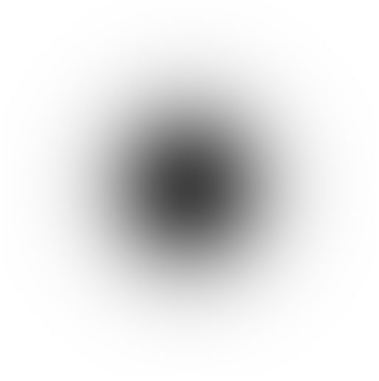
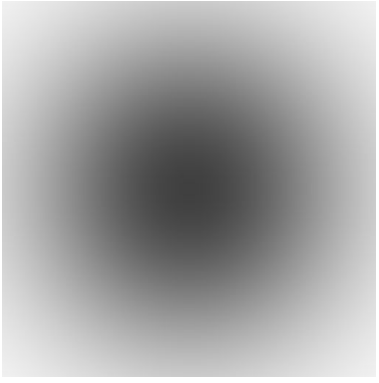
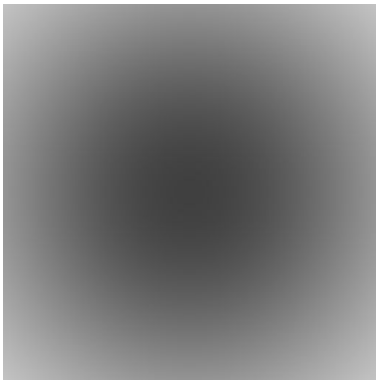
opencv version：3.2.0

1. Homomorphic filtering

Use homomorphic filtering to enhance the detail of house512.raw. Please use different parameters (rH,rL,D0...etc) to improve House512.raw. Compare and disc the effect using different values of parameters.

I choose a nice image and adjust the parameters increase or decrease. I'll show the filter shape and then compare each image.

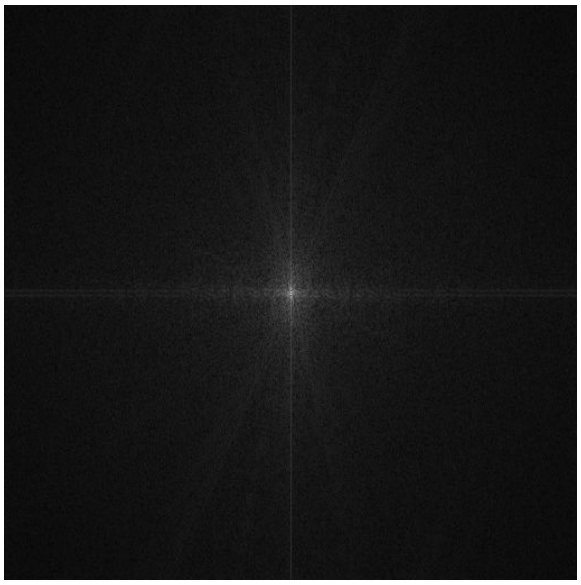
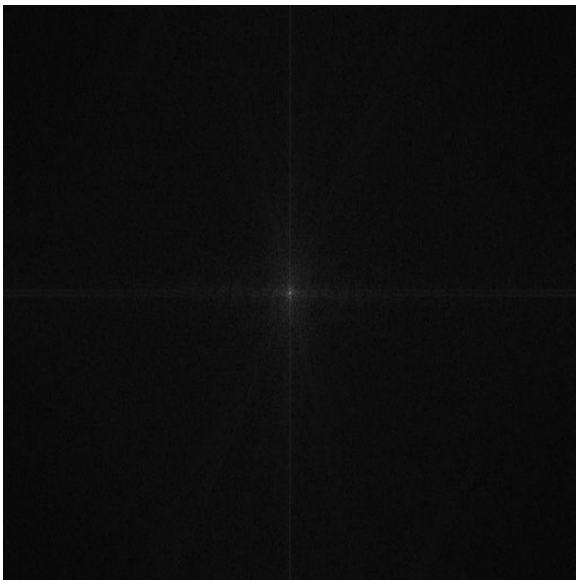
<table>
<tr><td colspan="3">rH=0.4,c=0.2, D_0 =100</td></tr>
<tr><td>rL=0.0</td><td>rL=0.1</td><td>rL=0.2</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td colspan="3">As we can see if we decrease the rL, the minima of the filter will be darker (more close to 0).So the center of F(u,v) * H(u,v) will come to 0(the DC or mean of the image). So we won't set rL to 0. If we increase the rL the value of DC will be bright.</td></tr>
<tr><td colspan="3">rL=0.1, c=0.2, D_0 =100</td></tr>
<tr><td>rH=0.2</td><td>rH=0.4</td><td>rH=1.2</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td colspan="3">If we decrease the rH, the gaussian will getting shorter and the difference of the low frequency and high frequency will not be amplified.If increase, the difference of high low frequency will be amplified.</td></tr>
</table>

<table>
<tr><td colspan="3">rL=0.1,rH=0.4 , D_0 =100</td></tr>
<tr><td>c=0.2</td><td>c=1.0</td><td>c=3.0</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td colspan="3">If we increase the c,the gaussian’s slope will be larger so gain of the high low frequency will be obvious.</td></tr>
<tr><td colspan="3">rL=0.1,rH=0.4,c=0.2</td></tr>
<tr><td>D_0 =50</td><td>D_0 =100</td><td>D_0 =150</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td colspan="3">Increase the D_0 we can increase the radius of the gaussian filter.</td></tr>
</table>

Summary:

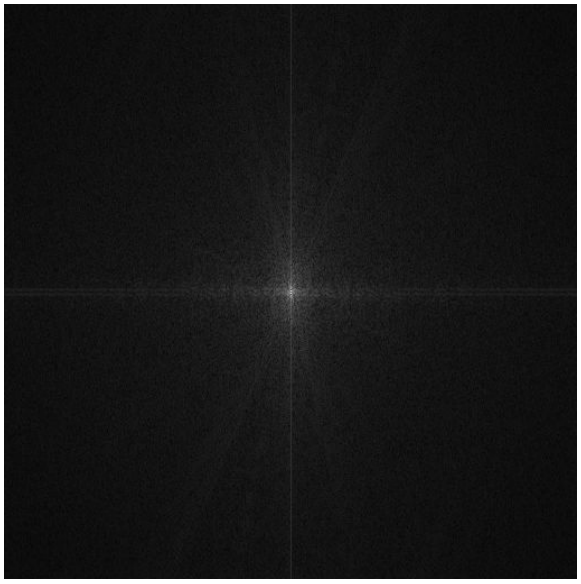
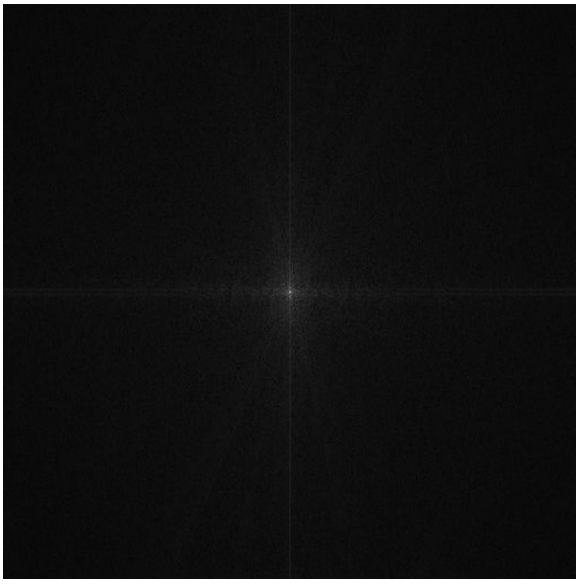
To decide using which parameters of the homomorphic filter. we need to know what you want to enhance from the image.rL can affect the brightness of the image. (rH -rL) affects the magnification of enhancement. c affect the high low frequency enhancement. D_0 affect the frequency you want to enhance or not.

This image result is the best image after I adjust the parameters of the homomorphic filter, but not sure is it the perfect result.

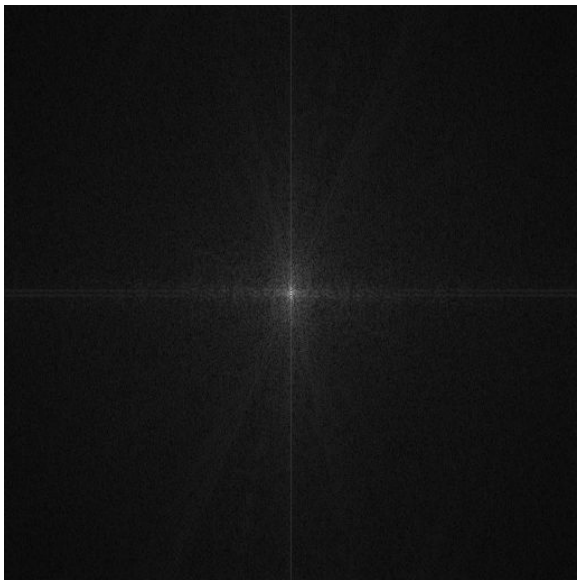
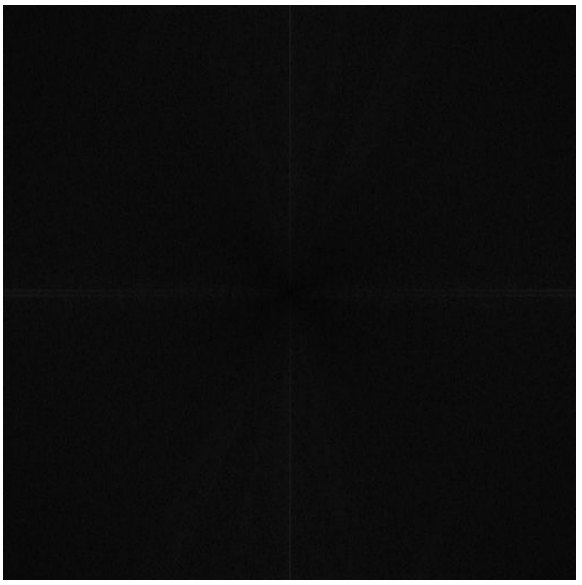
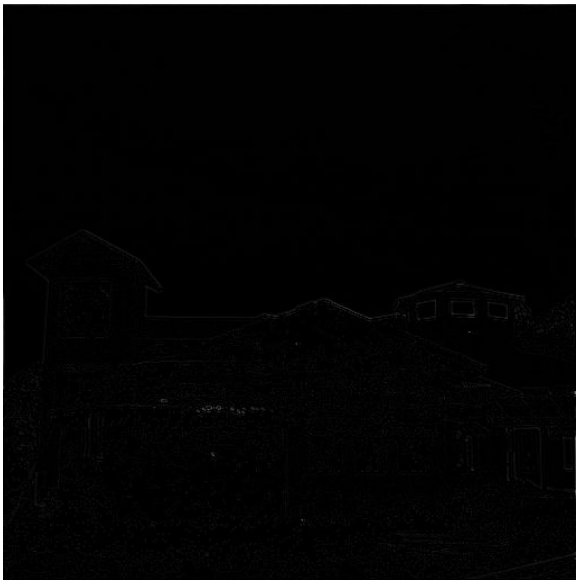
rL=0.1,rH=0.4,c=0.2, D_0 =100	
image after ln transfer's DFT	image after Homo filterr's DFT
	
origin image before ln trans	output image after exp trans
	

This image enhances the dark details, we can see the window, door and bushes, but the contrast at the cloud gets lower after a homomorphic filter. I don't know if the parameter didn't adjust to the perfect point, but the image enhances details pretty well.

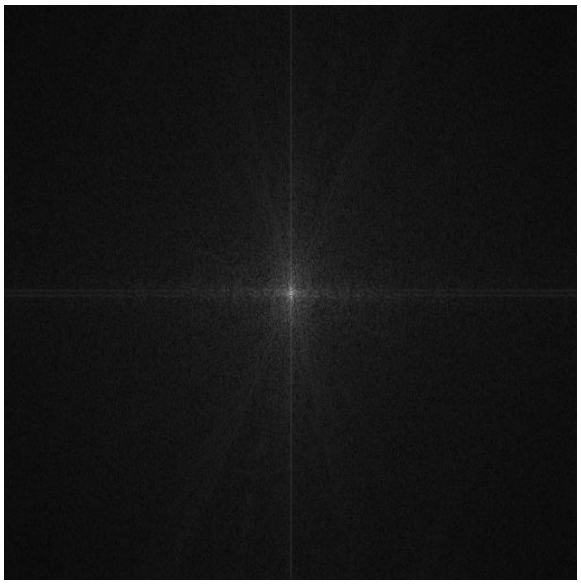
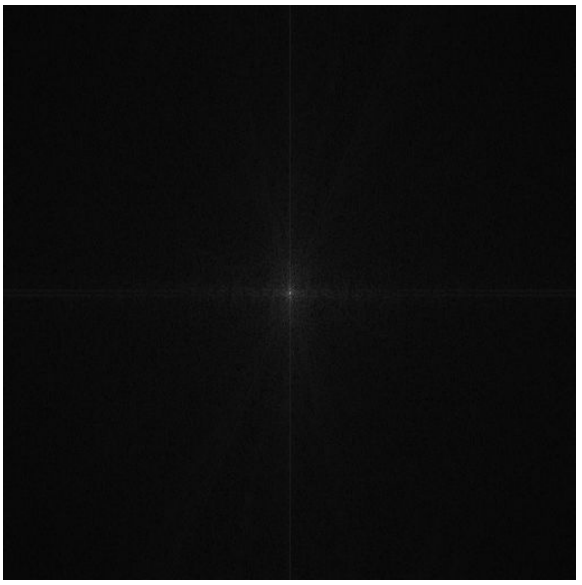
Let's see some more differences parameter result images do on homomorphic filters.

rL=0.2,rH=0.4,c=0.2, D_0 =100	
image after ln transfer's DFT	image after Homo filterr's DFT
	
origin image before ln trans	output image after exp trans
	

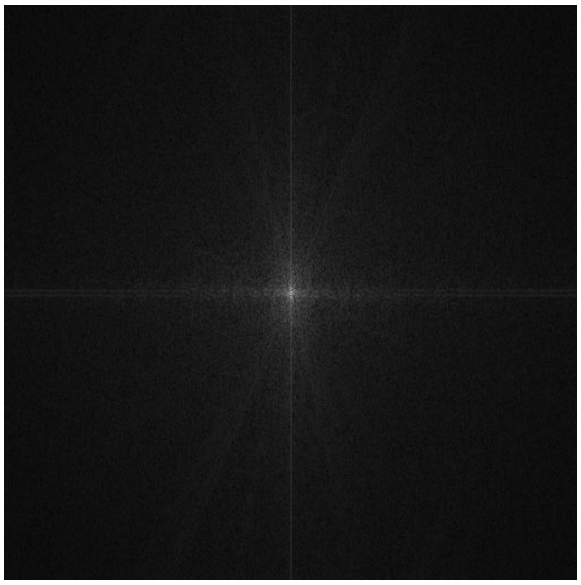
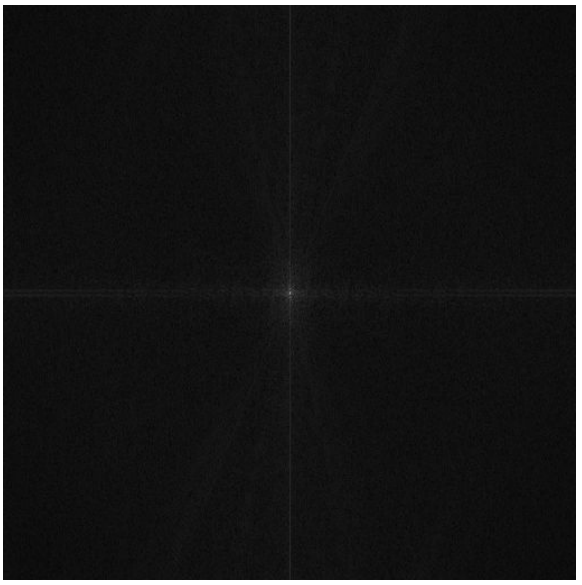
If we increase the rL the image will be brighter obviously.

rL=0.0,rH=0.4,c=0.2, D_0 =100	
image after ln transfer's DFT	image after Homo filterr's DFT
	
origin image before ln trans	output image after exp trans
	

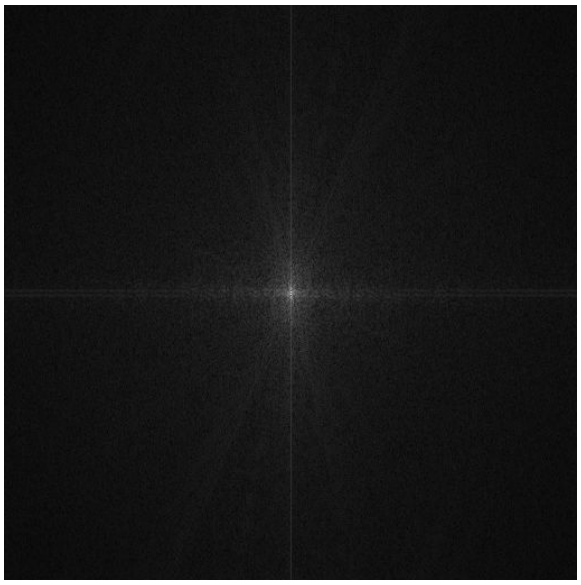
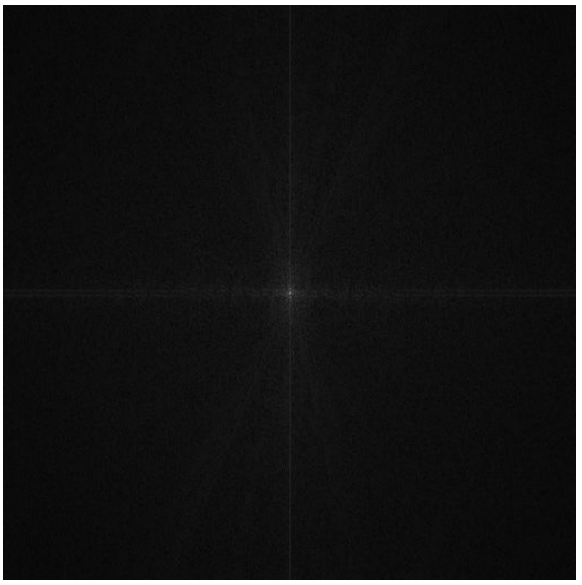
If we decrease rL the image will be dark because the center of DFT is the DC of the image. If rL =0 the DC will become 0 and the image will become black.

rL=0.1,rH=0.2,c=0.2, D_0 =100	
image after ln transfer's DFT	image after Homo filterr's DFT
	
origin image before ln trans	output image after exp trans
	

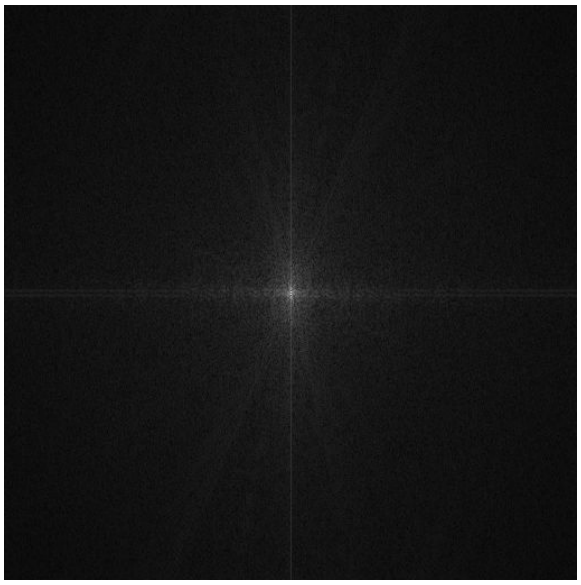
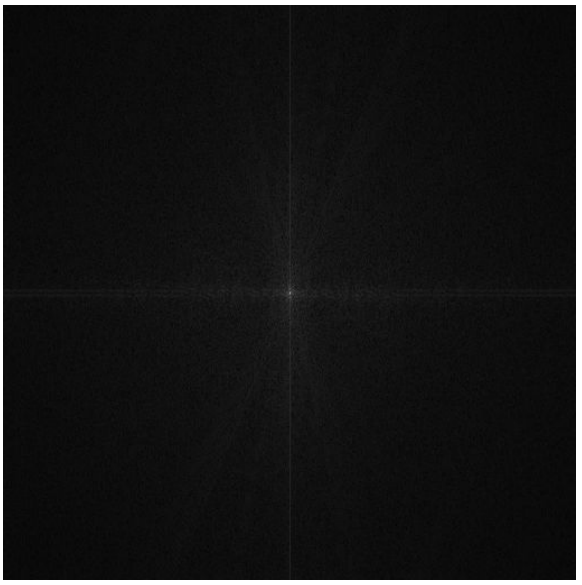
if we decrease the rH ,then rH-rL will be smaller. (rH-rL) means the range of your enhancement if it's too small the contrast will be small, look at the sky and compose with rH =0.4 then you can see the difference.

<table>
<tr><td colspan="2">rL=0.1,rH=1.2,c=0.2, D_0 =100</td></tr>
<tr><td>image after ln transfer’s DFT</td><td>image after Homo filterr’s DFT</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>origin image before ln trans</td><td>output image after exp trans</td></tr>
<tr><td>  </td><td>  </td></tr>
</table>

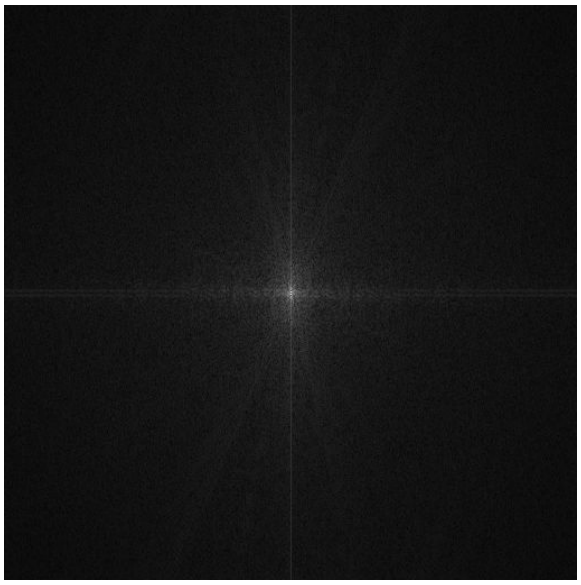
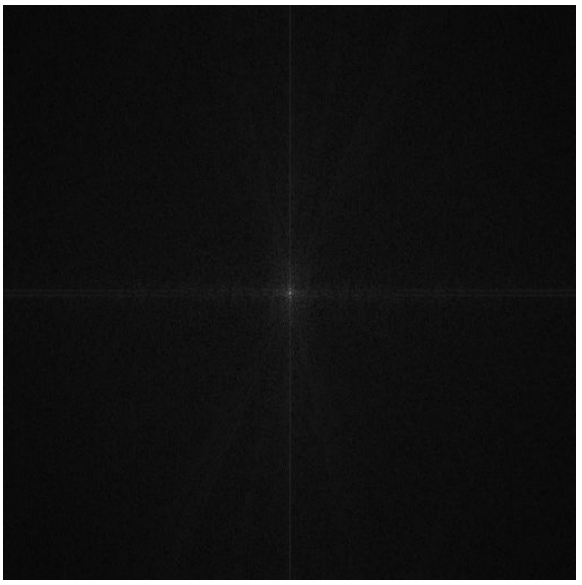
As we talk before increasing the rH let the high frequency’s noise contract be amplified.

rL=0.1,rH=0.4,c=1, D_0 =100	
image after ln transfer's DFT	image after Homo filterr's DFT
	
origin image before ln trans	output image after exp trans
	

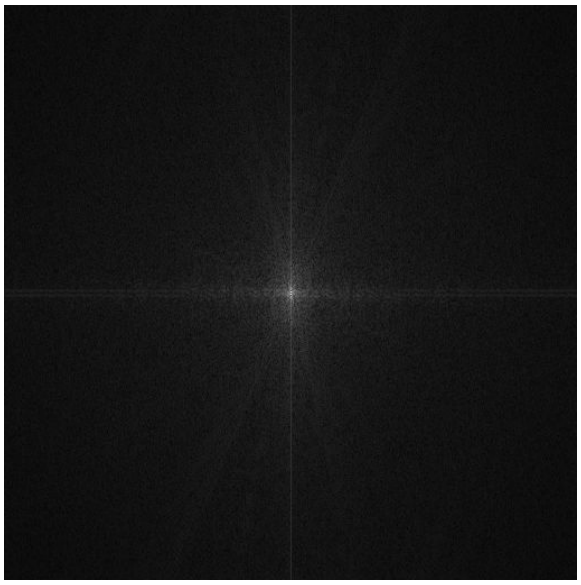
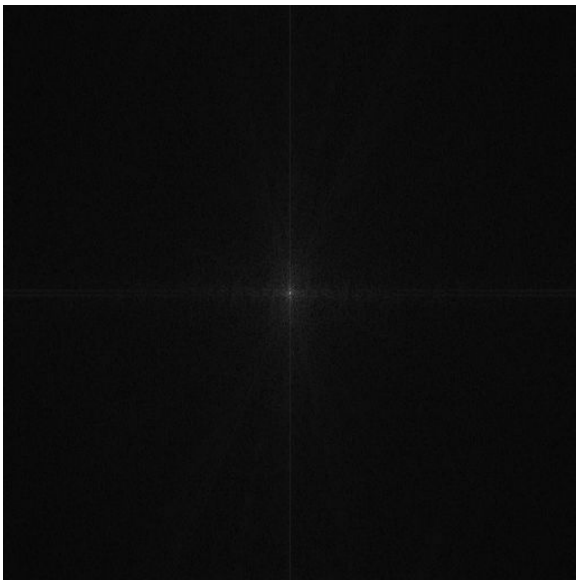
c will decide the slope of the filter, what effect you want at the edge, if you want more sharpness, increase the c. If not, decrease the c.

rL=0.1,rH=0.4,c=3, D_0 =100	
image after ln transfer's DFT	image after Homo filterr's DFT
	
origin image before ln trans	output image after exp trans
	

As we can see when we increase the c, the image's edge get more enhance.

rL=0.1,rH=0.4,c=0.2, D_0 =50	
image after ln transfer's DFT	image after Homo filterr's DFT
	
origin image before ln trans	output image after exp trans
	

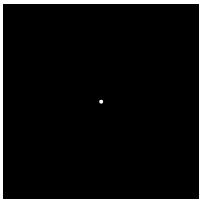
D_0 decide the high low frequency we want to enhance or inhibit if D_0 is low, then we enhance a lot of high frequency and inhibit less low frequency.

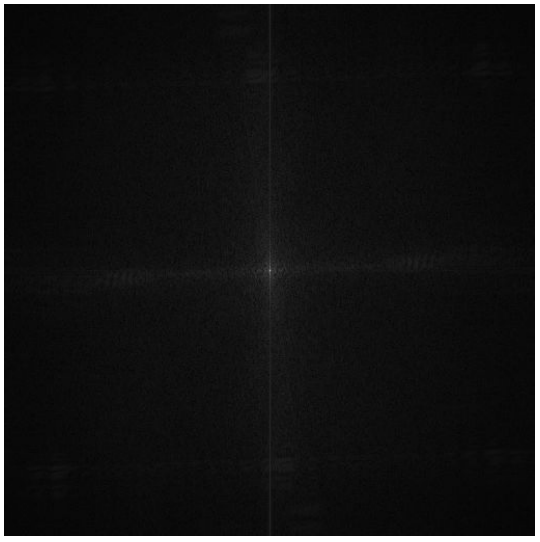
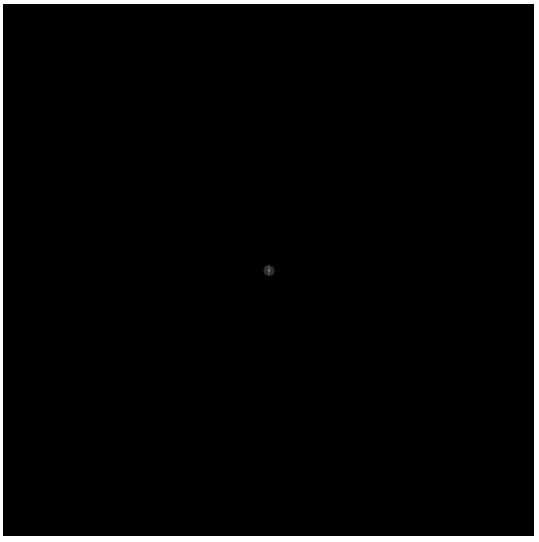
rL=0.1,rH=0.4,c=0.2, D_0 =150	
image after ln transfer's DFT	image after Homo filterr's DFT
	
origin image before ln trans	output image after exp trans
	

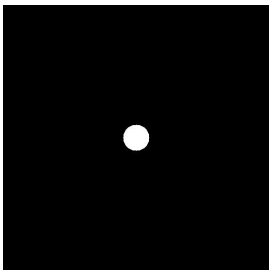
D_0 decide the high low frequency we want to enhance or inhibit if D_0 is high, then we enhance less of high frequency and inhibit more low frequency.

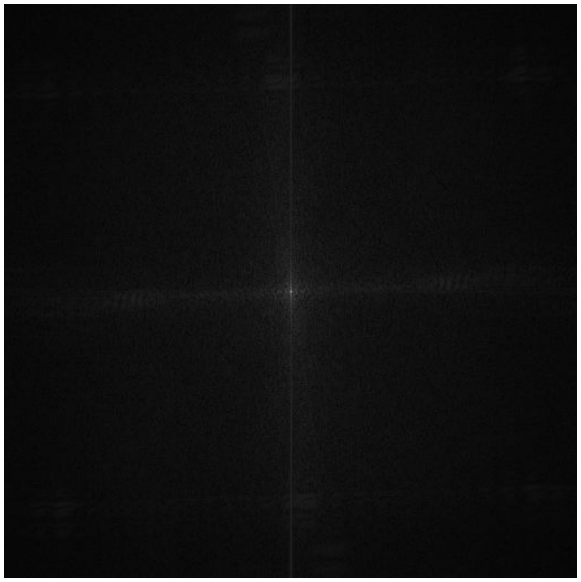
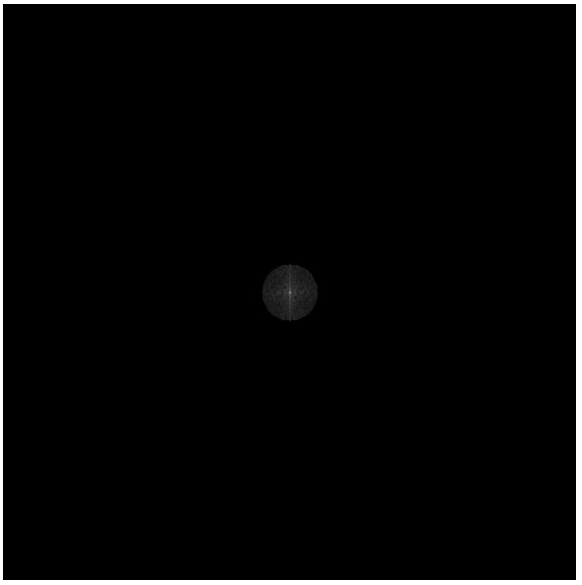
2.Filter in Frequency domain

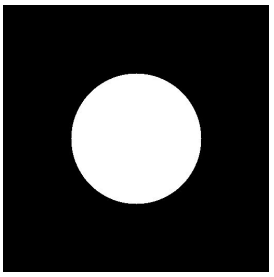
(a) Using ideal LPF with $D_0 = 5,\ 25,\ 125$ respectively to filter aerialcity512.raw in frequency domain. Show the filtered output images and their magnitude spectrum. Discuss and compare the visual differences between each output image. Calculate the MSE and PSNR value with the origin image.

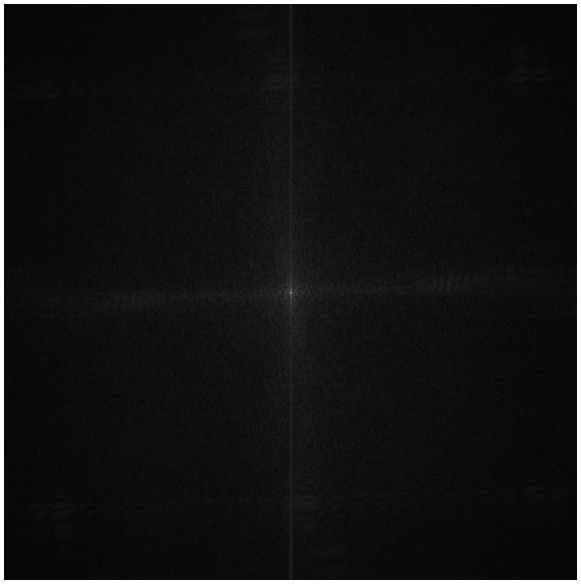
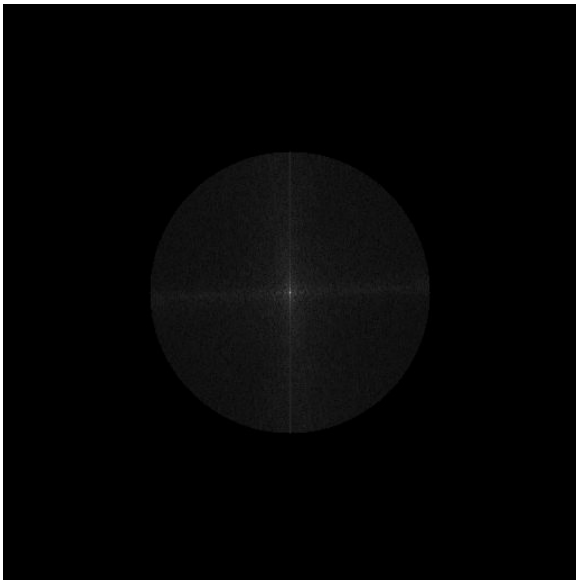
filter	

D_0 =5	
origin DFT	after filter DFT
	
origin image	after filter image
	

filter	

D_0 =25	
origin DFT	after filter DFT
	
origin image	after filter image
	

filter	

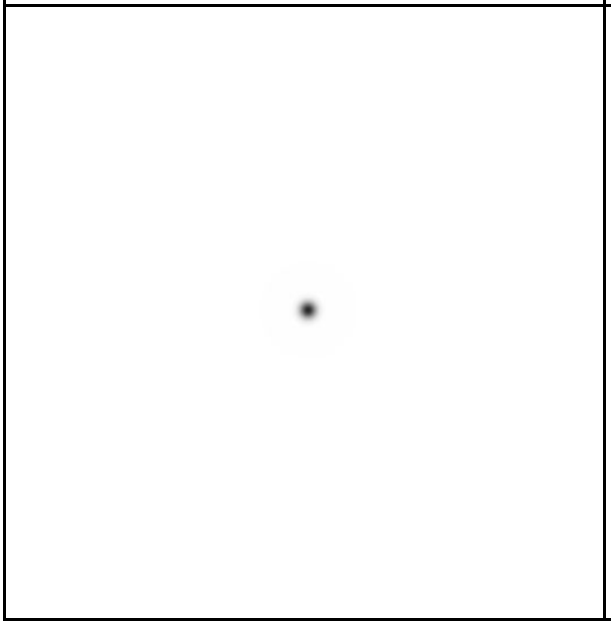
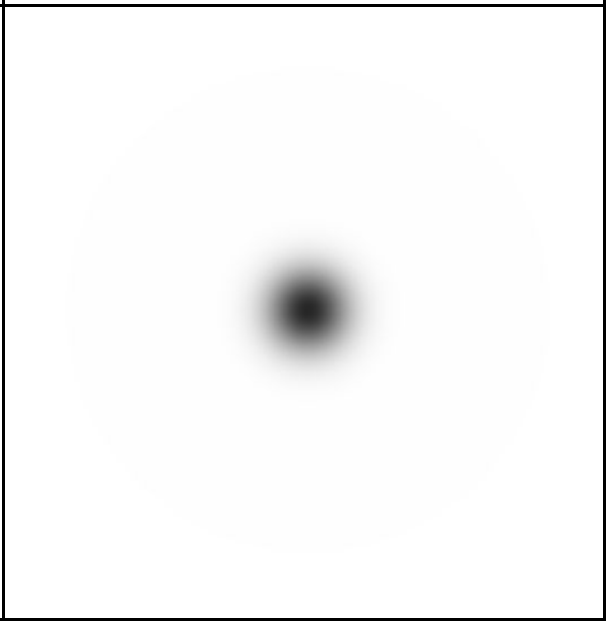
D_0 =5	
origin DFT	after filter DFT
	
origin image	after filter image
	

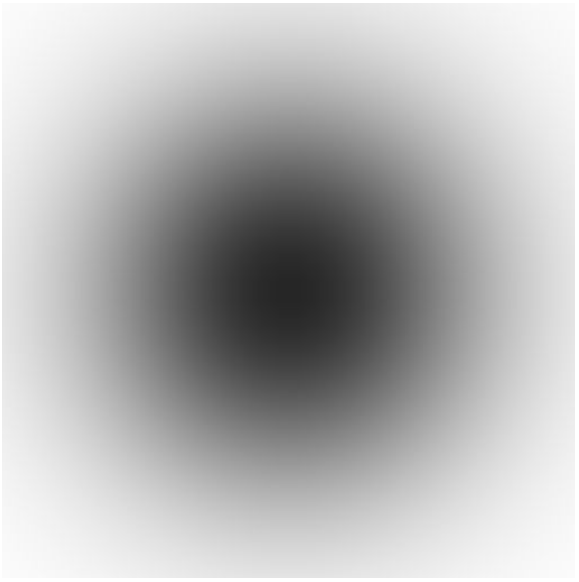
An ideal filter will kill all the out of range frequency. So if the filter goes larger, the image will be more similar to the original image. A square wave after DFT or IDFT will become a sinc wave so when we use an ideal filter we can see the wave in the image.

ILPF,d0=5, MSE=1127.493710, PSNR=17.609663
ILPF,d0=25, MSE=549.516846, PSNR=20.730994
ILPF,d0=125, MSE=173.286407, PSNR=25.743159

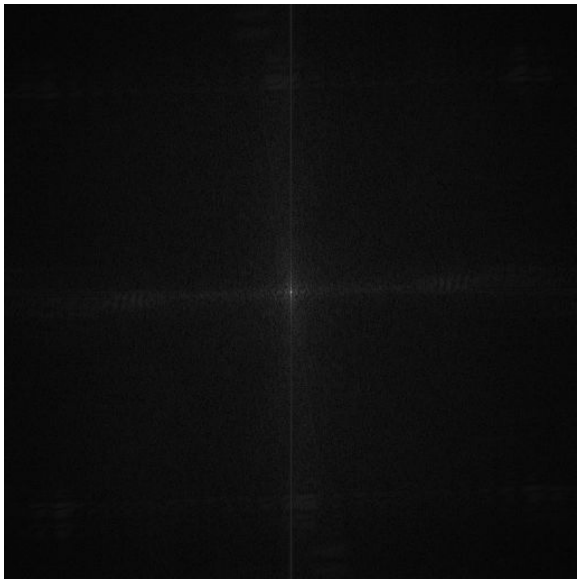
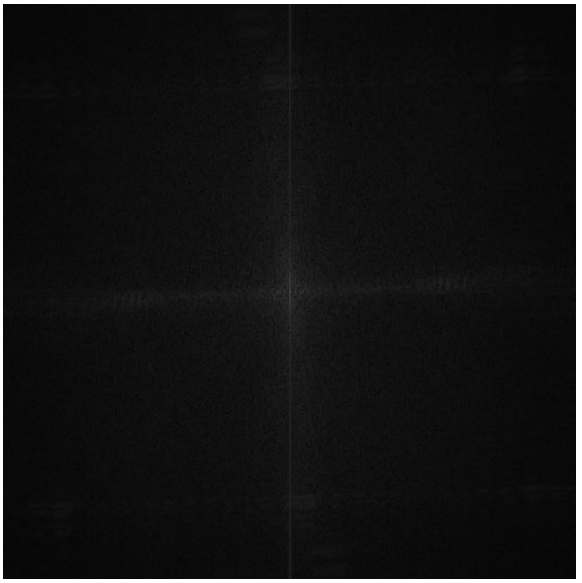
In a low pass filter if we let more frequency pass, we will get a similar image so the MSE and PSNR will be better.

(b) Using Gaussian HPF with $D_0 = 5,\ 25,\ 125$ respectively to filter aerialcity512.raw in frequency domain.Show the filtered output images and their magnitude spectrum. Discuss and compare the visual differences between each result image. Calculate the MSE and PSNR value with the origin image.

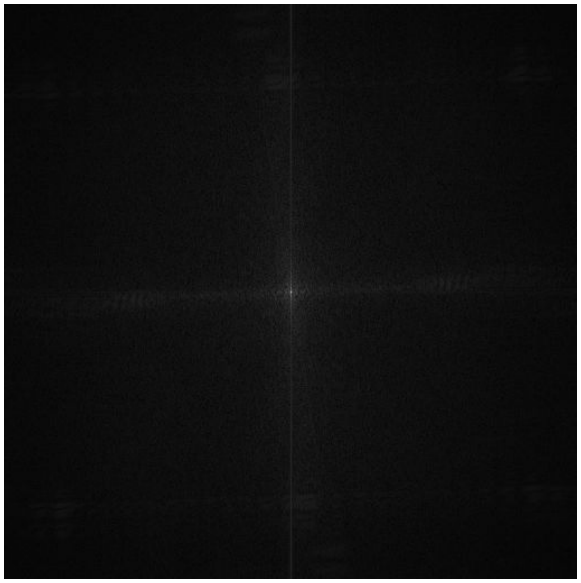
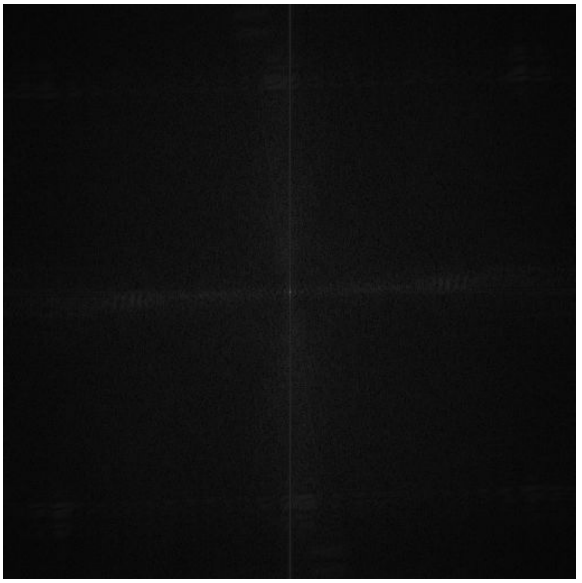
D_0 =5	D_0 =25
	

D_0 =125	
	

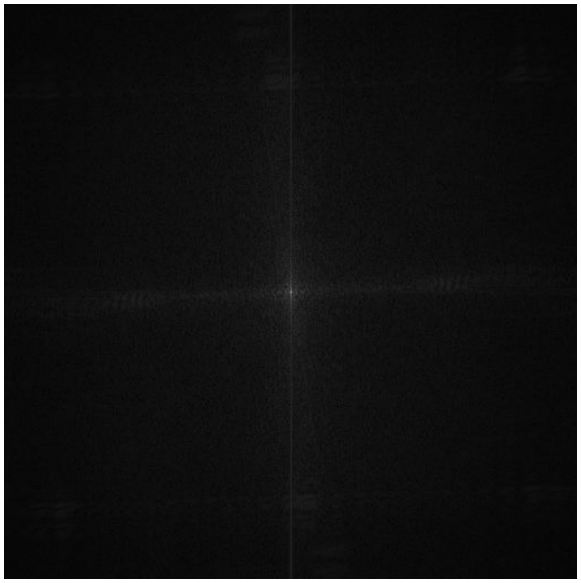
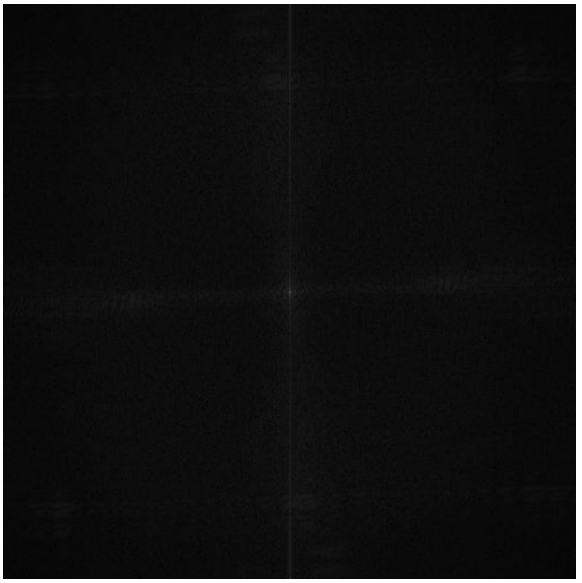
As we can see D_0 can decide the radius of the filter. The center of the filter is the DC of image, so we will inhibit the DC after the gaussian HPF , but we can't let the DC=0 so we will * a constant at the filter.

D_0 =5	
origin DFT	after filter DFT
	
origin image	after filter image
	

As we can see after filter DFT, the center of the image is inhibit so the DC of image drops obviously.

D_0 =25	
origin DFT	after filter DFT
	
origin image	after filter image
	

D_0 increase so the low frequency is lesser.

D_0 =5	
origin DFT	after filter DFT
	
origin image	after filter image
	

D_0 is too big so the low frequency is almost no more. only left the high frequency details.

To these results we use the constant 0.85 to not let the DC=0.

s

```
GHPF,d0=5, MSE=6749.636864, PSNR=9.838000
```

```
GHPF,d0=25, MSE=7599.122967, PSNR=9.323169
```

```
GHPF,d0=125, MSE=8154.797146, PSNR=9.016672
```

A high pass filter will kill the low frequency data, so the DC will change, If DC change MSE and PSNR will be worse a lot.

Result Image : LINK